

# Emission Reduction Techniques for Oil and Gas Activities

U.S. Forest Service  
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## FOREWORD

This document is intended to provide techniques which may be applied to oil and gas operations to reduce or mitigate emissions from development and production operations. Emission reduction techniques described herein can be applied to existing operations or considered as mitigation measures to be applied in planning and analysis of potential future development. Depending upon their intended applications, users of this document may consider directly using or recommending an emission reduction technique described here, modify one of the described emission reduction techniques for use in a unique situation, combine two or more techniques, or use this information as a basis to research other unforeseen technology.

### How to Use This Document

The table of contents is designed to provide information on the specific emission reduction technique (such as the emission type it will correct), the actual pollutants that will be reduced, and the pollutant effects. Each technique is color-coded to easily display the types of emissions that will be addressed by that specific technique. After each technique in the table of contents is an abbreviated listing of the pollutant(s) that will be reduced by that specific technique and a symbol that represents the pollutant effects this technique will reduce. The key for color coding reduction techniques, pollutant reduced, and pollutant effects is located on the following page.

This document is based on a powerpoint presentation created by the BLM in 2009 and technical material from the EPA Gas Star program. [\(References\)](#)

## Foreword

### Key to abbreviations & symbols:

#### POLLUTANT REDUCED





PM	coarse particulate matter
NO <sub>x</sub>	oxides of nitrogen
CO	carbon monoxide
VOC	volatile organic compounds
HC	hydrocarbons
CH <sub>4</sub>	methane

#### POLLUTANT EFFECTS






















◆	near-field visibility
♣	far-field visibility
⊛	deposition
✱	ozone

#### REDUCTION TECHNIQUE

Color coding:

	dust treatment
	reducing roadway emissions
	controlling or reducing combustion emissions
	controlling or reducing hydrocarbon emissions

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# Introduction

Oil and gas development that occurs on or near public lands, including lands managed by the USDA Forest Service, brings potential impacts to air quality and an accompanying focus on means to reduce emissions. Reducing emissions to the air may occur in any phase of oil and gas development; this document is organized by emission reduction techniques that apply to transportation, construction and drilling, production, and monitoring and maintenance. Use of these techniques may reduce project emissions and thus prevent significant impacts to Ambient Air Quality Standards or Air Quality Related Values.

As explained further below, this document is intended to serve as a reference and guide. It may apply to oil and gas projects that federal decision makers determine to be actions under the National Environmental Policy Act (NEPA). However, the document is neither intended to be used solely for NEPA purposes nor will it be binding when it informs the NEPA process. End users of this document must be conscious of their authority (see section 0.5) and will have the responsibility to interpret the use of this information in the appropriate context.

## 0.1 Users of This Document

The primary intended audience of this document will be front-line NEPA practitioners in Forest Offices, District Offices, and Regional Offices of the USDA Forest Service. Nevertheless, it is hoped that the document will prove useful to a wide array of users including other Federal Land Managers, oil and gas operators, state and federal regulators, and tribal governments. This document provides information that will be valuable when proposing and conducting an analysis of proposed projects (such as in NEPA and other air quality analyses outside the NEPA setting), and mitigating impacts from proposed emissions. The information presented here can also be used to retrofit existing operations if or when Ambient Air Quality Standards or Air Quality Related Values are exceeded or impacted. Examples of suggested wording for use in planning documents such as NEPA documents are included as tables 1 through 4, which can be found at the ends of their respective sections.

## 0.2 Intended Use

By using the color-coding and quick reference symbols for pollutant effects shown in the key on page iv, casual users should be able to readily use the document as a general source book for emission reduction techniques. In such use, the reader can use the mitigation tables simply as additional reference material. The document can also serve as a reference for staff in an advisory capacity in a non-NEPA setting (such as for oil and gas development near a National Forest but where no federal action is involved). Oil and gas operators may refer to the document as an aid in planning development and may find wording that will be the basis of operator-committed practices. Operators may be aware of effective emission reduction techniques not included in this document; they are encouraged to use these techniques and bring them to the attention of the USDA Forest Service.

In a NEPA setting involving formal discussions among the USDA Forest Service and other stakeholders, wording in this document may be adapted into mitigation language. If such language is ultimately written into a Record of Decision, it will be revised to be mandatory. The U.S. Environmental Protection Agency (EPA) recommends that mitigation measures, whether discretionary or required, that affect emissions from NEPA projects always be disclosed in NEPA documents including the Records of Decision.

The sections below describing emission reduction techniques or technologies and their characteristics

include general information on emissions reduced and other benefits, authority and applicability, and limitations. Benefits and limitations do not all carry equivalent weights; some benefits may outweigh some limitations and vice versa. Applicability may depend upon the setting, and some emission reduction techniques may be required or restricted depending upon the jurisdiction and the airshed.

Cost is often a factor and is mentioned in connection with several of the techniques discussed below. In order to limit the length of this document and extend its useful lifetime, it does not attempt to analyze the costs and benefits of specific techniques. Thorough cost-benefit analyses can be complex and are subject to change with the economy and advances in technology. Nevertheless, cost-benefit analysis is a useful tool and should be considered in decision making. Resources such as EPA's Gas STAR Web site (see section 5.0) give information on cost-benefit for emission reduction techniques. This document will be updated annually to incorporate new techniques.

### **0.3 Protection of Air Resources**

This paper identifies a range of typical emission reduction techniques for protecting air resources during oil and gas development and production operations. This is a partial list. For additional air resource emission reduction techniques and more detailed technical and investment-payback information, please visit the websites listed in section 5.0. Nothing in this presentation is an endorsement of a particular company, product, or service.

Please consult with the appropriate Forest Service Air Quality Resource Manager and the appropriate Air Quality Regulatory Agencies to discuss the use or implementation of these techniques to reduce emissions.

Using emission reduction techniques can reduce the following emissions:

- Hazardous Air Pollutants – can cause serious health problems
  - Benzene, toluene, xylene, formaldehyde
  - Ethyl-benzene, n-hexane
- Criteria Pollutants – national standards to protect health and welfare
  - PM<sub>10</sub> (dust), PM<sub>2.5</sub>, carbon monoxide, sulfur dioxide, ozone, nitrogen oxides
- Volatile Organic Compounds – contribute to ozone formation
  - hydrocarbon compounds excluding methane and ethane
- Greenhouse Gases – contribute to climate change
  - Carbon dioxide, methane, nitrous oxide (N<sub>2</sub>O).

### **0.4 Where Do Emissions Come From?**

This document presents emission reduction techniques that may apply to the transport, drilling, and production phases of oil and gas development. Various categories of sources can emit pollutants during each phase.

- Combustion Emissions: include criteria pollutants, volatile organic compounds, greenhouse gases, hazardous air pollutants.
  - Come from: vehicle tailpipe exhaust emissions, dehydrators, mobile and stationary engines, flaring



- Fugitive Emissions: include criteria pollutants, volatile organic compounds, hazardous air pollutants, greenhouse gases
  - Equipment leaks, evaporation ponds and pits, windblown dust (from truck and construction activity)
- Vented Emissions: include greenhouse gases, volatile organic compounds, hazardous air pollutants
  - Dehydrator vents
  - Condensate tanks, storage tanks
  - Venting during completion events

### **0.5 Who Has the Authority to Authorize or Require Emission Reductions?**

The authority to select or require an emission reduction technique will vary depending upon the laws and regulations that apply to a given situation. Emission reduction techniques may be selected or committed to by the applicant or operator. Such a commitment may not require regulatory authority; however, it may still be necessary to disclose the commitment as mentioned in section 0.2. In some cases, emission reduction technologies or goals for emission reductions will be required as a lease notice or stipulation by the Federal Land Manager. Air quality regulators and Federal Land Managers may require emission reduction techniques with the operator as a form of mitigation under NEPA. Many categories of sources and processes are regulated under federal or state law. Coordination with the appropriate state air quality control agency is essential.

The following sections of the document discuss selection of emission reduction techniques in more detail. There is also a discussion of air quality monitoring and the maintenance aspect of oil and gas development. Each section contains a part on air resource planning that suggests concepts to use when writing planning documents. Most of the examples of wording come from documents that were written pursuant to the National Environmental Policy Act; as explained in section 0.2, some of the wording may need to be revised if it is to be adapted to a Record of Decision, for example.





## **1.0 Air Resource Emission Reduction Techniques Transport**

Transportation of workers, materials, and equipment begins with initial surveys and continues for the life of the project. Vehicles can emit pollutants directly and by disturbing dust on paved or unpaved roadways. Some of the techniques described in this part involve various forms of centralization, which can reduce emissions by reducing the distance traveled on roads or the number of trips. However, centralized development can present its own set of problems. As discussed further in subsequent sections, centralization can increase some emissions such as by increasing the time and power required to drill wells. Similarly, electrification can reduce emissions in the immediate project area but, by increased use of electricity, lead to greater emissions from distant electric generating stations. A planning process that involves the proponents or operators, the state air quality control agency, and other stakeholders should evaluate the relative emissions of the techniques described below and their alternatives. In addition, check with local authorities regarding allowable use of any of these emission reduction techniques.

### **Representative Emission Reduction Techniques – Transport**

Emission reduction techniques that may apply to transportation include directional drilling; centralized water and condensate storage, water delivery, fracturing, and liquids storage; use of liquids gathering systems; telemetry; automation of wells; control of fugitive dust control; and vanpooling. These topics are discussed in this section.

## 1.1 Traffic Reduction

Much oil and gas development occurs in rural, and sometimes remote, areas with sparse access to infrastructure such as rail lines and mass transit. Most transportation around rural oil and gas fields is by truck or car, with their accompanying emissions. In remote areas, the ability to combine trips or carpool is limited or nonexistent, particularly in early stages of development. Nevertheless, reducing trucking and service traffic can reduce associated dust and tailpipe emissions.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust and construction activities.

Benefits:

- Reduces on-road emissions from exhaust.
- Reduces entrained particulate matter as road dust.
- Reduced road wear.
- Improved safety.

Where this can be applied:

- At least to some extent, to most projects.
- During development when coordinated crews are working rotating shifts.
- May more readily apply as development of a field progresses by gradually decreasing the ratio of miles traveled to sites visited and increasing opportunities for multi-passenger trips.

Limitations:

- Requires administrative authority (such as by company policy), otherwise will be limited as a voluntary program.
- Limits to the minimum number of trips required for tasks including safety-related activities and essential maintenance.

## 1.2 Directional Drilling of Multiple Wells Per Pad

This section discusses the use of directional drilling to drill multiple wells from a well pad, although directional drilling can also occur on a single-well pad. The environmental benefits to be gained from directional drilling will vary depending upon the location, geology, and other factors. In spite of other environmental benefits, air quality benefits relative to vertical drilling may not be realized in all cases. Accordingly, we treat this technique as one in which the potential to reduce air emissions is not pre-ordained but still should be considered.

Where directional drilling reduces emissions, reductions come from decreasing the number of pads and thus not constructing an equal number of separate roads. Accordingly, one obvious and immediate environmental benefit is to limit fragmentation of the landscape. Construction of a single pad normally can substantially reduce surface disturbance thereby reducing dust emissions relative to building multiple drill sites.

Directional drilling may require more power and thus have a greater potential for emissions than vertically drilling to the same point of contact with the producing horizon. However, drilling from a single pad can also reduce future travel on the network of roads in the oil and gas field. Recent advances in technology have also reduced drilling time on directional wells. Other experience with emission reduction for large drilling engines, such as with tier 2 and tier 4 diesel engines, has successfully shown reductions in air emissions from directional drilling. Large (over 750 horsepower) tier 2 diesel engines have been available from manufacturers since the early 2000s, and the manufacture of large tier 4 diesel engines is to be phased in by 2015.

Given the above issues, a careful analysis will be required to weigh the advantages and limitations of directional drilling. The topic is discussed further below.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust and construction activities.
- Future reduction of volatile organic compounds due to consolidated production facilities by making the capture of volatile organic compounds and methane more economically viable.

Benefits:



*There are sixteen wells on this well pad.*



*View of an efficiency drilling rig.*

- May decrease vehicle traffic; i.e., reduce road and pad construction related dust and emissions, in the construction and rig move phases.
- Reduces road network.
- May reduce truck traffic dust and emissions during production.
- Facilitates the use of consolidated production facilities, making controls more efficient and cost-effective on volatile organic compound and oxides of nitrogen emissions.

Where this can be applied:

- This may be applied in most development scenarios, though it is sometimes used in exploratory developments where access is limited due to terrain or minimal ground disturbance is desired.

Limitations:

- Oxides of nitrogen, carbon monoxide, and carbon dioxide and other engine emissions from drill rigs are much larger per engine than those associated with vehicle traffic. Therefore, the increase in drill time from directional drilling may result in a short-term emissions increase, even if emissions from vehicle traffic decrease in the long term.
- This may not work in exploration phase of development, because the field has not yet been delineated.
- In some areas, the geologic structures are not suited to directional drilling.
- Total air emissions might actually increase as a result of directional drilling due to the increase in true depth, i.e., greater distances drilled, greater drill times, and increased overall energy use.
- Technical, down-hole limits on directional drilling remain in spite of tremendous advances.



### 1.3 Centralized Water Storage and Delivery

Using centrally stored water that is piped to the well pads and fracturing facilities through a temporary, plastic, surface line.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Reduces the number of truck trips for hauling water.
- Decreases dust from road traffic.
- Reduced tailpipe emissions.
- Less disturbance of wildlife.

Where this can be applied:

- Can be used for developed and producing wells.
- Can be applied to individual or consolidated facilities.

Limitations:

- May not be feasible in some terrain.
- May not be feasible if wells are too far apart.
- Emissions occur during construction of centralized facility.
- May not be feasible if the collection point is too far away. However, water could be piped to a consolidated collection point thereby still reducing some of the road traffic.



*View of Fracking Site*

## 1.4 Centralized Fracturing

Using centralized fracturing pads with hard-line fracturing pipes, some running over one mile, that can serve many well pads - representing hundreds of wells in all.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Reduces movement of fracturing trucks and personnel.
- Decreases dust from road traffic.
- Reduced tailpipe emissions.
- Less disturbance of wildlife.

Where this can be applied:

- Where geological conditions are conducive.
- Where emissions from constructing fracturing pipes and other costs do not outweigh emission reductions.

Limitations:

- In some areas, the geologic structures are not suited to centralized fracturing.
- Emissions occur during construction of centralized facility.





*View of liquid storage site*

## 1.5 Off Site Centralization of Production and Use of Liquids Gathering Systems

Using liquids gathering systems to collect and pipe produced fluids from each remote well location to a centralized production and collection facility situated more closely to a major county or state highway.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust.
- Volatile organic compounds from the absence of venting tanks at well pads.

Benefits:

- Creates fewer emission sources and consolidates control of emissions.
- Reduces haul truck trips and decreases associated dust and tailpipe emissions.
- Increased economic viability of capturing flash emissions and returning them to market rather than venting.

Where this can be applied:

- In fields that produce significant quantities of natural gas liquids.
- Where construction of pipelines is feasible and permissible.

Limitations:

- May not be feasible in some terrain conditions.
- May not be feasible if wells are too far apart.
- Concentrated emissions occur during construction of centralized facility.
- Requires installation and maintenance of pipelines.

## 1.6 Telemetry and Well Automation

Using telemetry, rather than daily visits by operators, to remotely monitor and control production.

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Reduces truck trips and engine emissions.
- Decreases associated dust emissions.
- Increased safety.

Where this can be applied:

- At least to some extent, can be applied to most projects.
- Subject to availability of licensed spectrum and bandwidth.

Limitations:

- May require application-specific development or adaptation.
- Training required.
- Specialized servicing.



*Two meters with solar & telemetry*



*Valve with solar power and telemetry*



*Instrument box with solar panel and antenna*

## 1.7 Dust Suppression with Water

Reducing fugitive dust from vehicle traffic by applying water to unpaved roadways.



*Watering truck*

Emissions reduced:

- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Emission reduction; can greatly reduce dust near roadway and, to some extent, up to several miles away from roadway.
- May reduce road wear somewhat.
- Improved safety for drivers.
- Low initial cost.

Where this can be applied:

- Unpaved and partially paved roadways.
- At least to some extent, can be applied to most projects.

Limitations:

- Most effective with low traffic.
- Lasts only hours; requires frequent applications and maintenance. Availability of water in arid areas.
- Tailpipe emissions from vehicles making applications.
- Requires administrative authority for implementation and enforcement.

## 1.8 Dust-Suppressant Mixtures

Reducing fugitive dust from vehicle traffic by applying dust suppressants such as magnesium chloride, calcium chloride, lignin sulfonate, and asphalt emulsions to unpaved roadways.

Emissions reduced:

- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Emission reduction; can greatly reduce dust near roadway and, to some extent, up to several miles away from roadway.
- Reduced road wear.
- Improved safety for drivers.
- Moderate initial cost.
- Lasts up to a year.
- Good for low-traffic roads.

Limitations:

- Higher cost than water.
- Requires periodic re-treatment and maintenance.
- Tailpipe emissions from vehicles making applications.
- Possible migration of treatment materials.
- Requires administrative authority for implementation and enforcement. Check with local authorities regarding the allowable use of specific dust suppressants.

Where this can be applied:

- Unpaved and partially paved roadways.
- At least to some extent, to most projects.



*Road with dust suppressant*



*Paved roadway*

## 1.9 Road Sealing and Surfacing

Reducing fugitive dust from vehicle traffic by sealing or paving roadways using chip-seal, asphalt, or other road surfaces.

Emissions reduced:

- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Emission reduction; can greatly improve air quality near roadway and, to some extent, up to several miles away from roadway.
- Significantly reduced road wear and erosion of roadbed.
- Improved safety for drivers.
- Effective on high-traffic roads.
- Can withstand traffic for several years.

Where this can be applied:

- Unpaved or partially paved roadways.
- Where construction of permanent, paved roadways is feasible and permissible.

Limitations:

- High or very high initial cost; more cost-effective for roads with higher average daily traffic.
- Possible increase in multi-use traffic, with corresponding increases in tailpipe emissions.
- Fragmentation of the landscape.



*Dust Control — Examples and Illustrations. Treated and untreated sections of road. Dust Suppressant — good reduction in dust. (Dust trail still visible where there was no treatment.)*

## 1.10 Administrative Controls on Roadways

Using reduced vehicle speeds to decrease fugitive dust.

The quantity of dust entrained increases with vehicle speed. In addition to the engineering controls of roadway emissions mentioned above, administrative controls may be feasible. These administrative controls include restricted access and, more frequently, speed limits. An issue of authority arises because access roads in and near public lands including national forests typically are public roads under state or local jurisdiction for traffic control. Accordingly, effectively applying these administrative controls will require coordination with these officials. In addition, oil and gas operators in a field can enforce speed limits as company policies.



*Government SUV making way for truck on unpaved road*

Emissions reduced:

- $PM_{10}$  and  $PM_{2.5}$  from road dust.
- Tailpipe emissions including oxides of nitrogen, volatile organic compounds, carbon monoxide, and carbon dioxide due to improved fuel economy.

Benefits:

- Emission reduction.
- Reduced road wear.
- Improved safety.

Where this can be applied:

- At least to some extent, can be applied to most projects.
- Unpaved and partially paved roadways.
- On roads with high traffic and high dust potential.

Limitations:

- Requires authority to post speed limits.
- Requires effort to implement and enforce.



## 1.11 Vanpooling

Using vans and buses to shuttle employees to the worksite, thereby reducing the number of vehicle trips.



*A Vanpool Van*

Emissions reduced:

- Tailpipe combustion emissions, including oxides of nitrogen.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- PM<sub>10</sub> and PM<sub>2.5</sub> from road dust.

Benefits:

- Reduced overall vehicle emissions through reduction in vehicle miles traveled.
- Reduced road wear.
- Improved safety.

Where this can be applied:

- Most projects.
- Tasks not requiring movement of specialized or heavy equipment.
- Tasks occurring at fixed locations and where inter-site transportation can be arranged as needed.

Limitations:

- Requires exceptions for unscheduled trips.
- Costs of fleet operation and maintenance.

## 1.12 Planning Documents

This section presents ideas on how to word sections of documents prepared under the National Environmental Policy Act (NEPA) or other planning documents. As indicated above, some emission reduction techniques used during the transport phase may develop as applicant- or operator-committed practices. This means that an applicant or operator will commit to using an emission-reducing technique, usually in writing. The commitment might or might not appear in NEPA documents.

Table 1 shows a partial list of emission reduction techniques and suggests some wording that could be used in describing them. Complete wording and more detailed versions of the suggestions below can be found on the web site of the Natural Resources Law Center (<http://www.oilandgasbmps.org/browse.php?cat=1>) and in other resources. Refer to the responsible state air quality control agency to ensure that any emission reduction strategies comply with regulations and permit requirements.

**Table 1. Ideas for planning documents: transport phase.**

<b>Situation</b>	<b>Suggested Language</b>
Develop an annual transportation plan.	<i>“Annual transportation planning will occur in coordination with efforts required for the project area.”</i>
Carry out normal road maintenance activities.	<i>“Maintenance activities normally required include monitoring, blading, surface replacement, dust abatement, spot repairs, slide removal, ditch cleaning, culvert cleaning, litter cleanup, noxious weed control, and snow removal.”</i>
Reduce traffic and surface disturbance and associated dust and tailpipe emissions.	<i>“Where practical and feasible, the operator commits to reduce traffic and surface disturbance and associated dust and tailpipe emissions by utilizing hub and spoke drilling and completion techniques, centralized fracturing operations, and centralized condensate and water collection.”</i>
Implement dust suppression.	<i>“Implement dust suppression to minimize impacts to air, water, vegetation, and wildlife.”</i>
In dust abatement, use no more water than necessary.	<i>“Only the water needed for abating dust should be applied.”</i>
Apply dust suppressants to roads and stockpiles.	<i>“Operators will . . . apply water or suitable chemicals to keep dust in place on roads or material stockpiles.”</i>
Control transportation-related dust throughout the duration of the project.	<i>“Operator responsibilities for preventive and corrective maintenance of roads in the project area would extend throughout the duration of the project and include blading; cleaning ditches and drainage facilities; dust abatement; control of noxious and invasive species; maintenance of fences, gates, and cattle guards; and other requirements as directed.”</i>
Use gravel, water, or other dust suppressors.	<i>“The companies will use gravel, water, or other dust suppressors, as needed, to reduce dust associated with facility access roads.”</i>
Surface roads and well locations.	<i>“Mitigation measures may include surfacing roads and well locations.”</i>
Design roads to limit erosion and emission of fugitive dust.	<i>“The following standard practices limit the emission of fugitive dust: appropriate road design including shape, drainage and surface material to protect road bed from being eroded.”</i>
Carpool.	<i>“Carpool to reduce vehicle numbers, dust, noise.”</i>



## 2.0 Air Resource Emission Reduction Techniques Drilling Phase



*Twin rigs*

The drilling phase also involves construction of roads, well pads, and other infrastructure in the project area. Emissions from earth-moving equipment; drilling engines; pits, tanks, and sumps; flares; and fugitive dust from roads and construction can occur during this phase. Although the groups of emission sources associated with construction are treated separately here, the construction phase often overlaps in time with the production phase. The likelihood that peak emissions will occur during development, production, or a period of overlap between the two phases will depend upon field characteristics such as well density; the depth and geological surroundings of the producing formation; the predominance of oil, wet gas, or dry gas in production; and the power needed for compression. It is important that State air quality control agencies be notified of planned operations during construction and drilling.

### **Representative Emission Reduction Techniques – Construction and Drilling**

Emission reduction techniques that may apply during construction and drilling include selecting engines such as recently-available diesel engines with lower emissions or natural gas engines. Technology in this area is continually changing. For example, large nonroad diesel engines (over 750 horsepower) manufactured for sale in the U.S. through 2010 must meet emission standards known as tier 2. The same category of engines when manufactured from 2011 through 2014 must meet tier 4 transitional emission levels, and beginning in 2015 they must meet the final tier 4 standards. See section 2.1 below and the following Web site:

[www.epa.gov/nonroad-diesel/regulations.htm](http://www.epa.gov/nonroad-diesel/regulations.htm)

Venting releases methane and other hydrocarbons, including volatile organic compounds and hazardous air pollutants. Methane has approximately 21 times the global warming potential of carbon dioxide.

Flaring can be considered an emission reduction technique because it burns methane and other hydrocarbons that might otherwise be vented. Flaring natural gas is usually a better alternative than venting gas; however, some combustion products are also air pollutants. Flaring presents potential fire hazards and impacts to visibility, and citizen concerns may preclude the use of flaring at certain sites. As explained in section 2.3 below, flaring is usually regulated except in emergency circumstances and this document does not endorse flaring as a preferred technique. Well completion techniques with reduced emissions, sometimes referred to as “green completions,” which should be considered as an alternative to flaring, are discussed further in section 2.4 below.

## 2.1 Cleaner Diesel Power



*A Tier 2 diesel engine powers an electric motor to drill this well.*

Reducing engine emissions by moving toward cleaner diesel (or compression-ignition) engines, such as engines meeting the tier 2, tier 4 transitional, or tier 4 final emission standards as they become available.

Emissions reduced:

- Oxides of nitrogen, carbon monoxide,  $PM_{10}$ , and  $PM_{2.5}$ .
- Carbon dioxide.
- Hydrocarbons.

Benefits:

- Uses engines manufactured to meet standards.
- Engines are to be available on a regulatory schedule.

Where this can be applied:

- Generator sets where diesel-electric drilling is to be used.
- Small and medium wellhead engines, if in use.
- May be considered for applications for permits to drill or records of decision; states typically do not regulate mobile-source drill rig engines.

Limitations:

- Cost of purchasing newly manufactured engines meeting current emission standards.
- Drillers operate under contract to applicants or field operators; any specification of engine type must flow through a contract.

## 2.2 Natural Gas Power

Reducing engine emissions by using engines and generator sets fueled with natural gas.



*Natural gas powered engines are typically cleaner than diesel engines and are the approximate equivalent of Tier 4 diesel engines.*



*Natural gas fueled engines power electric motors to drill this well.*

Emissions reduced:

- Oxides of nitrogen, carbon monoxide, sulfur dioxide, PM<sub>10</sub>, and PM<sub>2.5</sub>.
- Hydrocarbons.

Benefits:

- Low emission characteristics.
- Fuel may be available on-site, following suitable processing.

Where this can be applied:

- In lieu of diesel-electric generator sets, as indicated by comparison of emission benefits and economics.
- Compressor stations.
- Small and medium wellhead engines, if in use.

Limitations:

- Requires selection of correct engines to meet power requirements.
- Cost of capital equipment.
- Drillers operate independently of applicants or field operators

## 2.3 Well Completions – Flaring



*Venting, as shown in this photograph, releases methane and other hydrocarbons.*



*A Flaring flame*

Flaring of natural gas in order to avoid venting and prevent safety hazards.

In the past, flaring of natural gas was more commonplace in the United States. Regulations now prohibit this practice in many areas except in the case of emergency orders; check with the responsible authorities for regulations that apply in any specific area. This discussion does not recommend or endorse flaring aside from its use in emergency conditions. Instead, flaring is considered as an emission reduction technique relative to major venting (such as in well blowdown) and in contrast with the reduced-emission well completions covered in the next section. Where flaring and venting occur on public lands, these emissions should be tracked and recorded. More information can be found at:

[www.epa.gov/gasstar/documents/installflares.pdf](http://www.epa.gov/gasstar/documents/installflares.pdf)

Emissions reduced:

- Methane greenhouse gas emissions.
- To some extent, volatile organic compounds.

Benefits:

- Avoids extensive venting, which may be prohibited by state regulation.
- May cheaply and directly eliminate safety hazards posed by natural gas under pressure.

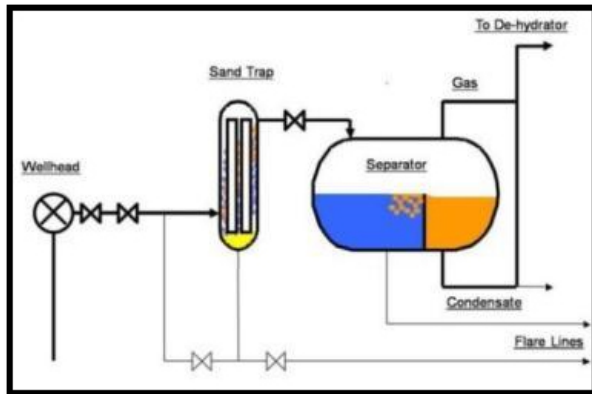
Where this can be applied:

- Where venting is impracticable (e.g., to prevent forceful venting of natural gas under emergency upset conditions) or prohibited (e.g., by state regulation).
- Where permitted, to flare natural gas considered to be economically irrecoverable at condensate wells or oil wells (an increasingly atypical circumstance).

Limitations:

- Emits oxides of nitrogen, carbon monoxide, and  $PM_{2.5}$ .
- Carbon dioxide (a less potent greenhouse gas than methane).
- Possibly emits volatile organic compounds that remain after incomplete combustion.
- Wastes valuable natural gas resources.
- Prohibited in some circumstances and jurisdictions.

## 2.4 Reduced-Emission Well Completions



*Green completion diagram*



*High-pressure separators*

Using “green completions” to recapture a significant portion of product that would have been vented or flared. This type of device separates gas, sand, and water.

- High-pressure vessel separates sand from field gas.
- Gas vessel separates gas from water used for hydrologic fracturing.
- Gas is routed to sales line.
- Sand dumps to drill pit manually.
- Water dumps to media tanks automatically.
- Water is filtered and reused for future fracturing jobs

More information is available at:

[www.epa.gov/gasstar/documents/greencompletions.pdf](http://www.epa.gov/gasstar/documents/greencompletions.pdf)

Emissions reduced:

- Methane and volatile organic compounds (relative to venting).
- Oxides of nitrogen, carbon monoxide, and  $PM_{2.5}$  (relative to flaring).

Benefits:

- Reduces methane and volatile organic compound emissions.
- Recovers product for sale.
- Improved overall safety at the well site.
- Recovers water for reuse.

Where this can be applied:

- Where safety permits recovery of gas (e.g., green completions are not inherently suitable to catastrophic releases of pressure such as blowouts).
- Where economics point toward using the technology.
- Where a sales line or other gas line with sufficient capacity is available to receive produced gas.
- Where natural gas liquids or, in some cases, crude oil accompany produced natural gas.

Limitations:

- Cost.
- Requires adequate reservoir pressure.
- Pressure of the gas must not exceed the rating of the sand trap or separator vessels.
- Gas must meet pipeline specifications.

## 2.5 Planning Documents

This section presents ideas on how to word sections of NEPA documents or other planning documents. Emission reduction techniques during construction and drilling can also include applicant- or operator-committed practices. Forest Service offices will determine the role of operator-committed practices case by case. Normally this occurs during NEPA review, though additional operator-committed measures may be imposed or negotiated at the time of applications for permits to drill to address changed conditions or new information.

Table 2 shows a partial list of emission reduction techniques and suggests some wording that could be used in describing them. Complete wording and more detailed versions of the suggestions below can be found on the web site of the Natural Resources Law Center and in other resources. Learn about the available construction and drilling technology from the project proponents, and refer to the responsible state air quality control agency to ensure that any emission reduction strategies comply with regulations and permit requirements.

<b>Situation</b>	<b>Suggested Language</b>
Conduct a pre-construction field meeting prior to beginning any dirt work.	<i>“A pre-construction field meeting shall be conducted prior to beginning any dirt work approved under this plan of development.”</i>
Implement fugitive dust control measures.	<i>“Develop a transportation plan to incorporate the following strategies: Implement fugitive dust control measures.”</i>
Employ dust suppression to minimize impacts.	<i>“Employ dust suppression to minimize impacts to air, water, vegetation, and wildlife.”</i>
Construct a flare pit on the well pad for drilling operations.	<i>“A flare pit will be constructed on the well pad for use during drilling operations. It will be located at least 125 feet from the well head and will be located down-wind from the prevailing winds.”</i>
Institute necessary precautions to minimize fire hazards.	<i>“If this well is drilled during the fire season (June-October), the operator shall institute all necessary precautions to ensure that fire hazard is minimized, including but not limited to mowing vegetation on the access route(s) and well location(s), keeping firefighting equipment readily available when drilling, etc.”</i>



Situation	Suggested Language
Disturbed areas shall be reclaimed as early as possible to their original condition.	<i>“All disturbed areas affected by drilling or subsequent operations, except areas reasonably needed for production operations or for subsequent drilling operations to be commenced within twelve (12) months, shall be reclaimed as early and as nearly as practicable to their original condition or their final land use as designated by the surface owner and shall be maintained to control dust and minimize erosion to the extent practicable.”</i>
Use Tier 3 (or Tier 4) engines or the equivalent.	<i>“By [date], the operator commits to achieve average drilling rig emissions equivalent to Tier 3 standards or better from 100 percent of drilling engines hired or run by the operator.”</i>
Commit to vertically drill wells (in order to minimize emissions from drilling).	<i>“Wherever possible, the operator commits to vertically drill all of the natural gas wells in the project area in order to reduce associated oxides of nitrogen, sulfur dioxide, and PM<sub>10</sub> emissions.”</i>
Bring well-site portable equipment that cleans up most of initial produced gas to pipeline sales standards.	<i>“Green Completions -- Completions that are able to defer initial gas volumes through specialized equipment rather than flaring to atmosphere are a proactive effort that is beneficial for all elements of the environment. ‘Green Completions’ reduce noise levels, visual effects from flaring, reduce air pollution, and are an economic gain in many cases.”</i>
Use water or chemicals to limit dust in demolition, construction, grading, or clearing.	<i>“The following standard practices limit the emission of fugitive dust: the use of water or chemicals to control dust in the demolition of structures, in construction operations, grading of roads, or clearing of land.”</i>
Minimize emissions of particulate matter from well pad and road construction.	<i>“During construction, emissions of particulate matter from well pad and resource road construction will be minimized by application of water, or other dust suppressants, with at least [the specified level of] control efficiency. Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced or otherwise stabilized ...”</i>
Drill rigs powered by direct electrical power.	<i>“The operator is also evaluating the possibility of providing electrical service to power drilling rigs with direct electrical power, reducing emissions to negligible amounts.”</i>

### 3.0 Air Resource Emission Reduction Techniques Production Phase

This section presents ideas on how to word sections of NEPA documents or other planning documents. Emission reduction techniques during construction and drilling can also include applicant- or operator-committed practices. Forest Service offices will determine the role of operator-committed practices case by case. Normally this occurs during NEPA review, though additional operator-committed measures may be imposed or negotiated at the time of applications for permits to drill to address changed conditions or new information.

Table 2 shows a partial list of emission reduction techniques and suggests some wording that could be used in describing them. Complete wording and more detailed versions of the suggestions below can be found on the web site of the Natural Resources Law Center and in other resources. Learn about the available construction and drilling technology from the project proponents, and refer to the responsible state air quality control agency to ensure that any emission reduction strategies comply with regulations and permit requirements.

- Release methane, a greenhouse gas (greenhouse gas) that has 21 times the global warming potential of carbon dioxide.
- Emit volatile organic compounds, which contribute to ozone formation.
- Emit hazardous air pollutants such as benzene, toluene, and xylene.
- Waste valuable natural gas resources.



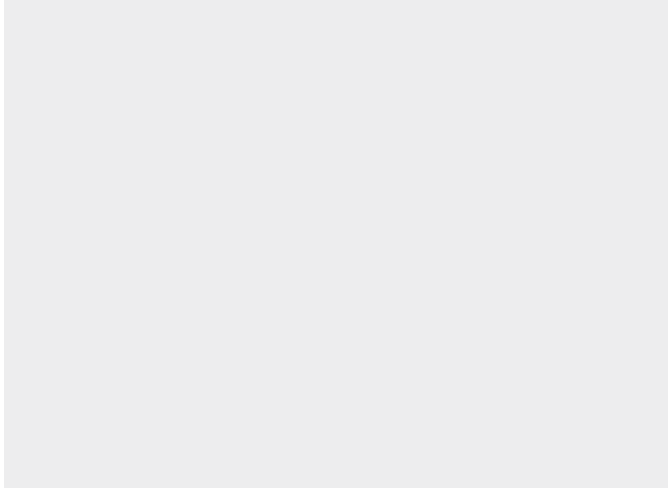
*Leaking ball valve*

*Aerial photo with imaging*

Pneumatic devices convert gas pressure to mechanical energy. In this document, pneumatic devices are assumed to operate on natural gas except where natural gas is replaced with air as an emission reduction technique. Pneumatic devices such as liquid level controllers, pressure regulators, and valve controllers release natural gas into the atmosphere in normal operation.

On-site engines or turbines, whose combustion of fuel is another source of emissions, may be present to produce the power needed to move the hydrocarbon fluids. Storage vessels can emit vapors through working, standing breathing, and flash emissions and other direct emissions to the atmosphere. Although these sources of emissions may be subject to state permitting requirements, additional emission reduction techniques may need to be considered.





*Metering Houses*

### **Representative Emission Reduction Techniques – Production**

Several techniques exist to control or recover hydrocarbon vapors and gases that could otherwise escape to the atmosphere. Operators have shown that the benefits of electrifying gas and oil fields can in some cases outweigh the disadvantages. Supplemental or alternative power sources can reduce emissions and can often operate with low maintenance in remote locations. Operators should also select engines with the best fuel requirements, power, and emission characteristics for individual field applications. Emission controls for engines, including large compressor engines, continue to evolve.

## 3.1 Solar Power

Using chemical pumps and well monitoring telemetry powered by solar panels.



*Examples of solar-power at production facilities*

More information is available in the presentation, Solar Power Applications for Methane Emission Mitigation:

[www.epa.gov/gasstar/documents/workshops/2008-tech-transfer/midland6.ppt](http://www.epa.gov/gasstar/documents/workshops/2008-tech-transfer/midland6.ppt)

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- PM<sub>10</sub> and PM<sub>2.5</sub> from road dust.

Benefits:

- Reduces truck trips, engine emissions, and methane emissions from gas pneumatic pumps.
- Silent operation.

Where this can be applied:

- At least to some extent, can be applied to most projects.
- At unshaded well and battery locations.

Limitations:

- Cost of capital equipment.
- Requires adequate number of panels to meet power requirements.
- Batteries, other electric storage, or alternative power sources needed during darkness.

## 3.2 Electric Power

Using electricity from the nation's power grid is typically cleaner than using onsite diesel or natural gas engines to power drill rigs, compressors, and pumping units. However, overhead power lines may have wildlife or visual impacts.



*Electric wellhead pump*

Emissions reduced:

- Oxides of nitrogen from tailpipe emissions.
- Volatile organic compounds, carbon monoxide, and carbon dioxide from tailpipe emissions.
- $PM_{10}$  and  $PM_{2.5}$  from road dust.

Benefits:

- Standard rates available from utility.
- Eliminates in-field emissions from engines replaced by electric motors.
- Eliminates emissions from vehicles hauling product (e.g., condensate trucks).
- Reduces methane emissions from gas pneumatic pumps.
- May reduce overall traffic for maintenance-related trips.
- Silent operation.

Where this can be applied:

- Wherever grid power is available.

Limitations:

- Proximity to the grid.
- Increased load on grid with increased emissions at electric generating units.
- Power loss in transmission (line loss) proportional to the square of the current.
- Permitting requirements for new service.

### 3.3 Tanks

Storing crude oil or condensate in enclosed tanks instead of open pits to reduce fugitive volatile organic compound emissions.



*Examples of tanks and pits*

Emissions reduced:

- Methane, volatile organic compounds, hazardous air pollutants

Benefits:

- Containment and control of product.
- Improved safety and wildlife protection.

Where this can be applied:

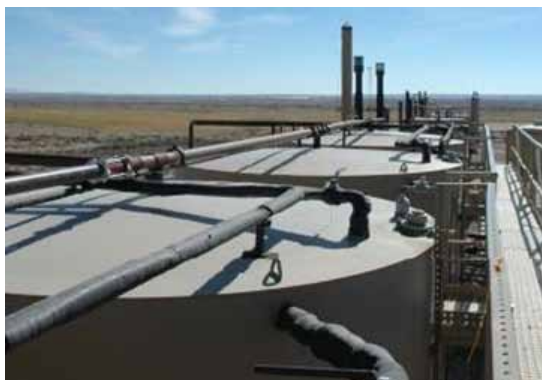
- Projects involving storage of liquid hydrocarbons.

Limitations:

- Construction, including access road.
- Cost of tank, fittings, and installation.
- Operation and maintenance costs.

### 3.4 Vapor Recovery Units

Using vapor recovery units on oil, condensate, and produced water storage tanks reduces vented emissions of volatile organic compounds and recovers valuable hydrocarbon vapors for sale or use on site. Vapor recovery can readily capture 95 percent of the vapors that would be emitted from tanks if left uncontrolled, and capture efficiencies of virtually 100 percent are possible.



*Examples of vapor recovery*

More information is available at:

[www.epa.gov/gasstar/documents/ll\\_final\\_vap.pdf](http://www.epa.gov/gasstar/documents/ll_final_vap.pdf)

Emissions reduced:

- Methane, volatile organic compounds, hazardous air pollutants, and

Benefits:

- Recovery of product otherwise lost.
- Potential improvements in fire safety.

Where this can be applied:

- Projects involving storage of liquid hydrocarbons.
- On storage tanks, where pressures of hydrocarbons are at or near atmospheric pressure.
- Where oxygen can be excluded or explosive mixtures otherwise avoided.

Limitations:

- Cost-effectiveness varies with volume of hydrocarbons that can be recovered.
- Must be correctly engineered for safe operation.

## 3.5 Hatches, Seals, and Valves

Using and maintaining proper hatches, seals, and valves to minimize volatile organic compound emissions.



*Thief Hatches and Vent sealing valves*

In order to minimize emissions and in addition to selecting appropriate hatches, seals, and valves relative to tank design, it is important to establish optimum pressure settings for this equipment.

Emissions reduced:

- Methane, volatile organic compounds, hazardous air pollutants, and

Benefits:

- Well-established technology.
- Moderate cost.

Where this can be applied:

- Projects involving storage of liquid hydrocarbons.
- On storage tanks, where pressures of hydrocarbons are at or near atmospheric pressure.
- Where oxygen can be excluded or explosive mixtures otherwise avoided.

Limitations:

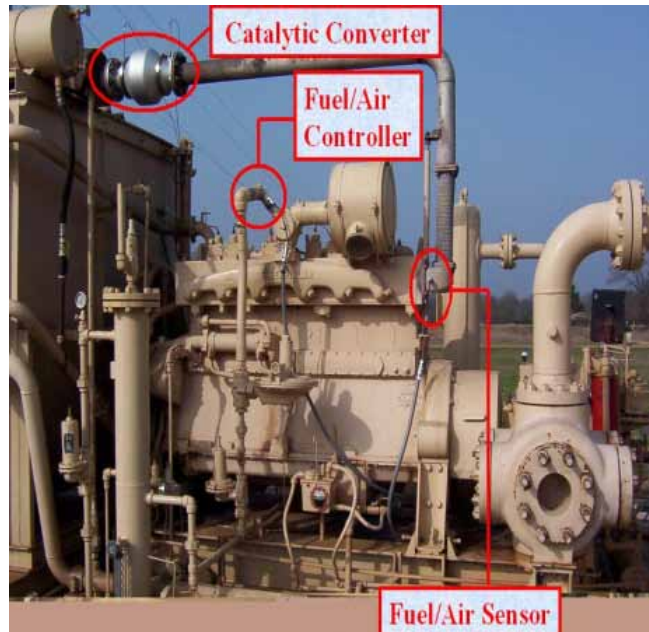
- Must be selected appropriately for application.
- Will release hydrocarbon vapors at designed pressure and temperature.



## 3.6 Controls for Compressor Engines

Improve emission controls on new or existing engines using a combination of techniques such as the following:

- Closed loop engine control,
- Selective catalytic reduction (covered as a stand-alone technique in section 3.7),
- System-installed power supply (solar powered, battery powered),
- Ultra-low sulfur diesel,
- Diesel particulate filter,
- After burner, and/or
- Other new technologies.



*Controls on engine*

Emissions reduced:

- Oxides of nitrogen, sulfur dioxide, carbon monoxide, and carbon dioxide.
- Some PM<sub>2.5</sub>.

Benefits:

- Moderate cost, depending upon application and options selected.

Where this can be applied:

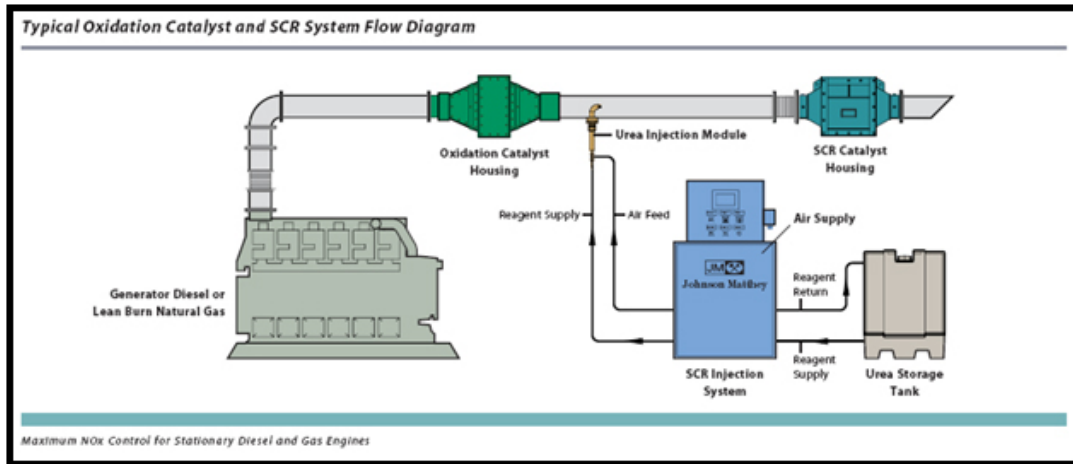
- Projects involving natural gas compression.
- Include control package as an option on new engines.
- Retrofit on existing engines.
- May be subject to regulatory approval by state.

Limitations:

- Availability by engine type and year of manufacture.
- May require testing to confirm target emission rate is achieved.

## 3.7 Selective Catalytic Reduction

Selective catalytic reduction works by injecting diesel exhaust fluid (DEF, a mixture of water and urea) into the exhaust. The DEF works with the heat of the exhaust and a catalytic converter to convert the oxides of nitrogen into nitrogen and water vapor. Commonly, a diesel particulate filter is included in the emission control package with selective catalytic reduction.



Emissions reduced:

- Oxides of nitrogen and
- PM<sub>2.5</sub> and hydrocarbons (if diesel particulate filter is included).

Benefits:

- Proven capability to reduce emissions.
- Feasibility of retrofitting.

Where this can be applied:

- Exhaust streams, e.g., on large engines, particularly where loads are steady or predictable.
- Where oxides of nitrogen emissions are of concern.

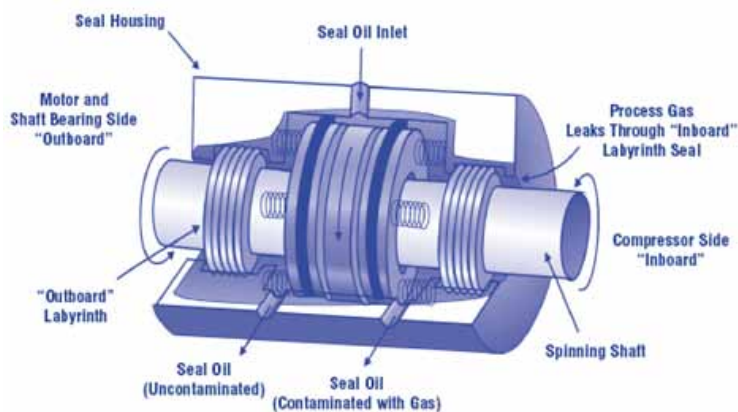
Limitations:

- Cost.
- Availability by for specific application.
- May require testing to confirm target emission rate is achieved.
- May be subject to regulatory approval by state.



## 3.8 Dry Seals in Centrifugal Compressors

Centrifugal wet seal compressor emissions from the seal oil degassing vent can be reduced by the replacement of wet seals with dry seals that emit less methane and have lower power requirements.



*Centrifugal pump*

More information can be found at:

[www.epa.gov/gasstar/documents/ll\\_wetseals.pdf](http://www.epa.gov/gasstar/documents/ll_wetseals.pdf)

Emissions reduced:

- Methane.
- Volatile organic compounds.

Benefits:

- Feasibility of retrofitting.

Where this can be applied:

- Natural gas compression where centrifugal compressors are in use.

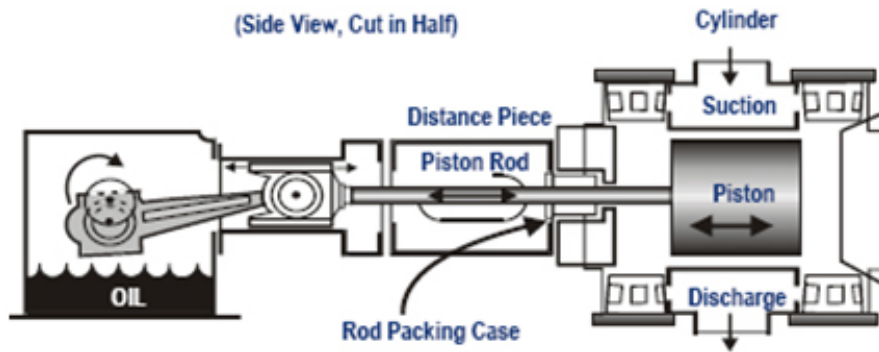
Limitations:

- Relatively specialized applications.

## 3.9 Packing Seals for Compressor Rods

The packing seals of reciprocating-rod compressors leak some gas by design. Emissions from rod packing can be reduced by the economic replacement of rod packing at frequent intervals as:

- Newly installed packing may leak 60 cubic feet per hour.
- Worn packing has been reported to leak up to 900 cubic feet per hour.



*Reciprocating rod*

More information is available at:

[www.epa.gov/gasstar/documents/ll\\_rodpack.pdf](http://www.epa.gov/gasstar/documents/ll_rodpack.pdf)

Emissions reduced:

- Methane.
- Volatile organic compounds.

Benefits:

- Feasibility of retrofitting.
- Proven capability to reduce emissions.

Where this can be applied:

- Natural gas compression where reciprocating-rod compressors are in use.

Limitations:

- Additional operational burden due to more frequent maintenance.
- Cost.

### 3.10 Reduced-Emission Pneumatic Systems

To reduce emissions of methane and volatile organic compounds:

- Replace high-bleed devices with low-bleed.
- Retrofit bleed reduction kits on high-bleed devices.



*Looking at controller*

More information is available at:

[www.epa.gov/gasstar/documents/11\\_pneumatics.pdf](http://www.epa.gov/gasstar/documents/11_pneumatics.pdf)

[http://www.methanetomarkets.org/events/2005/oil-gas/docs/methanerec\\_pd\\_vru\\_dehy.pdf](http://www.methanetomarkets.org/events/2005/oil-gas/docs/methanerec_pd_vru_dehy.pdf)

Emissions reduced:

- Methane.
- Volatile organic compounds.

Benefits:

- Feasibility and ease of retrofitting with fairly quick cost recovery.
- Product recovery.
- Proven capability to reduce emissions.

Where this can be applied:

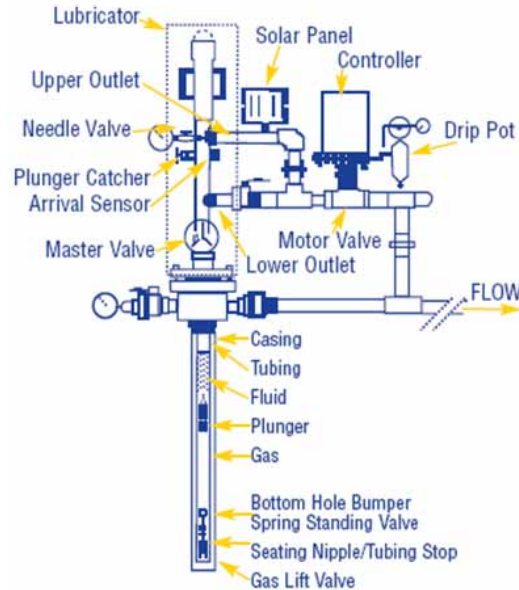
- Fields using natural gas in pneumatic controls.
- Where conversion to air-actuated or electric controls is economically infeasible.

Limitations:

- Accessibility of components.
- Continues to use natural gas.

### 3.11 Plunger Lift Systems and Automated Systems in Gas Wells

Methane emissions from well blowdowns can be reduced by installing plunger lifts and smart automation systems which monitor well production parameters.



More information can be found at:

[www.epa.gov/gasstar/documents/ll\\_plungerlift.pdf](http://www.epa.gov/gasstar/documents/ll_plungerlift.pdf)

[www.epa.gov/gasstar/documents/smart\\_automation.pdf](http://www.epa.gov/gasstar/documents/smart_automation.pdf)

Emissions reduced:

- Methane.
- Volatile organic compounds.

Benefits:

- Greater recovery of product.
- Operation and maintenance may be simplified.
- Potentially improved safety.

Where this can be applied:

- Typically in mature gas wells.
- Where down-well accumulation of liquids tends to compel blowdown to restore flow of natural gas.

Limitations:

- Cost-effectiveness.
- Relatively specialized applications.

## 3.12 Planning Documents

As in the preceding parts of this document, the section on air resource planning presents a partial list of ideas on the wording of planning documents. Considering field-specific conditions and continually developing technology, applicant- or operator-committed emission reduction techniques can play a particularly important role in the production phase. It is equally important to discuss these techniques with the operators or applicants. Many of the emissions in the production phase originate with stationary sources; accordingly, it is essential to refer to the responsible state air quality control agency to ensure that any emission reduction strategies comply with regulations and permit requirements.

As an illustration of field-specific challenges, table 3 below suggests wording on the possible use of desiccant dehydrators in place of glycol dehydrators. Some desiccant dehydrators may present problems in cold climates, depending upon the volume of water produced. However, other low-emission dehydrators are also available. Decisions about selecting a specific piece of equipment will depend on such factors as performance, capacity, and power requirements as well as the potential for emission reductions.

Table 3 shows a partial list of emission reduction techniques and suggests some wording that could be used in describing them. Complete wording and more detailed versions of the suggestions below can be found on the web site of the Natural Resources Law Center and in other resources.

**Table 3. Ideas for planning documents: production phase.**

Situation	Suggested Language
Require natural gas-fired engines for compressors and generators.	<i>“The air quality objectives for the proposed action include ... requiring natural gas-fired engines for compressors and generators, except in areas with sensitive resources, including people, where noise is an issue.”</i>
Install catalytic converters.	<i>“Install catalytic converters to minimize emissions.”</i>
Replace gas starters with air.	<i>“Engines for compressors, generators, and pumps are often started using small gas-expansion turbines. Pressurized gas expanded across the starter turbine rotates the engine for startup, and then vents to the atmosphere. Replacing the natural gas with compressed air will eliminate this source of methane emissions.”</i>
Install electric starters.	<i>“Gas-expansion starter turbines on compressors, generators, and pumps can also be replaced by electric starter motors, similar to an automobile engine starter.”</i>
Convert gas-driven chemical pumps to instrument air.	<i>“Replacing natural gas with instrument air to drive the glycol circulation and chemical-transfer pumps increases operational efficiency, decreases maintenance costs, and reduces emissions of methane, volatile organic compounds, and hazardous air pollutants.”</i>

Situation	Suggested Language
Convert gas pneumatic controls to instrument air.	<i>“Converting natural-gas-powered pneumatic control systems to compressed-instrument-air systems eliminates 100 percent of the methane emission from valve controllers and may also be used to eliminate methane emissions from pneumatic pumps and compressor-engine pneumatic starters.”</i>
Convert gas pneumatic controls to mechanical controls.	<i>“The most common mechanical control device is a level controller, which controls the position of a drain valve by mechanical linkages to the position of a liquid-level float. The mechanical device eliminates both the process controller bleed and the valve-actuation vent emissions. Mechanical controls can be used where the process measurement is close to the flow control valve, with a savings of 500 Mcf/yr per controller.”</i>
Use low-bleed pneumatic controllers.	<i>“All new and replaced pneumatic controllers will be a no-bleed or low-bleed design.”</i>
Replace glycol dehydrators with desiccant dehydrators.	<i>“Glycol dehydrators vent methane, volatile organic compounds, and hazardous air pollutants to the atmosphere from the glycol regenerator, bleed natural gas from pneumatic control devices, and burn natural gas in the glycol reboiler. Replacing glycol dehydrators with desiccant dehydrators reduces methane, volatile organic compound, and hazardous air pollutant, emissions by 99 percent and saves fuel gas for sales.”</i>
Eliminate well-site dehydrators.	<i>Operator “will not use well-site dehydrators.”</i>
Reroute glycol skimmer gas.	<i>“Some glycol dehydrators have glycol still condensers and condensate separators to recover natural gas liquids and reduce volatile organic compound and hazardous air pollutant emissions. Rerouting the skimmer gas to the reboiler firebox or other low-pressure fuel-gas systems reduces methane emissions and saves fuel. Using glycol skimmer gas as a fuel directly offsets use of saleable gas, increasing product revenues and quickly paying back the low capital, operating, and maintenance costs.”</i>
Prevent emissions from storage tanks.	<i>“Emission controls will be utilized on all condensate storage batteries with emissions greater than five tons per year” “At a minimum. The applied control technology must be capable of reducing emissions by 95 percent.”</i>

Situation	Suggested Language
Recover gas during condensate loading using recycle lines.	<i>“Condensate, when transferred from storage into tank trucks, can generate significant volumes of gas caused by pressure and temperature changes and evaporation. This gas is typically vented to the atmosphere but can be contained by connecting the tank truck vent to the condensate storage tank with a vapor-recovery system.”</i>
Calculate an economic replacement threshold for compressor-rod packing systems.	<i>“Gas leaks from compressor rods represent one of the largest sources of emissions at natural gas compressor stations. All packing systems leak under normal conditions. A simple calculation using company-specific financial objectives and monitoring data can determine emissions levels at which it is cost-effective to replace rings and rods.”</i>
Decrease heater-treater temperature.	<i>“Heater-treaters use thermal, mechanical, gravitational, and chemical methods to break emulsions and separate crude oil from water. Elevated temperature is effective in lowering oil viscosity and promoting phase separation, but requires fuel gas and causes volatile hydrocarbons in the oil to vaporize and vent. Heater-treater temperature settings at remote sites may be higher than necessary, resulting in increased methane and volatile organic compound emissions.”</i>
Reduce emissions from process heaters.	<i>“Use low-oxides of nitrogen burners in process heaters.”</i>

## 4.0 Air Resource Emission Reduction Techniques

### Monitoring and Maintenance

Agreement on reasonable emission reduction techniques can produce a plan of development that will prevent unnecessary emissions to the atmosphere. As development proceeds, monitoring, enforcement by regulatory and land management agencies, and record-keeping ensure that mitigation is effectively implemented. By introducing technology and practices designed to reduce emissions, applicants and operators can reduce overall emissions from a project. Once repaired, most emissions linked to equipment problems tend to stop; therefore, timely maintenance and repair can significantly reduce emissions. This part of the paper presents techniques that apply to monitoring and maintenance.

While most closely associated with production, monitoring and maintenance apply to all phases of development. As discussed above, consultation with air quality experts of the state air quality authority regarding monitoring and maintenance is essential.



*Spraying tank*

### Highlights of Monitoring and Maintenance

Examples of monitoring and maintenance activities: directed inspection and maintenance, infrared leak detection and ambient quality monitoring.



## 4.1 Directed Inspection and Maintenance and Infrared Leak Detection (DI&M)

Fugitive gas leaks can be reduced by implementing a DI&M Program which identifies and cost effectively fixes fugitive gas leaks using:

- Leak Detection
  - Infrared Camera
  - Organic Vapor Analyzer
  - Soap Solution
  - Ultrasonic Leak Detectors
- Measurement
  - Calibrated Bagging
  - Rotameters
  - High Volume Sampler



*Leak-testing a component*

More information can be found at:

[www.epa.gov/gasstar/documents/03\\_dim\\_in\\_gas\\_production\\_facilities.pdf](http://www.epa.gov/gasstar/documents/03_dim_in_gas_production_facilities.pdf)

Emissions reduced:

- Methane.
- Volatile organic compounds.

Benefits:

- Detects emissions by remote sensing.
- Ease of use following minimal training.

Where this can be applied:

- Most projects involving hydrocarbon production and treatment.
- In order to detect leaking process components, including valves, flanges, and connections.
- Sealing mechanisms, such as on reciprocating rods and pump seals.
- Hatches and seals on tanks.

Limitations:

- No direct quantification of emission rates.
- Most effective when used in a structured program requiring oversight and management.
- Cost of purchase and repair of instrumentation.

## 4.2 Air Quality Monitoring

Using air monitoring for:

1. Monitoring current and modeling future air quality conditions.
2. Designing emission control strategies.
3. Reviewing monitoring data and adapting to findings:
  - Adjusting development rates, timing, and places of development.
  - Refining mitigation measures

Emissions reduced:

- Indirectly, emissions of any pollutant of concern which can be monitored.

Benefits:

- Gives knowledge of concentrations and trends in the ambient air.
- Produces information that can be shared with the public.
- Supports air dispersion modeling efforts.

Where this can be applied:

- Large projects or project areas where adequate funding can be arranged.
- At a location that is representative under the monitoring objective(s).
- In areas where Federal Land Managers and regulatory agencies concur that monitoring is warranted.
- Where land access, possibly long-term, can be gained.
- Where electric power is available, unless passive sampling or monitoring using low-power equipment can suffice.
- In the “ambient air,” as defined for regulatory purposes, if required.

Limitations:

- Cost.
- Time required in order to collect and report data.
- Difficulty of meeting expectations of data users.
- Does not directly control or reduce emissions.



*Portable meteorological station*

### 4.3 Planning Documents

Downstream oil and gas processing facilities are normally subject to more regulations covering leak detection and repair than upstream production. However, inspection rules also apply to some upstream units and the operators should refer to state regulatory agencies about their specific situations. Although it cannot directly measure source-specific emission rates, ambient air monitoring can support tracking of regional trends. The lower the emissions per unit of equipment, the more likely that oil and gas development may proceed without jeopardizing air quality standards.

Table 4 builds on the examples above with a partial list of emission reduction techniques and suggests some wording that could be used in describing them. Complete wording and more detailed versions of the suggestions below can be found on the web site of the Natural Resources Law Center and in other resources.

**Table 4. Ideas for planning documents: monitoring and maintenance.**

Situation	Suggested Language
Begin a directed inspection and maintenance at compressor Stations.	<i>“Fluctuations in pressure, temperature, and mechanical stresses on pipeline components (such as valves and seals) eventually cause them to leak. A directed inspection and maintenance program concentrates on components such as valve packing, pneumatic controllers, open-ended lines, blowdown lines, pneumatic engine-starter motors, and pressure-relief valves, which are prone to large leaks that are cost-effective to find and fix.”</i>
Inspect flowlines annually.	<i>“Annual flowline inspection and a regular leak-repair schedule will reduce gas losses and prevent small leaks from growing into major leaks. Leaks in buried flow lines may be detected by using an ultrasound detector, or infrared imaging, or through the temporary introduction of odorant into the gas stream”</i>
Use ultrasound to identify leaks.	<i>“Some of the hardest leaks to find, and therefore among the largest leaks, are shutoff valves on open-ended lines that vent through an elevated stack. Ultrasound leak detectors are tuned to detect the high-frequency sounds associated with gas flowing through a valve that is not tightly closed. Lower-frequency background noises are filtered out. The magnitude of the sound corresponds to the magnitude of the leak. Ultrasound detectors can be applied to all in-service shutoff valves and pressure-relief, blowdown, starter-motor, and unit isolation valves.”</i>
Optical leak imaging.	<i>Operator “will employ forward-looking infrared (FLIR) methodology for detecting fugitive emissions (volatile organic compound and hazardous air pollutant reduction).”</i>

## 5.0 For More Information on Emission Reduction Techniques

EPA Natural Gas STAR Program

<http://www.epa.gov/gasstar/tools/recommended.html>

California Air Resources Board's Clearinghouse

<http://www.arb.ca.gov/cc/non-co2-clearinghouse/non-co2-clearinghouse.htm>

Four Corners Air Quality Group

<http://www.nmenv.state.nm.us/aqb/4C/>

Natural Resources Law Center

<http://www.oilandgasbmps.org/browse.php?cat=1>

Four Corners Air Quality Task Force, Report of Mitigation Options

<http://www.nmenv.state.nm.us/aqb/4C/TaskForceReport.html>

BLM Oil and Gas BMP Powerpoint

[http://www.blm.gov/wo/st/en/prog/energy/oil\\_and\\_gas/best\\_management\\_practices/technical\\_information.html](http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/technical_information.html)

