

**OIL AND GAS PRODUCTION FACILITIES**  
**CHAPTER 6, SECTION 2 PERMITTING GUIDANCE**

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY  
AIR QUALITY DIVISION

June 1997  
(revised November 1998)  
(revised January 2000)  
(revised August 2001)

The information presented in this document pertains to oil and gas production operations where oil and gas fluids are produced, processed and treated prior to lease custody transfer.



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## **Introduction**

This guidance document has been compiled to familiarize oil and gas production operators with the Wyoming Air Quality Standards and Regulations (WAQSR) Chapter 6, Section 2 permitting process.

A brief overview of the Wyoming Air Quality Standards and Regulations and the Wyoming Environmental Quality Act, upon which this guidance is based, is included.

A listing of terms and abbreviations, with their definitions, is found in Appendix D of this document.

## **Applicability**

If **ANY** regulated air contaminant is released to the atmosphere from an oil and gas (O & G) production site during the production, processing, storage, loading or transfer of oil and gas resources, that site is subject to Wyoming Air Quality Standards and Regulations and the Wyoming Environmental Quality Act.

Owners/operators of **ALL** emission sources constructed or modified after May 29, 1974 must comply with the WAQSR Chapter 6, Section 2 permitting requirements

**Failure to comply** with Wyoming air quality regulations may result in an enforcement action in the form of a “Notice of Violation” and penalties of up to \$10,000.00 per day.

## **Wyoming Air Quality Regulation Overview**

A very brief overview of some Wyoming air quality regulations which most commonly impact oil and gas production operations follows. This overview is not all inclusive. Other regulations or interpretations not listed here may impact operation. Please refer to the actual regulations for more complete information. A copy of the WAQSR is available free upon request. Ordering information is found at the end of this section.

### **WAQSR Permitting Requirements**

#### **Chapter 6, Section 2 (C6 S2) Permit Requirements for Construction, Modification and Operation**

C6 S2 is Wyoming's New Source Review (NSR) regulation, in effect since May 29, 1974. Facilities in operation before this date may have "grandfathered status" and may be exempt from C6 S2 permitting requirements. See definition of "grandfathered status" in Appendix C.

C6 S2 applies to virtually every situation where air contaminants are discharged to the atmosphere. The C6 S2 permitting process and its potential impacts on a project should be considered in the early stages of project development in order to avoid delays.

If a site, piece of equipment, source, facility or process, which may cause or increase the emission of a regulated air contaminant into the atmosphere, is constructed, modified or operated, that site, piece of equipment, source, facility or process must go through the New Source Review permitting process.

Under C6 S2, the Division has developed the 'Presumptive BACT/Notice of Installation' procedure for O&G production operations, allowing for start-up prior to permit issuance. This procedure is detailed later.

#### **Chapter 6, Section 4 (C6 S4) Prevention of Significant Deterioration (PSD)**

C6 S4 is applicable to any facility which is considered a "PSD major emitting facility"

A C6 S4 "PSD major emitting facility" is one that emits or has the potential to emit 250 tons per year (TPY) or more of a regulated air pollutant.

Sources subject to C6 S4 must adhere to specific permit application requirements such as air quality modeling and strict use of BACT.

Some oil and gas production operations have been subject to PSD requirements due to emissions of volatile organic compounds (VOC) or Sulfur Dioxide (SO<sub>2</sub>) in excess of 250 TPY.

## **WAQSR Permitting Requirements (cont'd)**

### **Chapter 6, Section 3 (C6 S3) Operating Permits**

C6 S3 is Wyoming's operating permit program designed to ensure compliance with all applicable regulations and construction permit conditions by operators of "major sources".

A C6 S3 "major source" is one that emits or has the potential to emit any of the following:

100 TPY or more of any regulated air pollutant (NO<sub>x</sub>, SO<sub>2</sub>, VOC, PM<sub>10</sub>)

10 TPY or more of any individual Hazardous Air Pollutant (HAP)

25 TPY or more of any combination of HAPs

All major sources are subject to C6 S3 regardless of when the source was constructed or modified. There is no "grandfathered status" provision under C6 S3.

WAQSR C6 S3 became effective for oil and gas production operations on February 21, 1995. Major sources in operation at that time had an application/compliance deadline of November 15, 1995.

Major sources commencing operation after November 15, 1995 have one year after commencing operation to submit the required C6 S3 application, comply with the "synthetic minor" exemption as provided by C6 S3(m) or limit emissions through federally enforceable permit conditions to less than "major source" levels.

### **Chapter 5, Section 3 (C5 S3) National Emission Standards for Hazardous Air Pollutants (NESHAP) for Source Categories**

C5 S3 describes specific "Maximum Achievable Control Technology" (MACT) standards for HAPs which must be met for particular types of sources for a given industry. MACT standards may specify equipment design, control and operational requirements, recordkeeping and reporting.

On June 7, 1999, the MACT standard for Oil and Natural Gas Production Facilities, Subpart HH, was promulgated.

Subpart HH may have a significant impact on the design, construction or reconstruction of a facility or piece of equipment. Consulting the standards during the design stage of a facility to determine which standard(s) apply, if any, is important to ensure timely application review and to avoid any delays in planned commencement dates.

The Division has developed the 'Presumptive BACT' process for glycol dehydration and liquid hydrocarbon storage equipment at O&G facilities. For new sources, 'Presumptive BACT' requirements ensure all potentially major sources for HAP emissions from dehydration units and hydrocarbon liquid storage tanks would be eliminated through C6 S2 permitting and subsequent control requirements.

# **WAQSR Performance and Operational Requirements**

## **Chapter 2, Section 7 (C2 S7) Hydrogen Sulfide**

C2 S7 is the State ambient air standard for hydrogen sulfide (H<sub>2</sub>S). In order to comply with this regulation controls may be required to ensure ambient sulfur dioxide or H<sub>2</sub>S standards are not exceeded.

As a minimum the Division prefers that process gas streams containing H<sub>2</sub>S be flared instead of discharging to the atmosphere.

**Caution: Flaring H<sub>2</sub>S creates Sulfur Dioxide (SO<sub>2</sub>), a regulated pollutant, and is likely to result in other control and permitting requirements.**

## **Chapter 3, Section 6 (C3 S6) Volatile Organic Compounds**

C3 S6 references the definition of “volatile organic compounds”, defines smokeless combustion devices and specifies the application of BACT to define acceptable control of VOC emissions.

For combustion devices designated as smokeless through BACT review, “smokeless” means a device designed for and operated with no visible emissions except for periods not to exceed a total of five minutes during any two consecutive hours.

For new combustion devices not designated as smokeless, the 20% opacity limit applies unless a lower limit is established.

## **Chapter 1, Section 5 (C1 S5) Abnormal Conditions and Equipment Malfunctions**

C1 S5 addresses the emission of pollutants which are vented or flared during events such as malfunctions, abnormal conditions or breakdowns beyond the control of the operator.

On April 11, 1986 it was adopted as policy that C1 S5 also include flaring or venting associated with well testing, completions, well workovers and other uncontrollable events the Division may determine to be applicable.

Minimum reporting requirements for these circumstances may be found in the reissue of Air Quality Memorandum, “Reporting Guidelines for Well Flaring or Venting”, dated December 7, 1999, in Appendix F of this guidance.

**Note: Division authorization to flare or vent is required in addition to authorization obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC) or the Bureau of Land Management (BLM).**

## **WAQSR Performance and Operational Requirements** (cont'd)

### **Chapter 5, Section 2 (C5 S2) New Source Performance Standards (NSPS)**

C5 S2 describes specific performance standards which must be met for particular types of sources for a given industry. These standards specify equipment design and operation, recordkeeping and reporting.

C5 S2 standards may have a significant impact on the design and construction of a piece of equipment or facility. Consulting the standards during the design stage of a facility is important.

The most common C5 S2 standard applicable to oil and gas production operations is Subpart Kb, which specifies construction and recordkeeping requirements for liquid hydrocarbon storage tanks.

This regulation overview briefly summarizes some of the more common Wyoming air quality standards and regulations which are commonly part of the new source review process. It is the applicant's responsibility to understand the regulations that are applicable to a source or facility and the air quality requirements which must be addressed.

To obtain a copy of the WAQSR contact the Wyoming Air Quality Division at:

(307) 777-7391

## **Chapter 6, Section 2 Oil and Gas Operations Application Process**

C6 S2 requires **ALL** new or modified sources or facilities which may generate air emissions be permitted prior to start up.

Since emissions from O&G production operations may not usually be determined prior to start-up, the Division has developed the **Notice of Installation (NOI)** procedure which allows facilities to become operational prior to issuance of a permit. The NOI procedure must be followed up with a complete permit application after the new O & G facility is in production.

The Division has incorporated BACT into the NOI process, calling it ‘**Presumptive BACT**’. Presumptive BACT applies to VOC and HAP emissions associated with dehydration units, hydrocarbon liquid storage tanks and pressure vessels (heater/treaters, separators, gunbarrels, water knockouts). Threshold levels of VOC and HAP emissions, above which emission controls are required, have been established by the Division and are incorporated into the ‘presumptive BACT’ process.

**NOTE:** The NOI process may not be used for production facilities where sour gas (H<sub>2</sub>S) is produced unless the only emissions of H<sub>2</sub>S are those associated with fugitive losses. If there are H<sub>2</sub>S emissions associated with vented gas, or if sour gas is flared, the operator should contact the Division for guidance on permitting.

**NOTE: NO internal combustion compressor engines or generator engines may be installed under the NOI process. Additionally, no pumping unit engines greater than 50 Hp or with NO<sub>x</sub> emissions greater than 10 TPY may be installed under the NOI process. Applicants must acquire a C6 S2 permit prior to installation of these engine.**

If you feel the NOI and subsequent application procedures are not applicable to your particular O & G production facility, contact the Division for guidance.

### **Notice of Installation (NOI)**

The **NOI** process enables startup of O & G production operations, where emissions are associated with production equipment for new, recompleted or stimulated wells, prior to issuance of a C6 S2 permit.

**Criteria for use** - There are two operational scenarios for which the NOI procedure may be used:

1. The source, facility, or increase in emissions requiring a permit is due to the following situations where new production rates must be established before total emissions can be determined:
  - a. new well
  - b. recompletion
  - c. stimulation project

## **Notice of Installation (NOI)** (cont'd)

**Note:** Workovers performed for repair, replacement or preventative maintenance of downhole equipment are not considered recompletion or stimulation projects and do not require a permit application.

2. The source or facility **ONLY** emits:
  - a. VOC and HAP emissions associated with pressure vessels, dehydration units, storage tanks, pneumatic equipment and fugitive leaks
  - b. combustion emissions (NO<sub>x</sub>, CO and VOC) associated with exempt sources specified in C6 S2 (k) and small (<50 Hp) pumping unit prime mover engines emitting less than 10 TPY NO<sub>x</sub>
  - c. FUGITIVE VOC, HAP and H<sub>2</sub>S emissions associated with well head components

## **NOI Used as a Complete Application**

In one case, the NOI serves as a complete application with no further permitting actions required. For all other cases, the NOI must be followed up with a complete C6 S2 application.

The NOI serves as a complete C6 S2 application for production facilities from which the only emissions are, and will continue to be:

- **FUGITIVE** VOC, HAP and H<sub>2</sub>S associated with the well head, pumping tee or 'christmas tree' components, and with a closed-system pressure vessel;
- NO<sub>x</sub> and CO associated with sweet natural gas-fired process heaters (<10 MMBtu/hr);
- less than 10 TPY NO<sub>x</sub> associated with small (<50 Hp) internal combustion pumping unit prime mover engines;

To use the NOI as a complete application, submit the NOI form (**AQD-OG7**) to the Division within 40 days of the "*First Date of Production*". No further application to the Division is necessary.

**NOTE:** **The NOI form DOES NOT serve as a complete application** for facilities with hydrocarbon liquids storage tanks and/or glycol dehydration units. These facilities require a complete C6 S2 application.

## **Notice of Installation (NOI)** (cont'd)

Equipment meeting the two criteria described above may be installed and operation may begin.

Within 40-days of the “*First Date of Production*” submit the appropriate NOI form(s) (**AQD-OG7 & AQD-OG7d**) to the Division. Emissions and production information on these forms must be based on, at least, the first 30-days following the “*First Date of Production*” at the new or modified facility. The NOI procedure includes prescribed controls for VOC and HAP emissions from tanks, pressure vessels and glycol dehydration units

There are two NOI forms:

Form **AQD-OG7** is for use with facilities consisting of the ‘usual, standard production equipment’ including separation vessels and tankage, but **NO** glycol dehydration unit.

Form **AQD-OG7d** is to be used for glycol dehydration units.

If a facility consists of the ‘usual standard production equipment’ and no dehydration unit, only form **AQD-OG7** must be submitted.

If the facility consists of the ‘usual standard production equipment’ in addition to a dehydration unit, both forms **AQD-OG7 AND AQD-OG7d** must be submitted.

If the facility consists of a dehydration unit only, only form **AQD-OG7d** must be submitted.

## **NOI & Presumptive BACT for Storage Tanks and Pressure Vessels**

When, through BACT review, control of VOC and HAP emissions associated with flashing losses from pressure vessels and production storage tanks at new or modified wellsite facilities is required, the following control systems/devices are accepted by the Division:

- Vapor recovery device that is designed and operated to reduce the mass content of VOCs and total HAPs in the vapors vented to the device by at least 98% by weight.
- An enclosed, smokeless combustion device (e.g., thermal vapor incinerator, boiler or process heater) or flare than can be demonstrated to reduce the mass content of VOCs and total HAPs in the vapors vented to the device by at least 98% by weight.
- Any other control device or configuration that can be demonstrated to reduce the mass content of VOCs and total HAPs in the vapors vented to the device or configuration by at least 98% by weight, subject to the Division’s concurrence with the control scheme and approval.

## **NOI & Presumptive BACT for Storage Tanks and Pressure Vessels**

(cont'd)

To estimate air emissions from pressure vessels and storage tanks, there are software applications available which simulate flashing emissions. The Division recommends a flash simulation model which uses either the Peng-Robinson or Sauve-Robinson-Klieve (SRK) equations of state. The following is a list of suitable software. This list is not all inclusive nor does it represent any endorsement by the State.

### **E & P TANK Version 1.0 or 2.0 Software**

To order a copy contact the API Order Desk, 202-682-8375

<<http://www.api.org/>>

### **K-FLASH by Kesler Engineering, Inc.**

To order contact 908-238-6700

### **HYSIM by Hypotech**

To order contact 713-870-1900

For air emissions from pressure vessels and tanks used for **crude oil** production and storage, the Vasquez-Beggs correlation, in addition to the aforementioned software, may be used. **The Vasquez-Beggs correlation is not appropriate for use with condensate liquids.** The Division provides an Excel spreadsheet to perform this calculation. The spreadsheet can be downloaded from the DEQ website:

<<http://deq.state.wy.us/aqd.htm>>

Working losses (vapors displaced from tanks when liquids enter the tank) and breathing losses (also known as standing or storage losses) may be estimated using:

EPA's TANKS ver. 3.0 - 4.0 software

download from: <<http://ttnwww.rtpnc.epa.gov/html/chief/tank-dn.htm>>

Note: E & P TANK, K-FLASH and HYSIM software calculate working, standing and breathing losses in addition to flashing losses, so EPA's TANKS ver 3.0 - 4.0 software is not necessary when using these emission models.

## **NOI & Presumptive BACT for Storage Tanks and Pressure Vessels**

(cont'd)

Pressure vessels (separators, treaters, knockouts, gunbarrels, etc..) and storage tanks at new or modified oil and gas production wellsite facilities may be installed and operation may begin immediately.

Within 40-days of the 'First Date of Production'<sup>1</sup> the applicant shall file a Notice of Installation (form AQD-OG7) with the Division. Among other information, the NOI shall include 'Projected Average Annual VOC and HAP Emissions' associated with the pressure vessels or tanks.

Within 180-days of the 'First Date of Production' a complete Chapter 6, Section 2 Oil and Gas Production Operations Permit Application must be filed with the Division.

## **Determination of 'Projected Average Annual VOC and HAP Emissions' from Storage Tanks and Pressure Vessels**

To determine 'Projected Average Annual VOC and HAP Emissions' use the following steps:

**STEP 1** Determine the average daily liquid hydrocarbon production rate at the facility based on, at least, the first 30 days following the 'First Date of Production'.<sup>1</sup> To account for an expected decline in liquid production rates during the first year of operation multiply the average daily liquid hydrocarbon production rate by the appropriate decline factor listed below:

For **condensate** production, multiply the average daily condensate production rate from the first 30-days by 0.6. This accounts for a first year expected decline of 80%. (It is acceptable to use projected decline rates less than 80%. Decline rates greater than 80% may not be used unless pre-approved by the Division.)

For **crude oil** production, multiply the average daily oil production rate from the first 30-days by the average first-year production decline rate typical for the field/formation from which the new well produces. The decline rate used must be confirmed through documentation presented with the NOI.

**STEP 2** Determine, through sampling, the chemical composition of the 'wet' condensate or oil<sup>2</sup> and additional physical properties necessary for input to an emissions estimating model or equation. A 'representative' analysis of the wet condensate or oil is acceptable. A representative analysis must consist of at least five

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<sup>1</sup> See Appendix C, Definitions for 'First Date of Production'

<sup>2</sup> See hydrocarbon liquid sampling and analyses in Appendix D

samples from surrounding wells producing from the same formation and field as the new well.

## **Determination of ‘Projected Average Annual VOC and HAP Emissions’ from Storage Tanks and Pressure Vessels (cont’d)**

- STEP 3** Gather all operating parameters for the pressure vessels and storage tanks, (temperature, pressure, throughput, etc.) necessary for input to an approved emissions model or equation.
- STEP 4** Using the declined average annual liquid production rate from STEP 1, the physical properties of the liquid from STEP 2 and the operating parameters for STEP 3, use an approved emissions estimating model or procedure to determine tons per year of VOC and HAP flashing emissions. These are the **‘Projected Average Annual VOC and HAP Flashing Emissions’** for the first year of operation.

## **Control Requirements for Storage Tanks and Pressure Vessels**

If **projected average annual VOC or HAP flashing emissions**, rounded to the nearest 1.0 ton, are equal to or greater than “major source” levels (100 TPY VOC, 25 TPY combined HAPs, 10 TPY individual HAP), an approved control must be installed and operational no later than 120-days after the ‘First Date of Production’ and before “major source” levels are emitted.

**CAUTION:** A source or facility **SHALL NOT** emit regulated air pollutants at rates which would equal or exceed “major source” levels in actual first-year emissions. VOC or HAP flashing emissions **MUST** be limited through a combination of emissions control and/or limited production prior to reaching “major source” levels.

**NOTE:** Continuous operation of combustion devices used for control of flashing emissions from potentially major sources, by monitoring for the presence of a continuous pilot flame using a thermocouple and continuous recording device or any other equivalent device to detect the presence of a flame, will become an enforceable permit condition.

**NOTE:** The Division shall be notified of installation within 15 days after installation of the approved control device.

If **projected average annual VOC flashing emissions**, rounded to the nearest 1.0 ton, are equal to or greater than 40 TPY and less than “major source levels”, an approved control must be installed and operational no later than 120-days after the ‘First Date of Production’.

**NOTE:** The Division shall be notified of installation within 15 days after installation of the approved control device.

If **projected average annual VOC flashing emissions**, rounded to the nearest 1.0 ton, are less than 40 TPY, no control is required under the presumptive BACT process.

## **Control Requirements for Storage Tanks and Pressure Vessels** (cont'd)

Normally, production from new wells declines substantially during the first year of production. This is anticipated with the projected decline rates for condensate and oil production allowed under the Presumptive BACT process. Occasionally production rates remain constant or even increase after a new well is brought on line. When this is the case, and Projected Average Annual VOC flashing emissions do not decline to below 'Presumptive BACT' levels (40 TPY during the first year) as predicted during the NOI process, the applicant may be required to install an emissions control device. This will be determined during permit application review.

Opacity of emissions from combustion devices installed under the NOI/Presumptive BACT process is limited to 20 percent prior to permit issuance. Upon permit issuance, the Division may specify a lower limit on opacity of emissions from combustion devices or may require they be smokeless as defined in Chapter 3, Section 6(b)(i) of the WAQSR.

While control devices installed under the NOI/Presumptive BACT process are not installed under authorization of any permit, their continued operation will be required by a subsequently issued permit.

Flashing emission control devices installed under the NOI/Presumptive BACT process may be removed after the first year following installation of the control device provided it can be demonstrated that the previous, 30-day, uncontrolled, annualized VOC emission rate is less than 30 TPY. No prior authorization or permit modification is required by the Division for control device removal, however, the owner/operator must notify the Division of removal and certify by letter the reduced emission rate within 30-days of control device removal.

## **NOI & Presumptive BACT for Glycol Dehydration Units**

The following applies to glycol dehydration units located at natural gas production wellsite facilities. This does not include dehydration units located at natural gas processing plants, natural gas compression facilities, natural gas transmission facilities or natural gas storage facilities. Dehydration units located at facilities other than natural gas production wellsite facilities must be permitted by the Division prior to installation.

When, through BACT review, control of emissions associated with glycol dehydration units, including the reboiler still vent and the vent from the GCG separator (flash tank), if present, is required, the following control systems/devices are accepted by the Division:

1. Vapor recovery device (e.g., condenser, BTEX control system) that is designed and operated to reduce the mass content of total HAPs in the gases vented to the device by at least 95% by weight and the mass content of VOCs in the gases vented to the device by at least 90% by weight.
2. An enclosed combustion device (e.g., thermal vapor incinerator, boiler or process heater) or flare that can be demonstrated to reduce the mass content of total HAPs in the gases vented to the device by at least 95% by weight and the mass content of VOCs in the gases vented to the device by at least 90% by weight.
3. Any other control device or configuration that can be demonstrated to reduce the mass content of total HAPs in the gases vented to the device or configuration by at least 95% by weight and the mass content of VOCs in the gases vented to the device or configuration by at least 90% by weight, subject to the Division's concurrence with and approval of the control scheme.

## **NOI & Presumptive BACT for Glycol Dehydration Units** (cont'd)

Air emissions from glycol dehydration units shall be determined using the model GRI-GLYCalc Version 2.0 or higher. Other methods of determining emissions may be used with pre-approval from the Division.

GRI-GLYCalc can be ordered through the GTI Fulfillment Center:

GTI Fulfillment Center  
1510 Hubbard Drive  
Batavia, IL 60510  
FAX: 630.406.5995  
Phone: 630-406-5900  
E-Mail: [fillit@compuserve.com](mailto:fillit@compuserve.com)

Glycol dehydration units at new or modified oil and gas production wellsite facilities may be installed and operation may begin immediately.

Within 40-days following the 'First Date of Production'<sup>3</sup> the applicant shall file a Notice of Installation (NOI) form AQD-OG7d with the Division. Among other information, the NOI shall include 'Projected Potential Annual VOC and HAP Emissions' from the dehydration unit(s).

Within 180-days of the 'First Date of Production' a complete Chapter 6, Section 2 Oil and Gas Production Operations Permit Application must be filed with the Division.

## **Determination of 'Projected Potential Annual VOC and HAP Emissions' from Glycol Dehydration Units**

To determine 'Projected Potential Annual VOC and HAP Emissions' use the following steps:

- STEP 1** Determine the average, daily gas production rate at the new or modified facility based on, at least, the first 30-days following the 'First Date of Production'.  
To account for an expected 80% decline during the first year of operation, multiply the average, daily gas production rate by 0.6. This is the projected, daily gas production rate for the first year of operation. It is acceptable to use projected decline rates less than 80%. Decline rates greater than 80% may not be used unless preapproved by the Division.

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<sup>3</sup> See Appendix C - Definitions, for 'First Date of Production'

## **Determination of ‘Projected Potential Annual VOC and HAP Emissions’ from Glycol Dehydration Units (cont’d)**

- STEP 2** Determine, through sampling, the chemical composition of the **wet** gas. The wet gas sample must be taken upstream of the dehydration unit. Normally this is at the gas outlet of the separator. (See natural gas sampling and analysis in Appendix D.) This analysis must be used as input in the GRI-GLYCalc model. A ‘representative’ analysis of wet gas is acceptable. A representative analysis must consist of at least five samples from surrounding wells producing from the same formation and under the same conditions as the new well.
- STEP 3** Gather all operating parameters necessary for input to the GRI-GLYCalc model.
- STEP 4** Using the projected first year, daily gas production rate, wet gas composition and operating parameters described in STEPS 1 - 3, **the maximum lean glycol circulation rate for the particular pump model in use** and the GRI-GLYCalc model, determine tons per year of VOC, and individual and total HAP emissions. These are the ‘Projected Potential Annual VOC and HAP Emissions’ for the first year of operation.

## **Control Requirements for Glycol Dehydration Units**

**If ‘Projected Potential Annual VOC or Total HAP’ emissions**, rounded to the nearest 0.1 ton of total HAPs and 1.0 ton of VOCs, from the dehydration unit(s) at a single or PAD production facility are equal to or greater than major source levels (100 TPY VOC, 10 TPY for an individual HAP or 25 TPY for combined HAPs), an approved emission control device must be installed within 45 days of the ‘First Date of Production’.

**CAUTION:** A dehydration unit **SHALL NOT** emit regulated air pollutants at rates exceeding “major source” levels in actual first-year emissions prior to the 45-day control installation deadline. Emissions **MUST** be limited through a combination of emissions control and/or limited production prior to reaching “major source” levels.

**REMINDER:** The Division shall be notified within 15 days after installation of the approved control device on dehydration units with ‘major source’ levels of ‘Projected Potential Annual VOC or Total HAP Emissions’.

**If ‘Projected Potential Annual VOC or Total HAP Emissions’**, rounded to the nearest 0.1 ton of total HAPs and 1.0 ton of VOCs, from the dehydration unit(s) at a single or PAD production facility are

## **Control Requirements for Glycol Dehydration Units** (cont'd)

equal to or greater than 15 TPY VOC or 7 TPY total HAPs, and less than major source levels, one of the following must be done:

1. Install an approved emission control device satisfying the BACT requirements described earlier within 120-days of the 'First Date of Production'. Operation of the control device will become an enforceable permit condition.

**REMINDER: The Division shall be notified of installation of the control device within 15 days after installation.**

2. Install a different glycol circulation pump or modify the existing pump in order to physically limit the maximum lean glycol circulation rate such that 'Projected Potential Annual Emissions' do not exceed 15 TPY VOC or 7 TPY total HAPs. Installation of a different glycol pump or modification of the existing pump must take place within 120-days of the 'First Date of Production'. The dehydration unit may then receive a waiver from permitting requirements.

**REMINDER: The Division shall be notified of installation of the different pump or modification to the existing pump within 15 days after installation or modification.**

3. Limit 'Projected Potential Annual VOC and Total HAP Emissions' to less than 15 TPY VOCs or 7 TPY total HAPs by limiting the glycol pump circulation rate. The limited glycol pump circulation rate must be implemented within 40 days of the 'First Date of Production'.

**REMINDER: Certification that the pump rate has been limited must be confirmed on the NOI form. Recordkeeping and monitoring of the limited rate must be implemented within 40 days of the 'First Date of Production'.**

The limited glycol circulation rate and recordkeeping and monitoring of the limited rate, on no less than a monthly basis, will be enforceable permit conditions.

To determine the limited lean glycol circulation rate, use the same parameters determined in STEPS 1-4 above in the GRI-GLYCalc model, changing only the lean glycol circulation rate.

## Control Requirements for Glycol Dehydration Units (cont'd)

If 'Projected Potential Annual VOC or Total HAP Emissions', rounded to the nearest 0.1 ton of total HAPs and 1.0 ton of VOCs, are less than 15 TPY VOC and 7 TPY total HAPs no control is necessary under the 'Presumptive BACT' process.

Normally, gas production from new wells declines substantially during the first year of operation. This is anticipated with the projected decline rate allowed under the Presumptive BACT process. Occasionally gas production rates remain constant or even increase after a new well is brought on line. When this is the case and Projected Potential Annual VOC and Total HAPs emissions have not declined to below 'Presumptive BACT control levels' as predicted during the NOI process, the applicant may be required to follow one of the three options listed above. This will be determined during permit application review.

## Recordkeeping and Monitoring Requirements

When 'Projected Annual VOC and/or Total HAP Emissions' are limited through reduction of the lean glycol circulation rate, the limited circulation rate will become an enforceable permit condition, as follows:

*The lean glycol circulation rate of the ACME Model 12345 glycol circulation pump shall not exceed ## gallons per minute (## strokes per minute).*

The permittee will be required to monitor and keep records to ensure compliance with the limited rate, as follows:

*ABC Production Company shall monitor and record the lean glycol circulation rate each time the XYZ dehydration unit is inspected or visited by field personnel. This shall occur no less than one time every 30 days. With each inspection or visit, the lean glycol circulation rate shall be recorded as follows:*

*circulation rate, as found (gpm, spm) \_\_\_\_\_  
circulation rate, as left (gpm, spm) \_\_\_\_\_  
date of inspection \_\_\_\_\_  
inspected by \_\_\_\_\_*

*gpm = gallons per minute<sup>4</sup>  
spm = strokes per minute*

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<sup>4</sup> See Appendix D, Page D10, for information on determining glycol circulation rates

## **Chapter 6, Section 2 Application**

Production equipment is in operation, the NOI was submitted within 40-days of the 'First Date of Production' and now the complete Chapter 6, Section 2 permit application must be filed.

Within 180 days of the "*First Date of Production*" submit **THREE** copies of each application with the required attachments to the Division's Cheyenne Office at:

122 West 25<sup>th</sup> Street  
Herschler Building, 4-W  
Cheyenne, Wyoming 82002

The Division will distribute copies to the appropriate District Office.

A complete application shall include:

- **AQD-OG1** Application Cover Sheet
  
- The appropriate form for each source;
  - AQD-OG2** Reciprocating Engine form
  - AQD-OG3** Glycol Dehydration Unit form
  - AQD-OG4** Storage Tanks and Other VOC Emission Sources at **Wellsite Facilities**
  - AQD-OG4a** Storage Tanks and Other VOC emission sources at **Centralized Tank Batteries**
  - AQD-OG5** Flares/Combustion Control Devices and other Fuel Burning Equipment
  - AQD-OG6** Pollutant Emission Summary for all Pollutants and for total HAPs  
Always fill out the first portion of the form for all pollutants.  
If total HAP emissions from the facility exceed 9 TPY, fill out the second section of the form - a breakdown of individual HAPs. If any sources at the facility are, or will be controlled, include **BOTH** uncontrolled and controlled emissions for those sources.
  
- Identification of emissions estimating methods for each source:
  - Include examples and references of all calculation methods and emission factors used (see Appendix B for calculation methods) and documentation of any assumptions.
  
- Any required attachments including:
  - A brief process description identifying emission sources.
  - Any manufacturer's information pertaining to emissions.
  - Any laboratory analysis used to obtain information for emission estimates. (With any analysis, include a description of sample origin, sampling procedures and sampling parameters (i.e., pressure and temperature)).
  - Any BACT control cost analyses and supporting documentation
  - Any process simulation software **INPUT** and **OUTPUT**.

## **Chapter 6, Section 2 Application** (cont'd)

Any additional attachments necessary to fully document the application.

When the Division receives the application it will be dated, logged into the Division's tracking system, assigned a reviewing engineer, and a receipt letter will be sent to the applicant.

The reviewing engineer has up to 30-days to perform a completeness review, during which time the application is checked to ensure adequate information has been submitted and correct emission calculation techniques have been used.

The reviewing engineer has up to 60-days to complete a technical review, write an application analysis and make any recommendations. It is during this process that BACT is evaluated, the decision to issue a permit or waiver takes place and any compliance requirements are proposed.

The applicant is then informed of the decision to waive the facility from permit requirements or that a proposed permit is going out for the mandatory 30-day public comment period.

**Note:** If public comments are received or a public hearing is requested delays may occur.

## **Best Available Control Technology (BACT)**

Chapter 6, Section 2 (c)(v) states Best Available Control Technology, with consideration given for technical feasibility and economical reasonableness, will be used for reducing or eliminating emissions from a facility.

BACT is a process, not an emission limit. Regulation does not set a minimum emission threshold below which BACT does not need to be considered. However, **for sources other than pressure vessels and storage tanks and glycol dehydration units installed under the “presumptive BACT” process**, Division policy requires BACT must be considered for:

VOC emissions 15 TPY or more

Total HAP emissions 5 TPY or more

NO<sub>x</sub> emissions from a pumping unit engine, if the engine is 50 Hp or more or NO<sub>x</sub> emissions from the engine are 10 TPY or more ...

### **THEN EITHER**

The emission source will be controlled using BACT

### **OR**

A BACT analysis will be performed and submitted with the application showing either:

Control is not technically feasible (i.e., due to physical constraints the emissions can not be controlled)

### **OR**

Control is not economically reasonable (i.e., based on a control cost analysis the “cost to control per ton of pollutant reduced” is uneconomical).

**CAUTION:** BACT may be required at lower levels and for other emission sources than stated in this guidance, but as a minimum, BACT must be considered when equal to or above these guidance emission levels.



## **How to obtain Chapter 6, Section 2 application forms and information**

The Air Quality Division has designed a set of application forms for the Oil and Gas Production Industry. These may be obtained at no charge by:

Making verbal or written request to:

Wyoming Department of Environmental Quality  
Air Quality Division  
122 West 25<sup>TH</sup> Street  
Herschler Building, 4-W  
Cheyenne, Wyoming 82002  
Telephone: (307) 777-7391  
Fax: (307) 777-5616

Downloading electronic copies of these forms from the Air Quality Section of the State of Wyoming Department of Environmental Quality Web Site at

<<http://deq.state.wy.us/aqd.htm>>

## **Fees**

A fee based on a rate of \$30.00 per hour will be assessed for the time it takes Division personnel to process the application. A bill will be sent to the applicant when the processing of the Chapter 6, Section 2 permit application is complete.

The Division billing is handled as follows:

**Initial billing** is assessed when a proposed permit is sent to public notice. Initial billing must be paid prior to issuance of the final permit.

**Final billing** is assessed for waivers and permits after these are issued.

# **APPENDIX A**

## Forms



## **Oil and Gas Production Operations Application Forms**

<b>AQD-OG1</b>	Application Cover Sheet
<b>AQD-OG2</b>	Reciprocating Engine Form
<b>AQD-OG3</b>	Glycol Dehydration Unit Form
<b>AQD-OG4</b>	Storage Tanks and Other VOC Emission Sources for <u>Well Site Facilities</u>
<b>AQD-OG4a</b>	Storage Tanks and Other VOC Emission Sources for <u>Central Tank Batteries</u>
<b>AQD-OG5</b>	Heaters, Boilers, Combustion Chambers, Flares and Other External Combustion Equipment
<b>AQD-OG6</b>	Pollutant Emission Summary
<b>AQD-OG7</b>	Notice of Installation Form for Storage Tanks and Pressure Vessels. This form is for production facilities WITHOUT dehydration units. If the facility includes a dehydration unit, included form AQD-OG7d.
<b>AQD-OG7d</b>	Notice of Installation Form for Glycol Dehydration Units.
<b>AQD-OG8</b>	Multiple Facility Application Form
	<b>Note:</b> If there are more than (5) five facilities in a multiple facility application, please submit the required information in table format using an electronic spreadsheet such as Excel or Access.
<b>AQD-OG9</b>	Change of Ownership Form
<b>AQD-OG10</b>	BACT Control Cost Analysis Worksheet

These forms are available in WordPerfect, PDF or Excel formats in the Downloadable Files, Forms and Reports section under “Oil and Gas Application Forms” of the Air Quality Section of the State of Wyoming Department of Environmental Quality Web Site at  
<<http://deq.state.wy.us/aqd.htm>>



# **APPENDIX B**

## Calculation Methods



**APPROVED CALCULATION METHODS AND PRACTICES**

Air emissions are usually calculated and shown in two formats. Please supply both these formats when requested, using the following significant figure representations:

**x.xx lb/hr** (Pounds per hour format)  
**x.x TPY** (Tons per year format)

**EMISSIONS FROM RECIPROCATING ENGINES**

Complete a “Reciprocating Engine Form” (AQD-OG2) for each engine.

The preferred method for calculating engine emissions is use of Manufacturer's emission factors, in grams per horsepower hour (g/Hp-hr), for nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO) and non-methane/non-ethane hydrocarbons (NMEHC, also considered VOC).

**Note:** If manufacturer’s emission factors can not be obtained then it is acceptable to use the appropriate emission factors from EPA’s AP-42, Section 3, latest version.

The most commonly used emission factors from table from AP-42, Section 3, for uncontrolled natural gas fired internal combustion engines, are listed below:

**AP-42, Table 3.2-1: Emission Factors for Uncontrolled Natural Gas Prime Movers**

Pollutant	2-Cycle Lean Burn		4-Cycle Lean Burn		4-Cycle Rich Burn	
	lb/hp-hr (power input)	lb/MMBtu (fuel input)	lb/hp-hr (power input)	lb/MMBtu (fuel input)	lb/hp-hr (power input)	lb/MMBtu (fuel input)
NO <sub>x</sub>	.024	2.7	0.026	3.2	0.022	2.3
CO	0.00331	0.38	0.00353	0.42	0.019	1.6
TOC <sup>1</sup>	0.013	1.5	0.011	1.3	.00265	0.27

1-TOC is total organic compounds (also sometimes referred to as THC). To determine VOC emissions calculate TOC emissions and multiply the answer by the VOC weight fraction of the fuel gas used.

***Reciprocating engine emission calculation example:***

Manufacturer's NO<sub>x</sub> Emission Factor (EF) is 2.0 g/Hp-hr  
Engine's Maximum Site Rated Horsepower was calculated to be 250 Hp  
Engine is expected to operate year round or 8,760 hours/year

$$\text{Emissions (lb/hr)} = \text{EF (g/Hp-hr)} * (1 \text{ lb}/454 \text{ g}) * \text{Max. Site HP (Hp)}$$
$$\text{Emissions (lb/hr)} = (2.0 \text{ g/Hp-hr}) * (1 \text{ lb}/454 \text{ g}) * (250 \text{ Hp}) = \underline{\underline{1.10 \text{ lb/hr NO}_x}}$$

$$\text{Emissions (TPY)} = \text{Emissions (lb/hr)} * \text{Operating Hours (hrs/yr)} * (1 \text{ ton}/2000 \text{ lb})$$
$$\text{Emissions (TPY)} = (1.10 \text{ lb/hr}) * (8760 \text{ hours/year}) * (1 \text{ ton}/2000 \text{ lb}) = \underline{\underline{4.8 \text{ TPY NO}_x}}$$

***Reciprocating engine VOC emission calculation example:***

AP-42 TOC Emission Factor (EF) = 0.00265 lb/Hp-hr  
Engine's Maximum Site Rated Horsepower is 250 Hp  
Engine is expected to operate year round or 8,760 hours/year  
\*\*\***Assumption:** Use TOC factor for VOC factor.

$$\text{VOC Emissions (lb/hr)} = \text{TOC EF (lb/Hp-hr)} * \text{Max. Site Hp (Hp)}$$
$$\text{Emissions (lb/hr)} = (0.00265 \text{ lb/Hp-hr}) * (250 \text{ Hp}) = \underline{\underline{0.66 \text{ lb/hr VOC}}}$$

$$\text{VOC Emissions (TPY)} = \text{VOC Emissions (lb/hr)} * \text{Operating Hours (hrs/yr)} * (1 \text{ ton}/2000 \text{ lb})$$
$$\text{Emissions (TPY)} = (0.66 \text{ lb/hr}) * (8760 \text{ hours/year}) * (1 \text{ ton}/2000 \text{ lb}) = \underline{\underline{2.9 \text{ TPY VOC}}}$$

**EMISSIONS FROM GLYCOL DEHYDRATOR REBOILER STILL COLUMN VENTS**

**Complete a "Glycol Dehydration Unit Form" (AQD-OG3) for each unit.**

Air emissions from glycol dehydration units shall be determined using the model GRI-GLYCalc Version 2.0 (or higher). Other methods may be used only with pre-approval from the Division.

Information provided to the Division shall include:

- a. A recent extended lab analysis of wet gas. A wet gas sample is taken upstream of the contactor/absorber tower, of the dehydration unit). Correct gas sampling procedures are outlined in the GRI-GLYCalc manual.
- b. A printout of the GRI-GLYCalc model input AND output parameters. (Choose the programs 'aggregate report.)

## EMISSIONS FROM HYDROCARBON STORAGE TANKS

Complete a “Storage Tanks and Other VOC Emission Sources Form” (AQD-OG4 or AQD-OG4a) for each tank.

There are three types of emissions from hydrocarbon liquid storage tanks; 1) flashing losses, 2) working losses and 3) breathing losses. All three must be accounted for when determining the total emissions from storage tanks.

The Division will accept several different methods for the calculation of VOC/HAP emissions from storage tanks. Regardless of the method used, information provided to the Division shall include the input and output for simulation models and software, all calculations, documentation of any assumptions used, descriptions of sampling methods and conditions, copies of any lab sample analysis, etc.

### Flashing Losses

Flashing losses are emissions which occur when hydrocarbon liquids are exposed to temperature and pressure drops (i.e., from separator pressure/temperature to storage tank pressure/temperature). Flashing loss emission estimation methods are listed below:

1. **HYSIM, HYSYS, K-FLASH Simulation Software** - use either Peng-Robinson or S-R-K methods to model the VOC/HAP flashing, working and breathing losses. (An extended hydrocarbon liquid analysis of a pressurized hydrocarbon liquid sample, from the separator upstream of the flash being modeled, is required).
2. **E & P TANKCalc (API Process Simulation Model)** - an air emissions model for VOC/HAP flashing, working and breathing losses from petroleum production storage tanks and flash vessels (development supported by the American Petroleum Institute (API) and the Gas Research Institute (GRI)). This program requires an extended analysis of the hydrocarbon liquid from the pressurized vessel. The sample must be pulled upstream of the storage tank, at the temperature and pressure of that vessel. Version 2.0 was released in April, 2000.
3. **Vasquez-Beggs Correlation** - a mathematical correlation for estimating flashing emissions from **crude oil** storage tanks. This correlation requires a analysis of vapors from the stock tank, basic facility process information and the specific gravity of gas off the separator. This is a simpler method than the process simulators mentioned above, but reportedly will underestimate VOC emissions for larger pressure drops. Vasquez-Beggs is used for modeling **flashing emissions associated with crude storage tanks, not natural gas/condensate storage tanks**. Constraints for using Vasquez-Beggs are listed on an Excel 5.0 spreadsheet which can be obtained from the Division.
4. **Other Methods** - Alternate methods must receive prior approval from the Division.

## Working and Breathing Losses

**Working losses** are those vapors which are displaced from a tank when liquids enter the tank.

**Breathing losses** (also known as standing or storage losses) are those vapors which are displaced from a tank due to expansion and contraction of the tank's vapor space caused by temperature and barometric pressure changes.

The Division will accept VOC/HAP emission calculations for hydrocarbon storage tank working and breathing losses as estimated by:

1. EPA's Tanks 3.0 through 4.06 software
2. AP-42, Section 7 calculation methods
3. E&P air emissions model
4. HYSIM, HYSYS and K-FLASH simulation software

## FLASHING EMISSIONS FROM PRESSURIZED VESSELS

**Complete the appropriate section of the "Storage Tanks and Other VOC Emission Sources Form" (AQD-OG4 or AQD-OG4a) for flashing vessels.**

The same methods used to calculate flashing emissions from tanks are used to calculate emissions from pressurized vessels.

Gas is released from solution as hydrocarbon liquids undergo pressure and/or temperature drops. This occurs as fluids flow from the wellhead to a pressurized vessel, and from one pressurized vessel to another pressurized vessel. Flash gas is released from solution each time the pressure/temperature on the fluids is decreased. Pressure vessels are designed to operate within a specific pressure range. As more flash gas is generated, pressure increases in the vessel until some of the gas must be vented. If the vent is to atmosphere, this emission source must be accounted for.

### ***Pressurized vessel emission calculation example:***

Approximately 15 barrels per day of a 50° API Hydrocarbon liquid is dumped from a high pressure separator (operating at 500 psig) to a heater treater (operating at 20 psig). The flash gas generated in the heater treater is used as fuel for the 0.5 MMBtu/hr heater treater burner. (A fuel gas analysis of the treater flash gas provides a lower heating value, LHV, of 1,300 Btu/scf.) The heater treater burner is thermostatically controlled and is in use an average of 15 minutes/hour, year round.

First, calculate the percent run time of the heater treater burner -

$$\begin{aligned}\text{Percent run time (\%)} &= \text{run time (min/hr)} * 1 \text{ hr}/60 \text{ min} * 100 \\ \text{Run time (hrs/day)} &= 15 \text{ min/hr} * 1 \text{ hr}/60 \text{ min} * 100 = \underline{\underline{25\%}}\end{aligned}$$

Second, calculate the total fuel consumption for heater treater burner -

$$\begin{aligned}\text{Fuel required (scf/hr)} &= \text{Burner rating (MMBTU/hr)} * 1 / \text{LHV (Btu/scf)} * \% \text{Run time} / 100 * 1,000,000 \text{ Btu/MMBtu} \\ \text{Fuel required (scf/hr)} &= (0.5 \text{ MMBtu/hr}) * 1 / 1,300 \text{ Btu/scf} * 25\% / 100 * 1,000,000 \text{ Btu/MMBtu} = \underline{\underline{96.15 \text{ scf/hr}}}\end{aligned}$$

Third, calculate the amount of flash gas generated -

From the Vasquez-Beggs method, the total flash gas generated is approximately 3000 SCFD or 125 scf/hr

Fourth, calculate how much of the flash gas is not consumed as fuel -

$$\begin{aligned}\text{Vented gas (scf/hr)} &= \text{Total gas (scf/hr)} - \text{Fuel required (scf/hr)} \\ \text{Vented gas (scf/hr)} &= (125 \text{ scf/hr}) - (96.15 \text{ scf/hr}) = \underline{\underline{28.85 \text{ scf/hr}}}\end{aligned}$$

Finally, calculate how much of the vented gas is VOCs -

**\*\*Assumption:**            The flash gas molecular weight (Gas MW) = 50 lb/lb-mole  
                                      The VOC weight fraction of the flash gas = 0.9

$$\begin{aligned}\text{Emissions (lb/hr)} &= \text{Vented gas (scf/hr)} * 1/379 \text{ scf/lb-mole} * \text{Gas MW (lb/lb-mole)} * \text{VOC wt. fraction} \\ \text{Emissions (lb/hr)} &= (28.85 \text{ scf/hr}) * (1/379 \text{ scf/lb-mole}) * (50 \text{ lb/lb-mole}) * 0.9 = \underline{\underline{3.43 \text{ lb/hr}}}\end{aligned}$$

$$\begin{aligned}\text{Emissions (TPY)} &= \text{Emissions (lb/hr)} * 8,760 \text{ hrs/yr} * 1 \text{ ton}/2,000 \text{ lb} \\ \text{Emissions (TPY)} &= (3.43 \text{ lb/hr}) * (8,760 \text{ hrs/yr}) * (1 \text{ ton}/2,000 \text{ lb}) = \underline{\underline{15.0 \text{ TPY}}}\end{aligned}$$

## **EMISSIONS FROM TRUCK LOADOUT**

**Complete the appropriate section of the “Storage Tanks and Other VOC Emission Sources Form” (AQD-OG4a for Central Tank Batteries) for truck loadout. Truck loadout emissions are generally insignificant at single wellsite facilities and do not need to be accounted for.**

VOC emissions should be calculated from the following formula, using data from the tables in AP-42, Section 5.2

$$L_L = 12.46 * S * P * M / T$$

Where:

**L<sub>L</sub>** = loading loss, pounds per 1,000 gallons (lb/1,000 gal) of liquid loaded.

**S** = a saturation factor (See Table 5.2-1 below)

**P** = true vapor pressure of liquid loaded, pounds per square inch absolute, psia.

**M** = molecular weight of tank vapors, pounds per pound-mole (lb/lb-mole)

**T** = temperature of bulk liquid loaded, °R, (°F + 460)

Table 5.2-1 below, is required to supply the “S” variable in the above equation and Table 7.1-2 may provide the “P” and “M” values.

**Table 5.2-1: Saturation (S) Factors for Calculating Petroleum Liquid Loading Losses**

Cargo Carrier	Mode of Operation	S Factor
Tank Trucks and Rail Tank Cars	Submerged loading of a clean cargo tank	0.50
	Submerged loading: dedicated normal service	0.60
	Submerged loading: dedicated vapor balance service	1.00
	Splash loading of a clean cargo tank	1.45
	Splash loading: dedicated normal service	1.45
	Splash loading: dedicated vapor balance service	1.00

**Table 7.1-2: Properties of Selected Petroleum Liquids**

(Only crude oil properties are supplied here. The full table of values can be found in AP-42, Table 7.1-2)

Petroleum Liquid	Vapor Molecular Weight at 60°F, M <sub>v</sub> (lb/lb-mole)	Condensed Vapor Density at 60 °F, W <sub>vc</sub> (lb/gal)	Liquid Density At 60 °F, W <sub>l</sub> (lb/gal)	True Vapor Pressure, P <sub>va</sub> (psi) at various temperatures in °F.						
				40	50	60	70	80	90	100
Crude Oil RVP 5	50	4.5	7.1	1.8	2.3	2.8	3.4	4.0	4.8	5.7

***Example of a Truck Loadout Emission Calculation:***

An average of 360 bbls of crude oil per month, stored at an average annual temperature of 50°F, is loaded into a tank truck when sold from the lease. The truck is designed such that liquids enter into the tank bottom (submerged loading) to avoid splashing.

- From Table 5.2-1, for submerged loading, dedicated normal service: “S” = 0.6
- From Table 7.1-2, for crude oil, RVP=5 at 50°F: “P” = 2.3
- From Table 7.1-2, for crude oil, RVP=5 at 50°F: “M” = 50

Therefore:

$$L_L = \frac{12.46(0.60)(2.3 \text{ psi})(50 \text{ lb/lb-mole})}{(50^\circ\text{F} + 460)} = \underline{\underline{1.69 \text{ lb/1,000 gal loaded}}}$$

**\*\*Assumption:** The truck capacity is 180 bbl and requires 2 hours to load.

$$\begin{aligned} \text{Emissions (lb/hr)} &= L_L (\text{lb/1,000gal}) * \text{truck load rate (bbl/hr)} * 42 \text{ gal/bbl} \\ \text{Emissions (lb/hr)} &= 1.69 \text{ lb/1,000 gal} * 180 \text{ bbl/2 hr} * 42 \text{ gal/bbl} = \underline{\underline{6.39 \text{ lb/hr}}} \end{aligned}$$

$$\begin{aligned} \text{Emissions (TPY)} &= L_L (\text{lb/1,000gal}) * \text{Annual Sales Vol. (bbl/yr)} * 42 \text{ gal/bbl} * 1 \text{ ton/2,000 lb} \\ \text{Emissions (TPY)} &= 1.69 \text{ lb/1,000 gal} * (360 \text{ bbl/mo} * 12 \text{ mo/yr}) * 42 \text{ gal/bbl} * 1 \text{ ton/2,000 lb} = \underline{\underline{0.2 \text{ TPY}}} \end{aligned}$$

### **FUGITIVE VOC/HAP EMISSIONS**

**Complete the appropriate section of the “Storage Tanks and Other VOC Emission Sources” Form (AQD-OG4a for Central Tank Batteries) for fugitives. Fugitive emissions at single wellsite facilities are generally insignificant and do not need to be considered in the application.**

The Division will accept fugitive VOC/HAP emission estimates calculated by:

- a. Methods contained in EPA publication EPA-453/R-95-017, titled Protocol for Equipment Leak Emission Estimates, November 1995.
- b. Emission estimation software known as GRI-HAPCalc, version 2.0 (or latest version).

Information provided to the Division shall include:

- a. A listing of the component counts (i.e., number of valves, flanges, threaded connections, relief valves)

Component counts may be obtained by any of the following methods:

1. An actual component count of the facility.
  2. An estimate of the facility component count based on other like facilities, facility drawings, etc.
  3. The default component count for the applicable facility type in GRI-HAPCalc.
- b. A determination of the VOC/HAP weight fraction of the various service categories

used. The component emission factors, provided in the following table, may be used to calculate average fugitive emissions for oil and gas production operations. The emission factors are based on the emission factor table called "Oil and Gas Production Operations Average Emission Factors" from EPA-453/R-95-017.

The emission factors in the following table are for total hydrocarbon emissions and must be multiplied by the appropriate VOC/HAP weight fraction of the fluids being used.

**Fugitive Equipment Leak Emission Factors**  
(lb/hr/component)

Equipment Type	Equipment Service Category			
	Gas	Heavy Oil (< 20 API Gravity)	Light Oil (> 20 API Gravity)	Water/Light Oil <sup>1</sup>
Connectors <sup>2</sup>	.00044	.0000165	.000463	.000243
Flanges	.00086	.00000086	.000243	.00000639
Open-ended Lines	.00441	.000309	.00309	.00055
Pumps	.00529	N/A	.02866	.0000529
Valves	.00992	.0000185	.0055	.000216
Other <sup>3</sup>	.01940	.0000705	.0165	.0309

1-The Water/Light Oil emission factors apply to water streams in light oil service with a water content between 50% and 99%. For streams with a water content greater than 99% the emission rate is considered negligible.

2-Connectors are considered thread and coupling type connections.

3-The "Other" equipment type includes compressor seals, relief valves, diaphragms, drains, dump arms, hatches, instruments, meters, polished rods and vents.

***Fugitive emission calculation example:***

For 25 valves in light oil service containing condensate.

**\*\*Assumption:** 20% (by weight) of the vapor emitted from the components is VOC and 10% by weight) of the vapor is hazardous air pollutants (HAP).

**VOC Emissions (lb/hr) = E. F. From Table (lb/hr/component)\*Quantity\*VOC wt. Fraction**

$$\text{VOC Emissions (lb/hr)} = .0055(\text{lb/hr/component}) * 25 \text{ valves} * 0.20 = \underline{\underline{0.03 \text{ lb/hr}}}$$

**VOC Emissions (TPY) = Emissions (lb/hr)\*8760 hrs/yr\*1 ton/2000 lb**

$$\text{VOC Emissions (TPY)} = .03(\text{lb/hr}) * 8760 \text{ hrs/yr} * 1 \text{ ton/2000 lb} = \underline{\underline{0.1 \text{ TPY}}}$$

**HAP Emissions (lb/hr) = E.F. From Table (lb/hr/component)\*Quantity\*HAP Wt. Fraction**

$$\text{HAP Emissions (lb/hr)} = .0055(\text{lb/hr/component}) * 25 \text{ valves} * 0.10 = \underline{\underline{0.01 \text{ lb/hr}}}$$

**HAP Emissions (TPY) = Emissions (lb/hr)\*8760 hrs/yr\*1 ton/2000 lb**

$$\text{HAP Emissions (TPY)} = .01\text{lb/hr} * 8760 \text{ hrs/yr} * 1 \text{ ton/2000 lb} = \underline{\underline{0.04 \text{ TPY}}}$$

## EMISSIONS FROM PNEUMATIC SOURCES

Complete the appropriate section of the “Storage Tanks and Other VOC Emission Sources Form” (AQD-OG4 or AQD-OG4a) for pneumatic sources. **ONLY Pneumatic Pump emissions need be calculated for single wellsite facilities. Emissions from other pneumatic sources, such as level and pressure controllers, are normally insignificant at single wellsite facilities.**

The following formula for calculating emissions from pneumatic sources is accepted by the Division:

$$\text{Emissions (lb/hr)} = \text{PSCR (scf/min)} * (60 \text{ min/1 hr}) * (1/379 \text{ scf/lb-mole}) * \text{gas MW (lb/lb-mole)} * \text{VOC wt. fraction}$$

Where -

PSCR = Pneumatic source consumption rate (scf/min), as per manufacturer’s literature.

Gas MW = Supply gas molecular weight (lb/lb-mole)

### *Pneumatic source emission calculation example:*

The facility uses a pneumatic pump, motivated with field gas rather than instrument air, to pump chemical. The field gas has a molecular weight of 22 lb/lb-mole and a VOC weight fraction of 0.24. The pump consumes 1 scf/min of supply gas, as per manufacturer’s literature.

$$\begin{aligned} \text{Emissions (lb/hr)} &= \text{PSCR (scf/min)} * (60 \text{ min/1 hr}) * (1/379 \text{ scf/lb-mole}) * \text{gas MW (lb/lb-mole)} * \text{VOC wt. fraction} \\ \text{Emissions (lb/hr)} &= (1 \text{ scf/min}) * (60 \text{ min/hr}) * (1/379 \text{ scf/lb-mole}) * (22 \text{ lb/lb-mole}) * (0.24) = \underline{\underline{0.84 \text{ lb/hr VOC}}} \end{aligned}$$

$$\text{Emissions (TPY)} = (0.84 \text{ lb/hr VOC}) * (8,760 \text{ hr/yr}) * (1 \text{ ton/2,000 lb}) = \underline{\underline{3.7 \text{ TPY VOC}}}$$

## EMISSIONS FROM EXTERNAL COMBUSTION EQUIPMENT

Complete the appropriate section of the “Heaters, Boilers, Flares and Other External Combustion Equipment Form” (AQD-OG5) for Heaters, Boilers, Etc.

NO<sub>x</sub>, CO and VOC emissions from production unit heaters should be calculated using the emission factors (EF) provided in AP-42, Tables 1.4-2 and 1.5-2. The following table lists these factors:

**Emission Factors for Fuel Boilers & Heaters**

Pollutant	Fuel to be Combusted (Combuster Size, MMBtu/hr heat input)				
	LP Gas <sup>1</sup> (0.3 to 10)	LP Gas (10 to 100)	Natural Gas <sup>2</sup> (< 0.3)	Natural Gas (0.3 to 10)	Natural Gas (10 to 100)
NO <sub>x</sub>	14 lb/1000 gal	19 lb/1000 gal	94 lb/mmcf	100 lb/mmcf	140 lb/mmcf
CO	1.9 lb/1000 gal	3.2 lb/1000 gal	40 lb/mmcf	21 lb/mmcf	35 lb/mmcf
TOC <sup>3</sup>	0.5 lb/1000 gal	0.5 lb/1000 gal	11.0 lb/mmcf	8.0 lb/mmcf	5.8 lb/mmcf

1-LP gas emission factors are based on an average liquid propane heating value of 91,500 Btu/gal. Ratio the emission factor according to the Btu content of the LP actually used.

2-Natural gas emission factors are based on an average natural gas heating value of 1000 Btu/scf. Ratio the emission factor according to the Btu content of the natural gas actually used.

3-VOC emissions may be determined by multiplying the calculated TO (total organic compounds) emission rate by the weight percent of VOC compounds in the fuel gas stream.

### *Natural gas fuel fired burner example calculation:*

- A heater treater, using natural gas for fuel, has a burner rating of 0.5 MMBtu/hr.
- Fuel gas analysis shows the gas to have a lower heating value (LHV) of 1,200 Btu/SCF.
- A VOC weight fraction of 0.2 was calculated using the mole percent of VOCs (from the fuel gas analysis) and the corresponding molecular weights of the VOC components.
- The burner is assumed to operate continuously, 8,760 hours per year (however, actual conditions may be the burner is thermostatically controlled and operates a fraction of this time.)

- **From Table 1.4-2** for a natural gas fired burner rated at 0.5 MMBtu/hr, the NO<sub>x</sub> EF = 100 lb/mmcf

**Emissions (lb/hr)=Burner Rating (MMBtu/hr)\*EF (lb/mmcf)\*average gas heating value (SCF/1000 Btu)**  
 NO<sub>x</sub> Emissions (lb/hr) =0.5 MMBtu/hr \* 100 lb/mmcf \* SCF/1000 Btu = 0.05 MMBtu\*lb\*SCF/hr\*mmcf\*Btu

Convert units:

$$(0.05 \text{ MMBtu} * \text{lb} * \text{SCF/hr} * \text{mmcf} * \text{Btu}) * (10^6 \text{ Btu/MMBtu}) * (\text{mmcf}/10^6 \text{ SCF}) = 0.05 \text{ lb/hr NO}_x$$

Ratio emissions according to the Btu content of the burner gas used:

$$0.05 \text{ lb/hr} * 1200/1000 = 0.06 \text{ lb/hr NO}_x$$

Convert to tons per year (TPY):

$$0.06 \text{ lb/hr} * 8760 \text{ hr/yr} * \text{ton}/2000 \text{ lb} = 0.3 \text{ TPY NO}_x$$

## EMISSIONS FROM FLARES

Complete the appropriate section of the “Heaters, Boilers, Flares and Other External Combustion Equipment Form” (AQD-OG5) for Flares.

NOx and CO emissions from flares should be calculated using the following emission factors:

### **Emission Factors for Flare Operations<sup>1</sup>**

Component	Emission Factor (lb/MMBtu)
Carbon Monoxide	0.035
Nitrogen Oxides	0.14

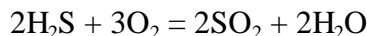
<sup>1</sup>Based on tests using crude propylene containing 80% propylene and 20% propane.

$$\text{Emissions (lb/hr)} = \text{Flare gas vol (scf/hr)} * \text{LHV (Btu/scf)} * (1 \text{ MMBtu}/1,000,000 \text{ Btu}) * \text{EF (lb/MMBtu)}$$

VOC emissions should be calculated based on a 98% destruction efficiency of the VOC gas stream going to the flare.

$$\text{Emissions (lb/hr)} = \text{Flare gas vol (scf/hr)} * 1/379 \text{ scf/lb-mole} * \text{Flare gas MW (lb/lb-mole)} * \text{VOC wt. fraction} * 0.02$$

For sour gases (i.e., gas containing H<sub>2</sub>S), SO<sub>2</sub> emissions should be calculated based on the mass balance conversion of H<sub>2</sub>S to SO<sub>2</sub>, occurring when the gas is flared.



$$\text{SO}_2 \text{ Emissions (lb/hr)} = \text{Flare gas vol. (scf/hr)} * 1/379 \text{ scf/lb-mole} * 64 \text{ lb/lb-mole} * \% \text{H}_2\text{S} / 100$$

### ***Flare emission calculation example:***

- Approximately 10 MSCFD of gas is being flared. It has a lower heating value (LHV) of 1,400 Btu/scf and a molecular weight (MW) of 26.4 lb/lb-mole.
- The VOC weight fraction of the flared gas is 0.28
- The flared gas also contains 4.4% H<sub>2</sub>S

First, calculate VOC emissions which would result from venting the gas to atmosphere (i.e., uncontrolled):

$$\text{Emissions (lb/hr)} = \text{vented gas vol (scf/hr)} * 1/379 \text{ scf/lb-mole} * \text{Vent gas MW (lb/lb-mole)} * \text{VOC wt. fraction}$$
$$\text{Emissions (lb/hr)} = (10,000 \text{ scf/day} * 1 \text{ day}/24 \text{ hr}) * (1/379 \text{ scf/lb-mole}) * (26.4 \text{ lb/lb-mole}) * (0.28) = \underline{\underline{8.13 \text{ lb/hr}}}$$

$$\text{Emissions (TPY)} = (8.13 \text{ lb/hr}) * (8,760 \text{ hr/yr}) * (1 \text{ ton}/2,000 \text{ lb}) = \underline{\underline{35.6 \text{ TPY VOC}}}$$

Second, calculate VOC emissions which result from flaring the gas (controlled):

$$\text{Emissions (lb/hr)} = \text{Flare gas vol (scf/hr)} * 1/379 \text{ scf/lb-mole} * \text{Flare gas MW (lb/lb-mole)} * \text{VOCwt.fraction} * 0.02$$
$$\text{Emissions (lb/hr)} = (10,000 \text{ scf/d} * 1 \text{ d/24 hr}) * (1/379 \text{ scf/lb-mole}) * (26.4 \text{ lb/lb-mole}) * (0.28) * (0.02) = \underline{\underline{0.16 \text{ lb/hr}}}$$

$$\text{Emissions (TPY)} = (0.16 \text{ lb/hr}) * (8,760 \text{ hr/yr}) * (1 \text{ ton/2,000 lb}) = \underline{\underline{0.7 \text{ TPY VOC}}}$$

Third, Calculate sulfur dioxide emissions created when the hydrogen sulfide gas is flared:

$$\text{SO}_2 \text{ Emissions (lb/hr)} = \text{Flare gas vol. (scf/hr)} * 1/379 \text{ scf/lb-mole} * 64 \text{ lb/lb-mole} * \% \text{H}_2\text{S} / 100$$
$$\text{Emissions (lb/hr)} = (10,000 \text{ scf/d} * 1 \text{ d/24 hr}) * (1/379 \text{ scf/lb-mole}) * (64 \text{ lb/lb-mole}) * (4.4/100) = \underline{\underline{3.10 \text{ lb/hr SO}_2}}$$

$$\text{Emissions (TPY)} = (3.10 \text{ lb/hr SO}_2) * (8,760 \text{ hr/yr}) * (1 \text{ ton/2,000 lb}) = \underline{\underline{13.6 \text{ TPY SO}_2}}$$

Finally, Calculate NOx or CO emissions from flaring:

$$\text{Emissions (lb/hr)} = \text{Flare gas vol (scf/hr)} * \text{LHV (Btu/scf)} * (1 \text{ MMBtu/1,000,000 Btu}) * \text{EF (lb/MMBtu)}$$
$$(10,000 \text{ scf/d} * 1 \text{ d/24 hr}) * (1,400 \text{ Btu/scf}) * (1 \text{ MMBtu/1,000,000 Btu}) * (.035 \text{ lb/MMBtu}) = \underline{\underline{0.22 \text{ lb/hr CO}}}$$

$$\text{Emissions (TPY)} = (0.22 \text{ lb/hr CO}) * (8,760 \text{ hr/yr}) * (1 \text{ ton/2,000 lb}) = \underline{\underline{1.0 \text{ TPY CO}}}$$

## Mole Percent to Weight Percent Conversion

Most emission calculations require weight percent be used, rather than mole percent. Most lab analyses list liquid and gas constituents in mole percent.

The following demonstrates how to convert mol% to wt%:

- From the gas lab analysis, convert each component's mole percent (**column 1**) to a mole fraction (**column 2**) by dividing each by 100.
- Multiply each mole fraction (**column 2**) by the molecular weight (**column 3**) of each component. This gives the molecular weight of each separate component. (**column 4**)
- Sum the molecular weight of all components (**column 4**) to get the total gas MW. (**85.08**)
- Sum all the VOC component MWs, to get the total VOC MW.  
VOC = all C<sub>3</sub><sup>+</sup>, or methane plus components. (**81.50**)
- Divide the VOC MW by the total gas MW. (**81.50 ÷ 85.08**) = **0.9580**
- Multiply the VOC weight fraction times 100 to get the VOC weight percent.  
**0.9580 × 100 = 96 wt% VOC**

<u>gas components</u>	<u>1</u> mol%, <sub>i</sub>	<u>2</u> mol%, <sub>i</sub> / 100	<u>3</u> MW <sub>i</sub>	<u>4</u> = MW of each component 2×3
CO <sub>2</sub>	0.07	0.0007	44.01	0.0308
N <sub>2</sub>	0.03	0.0003	28.01	0.0084
Methane (C <sub>1</sub> )	9.32	0.0932	16.04	1.4949
Ethane (C <sub>2</sub> )	6.79	0.0679	30.07	2.0418
Propane (C <sub>3</sub> )	8.40	0.0840	44.10	3.7044
Isobutane (iC <sub>4</sub> )	3.46	0.0346	58.12	2.0110
N-Butane (nC <sub>4</sub> )	5.85	0.0585	58.12	3.4000
Isopentane (iC <sub>5</sub> )	4.45	0.0445	72.15	3.2107
N-Pentane (nC <sub>5</sub> )	3.55	0.0355	72.15	2.5613
N-Hexane (nC <sub>6</sub> )	2.84	0.0284	86.18	2.4475
Hexanes (C <sub>6</sub> )	3.76	0.0376	84.18	3.1652
Benzene	0.54	0.0054	78.11	0.4218
Heptanes (C <sub>7</sub> )	11.42	0.1142	100.20	11.4428
Toluene	0.18	0.0018	92.14	0.1659
Octanes (C <sub>8</sub> )	16.80	0.1680	114.23	19.1906
Ethyl Benzene	0.21	0.0021	106.17	0.2230
Xylenes	4.10	0.0410	106.17	4.3530
Nonanes (C <sub>9</sub> )	5.11	0.0511	128.26	6.5541
Decanes Plus (C <sub>10</sub> <sup>+</sup> )	<u>13.11</u>	<u>0.1311</u>	142.29	<u>18.6542</u>
		100.00	1.00	<b>85.08</b> = MW <sub>TOTAL GAS</sub>

## Emission Simulation Software

The following software, may be used to quantify air contaminant emissions in an application or emission inventory. (Please note the Division attempts to utilize software which is accurate, effective and inexpensive. The Division does not promote any particular commercial software or supplier):

### **TANKS 3.0 - 4.06**

Download the latest version from the Air Chief BBS web site at: <http://ttnwww.rtpnc.epa.gov/html/chief/tank-dn.htm>

This free software may be used to estimate the working and breathing losses from storage tanks containing hydrocarbon liquids.

### **GRI-GLYCalc**

GTI Fulfillment Center  
1510 Hubbard Drive  
Batavia, IL 60510  
FAX: 630.406.5995  
Phone: 630-406-5900  
E-Mail: fillit@compuserve.com

This software is used to simulate emissions from tri-ethylene (TEG) or ethylene glycol (EG) dehydration systems (i.e., still column vent, flash tank or pump gas separator and effects of controls on still column emissions).

### **HAPCalc 2.0**

same as contact for GRI-GLYCalc

This software is used to estimate hazardous air pollutant emissions from sources such as engines, fugitives, natural gas fuel burning sources.

**Flash Simulation software** There are numerous software applications which can simulate flashing calculations. The Division recommends a flash simulation which uses either Peng-Robinson or Sauve-Robinson-Klieve (SRK) equations of state methods. The following is a list of known software which may be suitable, this list is not all inclusive nor does it represent any endorsement by the State:

<b>KFLASH</b>	by Kesler Engineering, Inc.	(908) 238-6700
<b>HYSIM</b>	by Hypotech	(713) 870-1900
<b>E &amp; P Tank</b>	by American Petroleum Institute	(202) 682-8375

**API Publication Number 4683**

A report establishing simple techniques to estimate key variables in the absence of laboratory analyses, such as Reid Vapor Pressure (RVP), gas molecular weights, hazardous air pollutant species (HAPs) distributions, and specific gravity of separator gas, is available from API. The report is called:

**API Publication Number 4683**

**Correlation Equations to Predict Reid Vapor Pressure and Properties of Gaseous Emissions for Exploration and Production Facilities.**

Other sources of assistance regarding oil and gas industry environmental compliance issues are:

Wyoming Air Quality Division	(307) 777-7391
Independent Petroleum Association of Mountain States	(303) 623-0987
Petroleum Association of Wyoming (PAW)	(307) 234-5333
Gas Research Institute (GRI)	(512) 623-0987
American Petroleum Association (API)	(202) 682-8562
Bureau of Land Management (BLM)	(307) 775-6256
EPA Region VIII Office	(800) 227-8917

Any of the following information may be obtained electronically from the listed web site or in hard copy form by sending a request to the organization listed:

**Wyoming Air Quality Standards and Regulations  
Chapter 6, Section 2 Oil and Gas Production Operations Permitting Guidance  
Wyoming Oil and Gas Industry Application Forms**

Hardcopy: Wyoming Department of Environmental Quality  
Air Quality Division  
122 W 25th Street  
Herschler Building, 4-W  
Cheyenne, WY 82001  
Ph: (307) 777- 7391

Casper District Office  
Ph: (307) 473-3475

Download site: <http://deq.state.wy.us/aqd.htm>

<b>EPA Document AP-42 -</b>	(Document Order No. 055-000-00500-1)	\$56.00
<b>AP-42, Supplement A -</b>	(Document Order No. 055-000-00551-6)	\$23.00
<b>AP-42, Supplement B -</b>	(Document Order No. 055-000-00565-6)	\$34.00

Hardcopy: Superintendent of Documents  
P.O. Box 371954  
Pittsburgh, PA 15250-7954  
Ph: (202) 512-1800 Fax: (202) 512-2250

Download site: <http://www.epa.gov/oar/oaqps/efig/efigdocs.html>

**Oil and Gas Industry Fugitive Emission Factors -**

Hardcopy: EPA Fax Chief (919) 541-5626 and key in request ID no. 3502

Download site: <http://134.67.104.12/html/chief/ef-dn.htm>

**Hazardous Air Pollutants List -**

Download site: <http://www.epa.gov/oar/oaqps/airtox/188polls.txt>

## **APPENDIX C**

### Definitions and Abbreviations



**Definitions/Abbreviations**

**Air Contaminant** - shall mean dust, fumes, mist, smoke, other particulate matter, vapor, gas or any combination of these; but shall not include steam or water vapor.

**BACT** - Best Available Control Technology

**BBL** - Barrel, based on 42 gallons per barrel.

**CO** - Carbon monoxide

**Condensate** - Hydrocarbon liquid separated from natural gas that condenses due to changes in temperature, pressure, or both, and remains liquid at standard conditions.

**Custody Transfer** - The transfer of produced petroleum and/or condensate, after processing and/or treatment in the producing operations, from storage vessels or automatic transfer facilities to pipelines or any other forms of transportation.

**Division** - The Department of Environmental Quality, Air Quality Division

**First Date of Production** - When the source or facility actually begins operation for the purpose of generating goods (i.e., first date when product is sent to sales). This would not include a start-up to check functional operation of the “machinery”. For wells with multiple-zone completions, First Date of Production is defined as the “date of commingled production” (when producing zones are commingled and sufficiently tested and product is first sold from the installation).

**Fugitive Emissions (Fugitives)** - Air emissions which result from gas vapors escaping through and around seals, packing, gaskets, threads, and other such pressure sealing connections.

**Grand fathered** - A facility, installation or site which was built or in service before May 29, 1974 and that has not been physically or operationally changed, causing an increase in any pollutant (to which any state standard applies) or causing the emission of a new pollutant. (Modifications which could eliminate grandfather status are increasing production rate by fracturing, acidizing, recompletion of a zone, change in artificial lift methods, bringing new wells into a central battery or a waterflood response. Also such things as installing an engine, increasing horsepower, change in burner ratings. This list is not all inclusive and judgement should be used to determine appropriate status.)

**H<sub>2</sub>S** - Hydrogen Sulfide

**HAP** - Hazardous air pollutant, found in Section 112(b) of the Clean Air Act is a list of 188 contaminants with the classification “hazardous air pollutant”. Typical hazardous air pollutants include benzene, toluene, ethyl-benzene, xylene, n-hexane, formaldehyde, methanol and others.

**Hp** - Horsepower

**lb/hr** - Pounds per hour, typically represented to the hundredths (x.xx) position of accuracy.

**MACT** - Maximum Achievable Control Technology

**Major Source** - A source which emits either 100 TPY or more of a regulated pollutant, 10 TPY or more of a hazardous air pollutant, or 25 TPY or more of the total hazardous air pollutants.

**Major Emitting Facility** - A facility which either has the potential to emit 250 TPY or more of any one regulated are pollutant or is a named facility and has the potential to emit 100 TPY or more of any one regulated air pollutant.

**MMBtu** - Million British thermal units, this is a heat energy unit.

**MMSCFD** - Million standard cubic feet of gas per day, based on standard conditions of 60°F and 14.7 psia.

**NO<sub>x</sub>** - Nitrogen Oxide

**NSPS** - New Source Performance Standards

**PSD** - Prevention of Significant Deterioration

**Potential to Emit** - The maximum capacity of a stationary source to emit any air pollutant under its physical and operational design. Any physical or operational limitation on the capacity of a source to emit an air pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored or processed, shall be treated as part of its design if the limitation is enforceable by the EPA and the Division.

**Regulated pollutants** - Also known as criteria pollutants, Air pollutant emissions which have ambient air standards associated with them. Regulated pollutants include such emissions as volatile organic compounds (VOC), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), hazardous air pollutants (HAP) and others.

**SO<sub>2</sub>** - Sulfur Dioxide

**Synthetic Minor** - “Synthetic Minor” sources are sources that do the following types of things to limit emission rates below 100 TPY: 1) limit operating hours of a source or 2) limit production rates such that source emissions are less than 100 TPY.

**TPY** - Tons per year, typically represented to the tenths (x.x) position of accuracy.

**UTM Coordinate** - Universal Transverse Mercator coordinate system which uses a horizontal and vertical coordinate, located inside a specified zone.

**VOC** - Volatile organic compound, means any organic compound which participates in atmospheric photochemical reactions; typically considered C<sub>3</sub><sup>+</sup> or Non-methane/ethane hydrocarbon vapors.

**VOC Weight Percent** - This is the weight of the volatile organic compounds, expressed as a percent, as compared to the total weight of the compounds in a gas stream. (This should not be confused with the volume or mole percent of a gas stream, which is usually how it is expressed in a lab analysis of a gas.)

**WAQS&R** - Wyoming Air Quality Standards and Regulations

**Worst case** - A situation allowed in air permitting in the State of Wyoming where a facility, site or source (which is representative of all the facilities, sites or sources within a designated field area) may be used to represent the worst air emissions for the field area sources.

**Wyoming Environmental Quality Act** - Wyoming Statute, Title 35 “Public Health and Safety”, Chapter 11 “Environmental Quality” which provides the authority for the rules and regulations of the Air Quality Division.



## **APPENDIX D**

### Sampling and Analysis of Hydrocarbon Liquids and Natural Gas



**Separator Liquid Collection** (information from E&P TANK Emissions Model User's Manual)

The separator liquid sample collection point should be upstream of any metering device or flow restriction to ensure single phase flow. There is often a temperature reduction on the separator liquid flowline, but this does not alter the sample integrity. Conversely, if the flowline temperature is in excess of the operating temperature of the separator, it is advisable to sample directly from the site gauge on the separator.

Care must be taken when sampling from the separator sight gauge. The upper and lower valves installed on sight gauges have restricted flow orifices and check valves. Therefore, as fluids are removed through sight gauge valves, there is a preferred flow of the gas phase through the top valve. One must maintain the liquid level above the bottom sight glass valve while collecting the separator liquid samples. If the liquid level is allowed to decrease to the point of sample collection, excess gas will be drawn into the cylinder with the separator liquid, voiding the validity of the separator sample.

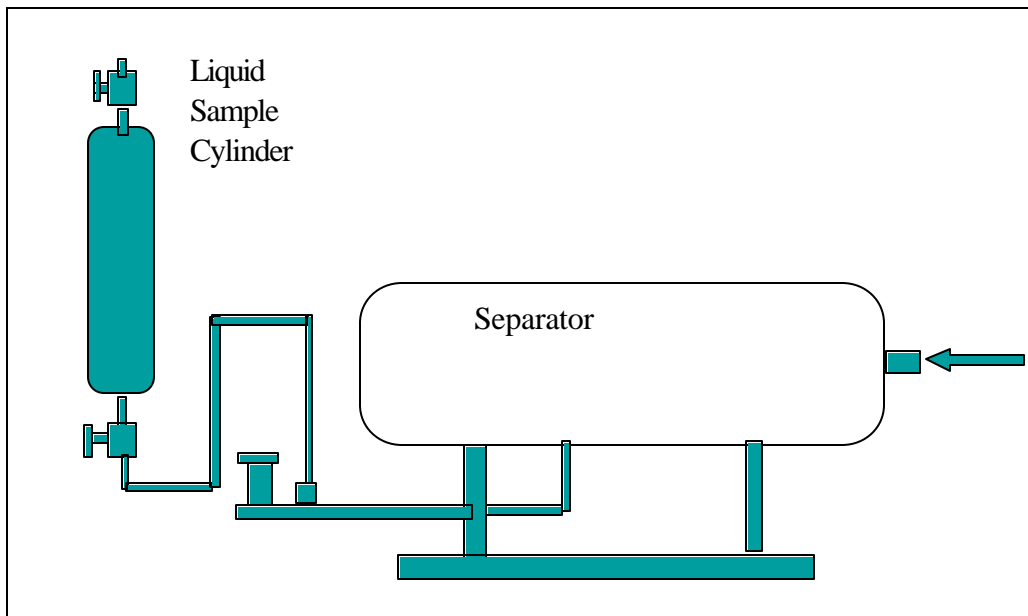
Flexible lines used to connect the sample source to the sample cylinder should be as short as possible. One should check for entrained water in the liquid source stream. Water and any other contaminant must be removed completely prior to the collection of any separator liquid samples. It is advisable to re-check the sampling points and line for contaminants after completing the sampling procedure to ensure proper samples have been collected.

**Separator Liquid Collection: Evacuated Cylinder Method**

1. The cylinders should be evacuated by the laboratory before being sent to the field.
2. Select a sample point from which a representative first stage separator liquid sample can be collected.
3. Compare the pressure and temperature of the sample source to the maximum operating pressure and the current temperature of the sample cylinder to ensure that the cylinder will safely contain the liquid sample. The cylinder temperature should not be more than 10EF (6EC) lower than the source temperature. If it is, this technique should not be used. Low cylinder temperatures often cause the cylinder to fill completely with liquid, thus resulting in a serious hazardous situation when the cylinder is allowed to warm. To prevent the hazardous situation, an alternate technique, such as the Liquid Displacement Method, should be used. The Cylinder must be an approved type with a current certification date for sample transportation to

the laboratory.

4. Connect the sampling line to the liquid source and the sample cylinder in the manner shown in Figure C-1, leaving the fitting on the cylinder end of the connector line finger tight.



Figure

C-1 Evacuated Cylinder Method

5. Slowly purge the sample line to displace air and to vent sufficient liquid to clean the sample point and sampling system.
6. With a wrench, properly tighten the connecting line fitting to the cylinder fitting.
7. With the sample line purged and full of liquid and the separator liquid source valve fully open, hold the cylinder in a vertical position with the inlet valve at the bottom and slowly (but fully) open the lower cylinder valve to admit liquid into the container. Refer to Figure C-1.
8. When the liquid stops flowing into the cylinder, close the inlet valve before moving the cylinder out of the vertical position. The sample collected in this manner will be in two phases, gas and liquid. The sample cylinder will have some portion of its volume as gas cap, which can safely accommodate any liquid expansion if the cylinder temperature increases during shipment to the laboratory.

9. Close the valves from the sample source and de-pressurize the connect line. Dismantle the sampling assembly and install the blow plug in the sample cylinder valve used for sample entry.

Notes (Item 8):

The (safe) situation of having a two phase system in the container will not change to an unsafe single liquid phase situation unless one or more of the following is allowed to occur:

- Sample container is agitated while filling.
- Containers being filled are much colder than the separator.
- Containers are left on the pressure source for an extended length of time. It is not important to have the container completely full of sample. The representative liquid has been admitted to the cylinder and is not altered in composition; it merely has been flashed to a two phase condition for transport to the laboratory. When this sample is received in the laboratory, it is pressured up to considerably above the source pressure by mercury injection prior to removal of any portion of the contents. During the repressurization, the saturation pressure is measured to check the validity of the sample contained. If the saturation pressure obtained does not approximate the separator conditions, any subsequent analysis using the sample will be in error.

Medium gravity, 20 to 27 API crude oils are particularly susceptible to foaming and, if sampled directly into an evacuated cylinder, could result in obtaining a cylinder virtually full of gas with a small amount of foamy oil. The procedure of sampling a liquid by gas displacement is used to overcome this potential foaming problem.

## **Separator Liquid Collection: Gas Displacement Method:**

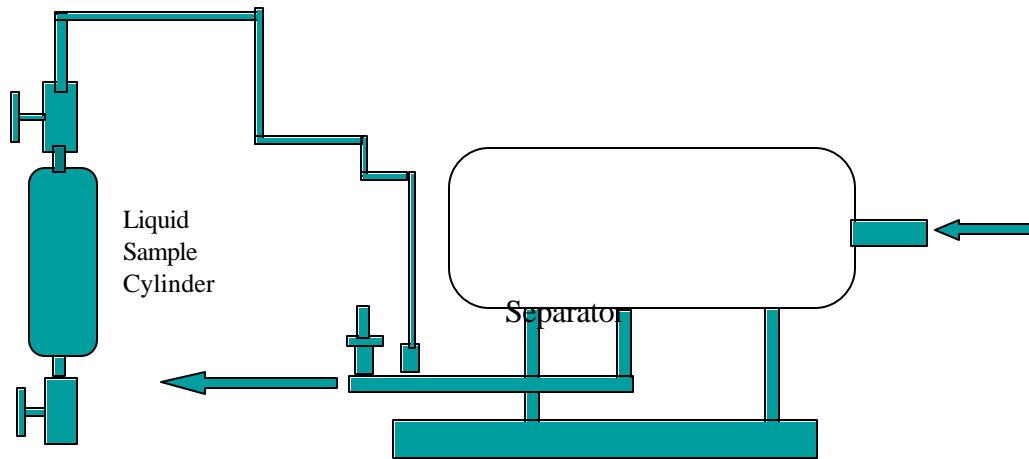
1. Select a sample point from which a representative first stage separator liquid sample can be collected.
2. Compare the pressure of the sample source to the maximum operating pressure of the sample cylinder to ensure that the cylinder will safely contain the liquid sample. The cylinder must be an approved type with a current certification date for sample transport to the laboratory.
3. Fill the cylinder to be used for collecting the separator liquid sample with equilibrium separator gas as per the procedure outlined in Separator Gas Collection - Evacuated Cylinder Method.
4. Connect the sampling line to the liquid sample source and to the gas filled liquid sample cylinder in the conventional manner shown in Figure C-1 leaving the fitting on the cylinder end of the connecting line finger tight.
5. Slowly purge the sample line to displace air and to vent enough liquid to clean the sample point and sampling system.
6. With a wrench, properly tighten the connecting line fitting to the cylinder fitting.
7. With the sample line purged and full of liquid and the sample source valve fully opened, hold the cylinder in a vertical position as indicated in Figure C-1, with the inlet valve at the bottom and fully open the lower cylinder valve.
8. Holding the cylinder vertical, slowly open the top valve of the cylinder to bleed gas at a very low rate. The low bleeding rate is necessary so no appreciable pressure drop occurs in the sampling system, thus maintaining the separator liquid in one phase while it enters the sample cylinder.
9. When separator liquid flows from the top valve, close, first the top valve and second, the bottom valve of the cylinder. Close the valve from the source and depressurize the sampling system.
10. Disconnect the sample cylinder from the sampling hose.
11. Holding the cylinder vertical, in a single motion quickly release a small amount of liquid from the bottom valve. This will relieve the dangerous situation of having a cylinder completely filled with liquid for transport to the laboratory, without altering the sample. Creating a gas cap in this manner can easily alter the sample composition. In order to prevent the alteration of the sample composition, the liquid must be taken in one quick motion.

12. Install blow plugs securely in both valves.
13. Fill in information on the sample tag as completely and accurately as possible and attach to the sample cylinder.

Note: Medium gravity, 20 to 27 API, crude oils are particularly susceptible to foaming and if sampled directly into an evacuated cylinder, could result in obtaining a cylinder virtually full of gas with a small amount of foamy oil. The procedure of sampling a liquid by gas or liquid displacement is used to overcome this potential foaming problem.

### **Separator Liquid Collection: Liquid Displacement Method**

1. Fill the cylinder with a suitable liquid which is more dense than, and immiscible with the separator liquid. Suitable liquids for use are displacement media which are: mercury, brine, glycol/water mixtures and water. The latter three should not be used in sour systems.
2. Select a sample point from which a representative first stage separator sample can be collected.
3. Compare the pressure of the sample source to the maximum operating pressure of the sample cylinder to ensure that the cylinder will safely contain the liquid sample. The cylinder must be an approved type with a current certification date for sample transport to the laboratory.
4. Connect the sample line to the separator liquid source and to the sample cylinder in a manner as shown in Figure C-2, leaving the fitting on the cylinder end of the connector line finger tight.
5. Partially open the separator liquid source valve, allowing a slow displacement of air from the connecting line. Continue venting sufficient liquid to clean the sample point and sampling system.
6. With a wrench, properly tighten the connecting line to the cylinder fitting.
7. Fully open the separator liquid source valve.
8. Maintain the cylinder in a vertical position with the inlet valve at the top throughout the sample collection procedure.
9. Fully open the upper cylinder valve.



#### C-2 Liquid Displacement Method

10. With the cylinder perfectly vertical, slowly open the bottom valve of the cylinder to allow a slow (small) stream of displacement liquid to drain into a graduated cup.
11. Maintain the slow rate of displacement liquid removal so that no appreciable pressure drop occurs in the sampling system. One must not rush this procedure.
12. When 90 percent of the sample cylinder volume has been collected, close first the bottom valve and then the top valve of the sample cylinder.
13. With the top valve of the cylinder closed, slowly drain from the bottom of the cylinder the remaining 10 percent of the displacement liquid. Close the bottom valve of the sample cylinder immediately when the separator liquid appears. Creating a gas cap in this manner is easily accomplished, perfectly safe and of very little risk to the integrity of the sample.
14. Close the valve from the sample source and depressurize the sampling system.
15. Disconnect the sample cylinder from the sampling hose.
16. Securely install blow plugs into both sample cylinder valves.
17. Fill in information on the sample tags as completely and accurately as possible and attach to the

sample cylinder.

## **Natural Gas Sampling** (information from GRI-GLYCalc emission model)

**The natural gas composition is one of the most important inputs to GRI-GLYCalc.** To obtain accurate emissions estimates, the gas must be carefully sampled and analyzed for both hydrocarbons (C1-C8+ including aromatics) and non-hydrocarbons (CO<sub>2</sub>, N<sub>2</sub>, and H<sub>2</sub>S). It is particularly important to accurately determine the composition of BTEX in the gas, since the BTEX compounds are more soluble in glycols than the aliphatic hydrocarbons.

The natural gas sampling location and method can have a significant impact on the analysis. The best place to collect a gas sample for use in GRI-GLYCalc is from the inlet (i.e., wet) gas line, preferably downstream from an inlet separator that removes liquids from the gas stream. Many operators collect gas samples by attaching a high-pressure cylinder directly to the sample port on the gas line. This method may be adequate for determining BTU content or other bulk properties of the gas **but is unacceptable for measuring low concentration components such as BTEX.** A manifold to remove entrained liquids from the sample and a probe to collect the sample from the center of the gas line are required for the most reliable sample collection. The Gas Processors Association (GPA) standard 2166 is a good reference for natural gas sampling. (This sampling method is available from the GPA for a small fee.) A modified version of EPA Method TO-14, typically used for ambient air sampling, has also been demonstrated to be effective for natural gas sampling.

At many dehydrator locations, the gas sampling port cannot accept a sampling probe, and modifications to use the probe may be expensive and time-consuming. In these cases, it is essential to use a manifold to eliminate the entrained liquids in the pipeline. Liquids in the gas sample tend to bias the analytical results, especially for trace components like BTEX.

## **Natural Gas Analysis**

The standard natural gas analysis used by most of the industry is GPA 2261 which reports concentrations of CO<sub>2</sub>, N<sub>2</sub>, individual C1 - C5 hydrocarbons, and total C6+. For estimating emissions from dehydrators, the BTEX and some of the C6+ concentrations are also important. GRI-GLYCalc emissions calculations are most reliable when the gas concentrations of all the specific compounds listed in the input form are known. **An extended analysis method such as GPA 2286 is required to speciate the necessary compounds for the most accurate GRI-GLYCalc emission estimates.**

## **Glycol Circulation Rate Determination**

This example is for a Kimray glycol pump. For pumps other than Kimray, consult the manufacturer for glycol flow rates/pump strokes.

To determine the glycol circulation rate for Kimray a pump, count the pump strokes for a known period of time and convert the stroke rate to a flow rate using the flowrate table shown below. The time required for 25 strokes (strokes should be counted for at least 2 minutes) should be recorded and then the counted number of strokes per minute converted to a glycol circulation rate. Use this flow rate in all calculations requiring the glycol circulation rate.

Example: Calculate the glycol flow rate in gallons per hour for a Kimray model 20015SC pump in which 22 strokes were counted in 2 minutes 15 seconds as follows:

$$\begin{aligned}
 2 \text{ minutes } 15 \text{ seconds} &= 2.25 \text{ minutes} \\
 22 \text{ strokes}/2.25 \text{ minutes} &= 9.8 \text{ strokes/minute} \\
 (9.8 \text{ strokes/minute}) \times (60 \text{ minutes/hour}) &= 588 \text{ strokes/hour} \\
 (588 \text{ strokes/hour}) \times (0.114 \text{ gallons/stroke}) &= 67 \text{ gallons/hour}
 \end{aligned}$$

### **KIMRAY - Glycol Flow Rates**

<b>Pump Model</b>	<b>Strokes/Minute</b>	<b>Glycol Output Strokes/Gallon</b>	<b>Glycol Output Gallons/Stroke</b>
315P	20 - 100	435	0.0023
1715PV	8 - 40	59	0.017
4015PV	12 - 40	59	0.017
9015PV	12 - 40	26.3	0.038
21015PV	10 - 32	9	0.111
45015PV	10 - 28	3.5	0.283
2015SC	5 - 55	147	0.0068
5015SC	10 - 50	52	0.0193
10015SC	10 - 48	25	0.04
20015SC	10 - 40	8.8	0.114

## **APPENDIX E**

### **Guidance Memos and Notices**



**Guidance Memos and Notices**

Guidance memos and notices are available upon request from the Division and are found on the DEQ Website under “Construction Permit (Chapter 6, Section 2) Forms and Guidance Documents.

The DEQ website address is <<http://deq.state.wy.us/aqd.htm>>

These are:

<u>Date of Memo or Guidance</u>	<u>Subject of Memo or Guidance</u>
12/7/99	Reporting Guidelines for Well Flaring and Venting
10/23/95	Oil and Gas Industry Permitting Guidance
2/4/97	Installation of Equipment - Air Permit Requirements
5/22/97	Rescinding Waiver Thresholds for Production Facilities

