Alberta Energy Regulator

Directive 039

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Revised Program to Reduce Benzene Emissions from Glycol Dehydrators

Contents

1 Introduction

This edition of Alberta Energy Regulator (AER) *Directive 039* provides the requirements for the reduction management and reporting of benzene emissions from glycol dehydrators (dehydration and refrigeration) and other benzene emission sources. Questions or comments about this directive can be directed to the AER Customer Contact Centre at inquiries@aer.ca or to the benzene program coordinators by email at BenzeneD39@aer.ca.

1.1 Purpose of this Directive

With the issuance of this directive, the AER has established requirements to ensure continued reductions of benzene emissions to reduce potential exposure for the public receptor and the environment. Air dispersion modelling results (*Air Dispersion Modelling of Glycol Dehydrator Benzene Emissions*, CAPP, 2016) show that, to consistently meet the *Alberta Ambient Air Quality Objectives* (AAAQOs) for the benzene one-hour average and annual average, the upstream oil and gas industry must not exceed the reduced emission targets set out in this directive. The AER would like to acknowledge the Benzene Technical Advisory Team (BTAT), for their input into this directive. BTAT is a multistakeholder committee consisting of participants representing industry, the Canadian Association of Petroleum Producers (CAPP), and regulators from Alberta, British Columbia, and Saskatchewan.

1.2 What's New

Administrative changes were made throughout to bring information up to date and correct minor grammatical issues. The following substantive changes were also made:

- Section 4.1: How control efficiencies can be applied to vapour recovery units has been clarified.

- Section 5.2: Requirements around the timing of extended analysis and the accuracy of reported results have been clarified.
- Section 5.3: Requirements around reporting methane on the inventory form have been clarified.
- Appendix 2: Clarified when TCT can be completed below 15°C.
- Appendices 4 and 5 have been removed. The forms remain available from the *Directive 039* landing page.

1.3 AER Requirements

AER requirements are those rules that a responsible duty holder as specified in legislation (e.g., licensee, operator, company, applicant, approval holder, or permit holder) is required to follow. The term "must" indicates a requirement, while terms such as "should," "recommends," and "expects" indicate a recommended practice.

Each AER requirement is numbered. Information on compliance and enforcement can be found on the AER website.

2 Close Proximity Dehydrators and Public Notification

2.1 Distance to the Nearest Public Receptor

A surface development within 750 m of a dehydrator emission source is considered to be in close proximity to a dehydrator emission source (e.g., still-column-vent, condenser system vent, flare exit).

Benzene emission limits are established based on the distance from the dehydrator emission source to the nearest public receptor at a close proximity development.

1) The licensee must determine the shortest distance from the dehydrator emission source to the nearest surface development that is within 1500 metres (m).

When ensuring compliance with the emission limits in this directive, a high level of accuracy is required when determining the location of a surface development that is less than 1500 m from a dehydrator emission source. The distance from the dehydrator emission source to the nearest close proximity development is used to establish the benzene emission limit for each dehydrator as outlined in section 3.

Where the distance to a surface development is more than 1500 m and the actual distance is not known, the distance may be estimated in metres or reported as "1501" m. The 1500 m enables quick reference, on site or with aerial photos, by section, range, and township roads, which are about 1.6 kilometres (km) apart.

2.2 Public Notification

The purpose of the notification procedures is to ensure that the public within 750 m of an operating dehydrator emission source are made aware of the dehydrator operations and are told who they can contact if they have questions.

2) The licensee must notify residents within 750 m of an operating dehydrator emission source (e.g., still-column-vent, condenser system vent, flare exit).

3) The licensee must ensure that notification required under item 2, is conducted, as a minimum, as follows:

   a) Notification must be done in person with a resident at each location within 60 days after initial startup of the dehydrator, after a change in status of the dehydrator to operating, after the transfer of the property with the dehydrator to another licensee, and within 12 months of a close proximity development becoming occupied or having a new resident, unless otherwise stipulated by the AER.

      Where a resident at a location cannot be notified in person, it may be appropriate for the licensee to deliver the information package. Where renotification is to update the licensee's contact information only, in person contact is not required and the information package can be delivered to the residence.

      High-occupant-density locations, such as an apartment complex or a business, may use modified notification procedures developed in consultation with staff at the appropriate AER field centre.

   b) The licensee must include with notification an information package that states the following:

      i) The status of compliance with this directive for all subject dehydrators.

      ii) That the dehydrator emission sources are within 750 m of the close proximity development.

      iii) That the emission does contain or does not contain benzene (as applicable to the specific dehydrator).

      iv) Benzene is a known carcinogen and is a non-threshold toxicant with potential for adverse effects at any level of exposure.

      v) Benzene can be emitted from some oil and gas operations, such as glycol dehydrators, where the gas being processed naturally contains benzene and where benzene emissions are being managed by industry under the AER requirements.

vi) The contact information of the licensee (name or title, phone number, email address), so the public can ask the licensee for more information.

vii) Contact information for Alberta Health Services (AHS) can be found by dialing Health Link at 811 from anywhere in the province. AHS can provide health-related information or direct the caller to their local environmental public health officer, or both: http://www.albertahealthservices.ca/assets/healthinfo/link/index.html

viii) That the AER regulates these emission sources as outlined in *Directive 039* to ensure that the AAAQOs are not exceeded at public receptors. Include details about where a copy of *Directive 039* can be found.

4) The licensee must maintain documentation verifying that notification has been done in accordance with this directive for as long as the dehydrator is in service and for the three-year period set out in section 5, item 54. Documentation includes the resident name, the location, the date and method of notification, and a copy of the notification documents provided to the resident. Documentation includes records of any concerns raised and how they were addressed by the licensee. Where completion of previous notification cannot be confirmed, renotification to current standards would be appropriate.

The notification requirements under this directive are independent of any other AER notification requirement, such as *Directive 056* notification or consultation processes. The requirements for each process must be met by the licensee.

3 Benzene Emission Requirements

3.1 General

5) Where the licensee identifies that operations do not comply with emissions limits, the licensee must immediately report the noncompliance to the AER at BenzeneD39@aer.ca and take immediate steps to bring operations back into compliance (for example, modify operations, such as glycol circulation rate, pump changes, shutdown). No dehydrator is permitted to operate while not complying with *Directive 039* emissions limits.

   Modifications of operations to bring them back into compliance may include adding control technologies or changing normal operating conditions such that the rate of emissions is reduced to ensure future compliance with the annual benzene mass limit as stated in this directive.

6) The licensee must ensure that individual dehydrator benzene emissions and cumulative site dehydrator benzene emissions do not exceed the benzene emission limits outlined in table 1.

7) The licensee must ensure that the site-specific dehydrator benzene emission rate before controls is determined using, at least, appropriate simulation software, appropriate site-specific testing procedures (including sampling protocol and analysis), or both.

For example, where the hydrocarbon components of rich and lean glycol are being used for mass balance, an appropriate sampling and analysis methodology is to be used (e.g., the methods described in GRI-GLYCalc™).

8) The licensee must ensure that emissions calculations and the assessment of test results are completed or overseen by a qualified person, and the qualified person is responsible for the accuracy of the data and the validity of all work done.

9) The licensee must ensure that a dehydrator does not exceed the applicable emissions limits in table 1 within 12 months of a new close proximity development becoming occupied by a resident.

3.2 Dehydrator Benzene Emission Limits

Limits for the dehydrator emissions released to the atmosphere from the still-column-vent or still-column control technology are based on the distance from the dehydrator emission source to the nearest close proximity development. Applying or establishing a benzene control efficiency (i.e., a per cent benzene that has been removed) for a control technology is described in section 4.

Table 1. Calendar-year emission limits for all dehydrators

Section		Distance in metres to the nearest close proximity development	Emission limit in tonnes in each calendar year*
A	No control or after control other than an appropriately designed flare, incinerator, or reciprocating engine†,‡,**	≤100	0.0
		101–250	0.1
		251–750	0.5
		not within 750	1.0
B	After-control emission limit for an appropriately designed flare, incinerator, or reciprocating engine†,‡,**	≤750	1.0††
		not within 750	3.0††

* Report emissions to two decimal places; the AER will round to one decimal for compliance purposes.

† An appropriately designed flare or incinerator must meet the performance requirements in *Directive 060*, section 7, for sour gas ≥10 mol/kmol H_2S to be eligible for the emission limits as stated in table 1, section B.

‡ Incinerator stack must be at least 9 m tall to be eligible for the emission limits as stated in table 1, section B (see section 4.1 of this directive).

** A reciprocating engine exhaust stack must be at least 6 m tall to be eligible for the emission limits as stated in table 1, section B (see section 4.1 of this directive).

†† Where equipment does not meet the requirements for an appropriately designed flare, incinerator, or reciprocating engine (e.g., stack height), these limits cannot be applied.

3.3 Additional Details for Dehydrator Benzene Emission Limits

10) If more than one dehydrator is located at a site, the licensee must ensure that the cumulative benzene emissions for all dehydrators on that one site do not exceed the highest individual dehydrator emission limit for that site as set out in table 1 of this directive.

11) For dehydrators that are only operating for part of the year (e.g., due to seasonal operation or when shut in for part of the year), the licensee must ensure that the annual emission limit is prorated and is calculated based on the portion of the reporting calendar year in which the dehydrator was operating as a dehydrator. The mass (tonnes) of benzene that was released during the operating period is assessed against the calculated prorated emission limit.

    For example, where the annual benzene emission limit is 1.0 tonne annually and the dehydrator only operates for six months of the calendar year and is then shut in (i.e., operates 1/2 of the year), the annual emission limit, and the maximum amount of benzene that can be emitted during the six months of operations, would be 1.0 tonne × 1/2 = 0.5 tonne.

    It is expected that industry will operate with an emissions buffer to ensure that emissions limits are not exceeded because of operational upsets or unscheduled down time during the year.

3.4 Cumulative Site Emissions for All Benzene Release Sources

12) The licensee or approval holder must ensure cumulative benzene emissions from all sources (dehydrator emissions plus other sources, e.g., tanks, excluding emissions from appropriately designed flare, incinerator, and reciprocating engine exhaust on the site), do not exceed the benzene emission limits in table 2.

Limits are based on the distance from the site boundary to the nearest close proximity development and excludes appropriately designed flare, incinerator, and/or reciprocating engine exhaust emissions as defined above. The licensee can apply the least restrictive of the dehydrator or site benzene emission limits for all sources where the distance from the nearest close-proximity development to the site boundary and dehydrator emission source are different distances resulting in two different emission limits per table 1 and 2 (excluding an appropriately designed flare, incinerator, or reciprocating engine).

Table 2. Cumulative site emissions for all benzene release sources

	Distance in metres to the nearest close proximity development	Emission limit in tonnes in each calendar year*
All sources of cumulative release, excluding appropriately designed flare, incinerator, or reciprocating engine.†,‡,**	≤100	0.0
	101–250	0.1
	251–750	0.5††
	not within 750	1.0††

* Report emissions to two decimal places; the AER will round to one decimal for compliance purposes.

† An appropriately designed flare or incinerator must meet the performance requirements in Directive 060, section 7, for sour gas ≥10 mol/kmol H2S.

‡ Incinerator stack must be at least 9 m tall to be excluded for table 2 (see section 4.1 of this directive).

** A reciprocating engine exhaust stack must, under section 4.1, be at least 6 m tall to be excluded for table 2.

†† Where equipment does not meet the requirements for an appropriately designed flare, incinerator, or reciprocating engine (e.g., stack height), emissions from this equipment will be included.

4 Benzene Emissions Controls

4.1 Control Technologies and Assigned Benzene Control Efficiency

In many circumstances, optimization of the dehydrator operations can yield sufficient reduction in benzene emissions without the use of additional controls.

Flare, incinerator, and vapour recovery with recycle or injection, reboiler burner, and reciprocating engine emission control equipment have each been assigned a maximum benzene emission control efficiency (as a per cent) that can be applied across sites where the control is appropriately engineered and operated for the removal of benzene emissions.

Benzene emission control efficiency for condensing systems has been demonstrated to vary widely, depending on factors such as the condenser system configuration, auxiliary equipment, and fluctuations in operating conditions (e.g., increased throughput). For example, increased noncondensable-gas flow rate / methane addition (e.g., stripping gas) can significantly reduce the ability of a condensing system to remove benzene. This large variability has warranted site-specific verification of each condenser's ability to remove benzene emissions. Therefore, simulation software packages accepted to estimate before-control benzene emissions from dehydrators are not accepted for estimating the condensing-system emissions.

When selecting a control technology for benzene emissions, licensees are advised to consider the overall venting and flaring contribution to greenhouse gas emissions on a CO_2-equivalent basis, in addition to resource conservation opportunities.

4.1.1 General

13) The licensee must estimate the site-specific before-controls benzene emissions using appropriate simulation software or site-specific sampling and analysis, or both, that can provide representative benzene emissions estimates for dehydrator normal operating conditions (e.g., GRI-GLYCalc™ and dehydrator inlet extended gas analysis at normal/average operating conditions, such as temperature and pressure).

14) Within 10 business days of an AER request, the licensee must provide documentation that satisfies the AER of the appropriateness of the simulation tool and the site-specific testing procedures, including sampling and analysis, used to determine the benzene emissions.

15) The licensee must calculate after-control emissions using an accepted before-controls estimation method outlined in this section or in section 4.2, and calculate an assigned benzene control efficiency value.

16) The licensee must assign, to a dehydrator control, a benzene control efficiency not greater than

    a) 90 per cent for a flare,

    b) 95 per cent for an incinerator,

    c) 100 per cent for vapour recovery engineered for zero benzene release from the system,

    d) 90 per cent for a reboiler burner engineered for benzene control and while combusting emissions,

    e) 95 per cent for a reciprocating engine engineered for benzene control and while combusting emissions, or

    f) as otherwise stipulated by the AER.

17) The control efficiency that can be claimed is up to the maximum allowed for the technology, and the licensee must account for reductions where the equipment configuration or operation will not yield the maximum allowed efficiency.

18) To claim the benzene reductions in item 16 above, the licensee must ensure that a flare or incinerator used to control benzene emissions meets or exceeds the performance requirements stated in this directive and in *Directive 060*, section 7, for sour gas service ≥10 mol/kmol H_2S (e.g., 12 m stack height above ground level for a flare to be assessed for emissions limits as an appropriately designed flare), or as otherwise stipulated by the AER.

19) When a control is not operational continuously, the licensee must include in the annual emissions inventory report the increase in benzene emissions to the atmosphere as outlined in the section 4.2 calculation for the benzene control efficiency.

After considering the technical merit of a control technology that may not fully meet the requirements of this directive, licensees are encouraged to contact the AER at BenzeneD39@aer.ca before incurring capital expenses to ensure that an expenditure is required and appropriate for achieving compliance with this directive.

20) The licensee must ensure that the liquids collected are handled and disposed of in a manner that will ensure that benzene emissions to the atmosphere are minimized and do not exceed the site limits.

Licensees are reminded that oilfield waste must be managed in accordance with AER *Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry*.

4.1.2 Incinerator

21) Subject to item 22 and in addition to meeting the requirements under section 7 of *Directive 060*, the licensee must ensure that an incinerator stack height is at least 9 m above ground level to qualify as an appropriately designed incinerator for tables 1 and 2 emission limits.

22) Where an existing incinerator stack does not meet the minimum required incinerator stack height, the licensee must receive written confirmation from the AER (at BenzeneD39@aer.ca) to assign table 1 or table 2 incinerator benzene emission limits or modified limits with a shorter incinerator stack height.

It is anticipated that where the emissions are sufficiently below the required emission limit, the reduced stack height may still be able to provide an equivalent reduction in emissions at the nearest close proximity development.

4.1.3 Reciprocating Engine

23) The licensee must ensure that a reciprocating engine exhaust stack height is at least 6 m above ground level to qualify as an appropriately designed reciprocating engine for tables 1 and 2 emission limits.

4.1.4 Vapour Recovery Unit

24) Where the licensee seeks to claim 100 percent control efficiency, under normal operating conditions, for the vapour recovery unit (VRU), the VRU must be operated such that the benzene emissions are captured (e.g., recycle or injection) and not released to the environment or to another control.

    If, under normal operating conditions, the VRU captures vapours but releases benzene to another control (e.g. flare, incinerator, etc.) or to the environment, the licensee cannot claim the 100% control efficiency for the VRU. In such a case, the licensee can only claim the benzene control efficiency for the final disposition of the vapours.

4.1.5 Condenser System

25) The licensee must ensure that each condenser system benzene control efficiency is assessed individually to verify the site-specific benzene control efficiency at least every five years or as otherwise stipulated by the AER.

26) In the absence of site-specific verification of condenser performance (e.g., total capture test, etc.), the licensee must assign zero per cent benzene control efficiency for compliance purposes.

27) The licensee must ensure that condenser system assessments are conducted within the normal operating conditions of the dehydrator and condensing system.

28) Where the normal operating conditions of the dehydrator or condensing system, or both, change such that the benzene emissions could be expected to increase, the licensee must ensure that the condensing system is reassessed for benzene control efficiency within the new or modified operating conditions of the dehydrator in a timely manner or as otherwise stipulated by the AER. See appendix 2 for details.

29) The licensee must ensure that the assessment of the dehydrator and condensing system benzene emissions accounts for the volume and disposition of all vapours, including those condensed and those released directly to the environment or to another control.

Sampling and analysis of vapour streams both into and out of the condensing system constitutes a total capture test (TCT). The total assessment of the dehydrator and condensing system would include vapour release sources (e.g., openings in piping or equipment).

30) The licensee must ensure that the requirements of appendix 2 of *Condensing System Total Capture Testing to Establish Benzene Control Efficiency* are met for site-specific testing to verify benzene emissions, unless otherwise directed by the AER (at BenzeneD39@aer.ca).

31) The licensee must submit notification of a proposed TCT (and subsequent amendments for testing dates and plans) by email to BenzeneD39@aer.ca at least two weeks before on-site testing is expected to occur. Notification must include the test dates, AER licence number, location (legal subdivision), and licensee contact information, including the name, email, and telephone number of the company representative.

    Where delays are experienced, the notification must be updated as soon as the change is identified and before the testing, detailing the new testing plan information; e.g. the date.

    This is a notification only and does not require a response from the AER to proceed. Appendix 2 identifies documentation requirements and details of testing requirements for a valid test. Submission of testing results without notification will not be accepted for compliance purposes.

4.2 New Benzene Control Technologies and Alternative Control Efficiencies

The AER encourages the development of technologies that capture still-column-vent vapours as a resource, and in doing so multiple benefits may be realized, such as

- reduced waste-stream emissions to the environment,
- reduced overall greenhouse gas emissions (e.g., methane),
- decreased fuel-gas consumption and increased hydrocarbon-resource conservation, resulting in cost savings, and
- decreased public and environmental exposure.

Site-specific testing will be required to determine a

- benzene control efficiency for a new technology, or
- higher benzene control efficiency for an existing technology as stated in section 4.1.

Before conducting site-specific testing, licensees should contact the AER at BenzeneD39@aer.ca to ensure that the testing methodology will be acceptable to the AER and that a benzene control efficiency (as a percentage) will be able to be assigned from the resulting data.

32) A new control technology or alternative benzene control efficiency, or both, not stated in section 4.1 must be assessed by the licensee for benzene control efficiency to the AER's satisfaction.

33) The licensee must receive written confirmation from the AER (at BenzeneD39@aer.ca) before conducting site-specific testing to determine either a benzene control efficiency for a new technology or a higher control efficiency for a technology identified in section 4.1.

As part of the considerations under item 33, the AER will review site-specific testing methodology and supporting data to determine whether a new control technology or alternative benzene control efficiency would comply with the requirements of this directive.

34) The licensee must submit appropriate engineering, technical details, and any other information required by the AER when requested in order to verify the alternative benzene control efficiency for technology as outlined in section 4.1 or for new control technology.

35) The licensee must provide documentation within 10 business days of an AER request to satisfy the AER of the appropriateness of a new control technology or alternative benzene control efficiency.

    Where it can be demonstrated to the satisfaction of the AER that a technology's benzene control efficiency can be repeated at multiple facilities, a conservative and protective control

efficiency may be accepted by the AER across multiple facilities without additional site-specific testing.

36) The licensee must maintain and operate the technology according to the manufacturer's engineering specifications in order to use the claimed benzene control efficiency.

When evaluating dehydration requirements in order to achieve the lowest possible benzene emission levels, licensees should refer to CAPP's *Best Management Practices, Control of Benzene Emissions from Glycol Regenerators (Natural Gas Dehydration and Refrigeration)*.

37) The licensee must receive written confirmation from the AER (at BenzeneD39@aer.ca) to use an alternative benzene control efficiency.

38) The licensee must calculate the benzene control efficiency according to the formula below, values for A and B are assigned based on verifiable assertions.

Benzene Control Efficiency [%] = A [%] × B [%]

Where:

A = maximum acceptable benzene control efficiency (as determined in section 4.1 or 4.2, or both) in per cent for the control technology/system under normal operating conditions.

B = control technology uptime or benzene removal time, or both, in per cent as a function of the technology's intermittent benzene control or reliability (or both). This is established with a clear understanding of how the control system operates and how often it operates; it requires documentation that supports the control technology or benzene removal time that is claimed.

For example, where the control is a reboiler burner engineered for benzene removal, a non-site-specific 90 per cent benzene control efficiency (A) is allocated to the control. Additional site-specific review of the configuration and operations determines whether the control will be capable of receiving and processing still-column-vent vapours during the reboiler cycle's on and off time. The reboiler at this site cycles, on average, at 80 per cent on and 20 per cent off by time. Therefore, the control will be operational and benzene will be removed 80 per cent of the time (B).

A sample calculation for this example:

Benzene control efficiency [%] = A [%] × B [%] = 90% × 80% = 72%

In this example, the AER would recognize a benzene control efficiency of 72 per cent without further site-specific assessment or testing.

The after-control release rate is calculated by applying the benzene control efficiency to the annual estimated before-control benzene emissions rate as tonnes/year.

For example, benzene emissions from the reboiler still-column-vent are estimated by appropriate simulation software (e.g., GRI-GLYCalc™) to be 1.5 tonnes per year under normal operating conditions. Therefore, with a control of 72 per cent for the 1.5 tonnes/year,

0.42 tonnes/year of benzene is estimated to be released from the control technology to the atmosphere.

5 Reporting

5.1 General Dehydrator Engineering and Operations Sheet (DEOS) and Inventory forms

The DEOS shows a predicted future-estimated benzene emission rate for the dehydrator with the recorded normal operating conditions, control technology, and equipment. The annual dehydrator benzene inventory form (inventory) is used to report to the AER, once a year, the actual past calendar year performance of all dehydrators on sites licensed to the company.

39) The licensee must ensure that the DEOS and inventory forms are overseen or completed by a qualified person appointed by the licensee and are signed by the qualified person overseeing the work done.

40) The licensee must ensure that all fillable fields (fields that require an entry) are completed on the DEOS form and inventory form using the options specified in the form.

    Do not alter the formats of the forms (e.g., altering the order of data, adding or changing columns on the inventory form, or entering links or formulas into cells).

    Should the particulars of a dehydrator not fit the preset selection options, please contact the AER at BenzeneD39@aer.ca to discuss an appropriate entry for the forms.

41) The licensee must report benzene emissions with at least two decimal places on the DEOS and on the annual inventory form. Emissions compliance will be assessed to one decimal place (e.g., reported value 0.04 = 0.0 compliance value).

DEOS and inventory forms are available on the AER web site.

5.2 DEOS Form

42) For each dehydrator contactor, a licensee must complete a DEOS using the form available on the AER website to report the benzene emissions under the dehydrator's average or normal operating conditions. The estimate of benzene emissions can be used for up to 12 months after the DEOS "Revision Date" where the range of the normal operating conditions, as recorded, is maintained.

43) The licensee must ensure that the DEOS is reviewed and updated every 12 months or upon dehydrator relocation, a change in operating status, or a change in the dehydrator's normal operating conditions (e.g., change in throughput gas composition; change in dehydrator operating conditions, such as glycol circulation rate; or resumption of operations).

    The DEOS is required, but the graph portion is not required where there is no measurable benzene in the dehydrator inlet extended gas analysis.

    Daily fluctuation should be accounted for within the normal operating conditions and emissions estimates and as such do not trigger a DEOS update.

44) Within the two months before the DEOS revision date, the licensee must complete an annual representative dehydrator inlet extended gas analysis and include the results in the DEOS update.

    An alternative extended gas analysis schedule may be adopted in the case where the gas sources and the benzene content of the gas do not change over time. The licensee may be required to demonstrate to the satisfaction of AER, upon request, that the implementation of an alternative gas analysis schedule is justified.

45) The DEOS update must include the accuracy, presented in the extended gas analysis, which should not be less than 0.00001 mole faction (or mole percentage equivalent).

46) The licensee must post a complete and accurate DEOS at the dehydrator for inspection by the AER.

47) When the dehydrator operational status changes to "not operating," the licensee must ensure that the DEOS is updated to reflect the not-operating status, and the licensee must update the DEOS again when the dehydrator operational status changes to operating.

    Only the "General Site Information" section of the DEOS needs to be completed for a not-operating dehydrator. Complete the distance to the nearest close proximity development, where known, from a not-operating dehydrator.

5.3 Annual Dehydrator Benzene Inventory Form

48) Licensees must complete and submit to the AER no later than **May 1** of each year the inventory with the data and form (available on the AER website) for the actual operations of the previous calendar year, listing all the licensee's operating and not-operating dehydrators.

    Where the due date falls on a recognized holiday, the inventory form is due on the first business day after May 1.

49) The licensee must submit the inventory form information in the designated information submission system as directed by the AER.

50) Each dehydrator (contactor) must be reported as a separate row.

    In situations where the dehydrator reboiler is used by more than one contactor, benzene emissions are to be allocated back to each dehydrator contactor and reported as a separate row on the inventory form.

51) The licensee as registered with the AER on December 31 of each year must report the dehydrator details on the licensee's annual inventory form for the entire calendar year operations (January 1 to December 31).

    To avoid double accounting, do not report a dehydrator owned by another licensee on December 31 of the operating year. The purchasing and the selling licensees are both responsible for ensuring that necessary information for compliance reporting is both obtained and provided, respectively, upon transfer of a licence for a site with a dehydrator.

52) The licensee must report a dehydrator as operating for the calendar year if it operated as a dehydrator at any time in the calendar year.

    For a not-operating dehydrator (e.g., the dehydrator did not operate as a dehydrator for any time in the reporting calendar year), only the first columns up to and including "Dehydrator Operating Status" need to be completed on the inventory form. Enter the distance, where known, to the nearest close proximity development from a dehydrator that is not-operating.

    A decommissioned dehydrator should be removed from the inventory form after it has been reported once as decommissioned (i.e., decommissioned status for a full calendar year).

53) If a control is not functioning for a period of time the licensee must, to account for higher emissions during control outages, adjust the calculated mass (tonnes) of benzene released and reported.

54) Licensees must keep all supporting documentation that verifies the inventory form data for three years after the submission date, and they must provide the documentation to the AER within 10 business days upon request.

    Documentation to verify the reported benzene emissions includes DEOS forms, emission simulations, extended gas analyses, dehydrator operating condition records, TCT reports, and records that the qualified person and responsible person roles and responsibilities have been met, etc.

55) The licensee must ensure that the completion and submission of the inventory form is overseen by the qualified person and the person responsible for the licensee.

    By submitting the inventory form data to the AER, the licensee is acknowledging that the person responsible has reviewed the information and has confirmed that the data is accurate and

represents actual operations. The person responsible thereby accepts responsibility, on behalf of the licensee, for compliance with these requirements.

56) The licensee must report on the inventory form the annual mass of methane released, in kilograms, for each dehydrator that operated in the calendar year.

Compliance for methane emissions will be addressed under a separate AER regulatory tool.

Appendix 1 Definitions

For the purpose of Directive *039* implementation and compliance assurance, the following definitions apply.

close proximity development	A permanent dwelling, public facility, or development occupied full time or part time (e.g., a private residence, school, hospital, campground recreation centre, work camp, or place of work excluding a neighbouring oil and gas production site) that is located no more than 750 metres from the dehydrator emission source, or no more than 750 metres from the site boundary if considering cumulative emissions from all sources.
condenser system	A condenser system includes all equipment between the still-column-vent exit and the designed condenser emission exit point that releases the treated vapours to the atmosphere or to another control technology (e.g., to a flare). All emissions added or lost between the still-column-vent vapours and the designed final exit point are accounted for as part of the condenser system.
control technology (control)	A technology that processes still-column-vent vapours in order to reduce benzene emissions to the atmosphere. This is often accomplished by the addition of equipment or a change in process flow of the still-column-vent vapours (e.g., vapour recovery with recycle, combustion as a fuel, combustion by flare or incinerator). For reporting purposes, controls are further defined as a primary control and a secondary control.
decommissioned	A dehydrator is classified as decommissioned when it is no longer possible to put it back into service due to its mechanical condition or location (e.g., where the dehydrator is moved to the boneyard, is disassembled, or is no longer serviceable) and the equipment is not going to be used again.
dehydration process	Glycol is commonly used in the oil and gas industry to lower the temperature at which hydrates form or to remove water from natural gas streams, or both. Two common processes are dehydration and refrigeration. While the processes differ both in the primary objective and in the equipment involved in contacting the glycol with the gas stream, the associated emissions released during the regeneration of glycol are similar in both processes, and consequently the emission mitigation strategies are aligned.
dehydrator	Process vessels designed for gas/glycol contact, after which the glycol is regenerated. For the purpose of this directive, a dehydrator includes both dehydration and refrigeration processes.

dehydrator emission source	The location where the still-column-vent vapours are released directly to the atmosphere. For still-column-vent vapours routed to a control technology, the source would be the release point from the technology. Where more than one technology is in use, the emissions source is the one closest to the surface development (e.g., exit from a flare, incinerator, burner vent, or condenser system).
dehydrator engineering and operations sheet (DEOS)	The form, available on the AER website, that is completed by the licensee and posted at the dehydrator location (dehydration and refrigeration) to identify the unique dehydrator, the normal operating conditions for the subsequent 12-month period, and the estimated benzene emissions based on all recorded operating parameters of the dehydrator remaining relatively constant. The format is fixed and the input fields are defined.
dehydrator operating conditions	Any parameter that could affect the rate of benzene emissions from a dehydrator still-column-vent (e.g., glycol circulation rate, benzene content of the inlet gas, stripping gas rate, flash-tank operations, control operations, pump type, temperature and pressure of the contactor or cold separator).
DEOS updating schedule	The DEOS is revised every 12 months, or sooner if operating conditions or operating status change or if the dehydrator is relocated. Status change does not include normal seasonal operating variability that occurs.
inventory form	The form used to individually report a licensee's entire inventory of glycol dehydrators (dehydration and refrigeration contactors) and the benzene emissions and other supporting data for each dehydrator for a calendar year of operations. The format is fixed and the input fields are defined in the downloadable template available on the AER website.
new or relocated dehydrator	A dehydrator that has been installed for the first time at a location or put back into service after 12 months or more under not-operating status.
normal operating conditions	The average of the day-to-day operating conditions over the year to estimate the emissions over the period the DOES will be applied (over the next 12 months or less).
not operating	A dehydrator is considered to be not operating where there is no glycol/gas contact (e.g., equipment is functioning as a separator, is shut in, or is bypassed).
operating	A dehydrator is operating where glycol contacts gas and where glycol regeneration results in emissions from the reboiler still-column-vent. Emissions may or may not contain benzene. Where the dehydrator operates intermittently, such as during seasonal operations, it is considered operating.
optimization of a dehydrator (optimize)	A reduction of emissions before the benzene vapours reach the still-column-vent resulting from a change in equipment or in operating parameters, or both, between initial gas/glycol contact and the regenerator still-column-vent. This is not a control.

person responsible	A senior employee of the licensee who represents the licensee and has the authority to allocate funds toward corrective actions and the authority to direct facility operations, including shutting in production (e.g., vice president of operations), in Alberta.
primary control	The first control technology the still-column-vent vapours are directed to in the order of process flow (e.g., VRU with recycle, incinerator, flare, reboiler burner engineered to remove benzene).
public receptor	A person outside of an upstream oil and gas site boundary
qualified person	A technical person (or persons) appointed by the licensee who has the necessary training, expertise, and technical knowledge of dehydration operations and air emissions management to complete or oversee others completing the tasks to ensure licensee adherence to the requirements of *Directive 039*. See also appendix 3: Qualified Person.
resident	A person who occupies a close proximity development, permanently or part time.
secondary control	The control technology, and subsequent control technologies, in order of process flow that the primary control vapours are directed to. One or more controls in sequence after the primary control that is used to reduce benzene emissions (several secondary controls are listed on the DEOS and inventory forms in the order in which they process benzene emissions).
surface development	A permanent dwelling, public facility, or development occupied full time or part time (e.g., a private residence, school, hospital, campground, recreation centre, work camp, or place of work, excluding a neighbouring oil and gas site).

Appendix 2 Condensing System – Total Capture Testing to Establish Benzene Control Efficiency

Total capture testing purpose:

- Establish site-specific benzene-control efficiency for a condensing system by measuring the removal of benzene emissions from the still-column-vent vapours at normal operating conditions and at steady-state dehydrator processing conditions for compliance purposes.
- Provide emission data that can be used to report before-control and after-control benzene emissions and to calculate the benzene control efficiency (in per cent) for a specific condensing system on a specific site.

In some situations, a one-time test can be adequate for several years (up to five years), provided the dehydrator's normal operating conditions do not change significantly.

A significant change in emissions is any change in dehydrator operations that will or is likely to alter benzene emissions such that

- emissions are estimated to be approaching the benzene emission limit,
- emissions are likely to exceed the required limit (i.e., in noncompliance), or
- the change in benzene emissions will be in the order of ±50% of the allowed limit.

If the licensee has questions or concerns, they are encouraged to contact the AER at BenzeneD39@aer.ca to discuss the testing.

A TCT may no longer be valid when the normal operating conditions of the dehydrator or condensing system, or both, change such that

- the benzene emission rate is expected to be significantly higher than the current reported emissions; or
- the benzene emissions are likely to, or will, exceed the required limits (i.e., a noncompliance).

Changes that might require a retest to claim a benzene removal efficiency include, for example, changes to any of the following:

- glycol circulation rate
- inlet gas composition or flow rate (or both)
- stripping gas operation or flow (or both)
- pump model/make (e.g., a modified or new pump)
- flash tank operation

If testing verifies that the dehydrator emissions are not in compliance with this directive, that test will not be considered valid after the dehydrator operating conditions are modified; emissions must, therefore, be verified again at the new normal operating conditions to establish a benzene control efficiency.

57) The licensee must assess a mass balance of noncondensable vapour from the TCT results to validate or adjust, or both, the TCT results to the satisfaction of the AER.

The mass balance of noncondensable vapour flow measured in the testing is used to validate the test. The methane/noncondensable vapour balance can be used to assess whether the test can be accepted for the benzene control efficiency or whether the benzene emissions rate should be adjusted to reflect loss of noncondensable vapours from the system.

The mass balance approach involves all of the following:

a) An acceptable sampling mass balance difference threshold (approximately ±10%; no adjustment of after-control emissions is required for an imbalance of up to 19%)

b) Rejecting or adjusting the mass balance threshold of a test (≥±20%; upward adjustment of after-control emissions is required)

c) Adjusting benzene emissions after control as an increase based on an imbalance of more than ±20% to allow for a 10% sampling difference threshold

For example, for a 30% methane loss or gain, adjust the after-control benzene emissions up by 20% allowing for the 10% imbalance due to minor equipment leaks or sampling error, or both.

d) Discarding the testing results where mass balance exceeds ±40%.

For example:

A dehydrator limit is 1.0 tonne per year (t/yr). A TCT is completed, and the before-control benzene emissions are 1.40 t/yr and after-control benzene emissions are 0.90 t/yr. The mass balance resulted in a 25% difference in vapour from the system. Therefore, an emissions adjustment is required or the test can be rejected.

Where the licensee chooses to adjust the test results, the after-control emissions are adjusted upward by 15% to meet the 10% tolerance allowance.

Difference in benzene emissions = after-control benzene emissions (t/yr) from TCT × adjustment % = 0.90 t/yr × 15% = 0.14 t/yr

Adjusted after-control benzene emissions = after-control benzene emissions from TCT (t/yr) + difference in benzene emissions = 0.90 t/yr + 0.14 t/yr = 1.1 t/yr

In this example, the dehydrator would be operating in noncompliance if it continued to operate at the same emissions rate.

58) To comply with this directive, the licensee must receive written confirmation from the AER at BenzeneD39@aer.ca to use the TCT results when the test results do not fall within the mass balance tolerance approach described here.

59) The licensee must ensure that TCT methodology and sampling include the following:

a) Consecutive condenser outlet and inlet benzene emission values to establish a benzene control efficiency for a condenser system.

To ensure that normal operating conditions of the condenser are not interrupted, testing is consecutive (not concurrent) and the condensing system outlet is tested before the reboiler still-column-vent exit (condenser inlet).

Accurate flow-rate measurement of all phases in the inlet and outlet streams is required during TCT.

b) Where multiple dehydrator unit still-column-vents are routed to a single condenser system, each dehydrator still-column-vent stream (condenser inlet), the licensee must ensure that the inlet sources are tested individually, and the condenser outlet emissions can be prorated back to each dehydrator.

c) TCT is completed under normal operating conditions, with normal dehydrator process and control equipment, at normal steady-state operations (e.g., at normal gas throughput), and for at least two hours per test.

d) The licensee must ensure that the testing is conducted when the ambient air temperature is at least 15°C. Overhead vapour temperature and ambient temperature shall be accurately measured and recorded.

e) When the licensee needs to complete a test (for compliance) below 15°C due to unplanned changes in operating conditions or other unforeseen compliance purposes, the licensee must get written confirmation from the AER at BenzeneD39@aer.ca.

A cold TCT (a test below 15°C ambient) generally requires only condenser exit sampling at not less than about 0°C for compliance until the full testing can be completed at ambient temperatures of 15°C or higher. The intent is to provide some confidence that emission limits will not be exceeded during the cooler winter months.

f) Testing should not be conducted within 48 hours of the condenser tank contents being drained, or as specified by the AER.

g) The licensee must ensure that liquids collected are managed to control benzene emissions to the atmosphere.

h) The process-flow details/schematic that reflects the dehydrator components and control configuration at the time of the TCT and during normal operating conditions are to be recorded and included with the TCT report.

i) Record operating conditions/parameters of the dehydrator at each TCT test point. Generally, this will include the type of data used in a simulation program. Collect an inlet gas sample for extended gas analysis to verify the composition of the inlet gas during each test, and sample the lean glycol for water content.

j) The licensee representative on the site verifies with the testing company representative and signs off on the operating conditions and system configuration details, as recorded for the TCT report at the time of the test, and verifies that the test conditions represent the normal operating conditions for the system.

k) All identified leaks from the condenser system are recorded and reported on the TCT report so that the leaks are shown on the schematic representing the system configuration.

l) Where the system has openings or leak sources, the licensee must ensure that benzene emissions are accounted for in the most conservative and therefore protective manner unless the openings or leaks are appropriately repaired before the TCT.

   Sources of leaks to the atmosphere could include the tie in on the still-column-vent, the tank gauge board, an open or leaking thief hatch, pressure-relief-type assemblies, secondary containment communication ports, tie-in points, or openings in piping before or after the condensing system.

Examples of accounting for all benzene emission streams:

- Where condenser-tank emissions are directed to the atmosphere, possible condenser- tank leak sources should be sealed before TCT is performed for the after-control emissions to ensure that all emissions going to the atmosphere after condensing are measured. However, when a leak bypasses the condensing part of the system, the noncondensed vapour composition and volumes would have to be accounted for and reported with 0% benzene control efficiency.
- Where condenser-tank emissions are directed to another control system, the exit vapours represent the inlet to the next control (e.g., to a flare), and unrepaired leaks are left open and not sealed for the normal condensing-system-designed outlet test.

  This would allow for the normal two sampling points and ensure that vapours from the designed outlet of the condensing system directed to another control are not over estimated. This sampling approach could overestimate the condenser benzene control efficiency but would

provide a more accurate emission estimate for the next control. (This will generally represent a more conservative result.) Therefore, no condenser efficiency could be claimed here. The test would only provide an estimate of how much benzene is being redirected to secondary controls.

Alternatively, three tests could be done: one at the designed condenser outlet with leaks open, one at the outlet with leaks sealed, and one at the reboiler still-column-vent (condenser inlet). Where the licensee completes the three-test-scenario maximum, representative benzene control efficiency values would be obtained for the condenser system, but with additional cost. (This will generally represent a more accurate result.)

60) The licensee must ensure that TCT oversight and reporting include the following:

a) A qualified person reviews the test methodology, on-site operations, and equipment before testing is conducted to ensure that the TCT will meet the requirements of this directive.

b) A qualified person conducts and verifies emission calculations and TCT to ensure compliance. A qualified person signs off on the accuracy and appropriateness of all work done on behalf of the licensee to comply with the requirements of this directive.

c) The qualified person reviews the final TCT report to ensure that the results are valid.

Appendix 3 Qualified Persons: Competencies for Performing the AER's *Directive 039* Program

Introduction

The person or persons appointed by the licensee is required to have an adequate combination of education, knowledge, experience, and communication and teamwork skills to complete the *Directive 039* program.

The person responsible is accountable for ensuring that the qualified person has the necessary qualifications for the work they have been assigned to oversee and complete.

Key Competencies

- An adequate combination of relevant education, training, and experience in science or engineering (two years or more is recommended)
- Knowledge of AER *Directive 039* regulatory requirements
- Knowledge of the typical operation of gas dehydration and gas refrigeration systems and associated emission-control technologies
- Experience operating, troubleshooting, or providing technical support for dehydration and refrigeration systems
- Ability to prepare spreadsheets, reports, and documents as necessary
- Ability to effectively communicate and coordinate with key parties (e.g., field and regulatory personnel)

Competencies for Specific Tasks

Operational Data Collection

- Ability to coordinate collection and interpretation of the extended gas analysis
- Ability to coordinate the collection and interpretation of relevant glycol regeneration operating data
- Ability to recognize data that is outside typical ranges of operation, including temperature, pressure, gas throughput, glycol circulation rate, pump speed/rate, and gas analysis
- Ability to coordinate collection and interpretation of the TCT, if needed

Benzene Emission Calculation

- Ability to properly interpret, record, and input data for calculation
- Proficiency in the use of regulatory-accepted simulation software for benzene emission calculation; understanding of the potential problems and limitations of the simulation software

- Thorough understanding of the calculation methods for estimating benzene emissions (e.g., simulation vs. rich/lean)
- Ability to complete emission calculations in the form required by AER *Directive 039*
- Ability to complete after-control emission calculations for various regulatory-accepted emission control methods
- Ability to interpret emission calculation results

Reporting

- Thorough knowledge of the requirements and an understanding of the intent of *Directive 039*, including benzene emission limits and other requirements for regulatory compliance
- Understanding of individual unit- and site-wide emissions limits
- Ability to generate an accurate dehydrator engineering and operations sheet (DEOS) report
- Ability to accurately generate an annual benzene dehydrator inventory form
- Ability to manage data or to track and compile information for regulatory compliance
- Ability to check information for accuracy and consistency

Communication

- Ability to manage data appropriately for collection, emission calculation, and report preparation to meet regulatory submission timeframes
- Ability to communicate with operators and recommend operational changes and optimizations
- Ability to follow up with field personnel to resolve discrepancies with received data
- Ability to critically assess information provided by field operators for consistency and accuracy and request supporting information as required