Directive 089

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Geothermal Resource Development

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1 Introduction

1.1 Purpose of This Directive

This directive sets out the Alberta Energy Regulator (AER) requirements for geothermal resource development below the **base of groundwater protection**. The requirements apply to the entire life cycle of a geothermal development: initiation, construction, operation, and closure. Contact Alberta Environment and Protected Areas (AEPA) for requirements for geothermal development at or above the base of groundwater protection.

As defined in the *Geothermal Resource Development Act* (*GRDA*), a geothermal resource is "the heat from the earth that is below the base of groundwater protection." Geothermal resources can be used for commercial purposes (i.e., sold to others) or noncommercial purposes (i.e., used by the producer for their own operations). Wells, facilities, and pipelines used for geothermal resource development must meet the requirements under this directive. In accordance with the *Geothermal Resource Development Regulation*, a facility associated with a geothermal resource licensed under a separate resource enactment and developed for noncommercial use is exempt from regulation under the *GRDA*. Contact the AER for more information.

This directive is made under the *GRDA* and forms part of the *Geothermal Resource Development Rules* (*GRDR*).

Many of the AER's requirements for oil and gas development apply to geothermal resource development. Consequently, this directive refers to other AER directives with applicable requirements.

In this directive, defined terms are set in **boldface** at first use, and the definitions are provided in appendix 1.

1.2 AER Requirements

In this directive, the term "must" indicates a requirement, while terms such as "should," "recommends," and "expects" indicate a recommended practice.

If a requirement applies at both the application stage and later in a development's life cycle, the requirement may refer to both the applicant and the licensee.

Each AER requirement is numbered in this directive.

Information on compliance and enforcement can be found on the AER website.

1.3 What's New in This Edition

The following changes were made to the directive:

- Revised section 2.2 to reflect how to submit application information using the designated information submission system and how to request information as confidential.
- Revised section 3.4.6 to reflect the sequence for well conversions to a geothermal well licence.
- Revised the category types for geothermal wells in section 4.2. Tables 3 and 4 were deleted as they are no longer valid.
- Added a reference to *Manual 028: Buried Geothermal Heat Distribution Pipelines* in section 5.3 and revised the AER contact information.

As part of the continued implementation of the *Liability Management Framework* policy, references and requirements for the liability management rating (LMR) and licensee liability rating (LLR) programs have been removed, and references to the various liability directives have been updated.

2 Geothermal Resource Development – General Requirements

Depending on the type of geothermal development, applicants will need the following licences:

- well licence under the *GRDA*
- facility licence for a **commercial development** under the *GRDA*
- pipeline licence under the *Pipeline Act*

Additional authorizations may be required under the following acts:

- *Environmental Protection and Enhancement Act* (*EPEA*)
- *Public Lands Act*
- *Water Act*

The applicant is responsible for determining what licences and authorizations are needed for their geothermal development and applying for them.

Applicants and licensees are responsible for managing the risks to public safety and the environment throughout the geothermal development life cycle.

1) The licensee of a well, facility, or pipeline for geothermal resource development must

   a) have all required authorizations in place and have satisfied operational requirements before starting operations,

b) understand the capabilities and limitations of the geothermal technology selected to develop the geothermal resource,

c) communicate the capabilities and limitations of the proposed geothermal technology to the AER,

d) upgrade equipment and operating practices as necessary to comply with changes in regulatory requirements, and

e) ensure risks to public safety or the environment are reduced to acceptable levels.

Risks cannot always be completely eliminated, but they may be considered as acceptable when they are reduced to a level that is "as low as reasonably possible," meaning they may be tolerable only if it can be demonstrated that all reasonable and practicable measures have been taken commensurate with the level of assessed risk.

2.1 Documentation

2) Unless otherwise specified, the applicant or licensee must keep all documentation required under this directive, including documentation of surface and subsurface rights, for the life cycle of the development.

3) If requested by the AER, the applicant or licensee must provide all documentation required under this directive.

2.2 Application Submission

All applicants are responsible for understanding and complying with legislative and regulatory requirements. When an applicant files a licence application, it declares that it understands and will follow the relevant requirements in this directive and the AEPA's *Conservation and Reclamation Directive for Renewable Energy Operations*.

In accordance with section 7 of the *GRDA*, applicants must not start site preparation, construction, or operation before receiving approval from the AER. This restriction includes the following activities:

- stripping topsoil
- removing vegetation
- constructing access roads
- stringing, bending, or welding pipe
- installing equipment

Surveying the site is permitted.

4) Applicants must submit applications via the designated information submission system indicated in *Manual 012: Energy Development Applications*.

5) Applicants must provide specific supplementary information required for a geothermal well licence application as an additional attachment as described in section 7.8.6 of *Manual 012* and filed in the appropriately labelled upload box during application submission. A miscellaneous upload box is also available to accept additional supporting information.

   For geothermal facility applications, applicants may file additional information as a miscellaneous document during submission.

Information that needs to be submitted by email is indicated throughout this directive.

Under section 49 of the *Alberta Energy Regulator Rules of Practice*, all documents filed relating to an application are on the public record unless confidentiality is requested before the documents are submitted. Several additional submissions are required for a complete geothermal well licence application. These are received and uploaded in the designated information submission system, and the AER may accept them as confidential. To receive confidential status for the submission, submit a written request setting out the details outlined in section 49(3) of the rules of practice and upload it using the miscellaneous upload box. The AER will review the request for confidentiality concurrently with the application filing and decide on the confidentiality request in accordance with section 49(4) of the rules of practice.

All geothermal development applications will be publicly available on the AER website for at least 30 days.

2.3 Rights and Consents

The *Surface Rights Act* does not apply to geothermal resource development in Alberta.

6) The applicant must obtain written consent (a lease) granting surface access from the landowner on whose property the geothermal development will be situated and from all landowners whose properties the applicant will have to cross to access the geothermal development regardless of whether access roads are needed.

7) If the application involves public lands, the applicant must obtain consents from occupants in accordance with section 9(1)(e) of the *Public Lands Administration Regulation*.

8) Before applying for a geothermal licence on public land, the applicant must have already applied for a public land disposition or hold a public land disposition.

For standalone geothermal wells, the applicant must have a geothermal resource tenure lease from the Government of Alberta or documented authorization obtained from the freehold mineral

owners. If the applicant wants to conduct geothermal exploration or development activities under an existing mineral tenure lease, it must be done as co-production.

9) An applicant must have the subsurface rights to develop the geothermal resource before applying for a geothermal well licence.

2.4 Eligibility to Apply for a Licence

10) Before applying for a licence, the applicant must

    a) obtain a **business associate (BA) code** from Petrinex and

    b) obtain licensee eligibility in accordance with *Directive 067: Eligibility Requirements for Acquiring and Holding Energy Licences and Approvals*.

2.5 Participant Involvement

11) An applicant must meet the participant involvement requirements in section 3 of *Directive 056: Energy Development Applications and Schedules* and follow the process set out in section 2 of *Manual 012* except for section 3.3.4.1 of *Directive 056* and section 2.3 of *Manual 012*. (Those sections do not apply because geothermal development is not covered by the *Surface Rights Act*.)

The consultation and notification requirements depend on the type of well, facility, or pipeline and are set out in the following tables in *Directive 056*:

- For geothermal wells, see table 5. Category type is based on the hydrogen sulphide (H_2S) content, H_2S release rate, and proximity to the public. All categories in table 5 are available for geothermal wells.
- For facilities, see table 1. Category type is based on the H_2S and sulphur content of the inlet gas stream. However, all geothermal facilities use category type B091, which is based on the H_2S and sulphur content of the inlet gas stream being <0.01 mol/kmol H_2S. If the inlet gas stream for the applied-for geothermal facility is >0.01 mol/kmol, applicants use the actual H_2S and sulphur content of the inlet gas stream to determine the parties requiring personal consultation and confirmation of non-objection, and to provide notifications to. The actual H_2S data is used to identify the category and disclose it in the consultation material. See section 5.6.9 and table 6 of *Directive 056* for requirements related to surface setbacks in planning its facility using the actual data. See section 4.2 of this directive on submitting the actual values for facility design values when filing a geothermal facility application.
- For pipelines, see table 3. Category type is based on pipe diameter and H_2S content of the transported product. All categories in table 3 are available for pipelines transporting geothermal products.

12) In addition to the consultation and notification requirements in *Directive 056*, the applicant must include the following information in a project update notification to the parties listed in tables 1, 3, and 5 of *Directive 056*:

    a) the area of the proposed geothermal resource development project

    b) the capacity of the proposed geothermal resource development project

    c) a description of the project-related activities

    d) a map showing the location of the project, including all current and proposed wells, facilities, and pipelines

    e) the proposed schedule for submitting regulatory applications for any new and converted wells, facilities, and pipelines

13) Once a geothermal well, facility, or pipeline licence has been issued, the licensee must provide a project update notification every five years to the parties listed in tables 1, 3, and 5 of *Directive 056*.

14) These notifications must include the following:

    a) licensee name and contact information

    b) a map showing the location of the project, including all current and proposed wells, facilities, and pipelines

    c) a summary of what regulatory applications have been filed with the AER

    d) for project areas still under development, an updated schedule for submitting regulatory applications for any additional wells, facilities, and pipelines

2.6 Emergency Preparedness and Response

15) The applicant or licensee must meet the requirements in *Directive 071: Emergency Preparedness and Response*, including developing and maintaining the appropriate emergency response plan (operation specific or corporate) for the licensee's geothermal operations.

2.7 Release Reporting

16) The licensee must immediately report any release of operating fluid, oilfield waste, water, or hydrocarbons referred to in sections 50(2) and 51 of the *GRDR* to the AER through the Energy and Environmental Emergency 24-Hour Response Line (1-800-222-6514).

2.8 Working Interest Participants

17) To apply for, hold, or transfer a well or facility licence, an applicant must be a working interest participant.

18) The applicant must provide the following current information about the working interest participants:

    a) full legal name of each working interest participant, which cannot be a partnership

    b) contact information for each working interest participant, including an email address and telephone number

    c) the percentages of working interest (totalling 100%) for every well and facility included in the application

19) For geothermal well applications, the information on working interest participants described in requirements 18(a) and (c) are captured in OneStop within the well licence application. Provide the information for requirement 18(b) via an upload to the appropriate "Additional Attachment" box in the well licence application. For geothermal facility applications, the submission for requirements 18(a) and (c) occurs using Schedule 2.1, whereas 18(b) is to be provided in a miscellaneous attachment to a geothermal facility licence application.

20) Licensees must inform the AER of any change to the working interest participant information within 30 days of the change occurring.

2.9 Holistic Licensee Assessment

The AER will comprehensively assess the licensee throughout the geothermal life cycle, and the results will inform regulatory decisions regarding the licensee. This assessment uses a multifactor approach to assess the capabilities of licensees to meet their regulatory and liability obligations. This multifactor approach includes the factors outlined below and the factors listed in section 4.5 of *Directive 067* for determining if a licensee poses an unreasonable risk. The AER may also consider additional information provided by the licensee throughout the life cycle, including applications, amendments, reports, and other submissions to the AER. This assessment is to ensure the responsible management by the licensee of their liability from their collective wells, facilities, pipelines, and sites.

A geothermal licence application (for a well, facility, or pipeline) will trigger a holistic licensee assessment. The AER will consider the results of the assessment and any other factors deemed appropriate in making the decision to approve, approve with conditions, or deny a licence application.

The holistic assessment uses various factors to identify risks posed by a licensee:

- financial health
- estimated total magnitude of liability (active and inactive), including abandonment, remediation, and reclamation
- remaining lifespan of the geothermal development and infrastructure and the extent to which existing operations may fund current and future liabilities
- management and maintenance of regulated infrastructure and sites, including compliance with operational requirements
- rate of closure activities and spending and pace of inactive liability growth
- compliance with administrative regulatory requirements, including the management of debts, fees, and levies
- any other factor the AER considers appropriate in the circumstances

The data that feeds into the assessment are drawn from numerous sources available to the AER, including the financial information submitted under *Directive 067*.

Financial information provided to the AER will be kept confidential for the period stated in section 94 of the *GRDR*.

21) Licensees must provide complete and accurate information as required by the AER for the holistic assessment.

2.10 Licensee Management Program

The Licensee Management Program is how the AER will proactively monitor licensees to support the responsible management of geothermal development. Under this program, the results from the holistic licensee assessment will be used to identify those licensees that are or are likely to be at risk of not meeting their regulatory and liability obligations throughout the geothermal development life cycle.

The AER may specifically engage and use appropriate regulatory tools or conduct compliance assurance activities with the licensee. This may involve providing education or recommendations to follow industry best practices and, where appropriate, initiating specific regulatory actions.

The AER encourages licensees to use available collaborative closure planning tools, such as the area-based closure approach, to help reduce their overall closure costs and work more efficiently to reduce liability on the landscape. Where special action is warranted, the AER may use appropriate regulatory tools or conduct other compliance assurance activities. Examples include changing licence eligibility under *Directive 067*, placing restrictions on licences/approvals, requiring security deposits in accordance with section 2.12 of this directive, or issuing orders.

22) Licensees must provide information to the AER as requested under the Licensee Management Program to ensure the responsible management of energy development throughout the geothermal development life cycle.

2.11 Liability Assessment

23) An applicant or licensee must provide an estimate of the total liabilities associated with the geothermal development, including the cost of providing reasonable care and measures and the cost to permanently end operations, which includes abandoning, remediating, and reclaiming the site.

The following factors relate to a geothermal liability assessment:

a) geographic location:
   i) location within province
   ii) proximity to environmentally sensitive areas
   iii) proximity to urban areas

b) H_2S and carbon dioxide (CO_2) content of production fluid

c) contamination management

d) site-specific reclamation considerations

e) wells:
   i) new or converted well
   ii) geothermal well type
   iii) depth and diameter of well
   iv) wellbore configuration
   v) cementing and completion details
   vi) wellbore integrity
   vii) groundwater protection
   viii) surface casing vent flow and gas migration

f) facilities:
   i) type
   ii) area and design capacity
   iii) hazardous materials

g) pipelines designated as problem sites

h) other factors affecting cost to close infrastructure and sites

A site-specific liability assessment may be required for the geothermal development to estimate the cost of suspension, abandonment, remediation, or reclamation of a particular site.

24) When directed by the AER, the licensee must conduct and submit a site-specific liability assessment in accordance with *Directive 001: Requirements for Site-Specific Liability Assessments* unless otherwise directed by the AER.

The AER will continually assess the liability holistically to ensure the responsible management by the licensee of their ongoing liability from their collective wells, facilities, pipelines, and sites.

2.12 Security Deposits

The *GRDR* gives the AER broad authority to require security deposits across the geothermal development life cycle. This includes but is not limited to at the time of application and amendments for well and facility licences as well as licence transfers.

25) When directed by the AER, the licensee must provide a security deposit in the amount and by the due date specified by the AER. The AER will not issue a licence or transfer a licence without confirmation that the licensee has posted the appropriate security deposit.

The AER will determine the need for a security deposit and the amount based on the AER's holistic assessment (see section 2.9), including whether the licensee poses an unreasonable risk (as outlined in section 4.5 of *Directive 067*), and any other factor the AER considers appropriate. The maximum amount of the security deposit that may be required is the licensee's total liabilities, including the cost of providing reasonable care and measures and the cost to permanently end operations, which includes abandoning, remediating, and reclaiming the site.

A request for a refund of the security deposit collected under this directive will trigger a holistic assessment of the licensee. If the holistic assessment of the licensee indicates there is a risk and a security deposit is still required to offset the risk, the security deposit will not be refunded. If the assessment indicates more security is required to what the AER currently holds, the licensee could be required to provide additional security to mitigate the risk. If the holistic assessment indicates that the risk has been sufficiently reduced, a refund or partial refund of the security deposit may be warranted.

For more information on the processes that apply when a security deposit is required or can be refunded, refer to *Directive 068: Security Deposits*.

3 Geothermal Wells

3.1 Well Types

Geothermal well types are based on their configuration.

The two most common geothermal configurations in use are **open loop** and **closed loop**. Both configurations involve the circulation of fluids for heat extraction at the surface and injection of cooled fluids subsurface for reheating. A key difference between the two configurations is how fluids are handled and the type of fluids used.

Fluids in an open-loop configuration move between the wellbore and the formation or reservoir as part of the fluid circulation process. Perforations in the casing or open-hole completions allow fluids to move in and out of the wellbore of an **open-loop injection well** or an **open-loop production well**. In an open-loop configuration, water is the type of fluid used.

For **closed-loop wells**, fluids remain within the wellbore (i.e., a self-contained system with no transfer of fluids between the wellbore and the formation or reservoir). Fluids such as glycol are used in a closed-loop configuration.

Table 1 lists the designated well types for the open- and closed-loop well configurations.

Table 1. Well types for geothermal configurations

Well type	Usage
Open loop	
Geothermal injection	Cool or cold fluid reinjection
Geothermal production	Warm or hot fluid production
Closed loop	
Geothermal circulation	Single closed-loop well
Geothermal circulation: in	Multiwell closed-loop configuration receiving cold-side circulation fluids
Geothermal circulation: out	Multiwell closed-loop configuration producing hot-side circulation fluids

Wells may be proposed that are not an open- or closed-loop configuration or do not use any fluids. These wells are designated as well type “geothermal other.”

Observation wells to monitor downhole temperature or pressure are designated as well type “geothermal observation.”

3.2 Technical Requirements

3.2.1 General

Geothermal well design is a professional work product and is expected to be authenticated by a qualified professional licensed to practice in Alberta, such as a member of the Association of Professional Engineers and Geoscientists of Alberta.

26) In addition to the requirements set out in this directive, the applicant or licensee must ensure that geothermal wells meet the requirements found in the following directives:

   a) section 7.7 of *Directive 056* except for section 7.7.9, "Drill Cutting Sample Requirements"

   b) *Directive 008: Surface Casing Depth Requirements*

   c) *Directive 009: Casing Cementing Minimum Requirements*

   d) *Directive 010: Minimum Casing Design Requirements*

   e) *Directive 080: Well Logging*

   f) *Directive 087: Well Integrity Management*

27) The licensee must take drill cutting samples from a drilled geothermal well. In the case of a multiwell pad, drill cuttings must be taken from the first well on the pad. The drill cuttings must be taken as follows:

   a) The licensee must start sampling as per the following applicable scenarios:

      i) If there are no existing wells within a two-kilometre (km) radius of the new geothermal well, sample from the base of the surface casing.

      ii) If there is an existing well within a 2 km radius of the new geothermal well, sample from the top of the deepest formation penetrated by the offset well.

      iii) If there is an existing well within a 2 km radius that has been drilled deeper than the new geothermal well, sample from 30 metres (m) above the target formation of the new geothermal well.

   b) The licensee must sample at 5 m intervals in the vertical section and at 20 m intervals in the horizontal section of the geothermal well.

   c) The licensee must sample to the total **measured depth** of the geothermal well.

For geothermal wells that will encounter downhole temperatures greater than 110°C, the AER expects the licensee to consider using thermal cement for any new geothermal well or portion of the wellbore extending from an existing well.

28) When converting an existing well to a geothermal well, the applicant must hydraulically isolate the zones to prevent cross flow of injected and reservoir fluids to the usable groundwater zone by cementing behind the production casing in accordance with *Directive 009*. The applicant must retain documentation to demonstrate cementing has created hydraulic isolation.

29) For closed-loop geothermal wells, the surface casing must be completed down to the base of groundwater protection, despite the exemptions in section 3 of *Directive 008*.

30) If a geothermal well is hydraulically fractured, the licensee must meet the requirements in *Directive 083: Hydraulic Fracturing – Subsurface Integrity*. (Geothermal wells are not the thermal wells excluded from *Directive 083*.)

31) The licensee must meet the requirements in *Directive 055: Storage Requirements for the Upstream Petroleum Industry*.

32) The licensee must meet the setback requirements in *Directive 056*.

33) The licensee must have acceptable measures in place to protect water bodies from contamination during drilling and operations and mitigate the impacts of a spill as set out in *Directive 056*.

34) The licensee must meet the requirements in *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting*.

35) The licensee must manage their waste at wells, facilities, and pipelines in accordance with the requirements in *Directive 050: Drilling Waste Management* and the waste requirements in *Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry*, including the handling of radioactive material from geothermal operations.

36) For open-loop production wells, the applicant must propose a minimum subsurface distance required to set back a geothermal well or well network from the lease boundary to prevent adversely affecting any adjacent subsurface operations authorized by the *Oil and Gas Conservation Act* (*OGCA*), the *Oil Sands Conservation Act*, the *Coal Conservation Act,* or the *Mineral Resource Development Act*.

37) Applicants must document how the proposed subsurface setback was determined and provide the information to the AER.

3.2.2 Inactive Wells

38) For any inactive geothermal wells, the licensee must meet the requirements of *Directive 013: Suspension Requirements for Wells*. Despite the exemption of observation wells in section 2.1 of *Directive 013*, inactive *geothermal* observation wells under the *GRDA* must meet all *Directive 013* requirements. A geothermal observation well is deemed inactive when no

bottomhole temperature has been taken for 12 consecutive months (temperature data are reported annually in accordance with section 7.3.3). A geothermal closed-loop well is deemed inactive when no wellhead temperature has been reported for 12 consecutive months.

Under *Directive 013*, inactive wells are classified as low, medium, and high risk. The AER classifies inactive geothermal observation wells as low risk. All other inactive geothermal wells are currently classified as medium risk.

Table 1 in *Directive 013* summarizes the well suspension requirements for each risk classification. In the row "Initial suspension & ongoing inspection requirements," option 3 for medium-risk wells does not apply to inactive geothermal wells.

39) For inactive geothermal observation wells, licensees must meet the requirements for a low-risk type 1 well as set out in table 1 of *Directive 013*.

3.2.3 Well Closure

Well closure activities include abandonment, remediation, and reclamation.

40) The licensee must meet the abandonment requirements in *Directive 020: Well Abandonment*. Closure requirements also apply to all wells converted to geothermal use.

Under section 137 of *EPEA*, a licensee must reclaim specified land. Geothermal wells are included in the definition of "specified land" in the *Conservation and Reclamation Regulation* and are subject to the applicable standards, criteria, guidelines, and directives established under that regulation, which includes returning sites to equivalent land capability.

3.3 Risk Assessment Requirements

41) Applicants must assess the risks related to the following hazards:

a) breach of reservoir containment

b) failure of well integrity

c) surface deformation (e.g., ground subsidence and heave)

d) induced seismicity

e) contamination of nonsaline water due to thermally mobilized constituents (applies only if a **receptor** exists within one kilometre of a proposed well)

f) any other hazards specific to the project

The level of detail in a risk assessment should be proportionate to the risk and appropriate to the nature of the hazard.

42) In addition to the emergency response plan noted in requirement 15, for each hazard that may pose significant risks to public safety or the environment, the applicant must develop and implement a mitigation, monitoring, and response plan to further reduce risks to levels as low as reasonably possible.

3.3.1 Induced Seismicity

43) At a minimum, a risk assessment must assess the presence of **critically stressed faults** within a 3 km radius of the proposed geothermal well to determine the potential for induced seismicity. This task can be done by identifying and documenting known earthquakes around the proposed wellbore and any faults using publicly available data (e.g., Alberta Geological Survey, Earthquake Canada).

44) If induced seismicity is identified as a risk by the applicant, licensee, or the AER, or if a seismic event is induced or triggered by the geothermal well operations, the applicant or licensee (whichever is applicable) must do the following:

a) Develop a mitigation, monitoring, and response plan that defines the thresholds of the "traffic light" protocol described in requirement 46 used to eliminate or reduce the magnitude of seismic events, including actions for following the traffic light protocol. The plan should be prepared by a qualified professional licensed to practice in Alberta and agreed to by the AER.

b) Implement the mitigation, monitoring, and response plan before starting drilling operations for a new well or before injection operations start for a converted well.

c) Install the following seismic monitoring equipment:

i) a seismometer network capable of detecting a seismic event of 2.0 local magnitude (M_L) within 10 km of the geothermal well

ii) accelerometers at strategic locations near residences, communities, and any critical infrastructure within a 10 km radius from the geothermal well unless otherwise directed by the AER

45) Seismic wave form monitoring data generated or collected as required by this directive must be submitted to

a) the AER in real time[1] and

b) the Incorporated Research Institutions for Seismology no later than one year after the data are collected (data will be public).

[1] See the AER's *Open File Report 2019-09: The Scientific Induced Seismicity Monitoring Network (SCISMN)* for details on how to provide seismic information to the AER.

46) The licensee must follow the traffic light protocol described below in response to a seismic event that occurs within 10 km of a geothermal well:

   a) Green light: If the seismic event is less than the low threshold magnitude agreed on between the AER and the licensee, the licensee need not take any action.

   b) Yellow light: If the seismic event is equal to or greater than the low threshold and less than a high threshold magnitude agreed on between the AER and the licensee, then the licensee must

      i) immediately report the event to the Energy and Environmental Emergency 24-Hour Response Line (1-800-222-6514) and

      ii) implement its mitigation, monitoring, and response plan to eliminate or reduce the magnitude of future seismic events.

   c) Red light: If the seismic event is equal to or greater than the high threshold magnitude, then the licensee must immediately

      i) review any operations underway and, if injecting fluids, reduce the rate of injection or pump fluids out from the well and, if hydraulically fracturing, suspend hydraulic fracturing at the subject well;

      ii) return the well to a safe state; and

      iii) immediately report the event to the Energy and Environmental Emergency 24-Hour Response Line (1-800-222-6514).

47) For the subject well under a “red light” event, the licensee must receive written consent from the AER to resume affected operations.

48) Before resuming affected operations of the subject well under a “red light” event, the licensee must implement a revised mitigation, monitoring, and response plan agreed on between the AER and the licensee.

49) The licensee must retain a copy of its mitigation, monitoring, and response plan on site during geothermal operations and submit the plan to the AER on request.

50) As operational data is acquired over the life of the development, the licensee must adjust the seismic magnitude thresholds in the traffic light protocol as necessary. The AER must agree on any adjustments to the protocol.

3.4 Application Requirements

3.4.1 General

51) An applicant must apply for a geothermal well licence in accordance with this directive and *Directive 056*.

52) The applicant must include an estimate of the liability as outlined in section 2.11 under separate cover with the application.

Each well under the AER's jurisdiction is assigned a well classification that differentiates between exploration and exploitation activity or other unique purposes or types for wells drilled in Alberta. The classifications and definitions for use in geothermal wells are listed in table 2.

Table 2. AER classifications for geothermal wells

AER classification	Description
Exploratory (XPL)	A well drilled to obtain reservoir parameters and intended to produce previously unexplored geothermal resources in a formation.
Development (DEV)	A well or additional wells drilled to develop the geothermal resource in a formation.
Development service well (DSW)	A well drilled to introduce fluids down the wellbore or into a formation or to gather pressure or temperature data for determining how well the development is performing.
Other (OTH)	A well drilled to test or use new geothermal technology as set out in requirement 58.

53) The applicant must upload the following information using the appropriate box in the geothermal well licence application in "Additional Attachments" as set out in section 7.8.6 of *Manual 012*:

a) a summary of the risk assessment in accordance with section 3.3

b) confirm what mitigation, monitoring, and response plan is required and will be implemented

c) if the potential of induced seismicity is identified in accordance with section 3.3.1, provide the details of the mitigation, monitoring, and response plan

d) the proposed subsurface setback and supporting information on how this distance was determined as described in section 3.2.1

e) a brief description of the geothermal technology to be used, its capabilities, and limitations

3.4.2 Injection Approval

For open-loop geothermal wells, an injection scheme approval is required before injection can start.

54) The licensee must apply for an injection scheme approval in accordance with *Directive 065: Resources Applications for Oil and Gas Reservoirs* (for the purpose of this directive, the term "disposal scheme" in *Directive 065* is to be read as "injection scheme").

55) If the injection fluid is a class II fluid under *Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements*, the licensee must receive an injection approval in accordance with that directive. If the injection fluid is not a class II fluid, the licensee must contact the AER for direction.

3.4.3 Prelicensing Approvals, Variances, and Disclosures

Applicants may seek prelicensing approval on their H_2S release rate assessment (see section 7.7.15 of *Directive 056*) before applying for a well licence.

Variances are needed in the following situations:

- An applicant cannot meet a technical requirement.
- An applicant cannot meet the participant involvement requirements.
- An applicant proposes to implement new technology.

The AER must approve any variance. Applicants may seek variances for the following when submitting a well licence application:

- critical well drilling plan (*Directive 036: Drilling Blowout Prevention Requirements and Procedures* and the *Industry Recommended Practice Volume 1: Critical Sour Drilling*)
- any surface casing requirements in section 3.2.1 of this directive, section 7.7.11 of *Directive 056*, and *Directive 008*)

56) An applicant must include any requests for variances in their application for a geothermal well.

57) If an applicant proposes to use new technology, the application must include sufficient information for the AER to verify an equivalent level of environmental protection and public safety will be achieved to meet the requirements in this directive.

58) The applicant must submit the request to use new technology, including for a "geothermal other" well type, at the same time as the geothermal well licence application.

59) The applicant must disclose in its well licence application

a) whether any other variances, excluding the use of new technology, have been approved or are being sought;

b) whether surface access consent has not yet been obtained; and

c) whether there are any outstanding concerns or objections to the application.

3.4.4 Licence Expiry, Extension, and Cancellation

60) Licensees must meet the requirements in section 7.2 of *Directive 056* for licence expiries, extensions, and cancellations.

3.4.5 Licence Amendments and Information Updates

61) The licensee must meet the requirements in section 7.5 of *Directive 056* for licence amendments and information updates for wells.

62) For any proposed changes to a well licence not captured in *Directive 056*, the licensee must email the AER at GeothermalApplications@aer.ca for direction.

63) If the licensee wants to change the well type of a *GRDA* well, the licensee must amend the existing licence by sending an application to GeothermalApplications@aer.ca with the subject line “Geothermal - Change of Well Type”. The well with its new well type must meet all the technical requirements in section 3.2 and risk assessment requirements in section 3.3.

3.4.6 Converting an Existing Licensed Well to a Geothermal Licensed Well

A well licence issued for a well drilled under the *OGCA* or *Mineral Resource Development Act* (*MRDA*) may be converted to a well licence under the *GRDA* for geothermal development. Figure 1is a process flow diagram showing the steps to convert an existing well licence to a geothermal well licence.

64) If the geothermal resource applicant is the licensee of the well for conversion, submit an amendment application via the designated information submission system to convert the well licence.

65) If the geothermal resource applicant is not the licensee of the well for conversion, they must first apply to transfer the well licence in accordance with section 6.Then, submit an amendment application via the designated information submission system to convert the well licence.

Surface access granted for an *OGCA*-regulated well will not meet the surface access requirement for a geothermal well set out in section 2.3. Confirmation of surface access consent is part of the application to convert the well under the *GRDA*.

Converted wells must meet the requirements of the *GRDR*, *Directive 056*, and this directive.

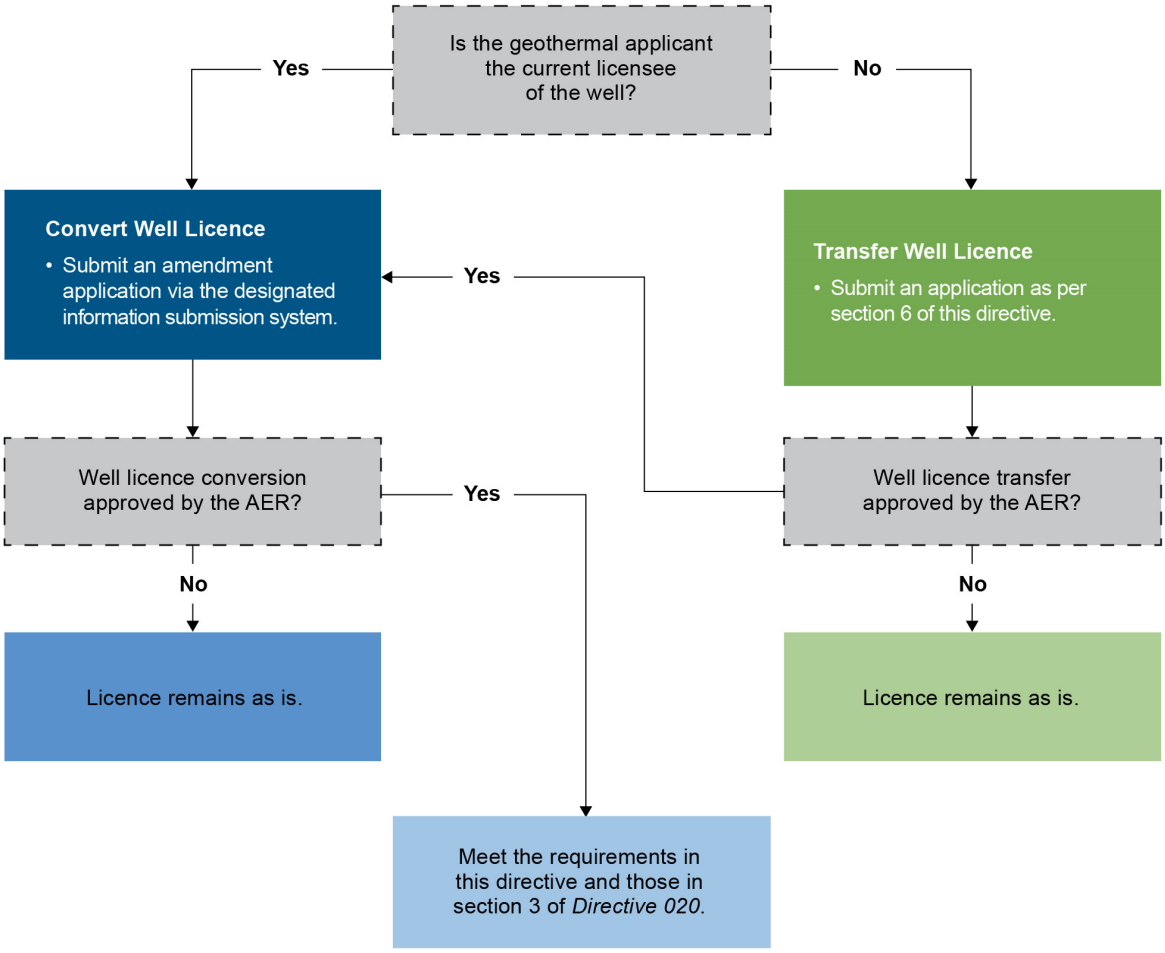

Figure 1. Conversion of a well licence to a geothermal well licence

66) Applications to convert well licences must include the following information in the "Additional Attachments – Support Information for Well Conversion" upload box:

a) the proposed heat transfer medium (i.e., fluid type)

b) any proposed modifications to the well

c) confirmation that the technical requirements in section 3.2 and *Directive 056* can be met

This is in addition to the other supplementary information required to be filed in a geothermal well licence application (described in section 7.8.6 of *Manual 012*) and filed in the appropriately labelled upload box during a conversion well licence application submission.

67) Zonal abandonment of converted wells must meet the requirements of section 3 of *Directive 020*.

The AER will review the information in the amendment application and, upon approval, will designate the well as a well under the *GRDA*.

3.4.7 Re-entry, Resumption, and Deepening

Re-entry and resumption both refer to activities conducted at an existing wellbore. When done by the existing licensee, it is called "resumption." When done by someone else, such as a new licensee, it is called "re-entry." Only a geothermal licensee may conduct or direct geothermal activities; therefore, an approved licence transfer may be required first (see section 3.4.6). The re-entry category is not valid for geothermal well licences.

68) A licensee must meet the requirements for re-entry, resumption, and deepening in section 7.6 of *Directive 056*.

4 Geothermal Facilities

A geothermal facility is a facility that uses geothermal energy to produce heat or power for commercial purposes.

69) Open-loop wells used for heat or power production and closed-loop wells used for power production must have an associated AER-licensed facility.

70) The applicant must contact the AER via GeothermalApplications@aer.ca to determine if a geothermal facility licence is required for closed-loop wells that produces only heat.

An *OGCA* facility licence may be amended to include heating or power generated from geothermal energy for use entirely within the facility. In this case, a facility licence under the *GRDA* is not required. However, the licensee is responsible for applying under the *OGCA* for any amendments required.

4.1 Technical Requirements

4.1.1 General

71) Geothermal facilities must meet the requirements found in the following directives:

a) *Directive 038: Noise Control*

b) *Directive 055*

c) *Directive 056*, section 5.6, except for the sulphur recovery requirements

d) *Directive 058*

e) *Directive 060*

4.1.2 Inactive Facilities

A geothermal facility is deemed inactive under the following conditions:

- No volumetric activity has been reported for 12 consecutive months. The facility inactive date is 12 months from the date of the last reported volumetric activity.
- Where the facility requires *EPEA* approval, it is deemed inactive when no volumetric activity has been reported for six consecutive months. The facility inactive date is six months from the date of the last reported volumetric activity.
- New facilities become inactive 24 months after the licence issue date if it has not reported any volumetric activity.

72) A licensee of an inactive geothermal facility must

   a) suspend the facility,

   b) abandon the facility, or

   c) reactivate the facility.

The AER expects the licensee to prepare a suspension or closure plan for the facility and begin suspension or closure activities immediately after shutting in the facility.

73) To suspend an inactive geothermal facility, the licensee must prepare a suspension plan that includes the following:

   a) details of suspension activities:

      i) identification of hazardous materials and measures to be taken to control them

      ii) how facility equipment will be isolated, de-energized, purged, and cleaned

   b) timelines for suspension activities, including the completion date of suspension

   c) ongoing monitoring and maintenance activities

74) The licensee must update the suspension plan as required to ensure it reflects ongoing activities.

75) The licensee must provide the suspension plan to the AER within 30 days of receiving a request from the AER.

76) The licensee must complete all suspension activities no later than one year after the facility inactive date.

77) The licensee must report the facility suspension date and any other suspension activity information requested by the AER within 30 days of the suspension date through the designated information submission system.

The facility suspension date is the date all suspension activities have been completed.

78) A licensee of a suspended facility must either abandon or reactivate the facility.

79) Reactivation of an inactive facility that has *not* been suspended must occur within 12 months of the facility inactive date.

80) To reactivate a facility, the licensee must be able to

    a) safely reactivate the facility to meet its licensed purpose and

    b) have a proven source of geothermal energy.

81) The licensee must report the reactivation date and any reactivation activity information requested by the AER within 30 days of the reactivation date through the designated information submission system.

    The reactivation date of an inactive or suspended facility is the date of first reported commercial heat or power after the facility inactive date.

4.1.3 Facility Closure

Facility closure activities include abandonment, remediation, reclamation, and applying for a reclamation certificate.

82) To close an inactive geothermal facility, the licensee must prepare a closure plan that includes the following:

    a) details of abandonment activities:

        i) identification of hazardous materials and measures to be taken to control them

        ii) how facility equipment will be isolated, de-energized, purged, and cleaned

        iii) how all aboveground equipment and infrastructure will be dismantled and removed

        iv) how the facility site will be maintained in a safe and secure manner

    b) details of ongoing site monitoring and maintenance activities, including vegetation control and site security

    c) details of environmental site assessment, remediation, and reclamation activities

    d) timelines, including proposed completion dates for abandonment, environmental site assessment, remediation, and surface land reclamation activities

83) The licensee must update the closure plan as required to reflect ongoing activities.

84) The licensee must provide the closure plan to the AER within 30 days of receiving a request.

85) The licensee must report the facility abandonment date and any other abandonment activity information requested by the AER within 30 days of the abandonment date through the designated information submission system.

The facility abandonment date is the date all abandonment activities have been completed.

Under section 137 of *EPEA*, a licensee must reclaim specified land. Geothermal facilities are included in the definition of "specified land" in the *Conservation and Reclamation Regulation* and are subject to the applicable standards, criteria, guidelines, and directives established under that regulation, which includes returning sites to equivalent land capability. Geothermal facilities with *EPEA* approvals may have additional requirements.

4.2 Application Requirements

86) An applicant must apply to construct or operate a geothermal facility in accordance with this directive and *Directive 056*.

When applying for a geothermal facility, use category type B091 even if the H_2S and sulphur content of the inlet gas stream is >0.01 mol/kmol. Values identified in the bullets below are to be entered in the application as indicated with actual values submitted in a PDF document identified as "Miscellaneous" attached to the facility application:

- maximum H_2S content of inlet gas – enter 0.01 mol/kmol
- total inlet rates – enter the maximum daily design rate at 101.325 kilopascals (kPa) pressure and 15 °Ctemperature
- sulphur inlet – if the sulphur inlet rate is >0.00 t/d, enter 0.00
- sulphur dioxide – for a geothermal facility with SO_2 emissions, submit a maximum continuous sulphur emission rate on a sulphur equivalent basis in tonnes per day (t/d) to two decimal places

87) The applicant must include an estimate of the liability as outlined in section 2.11 under separate cover with the application.

88) Applicants must include the following submitted in a PDF document identified as "Miscellaneous" attached to the facility application:

a) an assessment of potential impacts of air emissions and noise from all sources, including power generation equipment

b) a brief description of the geothermal technology to be used, its capabilities and limitations

c) confirmation of surface access consent

89) A geothermal facility must be on a separate lease from any existing oil and gas or mineral resource development.

90) If the applicant plans to share equipment or send or receive production or working fluids between a geothermal facility and an oil and gas or mineral resource development facility, the applicant must provide the following:

    a) a plot plan that clearly identifies the equipment regulated under the *GRDA* from that regulated under the other energy enactment

    b) process flow diagrams for the geothermal facility and the other oil and gas or mineral resource development facility

    c) an equipment list that clearly identifies which equipment belongs to which facility and any shared equipment

91) Geothermal facilities must not process or handle any hydrocarbons for commercial production.

4.2.1 Variances and Disclosures

Variances are needed in the following situations:

- An applicant cannot meet a technical requirement.
- An applicant cannot meet the participant involvement requirements.
- An applicant proposes to implement new technology.

The AER must approve any variance.

92) An applicant must include any requests for variances in their application for a geothermal facility.

93) If an applicant proposes to use new technology, the application must include sufficient information for the AER to verify an equivalent level of environmental protection and public safety will be achieved in accordance with the requirements in this directive.

94) The applicant must disclose in its facility licence application

    a) whether surface access consent has not yet been obtained,

    b) whether there are any outstanding concerns or objections to the application, and

    c) whether any potential exists to create a significant risk to public safety, the environment, or facility infrastructure.

4.2.2 Licence Expiry and Extension

95) Applicants must meet the requirements under section 5.2 of *Directive 056* for licence expiries and licence extensions.

4.2.3 Licence Amendments

96) A licensee must apply to amend the geothermal facility licence through the designated information submission system if proposing a modification listed in table 4 of *Manual 012* or listed in section 5.5 of *Directive 056.*

97) The licensee must apply to amend the geothermal facility licence via email to GeothermalApplications@aer.ca with the subject line "Geothermal facility application amendment" if the lease area is being expanded or if any of the following factors increase:

   a) the total facility inlet rate, including fluids (m^3/day)

   b) the commercial heating output of the facility

   c) the commercial power output of the facility

98) If any changes to the licence are proposed other than those listed in this section, the licensee must email the AER at GeothermalApplications@aer.ca for direction.

5 Geothermal Pipelines

For the definition of "pipeline," refer to the *Pipeline Act* and *Pipeline Rules*.

5.1 Technical Requirements

99) Applicants and licensees must meet the technical requirements in the *Pipeline Act*, *Pipeline Rules*, and section 6.6 of *Directive 056* and meet the design specifications in accordance with the CSA Group standard *CSA Z662: Oil and Gas Pipeline Systems*.

5.1.1 Pipeline Closure

Pipeline closure activities include abandonment, remediation, and reclamation.

Under section 137 of *EPEA*, a licensee must reclaim specified land. Geothermal pipelines are included in the definition of "specified land" in the *Conservation and Reclamation Regulation* and are subject to the applicable standards, criteria, guidelines, and directives established under that regulation, which includes returning sites to equivalent land capability. Geothermal pipelines with *EPEA* approvals may have additional requirements.

5.2 Application Requirements

100) Applicants must apply for a geothermal pipeline licence under the *Pipeline Act* and *Pipeline Rules* and in accordance with section 6 of *Directive 056*.

101) The applicant must include an estimate of the liability as outlined in section 2.11 under separate cover with the application.

5.3 Heat Distribution Systems

Pipelines used as heat distribution systems between a plant and a service connection are not defined under the *Pipeline Act*. The AER regulates these pipelines under *EPEA* as industrial pipelines.

The AER expects the licensee to select, design, construct, install, and monitor these industrial pipelines according to best practices and relevant standards. See *Manual 028: Buried Geothermal Heat Distribution Pipelines, Best Practices for Planning, Design, Operation, and Closure* for guidance and best practices.

Direct any questions to the Customer Contact Centre:

Phone: 403-297-8311
Toll-free: 1-855-297-8311
Fax: 403-297-7336
Inquiries@aer.ca

6 Application for Transfer of Geothermal Well, Facility, or Pipeline Licences

Agreements for the sale and purchase of AER-licensed wells, facilities, and pipelines do not result in a transfer of the associated licences until a licence transfer application has been submitted and approved by the AER.

AER licences with a licence status of Issued, Amended, Discontinued, Suspended, Abandoned, RecCertified, or RecExempt are eligible for transfer. Licences with a licence status of Cancelled or Re-Entered are not eligible for transfer.

The AER will not accept a licence transfer application unless both the transferor and transferee have AER identification codes that permit the holding of all the licence types included within the licence transfer application. For information about agent appointments, identification code requirements, and other eligibility requirements, refer to *Directive 067*.

The AER will process licence transfer applications as they are received.

A licence transfer application will trigger a holistic licensee assessment (see section 2.9) of both the transferor and transferee. This assessment will include reviewing abandoned, reclaimed, and reclamation-exempt sites to ensure they are held by a responsible party that can address, manage,

and monitor current conditions or future issues related to public safety or the environment should they arise.

The AER will consider the entire application package of licences to be transferred and may reject a licence transfer application that does not include licences that have received reclamation certification or that are abandoned and classified as "reclamation exempt." The AER will consider the results of this assessment and any other factors determined appropriate in making the decision to approve, approve with conditions, or deny a licence transfer application. The AER may require a site-specific liability assessment to be completed to support the holistic assessment.

For licences that have a public lands disposition that need to be assigned or transferred, if either party has arrears in respect of any debt to the Crown or taxes owing to a municipality, the AER will reject the public lands application for assignment or transfer of the disposition as outlined in section 153 of the *Public Lands Administration Regulation*.

It is the transferor's responsibility to ensure that all information relevant to the licences included in a transfer application is updated in AER systems before the application is submitted.

102) An applicant must apply for a licence transfer and submit the numbers of all the licences proposed for transfer through the designated information submission system.

103) The application must include the business associate (BA) code and contact information (including both an email address and phone number) for both the transferor and transferee.

A licence transfer application can be submitted by the transferor, the transferee, or an authorized agent or consultant acting on behalf of either party. The party initiating the submission is responsible for notifying the other party that the application has been submitted; the application must be accepted by both parties before it can be processed.

104) Before a licence transfer application will be accepted by the AER, both parties must make the declarations outlined in appendix 2.

105) The applicant must provide the following current information about the working interest participants involved in the licence transfer:

    a) full legal name of each working interest participant, which cannot be a partnership

    b) contact information for each working interest participant, including an email address and telephone number

    c) the percentages of working interest (totalling 100%) for every well and facility included in the application

106) The applicant must include an estimate of the liability as outlined in section 2.11 under separate cover with the application.

107) For licence transfer applications, any site-specific liability assessments submitted must be within the timelines as required by *Directive 011* and completed in accordance with *Directive 001*.

108) If one or both parties wish to withdraw a transfer application, they must submit a written request to the AER. Upon receipt of the request, the AER will process the application as withdrawn and will notify the licensees.

109) Licensees must provide information to the AER as requested for the transfer application.

The holistic assessment of a licensee is used to determine whether security deposits are required from the transferor or transferee and the amount of security deposit in accordance with section 2.12. To offset any potential increase in risk that may arise from a licence transfer, a transferor or transferee may be required, as a condition of approval, to provide a security deposit to the AER.

The AER does not provide a preliminary determination of expected security deposit requirements. They cannot be determined until the licence transfer application has been received and reviewed.

If a required security deposit is not received by the due date identified by the AER, the licence transfer application will be closed, and the transferor will remain the licensee of record.

The AER will convey its decision regarding a licence transfer application to both the transferor and the transferee. If a transferor or transferee is represented by an agent or uses the services of a consultant, the AER will also provide notice of its decision to the agent or consultant.

The licensee of record (transferor) remains responsible to comply with all applicable regulatory requirements for any well, facility, or pipeline in a licence transfer application until the AER approves the transfer. On approval of a licence transfer application, the new licensee of record (transferee) becomes responsible for any well, facility, or pipeline in the application as of the effective date of the transfer.

7 Geothermal Data Filing, Measurement, and Reporting Requirements

7.1 Well Data Requirements

110) Licensees must meet the requirements in *Directive 059: Well Drilling and Completion Data Filing Requirements* and *Directive 080*.

111) If **core images** are taken as part of the core analysis (in accordance with section 82 of the *GRDR*), they must be submitted by the licensee as compressed high-quality images to the designated information submission system.

112) If drillstem tests are conducted, licensees must meet the requirements in section 4.5 of *Directive 040: Pressure and Deliverability Testing Oil and Gas Wells*.

113) For open-loop wells, the licensee must conduct initial and annual sampling and analysis of the chemical and physical properties and composition of reservoir fluids, including the following:

   a) standard water chemistry parameters (e.g., pH, total dissolved solids [TDS])

   b) density

   c) H_2S

   d) hydrocarbons

114) For open-loop wells, the licensee must submit the analysis results from the initial and annual reservoir fluid sampling in accordance with the requirements in section 3.6 of *Directive 040*. Results of annual reservoir fluid sampling must be submitted by the end of each calendar year once commercial heat or power production has started.

115) For any fluid sampling and analysis of the reservoir, whether for open- or closed-loop systems, the licensee must meet the requirements in section 3.6 of *Directive 040*.

7.1.1 Confidentiality and Release of Well Data

As outlined in the *GRDR*, the following geothermal well data, as well as sample drill cuttings and core preserved by the AER, are held as confidential for one year:

- fluid analysis data
- routine pressure, temperature, and flow test data
- any log data, drillstem test data, wireline formation test data, and completion details
- any core analysis data
- hours on production and injection

The drill cuttings, core, and data automatically become nonconfidential one year from the well's finished drilling date.

Only under exceptional circumstances will the AER consider extending the period of confidentiality.

116) The applicant must apply for an extension at least 30 business days before the expiry date of the confidentiality period. Submit the extension request to GeoConfTeam@aer.ca.

The following information is not confidential and is public domain on receipt of the applicant's submission:

- the surface and bottomhole locations, elevation, current depth, drilling status, and casing and

cementing data

- the monthly totals of each type of fluid injected into injection wells and produced from production wells
- any information submitted about hydraulic fracturing fluids used in geothermal operations

7.2 Measurement Requirements

117) Licensees must meet the water measurement requirements in the following sections of *Directive 017: Measurement Requirements for Oil and Gas Operations*:

a) section 1.2, “Applicability and Use of Uncertainties”

b) section 1.3, “Maximum Uncertainty of Monthly Volume”

c) section 1.4, “Single Point Measurement Uncertainty”

d) section 1.5, “Confidence Level”

e) section 1.6, “Determination of Uncertainties”

f) section 1.7.3, “Injection/Disposal Systems” (for total water)

g) section 1.8.3, “Injection Systems” (only the row for total water)

h) section 1.9, “Measurement Schematics”

i) section 2, “Calibration and Proving”

j) section 3.2, “Metering Difference” (for injection/disposal systems)

k) section 15.2.3, “Water Source Production”

l) section 15.2.4, “Water Injection and Disposal Facility”

118) If geothermal production fluids contain any incidental hydrocarbons (i.e., gas, condensate, or oil), licensees must

a) via ResourceCompliance@aer.ca, notify the AER immediately on the first occurrence of detecting incidental hydrocarbons in production fluids and

b) meet the hydrocarbon-related measurement requirements in *Directive 017*.

119) A geothermal licensee must have the corresponding mineral rights, either by purchase or through agreement, before any hydrocarbons or other minerals may be produced.

120) Nonsaline or saline water from open-loop production wells must be continuously measured before commingling with water or fluids from another source in accordance with section 15.2.3 of *Directive 017*.

121) Water injected into open-loop injection wells must be continuously metered at each wellhead at the injection site, and the measured volumes must be reported to Petrinex in accordance with section 15.2.4 of *Directive 017*.

122) Fluids used in closed-loop wells must be continuously metered and the pressure measured at the wellhead before circulating downhole and after circulating uphole.

123) If the required metering and pressure measurement at closed-loop wells indicate an unexpected volumetric difference or pressure change, the licensee must investigate the cause and take corrective action as applicable.

7.3 Reporting Requirements

124) Licensees must meet the reporting requirements in *Directive 007: Volumetric and Infrastructure Requirements*. Refer to *Manual 011: How to Submit Volumetric Data to the AER* for information on how to submit volumetric data. In summary:

   a) For all wells,

      i) for each month, the wellhead minimum, average, and maximum temperature (℃) (excluding observation wells), and

      ii) if collected, for each month, the minimum, average, and maximum bottomhole temperature (℃).

   b) For commercial heating, the total monthly heat sold (kilojoules [kJ]).

   c) For commercial power, the total monthly power generated, exported and imported (kilowatt-hours [kWh]).

   d) All other volumetric activities at all geothermal wells and facilities are reported monthly.

125) Licensees must report any incidentally produced hydrocarbons in accordance with *Directive 007*.

7.3.1 Well Status Codes for Petrinex Reporting

126) Licensees must use table 32 in *Manual 011* to determine the appropriate well status for the type of geothermal configuration for reporting volumetric data in Petrinex.

Contact Production Accounting at PA.Help@aer.ca for help changing well status codes.

7.3.2 Facility Subtypes for Petrinex Reporting

127) Licensees must use table 31 in *Manual 011* to determine the appropriate facility subtype for reporting volumetric data in Petrinex.

Contact Production Accounting at PA.Help@aer.ca for help setting up the facility subtype.

7.3.3 Annual Reporting

128) By June 30 each year, the licensee must compile the following data for the previous calendar year and email it to Geothermal.DataSubmission@aer.ca.

a) For commercial heating, the total annual heat sold (kilojoules [kJ]), including how it was calculated (i.e., measurement points and parameters).

b) For commercial power, the total annual power generated, exported, and imported (kilowatt-hours [kWh]), including how it was calculated (i.e., measurement points and parameters).

c) For surface deformation, if applicable,

i) a summary of the results from implementing the mitigation, monitoring, and response plan, including measurements of any surface deformation, and

ii) a description of activities taken to mitigate any surface deformation.

Appendix 1 Definitions

base of groundwater protection	Base of groundwater protection is an estimate of the elevation of the base of the formation in which nonsaline groundwater occurs at that location. Variations in geology and topography are typical, so the actual elevation of the base of the formation will vary from location to location within the formation. The base of groundwater protection is set at 600 metres below ground level in the mountainous region and not set for the northeast corner of the province where the Canadian Shield outcrops. For more information, see Base of Groundwater Protection Data.
business associate (BA) code	The *Geothermal Resource Development Rules* require that a person (which includes a corporation) hold a subsisting identification code (BA code) in order to apply to the AER for a licence or approval under the rules.
closed loop	This geothermal configuration can consist of either a single closed-loop well or multiple closed-loop wells with connected wellbores. During geothermal operations, fluids are circulated within the wellbores with no transfer of fluids in or out of the reservoir or formation (i.e., a self-contained system). Also referred to as "closed-loop geothermal system."
closed-loop well	As defined in the *GRDR*, a well that is expected to have zero fluid injection and zero fluid production from a zone when fluids are circulated within the wellbore.
commercial development	An energy resource development for the purpose of developing and selling marketable products such as power, heat, minerals, or oil and gas.
core image	A core image is any photography of a core, including white light, ultraviolet light, hyperspectral image analysis, etc.
critically stressed fault	A fault that requires a small stress perturbation to slip and generate seismic events. For this directive, a critically stressed fault is a fault within approximately ±15 degrees of the maximum horizontal stress orientation for the geothermal well. Fluid injection subsurface can trigger seismicity in critically stressed faults. (Most induced seismicity events in Alberta have been found to be directly related to strike-slip faults.)
measured depth	The total depth of the wellbore along its actual course and not vertical depth.
open loop	This geothermal configuration consists of groups of open-loop injection wells and open-loop production wells. During geothermal operations, such a configuration will produce warm or hot formation fluids from the subsurface to the surface and inject cooler formation fluids back into the subsurface. Also referred to as "open-loop geothermal system."
open-loop injection well	A well used to inject cool or cold fluids from the wellbore into a subsurface reservoir or formation for reheating.
open-loop production well	A well that allows warm or hot fluids from a subsurface reservoir or formation to flow into the wellbore for production to the surface.

receptor

Something that may be adversely affected by contamination. Potential receptors include the following:

- a well used for irrigation, livestock watering, or domestic, municipal, or camp supply
- a wetland or wetland complex that is potentially influenced by groundwater discharge (i.e., marsh, fen swamp, or shallow open water wetland)
- traditional land-use features associated with groundwater (i.e., springs, wetlands, groundwater discharge areas)

A surface water body (stream, river, or lake) that is potentially influenced by groundwater discharge.

Appendix 2 Transfer Application Declaration

In submitting this application as transferor or transferee, you hereby declare the following:

- Your use of the confidential identification code and password for submission of this application has been duly authorized by your company (transferor/transferee), and the confidential identification code and password used are equivalent to and have the same binding effect as a signature executed by a duly authorized representative of the transferor/transferee company.
- You have the authority to make these (and the following if transferee) statements and thereby bind your company.
- The information in the application is complete and accurate.

In submitting this application as transferee, you declare that the transferee

- holds valid surface access rights for all wells, pipelines, and facilities included in this application;
- holds valid mineral rights for all licensed producing and inactive wells included in this application;
- has the right to produce, inject, or dispose of fluids for all licensed active and inactive wells included in this application;
- is a working interest participant in all wells and facilities included in this application; and
- will ensure that all applicable AER signage requirements are met as required, including erecting or altering existing signs to reflect the new licensee's name and contact information accurately, and accepts and assumes all the obligations of a licensee as provided for in law, including the energy resource enactments, regulations, rules, and AER directives and requirements.

For pipeline licence transfers only:

- The transferor hereby confirms that it has collected and retained all records required under the *Pipeline Rules* and CSA Group standard *Z662: Oil and Gas Pipeline Systems*. The transferor confirms that it has provided these records to the transferee by the effective date of the licence transfer.
- The transferee hereby confirms that it has received all records required to be collected and retained under the *Pipeline Rules* and standard *Z662: Oil and Gas Pipeline Systems* from the transferor. The transferee is responsible for producing these records on request by the AER. Failure to do so constitutes a noncompliance of AER requirements.