FLARING: QUESTIONS + ANSWERS
Second Edition
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Canadian Cataloguing In Publications Data
Main entry under title: Flaring Questions + Answers
1. Gas industry – Canada. I. Bott, Robert, 1945- II Canadian Centre for Energy Information
ISBN 1-894348-18-4

ABOUT THIS PUBLICATION
Flaring Questions + Answers, a companion publication to Sour Gas Questions + Answers, is produced by the Centre for Energy to explain flaring, venting and incineration of natural gas in Canada. Although some sour gas issues are also flaring issues, the majority of flaring involves sweet gas containing little or no hydrogen sulphide (H₂S). For a more complete understanding of flaring and sour gas, readers are urged to consult both documents and the oil and natural gas section of www.centreforenergy.com. Sources for further information are included at the back of each document.

Flaring Questions + Answers has been updated and expanded from the original version published in 2000. It provides more information about new technologies and operating methods that have substantially reduced the amount of flaring and venting in the Canadian upstream and midstream petroleum industry. Sections on emissions and research have been expanded and all statistics, technical information and illustrations have been reviewed and updated as required.

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NOTE: Special terms used in the oil and gas industry are usually defined in context within one page of where they first appear. A glossary of industry terms is included in Our Petroleum Challenge and posted in the oil and natural gas glossary on the Centre for Energy portal www.centreforenergy.com. An overview about the potential environmental impacts of the oil and gas industry is also posted in the oil and natural gas section of the portal.

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Advances in flaring and venting practices

Flaring – burning natural gas in an open flame – has long been part of the process for producing marketable natural gas and crude oil in the petroleum industry. However, flaring wastes potentially valuable resources and produces emissions that can affect human health, livestock and the environment. As a result, there has been a growing movement, in Canada and internationally, to reduce flaring. Government, industry and stakeholder groups in Alberta have been leaders in this initiative. From 1998 to 2005, the total amount of flaring in Alberta was reduced by 54 per cent despite strong growth in natural gas exploration and production. Among the key reasons for the sharp reduction in flaring:

- commitments by industry and regulators to address environmental impacts, meet public expectations and conserve resources
- economic incentives due to higher natural gas prices
- new technologies to produce, process, transport and utilize natural gas
- new methods to dispose of unmarketable natural gas

Venting – direct release of natural gas into the atmosphere – has also been reduced substantially, for similar reasons. In Alberta, the amount of reported venting was halved between 2000 and 2005. Wherever possible, industry today strives to contain natural gas and deliver it to customers. If this is impractical, the natural gas may be disposed of or utilized in other ways:

- burned in properly designed incinerators, which are generally more efficient than flares
- used to generate electricity and steam
- injected underground

About natural gas

The natural gas that is shipped through transmission pipelines and delivered to consumers consists almost entirely of methane (CH₄), the simplest hydrocarbon, plus small amounts of ethane (C₂H₆) and propane (C₃H₈), carbon dioxide (CO₂) and nitrogen (N₂). However, natural gas is seldom found in such pure form underground – except natural gas from coal, which is almost pure methane.

Raw natural gas is typically a mixture that may also include butane, pentane and heavier hydrocarbons as well as substances such as carbon dioxide (CO₂), hydrogen sulphide (H₂S), water vapour and/or helium (He). These substances are removed at processing plants before the natural gas is pipelined to customers.

If natural gas contains H₂S, it is called sour gas. H₂S has a strong “rotten egg” odour even in very low concentrations and is toxic at higher concentrations. Nearly one-third of the natural gas produced in Canada is sour.

Crude oil often contains some natural gas. Known as associated gas or solution gas, this natural gas is dissolved in the oil in pressurized underground reservoirs, but bubbles out of the oil – like carbonation in beverages – when the oil is brought to the surface where the pressure is reduced. Solution gas accounts for about nine per cent of Canadian natural gas production. If this gas contains H₂S, it is called sour solution gas.

Natural gas is also found in coal seams. This gas is known as coalbed methane (CBM) or natural gas from coal (NGC). This gas is generally “sweet,” containing little or no H₂S.

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1 Local distribution companies also add tiny amounts of a substance called mercaptan to the natural gas and propane used by consumers. Mercaptan gives retail natural gas and propane its characteristic odour so that even the smallest leaks are easily noticed. Methane, ethane and propane are odourless.
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Section 1 Recovering More Marketable Natural Gas

More than 98 per cent of the natural gas produced in Canada is processed to remove any impurities and then shipped by pipeline to customers or used within the oil and gas industry. However, some natural gas is not economical to process and ship due to small volumes or lack of pipeline connections. There are also operational and safety reasons why some natural gas cannot be sold or used. The unmarketable gas may be burned in flares or, in some circumstances, released directly into the atmosphere. Other disposal options are incineration or injecting the gas underground.
Why is some natural gas flared, vented or incinerated?
The oil and gas industry avoids flaring and venting natural gas whenever possible. Natural
gas is a valuable commodity, both economically and as a clean-burning, low-carbon
energy source, so there is a strong incentive to deliver every cubic metre of production
to customers. The government, as owner of the mineral rights on about 80 per cent of
Canadian natural gas production, also has a direct economic interest. Alberta established
its first petroleum regulatory authority, predecessor of the current Alberta Energy and
Utilities Board, in 1938 to prevent waste of natural gas from the Turner Valley field southwest
of Calgary.

There are also environmental reasons to avoid burning natural gas or releasing it into
atmosphere. Combustion (flaring and incineration) or venting can cause local and regional
air pollution. Combustion emits carbon dioxide, a greenhouse gas that contributes to
global warming. Venting releases methane, which has 23 times as much global warming
potential (per tonne) as carbon dioxide. See Section 3 for more information about emissions
and effects.

There are various circumstances where it may not be economic, practical or safe to conserve
natural gas:
• Volumes of solution gas from crude oil wells may be too small or the location too
remote to justify building pipelines and processing facilities.
• Incidents during drilling, production, processing or pipelining may lead to releases
of natural gas.
• After drilling a successful well, it may be necessary to produce natural gas for a short
period of time to establish flow rates and gas composition, key considerations when
determining the type and size of equipment to be installed.
• During and after some drilling and servicing operations, it is necessary to dispose of
natural gas contaminated with drilling mud, fracturing fluids or acids.
• Gas containing hydrogen sulphide (H2S) needs to be disposed of safely if it cannot
be processed otherwise. Combustion converts the H2S into water vapour and sulphur
dioxide (SO2), which are lifted and dispersed by the plume of hot gases.

The options for disposing of unmarketable natural gas include flaring, incineration, venting,
underground injection or uses such as pipeline heating and electrical generation.

What is flaring?
Flaring is the open-air burning of natural gas. Flaring disposes of the gas and releases
emissions into the atmosphere. Most of the flaring in Canada involves sweet natural gas,
although flaring is also used to dispose of some sour gas.

Flaring is an important safety measure during drilling operations and at natural gas facilities.
It safely disposes of gas during equipment failures, power outages and other emergencies or
“upsets” in drilling or processing operations. The natural gas might otherwise pose hazards
to workers and nearby residents. Flare systems are used throughout the petroleum industry
around the world, including thousands of locations in Canada.

A flare resembles a Bunsen burner in a science lab but on a much larger scale. A metal pipe,
known as the flare stack, carries gas to the top of the stack. A nozzle or burner tip may be
located at the top. A pilot light or electronic igniter ignites the gas. Many flare systems also
include a liquids separator, known as a knockout drum, which removes water and petroleum
liquids from the gas stream before it reaches the flare stack so the gas burns more efficiently.
An efficiently burning flare does not produce visible smoke. Black smoke indicates incomplete combustion, which can be caused by wind, impurities in the fuel, or poor mixing with the air.

**What are incinerators?**

Like flares, incinerators use combustion to dispose of natural gas. However, the combustion in incinerators occurs under controlled conditions below or within the stack. Incinerators are not affected by wind or other weather conditions, and they generally provide more efficient combustion, compared to open-air flaring.

Incinerators are used at most sour gas processing plants and some other facilities where natural gas or hydrogen sulphide must be disposed of routinely. Incinerators are more costly to install than flare stacks, and they require more frequent maintenance and monitoring to ensure they are operating properly. Portable incinerators are sometimes used in field operations.

Some “incinerators” are actually enclosed flares. A true incinerator has controls to maintain a specific air-to-fuel ratio, a refractory lining and a minimum residence time, while an enclosed flare is merely protected from outside weather. The most efficient combustion is provided by a true incinerator.

Government and industry statistics for natural gas consumption and emissions generally do not distinguish between incineration and flaring. Both are included under the single “flaring” category.

**What is venting?**

Venting is the release of natural gas directly into the atmosphere without flaring or incineration. Most of the venting in Canada occurs during the production of crude oil and oilsands bitumen. Some natural gas is released at the wellhead as the oil or bitumen is brought to the surface, and some is released during treatment and storage. Although the quantities released at any given well are typically small, there are many such wells, so the total amount is significant.

Venting also may occur during well testing – primarily from shallow, sweet, low-volume natural gas wells – and in the operations of natural gas wells, pipelines and processing plants. Changes in equipment and procedures have greatly reduced the amount of venting in Canada since the mid-1990s. In Alberta, for example, the total amount of venting dropped 55 per cent between 2000 and 2005.

**What is injection?**

In many crude oil producing fields, solution gas is recovered and injected back into the reservoir to maintain pressure and sustain production levels. The natural gas can later be produced and sold when crude oil production ceases. For example, the Hibernia, White Rose and Terra Nova projects off Newfoundland and Labrador currently use some of the natural gas produced along with crude oil to meet their own energy needs and inject the rest of the natural gas into the oil-producing formations.
Some gas plants in Western Canada also use underground disposal for the $\text{H}_2\text{S}, \text{CO}_2$ and water recovered during sour gas processing. This is known as acid gas injection because $\text{H}_2\text{S}$ and $\text{CO}_2$ are both gases that can form acids when combined with water. Acid gas injection has been adopted at about 45 plants in Alberta and British Columbia since 1990. It not only disposes of $\text{H}_2\text{S}$ safely, it also reduces greenhouse gas emissions of $\text{CO}_2$. The gas mixture can be injected into either saltwater aquifers or depleted oil and gas reservoirs. One project in northwestern Alberta and one project in northeastern British Columbia use the injected acid gas to coax more production from crude oil reservoirs.

**What are microturbines?**

Microturbines are small gas-fired turbines that produce electricity. Microturbines can burn natural gas that would otherwise be flared. The electricity is used to provide power for industry operations (such as pumping, compression or gas processing) or sold to the regional grid. In co-generation applications, the microturbines also produce steam for industry operations or nearby activities such as drying grain or heating greenhouses.

Microturbines came on the market in the late 1990s. In 1999, the Alberta government announced it would waive royalties on natural gas used for electricity or steam generation if the gas would otherwise be flared. This could be accomplished using microturbines because they have few moving parts, low maintenance requirements, and can burn low-quality gases including some sour gas. Microturbines are used at a growing number of Alberta sites and several in Saskatchewan.

**How much has natural gas conservation been improved?**

Compared to most of the world petroleum industry, the amount of natural gas flared, incinerated or vented in Canada was already low in the mid-1990s. However, government, industry and the public agreed that further improvements were possible and desirable in order to address both the emissions and the waste of a valuable resource. Alberta, which produces about 80 per cent of Canadian natural gas, led the way and other jurisdictions followed suit.

Until recently, the majority of flaring and venting involved solution gas from crude oil and bitumen production. Solution gas accounts for about nine per cent of total natural gas production in Canada, but the volumes at individual sites are typically small and may be some distance from established natural gas pipelines and processing plants. In Alberta, the amount of solution gas conserved (sold, utilized by industry or injected underground) increased from 90.2 per cent in 1993 to 96.3 per cent in 2005. Solution gas conservation also increased in British Columbia and Saskatchewan.

There were also reductions in flaring and venting from well testing, natural gas production and gas processing plants, but the decreases were smaller due to the large increase in natural gas drilling and production. Venting from pipelines was almost eliminated.
Section 2 Facilities and Methods

HIGHER NATURAL GAS PRICES, CHANGES IN GOVERNMENT REGULATIONS, AND INDUSTRY COMMITMENTS TO REDUCE EMISSIONS HAVE CREATED STRONG INCENTIVES FOR REDUCTIONS IN THE AMOUNTS OF NATURAL GAS FLARED, INCINERATED OR VENTED. NEW TECHNOLOGIES AND CHANGES IN PRACTICES HAVE MADE IT POSSIBLE TO ACHIEVE SIGNIFICANT IMPROVEMENTS AT EACH STAGE FROM DRILLING TO PIPELINING.
How have flaring and venting been reduced during well tests?

Well tests are conducted to determine flow rates and gas composition and to remove contaminants such as drilling mud, fracturing fluids or acids. Tests may continue for several days, and the natural gas is generally flared, although it may be vented from some low-volume wells. Despite a tripling of the number of wells drilled annually since the mid-1990s, the total amount of natural gas flared during well tests in Alberta declined due to new procedures and regulations, and venting during well tests was almost eliminated.

In the past, longer periods of testing were required to collect adequate information about reservoirs. Now this data can often be obtained by other means. In addition, regulators such as the Alberta Energy and Utilities Board have established time limits for well tests – 72 hours in most cases – and operators must provide reasons why longer tests might be required.

If there are existing pipelines to processing plants, the wells may be connected to the system during tests so that the natural gas can be processed and sold rather than flared; this is called “in-line testing.” However, some test flaring may still be necessary to determine well characteristics and remove waste materials. Coalbed methane wells are typically fractured immediately after drilling. This is done by injecting high-pressure nitrogen gas. After this, the mixture of methane and nitrogen flows to the wellbore. Because the nitrogen-rich gas cannot sustain combustion initially, it is vented and then flared (when the mixture can sustain combustion) before the wells are put into production. Wet coalbed methane wells, which are less common in Canada, also require dewatering, and this too can necessitate some pre-production flaring.

Government and industry continue to seek ways to reduce the frequency and duration of well test flaring.
How have flaring and venting of solution gas been reduced?

The largest reductions in flaring and venting relate to the solution gas released during crude oil and bitumen production. In Alberta, solution gas flaring was reduced by more than 72 per cent between 1996 and 2005, while solution gas venting was reduced by 59 per cent between 2000 and 2005. The reductions were due to changes in regulations, higher natural gas prices, new technologies and adoption of “best practices” by industry.

Much of the solution gas that was formerly flared or vented is now pipelined to processing facilities and sold to customers or used in industry operations. Oilsands bitumen facilities have been redesigned so that less natural gas is released into the atmosphere. Solution gas is also injected into oilfields to maintain reservoir pressure. In some fields, microturbines now generate electricity (and sometimes steam) using solution gas that previously would have been flared.

SOLUTION GAS FLARING IN ALBERTA (millions of cubic metres)

Source: Alberta Energy and Utilities Board
How have processing plants reduced flaring and venting?

Gas processing plants remove contaminants such as water, H$_2$S and CO$_2$ from raw natural gas and separate the products into marketable natural gas (mainly methane), natural gas liquids (ethane, propane and butane) and condensate (pentanes and heavier hydrocarbons). Most plants handling large volumes of sour gas convert more than 99 per cent of the H$_2$S into elemental sulphur, with any remaining H$_2$S burned in incinerators. Plants handling sweet gas or low volumes of sour gas typically burn any unmarketable gases in flares or incinerators.

Sour gas plants have continued to improve the efficiency of sulphur recovery and thus reduce the amount of incineration or flaring to dispose of H$_2$S. For example, some plants have been reconfigured to reprocess gas that does not meet pipeline specifications; this “non-spec” gas was previously flared or incinerated. Remote controls also allow plant operators to reduce or shut down the flow of natural gas from wells and pipelines when the plant is unable to process normal volumes.

In addition, an increasing number of plants now inject H$_2$S and CO$_2$ into underground formations. One plant in Alberta has adopted a new technology that uses bacteria to remove sulphur from low volumes of sour gas. Overall, the amount of natural gas flared or incinerated at processing plants has continued to decline in most years despite increases in total natural gas production. Little or no natural gas is vented from processing plants.

How have other petroleum facilities reduced flaring and venting?

Changes in equipment and procedures and the sharing of best practices within industry have reduced flaring and venting at many petroleum operations.

Pipeline companies, for example, used to vent large volumes of natural gas in order to perform repairs and maintenance on sections of pipe. New methods, adopted over the past decade to conserve valuable product and reduce greenhouse gas emissions, have almost eliminated this practice.
Section 3 Emissions and Effects

FLARING AND INCINERATION EMIT A NUMBER OF SUBSTANCES THAT CAN AFFECT HUMAN HEALTH, LIVESTOCK AND THE ENVIRONMENT. MORE EFFICIENT COMBUSTION IN WELL-DESIGNED PROPERLY OPERATED FLARES AND INCINERATORS PRODUCES FEWER HARMFUL POLLUTANTS. FLARING, INCINERATING AND VENTING ALSO RELEASE GREENHOUSE GASES THAT CONTRIBUTE TO GLOBAL WARMING. REGULATIONS AND INDUSTRY PRACTICES ARE DESIGNED TO REDUCE OR ELIMINATE HARMFUL EFFECTS.
What is emitted from flaring, incineration and venting?

Complete combustion of pure methane (CH\textsubscript{4}) produces only carbon dioxide (CO\textsubscript{2}) and water (H\textsubscript{2}O). However, combustion in flares and incinerators is seldom 100 per cent complete. Unprocessed natural gas usually contains a mixture of hydrocarbons and other substances, which can form a variety of chemical compounds during combustion. For example, incomplete combustion of hydrocarbons can lead to the formation of carbon monoxide (CO). Nitrogen in the air is also oxidized during combustion to form oxides of nitrogen, known collectively as NO\textsubscript{x}. As a result, flaring and incineration emit a number of substances that can affect human health, livestock and the environment.

The CH\textsubscript{4} in vented natural gas and the CO\textsubscript{2} and nitrous oxide (N\textsubscript{2}O) emitted from flares and incinerators are greenhouse gases that contribute to global warming. According to Environment Canada, flaring and venting in the oil and gas industry emitted the equivalent of 15.8 million tonnes of CO\textsubscript{2} in 2003, or about two per cent of total Canadian greenhouse gas emissions.

If vented natural gas contains heavier hydrocarbons or hydrogen sulphide (H\textsubscript{2}S), these can affect local and regional air quality. Methane itself is colourless, odourless and lighter than air, so it has little effect on local and regional air quality.

In addition to NO\textsubscript{x}, CO\textsubscript{2} and CO, emissions from flaring and incineration can include unburned hydrocarbons, particulate matter, polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOC). If the natural gas contains H\textsubscript{2}S, emissions can include sulphur dioxide (SO\textsubscript{2}), carbon disulphide (CS\textsubscript{2}) and carbonyl sulphide (COS). See the Centre for Energy booklet Sour Gas Questions + Answers (2nd edition, 2006) for more specific information about emissions from H\textsubscript{2}S combustion. Based on 2000 data for air contaminants in Canada, flaring and incineration account for 98 per cent of SO\textsubscript{2} emissions in the upstream petroleum industry and 24 per cent of H\textsubscript{2}S emissions.

Oxides of nitrogen such as nitric oxide (NO), and nitrogen dioxide (NO\textsubscript{2}) contribute to ground-level ozone (a component of smog) and acid deposition. In 2000, flaring and incineration accounted for 1.4 per cent of NO\textsubscript{x} emissions in the Canadian upstream petroleum industry.

Under some circumstances, inefficient combustion of hydrocarbons may also produce VOCs, which include a wide variety of hydrocarbon compounds heavier than ethane. VOCs combine with oxides of nitrogen in the presence of sunlight to create ground-level ozone and smog. In 2000, flaring and incineration accounted for 0.5 per cent of VOC emissions from the Canadian upstream petroleum industry.

One of the VOCs is benzene, which is classified as toxic and is a known cancer-causing compound. Glycol dehydrators, used to remove water from natural gas, are the largest industrial source of benzene emissions in Canada. Changes in equipment and procedures reduced benzene emissions in the upstream oil and gas industry by 76 per cent between 1995 and 2005. EUB requirements have further restricted the allowable benzene emissions from glycol dehydrators in Alberta.
Emissions of unburned hydrocarbons, particulate matter and polycyclic aromatic hydrocarbons (PAH) can result from many types of incomplete combustion, including forest fires and motor vehicles as well as inefficient burning in some flares. Studies indicate that the efficiency of combustion in flares can range from 66 per cent to more than 99 per cent. Various measures since the late 1990s have aimed to reduce emissions of incomplete combustion products. These measures include the adoption of research-based requirements for more efficient operation, better flare designs, and the reduction in solution gas flaring.

Particulate matter affects the respiratory health of humans and animals and is yet another component of smog. In 2000, flaring and incineration accounted for 63 per cent of particulate matter emitted by the Canadian upstream petroleum industry.

**How do emissions affect humans, animals, plants and the environment?**

Many of the substances emitted by flaring, incineration and venting can affect humans, animals, plants and the environment. Effects depend on the magnitude, duration and frequency of exposure, as well as the susceptibility of the individual organism or environment. Air monitoring data in Alberta indicate that most emissions from flaring, incineration and venting in the oil and gas industry occur in areas that are within the Canada-wide standards for air quality, including the standards for particulate matter and ozone in ambient air.

However, there is no question that high enough concentrations of petroleum-related emissions could affect the respiratory health, vision and skin of humans and animals. Exposure to some VOC and PAH substances increases the likelihood of cancers. VOCs, NOx and particulate matter can cause smog. Sulphur dioxide and oxides of nitrogen can acidify soils and lakes and affect the growth of crops and forests. Acid deposition can even cause wire fences to rust. Odours can affect quality of life – for example, make it difficult for people to sleep.
Who regulates facilities and emissions?

The Alberta Energy and Utilities Board and the Oil and Gas Commission of British Columbia are the principal regulators of crude oil and natural gas operations in the two main natural gas-producing provinces. Provincial regulators have a similar role in Saskatchewan and Manitoba. The National Energy Board, in co-operation with territorial authorities, regulates oil and gas exploration and production in the Northwest Territories. The Canada-Nova Scotia Offshore Petroleum Board and the Canada-Newfoundland and Labrador Offshore Petroleum Board regulate oil and gas exploration and production off the East Coast. Provincial, federal and First Nations environment, occupational health and safety, public health and emergency response authorities are also involved in many aspects of oil and gas regulation. Air emissions also fall under the jurisdiction of the federal government under the Canadian Environmental Protection Act, but no regulations have yet been proposed.

DECISION TREE

Under the approach to conservation and emissions adopted since 1999, regulators expect operators in the oil and gas industry to answer three key questions:
• Can flaring, incinerating, and venting be eliminated?
• Can flaring, incinerating, and venting be reduced?
• Will flaring, incinerating, and venting meet performance standards?

Tests
• Public concern?
• Health impacts?
• Economic alternatives?
• Environmental impacts/benefits?

Eliminate solution gas flaring and venting

YES

NO

Implement

Reduce flaring and venting

YES

NO

Meet performance requirements

Source: Alberta Energy and Utilities Board
Section 4 Research and Continuous Improvement

Scientific research in the 1990s indicated that some flares did not burn as efficiently as previously believed and therefore could be emitting more pollutants. Meanwhile, emissions from flaring, incineration, and venting were identified as sources of greenhouse gases. New technologies and higher natural gas prices made it possible to reduce emissions sharply and conserve more gas. Research continues to identify opportunities for improvements.
Why has conservation improved?

Several scientific studies in the 1990s indicated that in certain circumstances flares did not burn natural gas as efficiently as previously believed. This was specifically the case with low gas flow rates and high winds. With efficiencies as low as 66 per cent under actual field conditions, flares could be releasing a range of pollutants with potentially harmful effects on human and animal health, crops, forests, soil and water resources. These findings coincided with growing concern among people living near natural gas and oil production facilities about the emissions, odours, bright lights and noise associated with flaring.

The Clean Air Strategic Alliance (CASA) was established in 1994 as a new way to manage air quality issues in Alberta. CASA is a non-profit multi-stakeholder partnership, composed of representatives selected by industry, government and non-government organizations. In 1996, the Canadian Association of Petroleum Producers (CAPP) asked CASA to examine flaring and venting issues and make recommendations. The resulting CASA report in 1998 recommended sharp reductions in flaring and venting, including eventual elimination of routine solution gas flaring. Where flaring could not be avoided, CASA recommended measures to improve efficiency of combustion.

The Alberta Energy and Utilities Board (EUB) endorsed the CASA recommendations and in 1999 published a new Upstream Petroleum Industry Flaring Guide (Guide 60, since revised and now known as Directive 060); the guide set out new regulations and timetables for flaring reduction. The regulations initially addressed solution gas flaring but were later extended to include well tests, gas processing plants and coalbed methane operations as well as venting from all operations. The EUB set time limits on flaring, stated that flare operators should aim for at least 98 per cent combustion efficiency, and ordered a re-evaluation of all flares within 500 metres of residences. The Oil and Gas Commission of British Columbia has been taking action to reduce flaring since 2000 and in 2006 began developing a comprehensive flaring guideline aimed at minimizing flared volumes resulting from upstream oil and gas operations. These new B.C. guidelines would be harmonized with Alberta’s Directive 060 where appropriate.

Deep Well Injection

Diagram courtesy of ConocoPhilips.

About 45 plants in Western Canada use underground disposal for the H₂S, CO₂, and water recovered during sour gas processing. Acid gas injection not only disposes of H₂S safely, it also reduces greenhouse gas emissions of CO₂. The gas mixture can be injected into either saltwater aquifers or depleted oil and gas reservoirs.
The oil and gas industry actually achieved reductions significantly greater than those set out in the initial CASA recommendations and EUB regulations. This was partly due to the economic incentive from rising natural gas prices, and also reflected the sharing of “best practices” and new technologies through CASA, CAPP, the Small Explorers and Producers Association of Canada (SEPAC) and the Petroleum Technology Alliance Canada (PTAC).

Where flaring could not be avoided, changes such as improved burner tip design helped to reduce emissions. Other changes included monitoring the heating value of the gas to maintain a stable flare and ensuring that liquid separation tanks (knockout drums) were emptied more frequently. Research had indicated that full knockout drums could greatly reduce the efficiency of flare combustion.

These developments coincided with efforts by industry and government to reduce emissions of greenhouse gases such as methane and carbon dioxide. Flaring and venting were identified as sources of greenhouse gases that could be addressed at relatively low cost, while also conserving a marketable product. This led to a number of changes in the design of oil and gas facilities and the maintenance and repair procedures used by the pipeline industry.

Alberta’s initiatives in flaring and venting reduction have been recognized internationally, and the EUB plays a leading role in the World Bank Global Gas Flaring Reduction (GGFR) partnership to help the oil and gas producing countries that still flare and vent vast quantities of natural gas. Flaring is a major issue for developing countries. The amount flared and vented in Africa, for example, could potentially supply half of that continent’s electricity needs. All major petroleum producing jurisdictions in Canada endorsed the GGFR program in 2006 and submitted a national report.

According to the Canadian Association of Petroleum Producers (CAPP), companies accounting for 99.7 per cent of CAPP members’ production reported flaring about 1.0 million cubic metres of natural gas during 2004 or about 0.4 per cent of their production, and these companies reported venting 0.7 million cubic metres during 2004 or about 0.3 per cent of their production. Total Canadian natural gas production in 2004 was more than 200 million cubic metres.

**What research has been conducted into flaring, incineration and venting?**

Research by the EUB, the Alberta Oil Sands Technology and Research Authority, Alberta Health, Environment Canada and others in the 1990s established the need to address health and environmental issues related to flaring. The search for solutions, including alternatives to flaring and improvements in combustion efficiency, led to a $1.6-million research program co-ordinated by PTAC. Additional research has been pursued by industry, government and academic scientists.
The PTAC-led research included studies by the University of Alberta, the Advanced Combustion Technologies Lab of the CANMET Energy Technology Centre, Ontario Hydro Technologies, and the University of Calgary. This work included wind-tunnel tests to determine combustion efficiency of flares, which ranged from 66 to 99 per cent. Various factors, including burner tip design and the composition of the gas being burned, were shown to influence combustion efficiency.

Other research demonstrated that microturbines could generate electricity and steam burning low-quality natural gas, including some sour gas that would otherwise be flared. One company decided to employ a new technology using bacteria to remove sulphur from low volumes of sour gas and thus eliminate the need for flaring.

From 2001 to 2006, the Western Interprovincial Scientific Studies Association (WISSA) conducted the $17-million Western Canada Study of Animal Health Effects Associated with Exposure to Emissions from Oil and Natural Gas Field Facilities. WISSA is a non-profit association supported by contributions from the federal and provincial governments, the Canadian Association of Petroleum Producers, and the livestock industry.

The WISSA study covered 33,000 cattle in 200 herds across Western Canada. Data for these cattle were analysed to determine what health effects, if any, occurred in beef cattle exposed to long-term upstream petroleum industry emissions. The study looked at

- cattle health, productivity, and immune system function and structure
- air monitoring data
- information about feed and water quality and other risk factors such as infectious diseases, and
- data for a wildlife species, the European starling, in the study areas

The WISSA report in 2006 showed little or no correlation between oil and gas industry emissions and most indicators of animal health, but the authors noted that the major reduction in flaring was already underway during the study period. The authors said they expected continuing reduction in flaring and venting would further reduce the likelihood of adverse effects.

**Will improvements continue?**

The initiatives taken by government and industry in Alberta have resulted in significant reductions in flaring, incineration and venting. The most notable success relates to solution gas from crude oil and bitumen production, where further reductions will be more difficult to achieve because remaining solution gas sources tend to be small and/or remote from pipelines and processing plants. Industry and government are now focusing on ways to reduce well test flaring at conventional natural gas and coalbed methane wells. Improvements in flare design and management should continue to increase combustion efficiency and reduce harmful emissions where flaring cannot be avoided. Other jurisdictions are generally following Alberta’s lead, and further improvements should continue in the future.
FOR FURTHER INFORMATION

PUBLICATIONS


Canadian Association of Petroleum Producers. A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry, Volume 1, Overview of the GHG Emissions Inventory, and Volume 2: Overview of the CAC Inventory. Calgary: September 2004.


WEBSITES
The Canadian Centre for Energy Information web portal www.centreforenergy.com provides links to many sites with up-to-date information about natural gas in Canada, a list of supplemental publications, an overview discussing the potential environmental impacts of the oil and gas industry, and an online bookstore. The Centre for Energy’s general introduction to the industry, Our Petroleum Challenge, can be purchased online and provides information about drilling, pipelining and processing of natural gas as well as a glossary of industry terms.

Alberta Energy and Utilities Board www.eub.gov.ab.ca
Canadian Association of Petroleum Producers www.capp.ca
Clean Air Strategic Alliance www.casahome.org
Oil and Gas Commission of British Columbia www.ogc.gov.bc.ca
Synergy Alberta www.synergyalberta.ca
Western Interprovincial Scientific Studies Association https://www.wissa.info
**KEY DEFINITIONS**

**Batteries** – A system or arrangement of tanks or other surface equipment receiving the production of one or more wells prior to delivery to market or other disposition. Batteries include equipment or devices for measurement or separating the fluids into crude oil, natural gas or water.

**Flaring** – Flaring is open-air burning of natural gas. Flaring safely disposes of gas during equipment failures, power outages and other emergencies or “upsets” in drilling or processing operations. Flaring is also used to dispose of natural gas that cannot otherwise be conserved or marketed. Various emissions are released into the atmosphere during the flaring process.

**Incinerators** – Incinerators use combustion to dispose of natural gas. Some “incinerators” are actually enclosed flares. A true incinerator has controls to maintain a specific air-to-fuel ratio, a refractory lining and a minimum residence time, while an enclosed flare is merely protected from outside weather.

**Microturbines** – Microturbines are small gas-fired turbines that produce electricity by burning natural gas that would otherwise be flared. In co-generation applications, microturbines also produce steam for industry operations or nearby activities such as drying grain or heating greenhouses.

**Natural gas** – As it comes from the ground, natural gas is typically a mixture of substances. Natural gas normally contains a range of hydrocarbons such as methane, ethane, propane and butane along with hydrogen sulphide (H₂S) and possibly other odorous sulphur compounds, as well as carbon dioxide (CO₂) and water. The water often has a high salt content, reflecting the marine (ocean) environment from which the gas originated. After processing, the natural gas shipped in transmission pipelines and used by consumers contains mainly methane with small quantities of ethane and propane.

**Solution gas** – Solution gas, also known as “associated gas,” is natural gas found along with crude oil in many reservoirs. The gas is dissolved in the crude oil at reservoir pressures, but bubbles out of the oil when pressure is reduced at the surface.

**Sour gas** – Sour gas is natural gas containing hydrogen sulphide (H₂S), a compound of two hydrogen atoms and one sulphur atom. H₂S is flammable, has a strong rotten-egg odour, and at higher concentrations is poisonous to humans and animals. About one-fifth of the natural gas produced in Alberta and British Columbia is sour. Smaller amounts of sour gas are found in other petroleum-producing areas such as Saskatchewan, Manitoba, Nova Scotia and the Northwest Territories.

**Venting** – Venting is the release of natural gas directly into the atmosphere without flaring or incineration. Most venting in Canada occurs during the production of crude oil and oilsands bitumen. Venting also may occur during well testing – primarily from shallow, sweet, low-volume natural gas wells – and in the operations of natural gas wells, pipelines and processing plants.

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