Flaring & venting in the oil & gas exploration & production industry

An overview of purpose, quantities, issues, practices and trends

Report No. 2.79/288
January 2000
Global experience

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Flaring & venting in the oil & gas exploration & production industry

Report No: 2.79/288
January 2000
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The OGP

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The option to release gas to the atmosphere by flaring and venting is an essential practice in oil and gas production, primarily for safety reasons. Flaring is the controlled burning of natural gas produced in association with oil in the course of routine oil and gas production operations. Venting is the controlled release of unburned gases directly into the atmosphere. The availability of a flare or a vent ensures that associated natural gas can be safely disposed of in emergency and shutdown situations. Where gas cannot be stored or used commercially, the risk of fire and explosion must be reduced by either flaring or venting.

It is in an oil company’s interest to minimise the amount of gas flared in order to realise as much value as possible from the hydrocarbons being produced. A variety of mechanisms may potentially be used to minimise flaring. However, it may not be technically or economically feasible to sell some or all of the gas, for reasons that are often a combination of geography, availability of customers, and government energy policies. Similarly, it may not be technically or economically feasible to reinject the gas into underground reservoirs. Therefore, gas may have to be flared as a waste product. In some cases, venting may be preferable to flaring, depending on considerations such as local noise impacts, toxicity of gases being produced, and hydrocarbon content of the gas.

For environmental and resource conservation reasons, flaring and venting should always be minimised as much as practicable, consistent with safety considerations. Flaring and venting can have local environmental impacts, as well as producing emissions which have the potential to contribute to global warming. Available data indicate that, on a worldwide basis, gas flaring contributes only 1% of anthropogenic carbon dioxide emissions, and flaring and venting contribute only 4% of anthropogenic methane emissions. Case studies in this booklet illustrate some of the ways in which the industry has sought to reduce flaring and/or minimise its impacts through commercialisation of gas reserves, improvements in operation, maintenance and design of flare systems, and new ways of storing associated gas.

Despite these developments, the essential point is that no single approach to dealing with associated gas will be appropriate for all projects or locations. Industry needs to be able to choose from among a variety of creative and common sense approaches to address flaring and venting concerns in specific operations. To achieve this, governments need to provide an energy policy framework which will encourage and allow companies to select from among very different approaches in order to achieve the best practicable outcome in particular circumstances.
1 Introduction

The option to release gas to the atmosphere by flaring or venting is a necessary practice in the production of oil and gas. This booklet is intended to provide basic non-technical information about the reasons gas is flared or vented. It explains what flaring and venting are, why they occur, their links with the safety of workforces and local populations, and relevant environmental impacts.

It also describes some of the varied steps being taken within the industry to improve environmental performance by reducing flaring and venting emissions. Case studies are presented to illustrate some current and experimental practices in the oil and gas production business.

2 What is flaring?

Flaring is the controlled burning of natural gas in the course of routine oil and gas production operations. This burning occurs at the end of a flare stack or boom. Flare systems and their operation have been discussed by a number of authors of technical papers. Shore’s paper ‘Making the Flare Safe’ (Ref. 1) provides a general introduction to the systems used in the oil and gas industry.

A complete flare system consists of the flare stack or boom and pipes which collect the gases to be flared. The flare tip at the end of the stack or boom is designed to assist entrainment of air into the flare to improve burn efficiency. Seals installed in the stack prevent flashback of the flame, and a vessel at the base of the stack removes and conserves any liquids from the gas passing to the flare. Depending on the design, one or more flares may be required at a production location.

A flare is normally visible and generates both noise and heat. During flaring, the burned gas generates mainly water vapour and carbon dioxide. Efficient combustion in the flame depends on achieving good mixing between the fuel gas and air, and on the absence of liquids. Low-pressure pipe flares are not intended to handle liquids and do not perform efficiently when hydrocarbon liquids are released into the flare system.

The percentage combustion efficiency of a well designed and operated flare is in the high ninety percent range. Recent work by the U.S. Environmental Protection Agency has shown that combustion efficiencies are often greater than 98% (Ref. 2).

Gas being flared may come from a variety of sources. It may be excess to that which can be supplied commercially to customers. It may be unburned process gas from the processing facilities. It may be vapours collected from the tops of tanks as they are being filled. Sometimes, the gas may be from process upsets, equipment changeover or maintenance. Occasionally, a production shutdown may require the temporary flaring of all the gas stored on or arriving at a facility, to release high pressure and avoid a catastrophic situation occurring.

It is in the oil company’s interest to realise as much value as possible from the hydrocarbon accumulations the company is producing. Therefore, it is also in the company’s interest to minimise the amount of gas being flared. In this respect, the commercial aims of the company are consistent with good environmental practice.

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1 This booklet addresses flaring during oil and gas production operations. Although flares are sometimes used during drilling to test the productivity of a potential well, the technologies and issues related to burning during these so-called ‘well tests’ are different from flaring during production operations and are not discussed here.

2 There are situations where small amounts of gases escape to the atmosphere from pump seals, valves and tank spaces. These are typically called “fugitive” emissions. Fugitive emissions are the subject of a number of other reports (see Ref. 3). This booklet deals only with the controlled release or venting of gases.

3 Calculations of combustion efficiency do not normally include the negligible effect of carbon emitted as soot or smoke. Further, unless the flare is very smoky, the solid carbon emitted is likely to be insignificant. In fact, measurements made on propane flares have shown that soot accounted for a decrease of less than 0.5% in the combustion efficiency.
The aim of minimising flaring can be achieved through a variety of mechanisms which may range from marketing initiatives to maintenance strategies to new technologies. The following discussion, and the case studies which illustrate it, serve to explain how different solutions are appropriate in different circumstances.

Oil accumulations always occur with some amount of associated gas. Ideally, the associated gas will be sold to a customer as a fuel or petrochemical feedstock. However, unlike oil, gas is not an easily transportable fuel. A customer must be reasonably physically close in order for the additional expense of gas processing and transportation to be economically justifiable. The customer must also be willing to enter into the necessary commercial arrangements. The political will also needs to exist within government to provide an appropriate fiscal regime which will allow the project to go ahead.

However, these conditions can be difficult to achieve in practice. The government may have other national priorities that conflict with developing a supportive financial regime. Potential customers may have other projects they wish to pursue. Case Study No. 1 shows how market factors can influence flaring within a particular country or region.

Technology may also offer new ways to commercialise associated gas reserves. Although gas itself is relatively difficult to transport, it can be liquefied and then transported more easily. In recent years, the exploration and production industry has significantly improved gas liquefaction technologies - technologies which until recently could only be applied to the largest gas reserves.

In the situation where the associated gas cannot be commercialised, only three options remain: 1) vent it, 2) flare it, or 3) reinject and store it in the underground formations from which the oil is being recovered. Reinjection is a practicable option for some oilfields, but not in all cases. In some situations, the geological nature of the underground formations is such that the injected gas would migrate back to the oil production wells too easily, leading to inefficient and energy intensive gas recycling. Even for formations where reinjection is geologically practicable, the oilfield itself may be too small in economic terms to support the additional reinjection infrastructure.

Although the current viability of underground gas storage is limited by geology and economics, some companies are investigating ways of making underground storage more attractive. One example of this is the Sleipner carbon dioxide storage project now in operation offshore Norway (see Case Study No. 2).

3 What is venting?

Venting is the controlled release of gases into the atmosphere in the course of oil and gas production operations. These gases might be natural gas or other hydrocarbon vapours, water vapour, and other gases, such as carbon dioxide, separated in the processing of oil or natural gas.

In venting, the natural gases associated with the oil production are released directly to the atmosphere and not burned. Safe venting is assured when the gas is released at high pressure and is lighter than air. Because of the strong mixing potential of high-pressure jets, the hydrocarbon gases discharged mix well with the air down to safe concentrations at which there is no risk of explosion. Venting is normally not a visible process. However, it can generate some noise, depending on the pressure and flow rate of the vented gases.

In some cases, venting is the best option for disposal of the associated gas. For example, in some cases, a high concentration of inert gas is present in the associated gas. Without a sufficiently high hydrocarbon content, the gas will not burn and flaring is not a viable option. Sometimes the source of inert gas may come from the process systems. The purging of process systems with inert gas may, in itself, justify venting as the safest means of disposal.
4 Safety aspects

The availability of a flare or a vent is absolutely necessary in oil and gas production operations. It ensures that safe disposal of the hydrocarbon gas inventory in the process installation is possible in emergency and shutdown situations. Where gas cannot be stored or used commercially, it is essential that the risk of fire and explosion be reduced by either flaring or venting.

Even where associated gas is being sold or reinjected, small amounts of gas will still need to be flared or vented for safety reasons. Oil and gas processing and storage equipment is often operated at high pressures and temperatures. When abnormal conditions occur, the control and safety systems must release gas to the emergency flare or vent to prevent hazards to the employees or public. Good maintenance and operating strategies are the main mechanisms used to keep this already small volume as low as practicable.

Emergency flares are normally fitted with pilot systems maintaining a small flame as the ignition source in case the full size flare is activated. Recently, new flare equipment designed to operate without a pilot flame, and hence without emission when not active, was installed on a number of Statoil’s production facilities in Norway. This equipment, built around high reliability valves and ignition systems, is described in Case Study No. 3.

Another safety issue in the application of flaring and venting is the toxicity of the gases being disposed. In some situations, the toxicity of the gas relative to the toxicity of its combustion products may need to be considered when choosing between flaring and venting as a means of disposal. An example would be where gas containing hydrogen sulphide is being produced. Hydrogen sulphide is a gas that can be fatal if inhaled even at low concentrations. However, its combustion product, sulphur dioxide, is relatively less toxic.

5 Environmental issues

People outside the oil and gas industry sometimes express concerns about the environmental impacts of flaring and venting. One such concern relates to the potential for global climate change. Both carbon dioxide and methane (the major component of natural gas) are known as greenhouse gases associated with concerns about global warming.

Flaring produces predominantly carbon dioxide emissions, while venting produces predominantly methane emissions. The two gases have different effects, however. The global warming potential of a kilogram of methane is estimated to be twenty-one times that of a kilogram of carbon dioxide when the effects are considered over one hundred years. When considered in this context, flaring will generally be preferred over venting the same amount of gas in the design of new facilities where sufficient amounts of gas will be produced to run a flare.

While there are still many uncertainties in our understanding of the complex issue of climate change, it makes sense to avoid the unnecessary release of carbon dioxide or methane into the atmosphere, where practicable. This points to a need to reduce emissions in a reasonably practicable way. The case studies in this booklet illustrate some of the ways the oil and gas industry is achieving those reductions. However, it is important to recognise that other environmental impacts also need to be managed.

Sometimes those needs can conflict with managing greenhouse gas emissions. This conflict may take a variety of forms, but usually relates to the need to manage potential contributions to local environmental impacts, such as air quality, alongside global issues, such as climate change. Although the global warming potential of methane when compared to carbon dioxide usually suggests that flaring is a more environmentally attractive option than venting, neighbours of onshore oil and gas developments sometimes prefer venting because it is less visible and produces less noise.

In all cases, the company has the responsibility to make parties involved aware of all aspects of the issue to ensure reasoned decisions are taken and supported. Case Study No. 4 illustrates the way in which local factors need to be taken into account when designing flare systems.

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5.1 Measuring quantities of gas flared or vented

One of the challenges involved in addressing environmental aspects of flaring and venting is identifying how much gas is being released. All oilfields contain associated gas. In much the same way that bubbles appear when the cap is removed from a bottle of carbonated drink, so the associated gas is released when oil is brought up from the deep rock strata in which it is found. The proportion of associated gas to oil (the so-called GOR or Gas Oil Ratio) can vary significantly between oilfields. Moreover, in some oilfields, the GOR increases as more and more oil is produced, while in others it can reduce with time. Consequently, the amount of gas which must be dealt with can vary dramatically from year to year between oilfields and even within a specific oilfield.

As previously discussed, some or all of this associated gas may have to be flared or vented. Oil and gas production systems can be complex. The gas eventually reaching the flare or vent can come by means of a gathering system from a variety of sources - pressure relief systems, maintenance related depressurising systems, etc. Many of these systems supply gas to the gathering system, often only sporadically.

A major difficulty in managing flaring and venting is identifying exactly how much gas is coming from the various sources that are contributing to the overall volume flared and vented. There is debate within the industry regarding the extent to which it is possible to measure gas flow rates accurately under such varied conditions with the measuring devices presently available on the market. Although some oil companies and equipment manufacturers would disagree, low-pressure gas rate measurement can be a significant problem. Others believe that the best way to obtain consistent data is to base it on estimates and calculations.

In order to provide some degree of consistency of data, the OGP has published its own measurement and estimation protocol (Ref. 4). This document provides guidance on the different approaches to measuring or estimating flare and vent volumes.

Measurements and estimates of amounts of gas flared and vented have been produced by a number of organisations. On a global scale, the Carbon Dioxide Information Analysis Centre in the U.S. is considered one of the most definitive data sources (see Refs. 5 & 6). Regional data have been produced by intergovernmental agencies, as well as by oil industry associations such as the OGP (see e.g., Ref. 7). Some individual oil companies and national oil industry associations also compile flaring and venting data (see e.g., Ref. 8).

Because of linkages with the climate change debate, flaring and venting emission data are often presented in terms of the two main greenhouse gases which are produced: carbon dioxide and methane.
5.2 Carbon dioxide emissions from flaring

Atmospheric carbon dioxide \((\text{CO}_2)\) is produced both from natural sources and human (anthropogenic) activities. The most important source of carbon dioxide from human activities is the release during the consumption of fossil fuels. Figure 1 shows that 96% of human-related emissions of carbon dioxide are associated with the consumption of either solid, liquid, or gaseous hydrocarbon fuels.

The Carbon Dioxide Information Analysis Centre also identifies two additional contributors that make up the remaining 4%. These are cement manufacture and gas flaring operations. On a worldwide basis, gas flaring contributes only 1% to anthropogenic carbon dioxide emissions. The relative contributions from these sources in 1994 are presented in Figure 1 (source, Ref. 5).

As one perspective on these data, it can be noted that tropical deforestation with its resulting emissions to the atmosphere is estimated to be thirty times greater than the emissions from gas flaring.

![Figure 1: Contributions to anthropogenic carbon dioxide emissions, 1994](http://www.giss.nasa.gov/research/intro/matthews.01/)

5.3 Methane emissions from flaring and venting

Atmospheric methane is produced from a range of both natural sources, such as wetlands, and human activities. Of the total sources of methane entering the atmosphere for the period 1980-1990, 30% came from natural sources and 70% from anthropogenic sources (Ref. 6).

The anthropogenic sources can be further broken down into those that arise from the use of fossil fuels and those from so-called biospheric sources. Biospheric sources include such things as release of methane from rice farming, livestock rearing, burning of ‘biomass fuels’ such as wood, and landfills. These biospheric sources contribute over 73% of anthropogenic methane emissions (Ref. 6).

![Figure 2: Contributions to global methane emissions, 1994](http://www.giss.nasa.gov/research/intro/matthews.01/)

4 Source: United States National Aeronautic and Space Administration’s Goddard Institute for Space Studies. [http://www.giss.nasa.gov/research/intro/matthews.01/]
Another concern sometimes expressed is that the natural gas burned in a flare or vented to the atmosphere is a natural resource which could be effectively used as a source of energy or useful chemicals. Progressively, the world is seeking ways to avoid wasting natural resources, particularly those considered not renewable. As it is in the interest of the industry to realise as much value as possible from its hydrocarbon production, flaring and venting should always be minimised, consistent with safety considerations.

Many oilfields currently still in production were started at a time when there was less concern about conservation of resources than there is today and the issue of global warming had not been identified. However, for all of the reasons previously described, oil companies have continued to seek ways to reduce waste of gas and maximise the financial return from the resources they are developing.

As an example, Barns (Ref. 9) describes how, in 1950, the Indonesian oil industry flared 95% of the total amount of associated gas that it produced. By 1985, the amount of gas being flared had declined to 28%. Case Study No. 1 shows in some detail the kinds of factors that affect the speed and extent to which resource conservation improvements can be achieved in mature oil producing regions.

The overall impact of these factors has been a gradual reduction in volumes of gas flared and vented over the last two decades. It is generally accepted that flaring and venting volumes peaked in the mid 1970’s (Refs. 5 & 6). As an example, Figure 3 shows how the amount of carbon dioxide released from flaring has reduced since that time. Increase in later years is attributed to the general expansion of the E&P industry.

The remaining anthropogenic sources are associated with the use of fossil fuels and include such things as flaring and venting of natural gas, leakage from gas supply systems, and methane released during coal mining operations. Venting operations contribute significantly more methane than flaring operations.

The overall contribution of the various sources of methane in the atmosphere for 1994 are shown schematically in Figure 2 (source, Ref. 6). On a worldwide basis, flaring and venting operations contribute 4% to anthropogenic methane emissions.
7 Conclusions

Flaring and venting are unavoidable processes in the production of oil and gas. Primarily for reasons of safety, some gas may need to be flared or vented at the production site. In other cases, for reasons that are often a combination of geography and availability of customers for gas, as well as local political factors, some or all of the associated gas produced with the oil is flared.

Industry continues to seek opportunities to reduce the amount of gas being flared and vented. As an example, since the mid-1970’s, the amount of carbon dioxide emitted due to flaring has nearly halved, and further reductions continue to be sought. New technologies are being developed to assist in the commercialisation of associated gas reserves. Operation, maintenance and design of flare systems are improving. New ways of storing associated gas are being investigated.

While recognising the need for these improvements, it is important to note that flaring and venting are relatively small contributors to anthropogenic greenhouse gas-related emissions. Overall, flaring and venting contribute only 1% to anthropogenic carbon dioxide emissions, and 4% to anthropogenic methane emissions.

The most important single conclusion to be drawn from the information presented in this booklet is the need for industry to be able to choose from among a variety of creative and common sense approaches to address flaring and venting concerns in specific operations. Whether with respect to selecting among technologies, choosing between flaring or venting, or maintaining a balance between climate change and other environmental concerns, regulatory frameworks need to allow for best practicable choices to be made, rather than mandating a specific solution. No single approach will necessarily be appropriate for all projects or locations.

The intrinsic value of the gas being flared or vented motivates the industry to manage the issue well. Government regulatory policy needs to be sufficiently flexible to facilitate the choice of the management approach most appropriate for the project and the situation.
Appendix A – case studies

Case study 1: The role of market forces – flaring and the Nigerian oil industry

Most of Nigeria’s oil facilities were built in the 1960’s and 1970’s. In those days gas was not a popular energy source. Gas was more difficult to produce and transport than crude oil; there were few market outlets (domestic and international) for gas and there was little environmental awareness of the consequences of gas flaring.

In the 1960’s and 1970’s, the main interest was in the development of the country’s oil reserves. At this initial stage, the existing oil fields did not produce significant amounts of associated gas. This fact, coupled with the lack of a domestic gas market and commercial energy pricing policy, meant that installation of an expensive network of compression facilities and pipelines needed to link these scattered fields and market the gas could not be economically justified. Consequently, when the first small volumes of gas did start to flow to Nigerian industry, they were from non-associated gas reservoirs, which were a cheaper and more reliable source because they were produced at high pressure and did not depend on oil production.

One of the earliest solutions to the dilemma of gas flaring in Nigeria was the re-injection of produced associated gas into underground reservoirs. SPDC (Shell Petroleum Development Company) was the first company in Nigeria to re-inject gas, at Oguta in 1978. However, associated gas re-injection proved not to be a viable proposition in all cases. Most Nigerian oil reservoirs are technically unsuitable for large-scale re-injection.

From the standpoint of export markets, Nigeria’s physical isolation from the nearest major international gas markets in Europe ruled out a pipeline. This left the technologically more complex and expensive option of liquefying and shipping the gas. Nigeria’s first liquefied natural gas (LNG) plant is currently being installed. There are already plans for future expansion.

However LNG is only part of the answer. Any successful programme to end gas flaring in Nigeria depends on creating local markets. The key to achieving this lies with industry, which alone can harness the sort of volumes required. Although many industries are connected to gas pipelines, the major users of large volumes of gas so far are the National Electric Power Authority (NEPA) which uses gas to generate electricity and the National Fertiliser Company (NAFCON). Several new projects that will use associated gas are being planned, but there remains a need for more gas-based industrial development.

For that to happen, consumers need incentives to use gas rather than other energy sources, and suppliers need incentives to build expensive gas gathering, compression and treatment systems. Harnessing the gas which is currently being flared must, at the end of the day, be an economic proposition. The price has to be right to justify the use of gas by the consumer. The price must also justify the supplier’s investment in the necessary plant and equipment. To achieve this, allowances have to be made in fiscal and gas pricing policies and in operating agreements. The oil industry in Nigeria is working with the government to accomplish these objectives.

Case study 2: Research and development into carbon dioxide storage – the Sleipner CO₂ Project

A unique event took place in October 1996 when Statoil, Norway’s State oil and gas company, began storing carbon dioxide under the North Sea. Statoil’s Sleipner gas field is situated 250 km west of the Norwegian coast. As with many gas fields around the world, extracting the gas also yields unwanted products. In this case the gas contains 9% carbon dioxide. For the gas to be marketable, this concentration must be reduced to 2.5%.

Historically, gas contaminants have been typically vented to the atmosphere prior to selling the natural gas. However, Norwegian government concerns about carbon dioxide emissions from human activity and their potential contribution to global warming prompted a decision to impose a carbon tax on oil and gas production. Statoil and its partners started to look at radically new technology in order to commercialise the Sleipner gas reserve. They eventually decided that it might be technically and economically feasible (considering the carbon tax) to separate the carbon dioxide from the hydrocarbon gas and re-inject it into deep underground formations.

A new offshore platform, Sleipner ‘T’, containing all the necessary equipment was sited alongside the existing production platform, Sleipner ‘A’, in 1996. On Sleipner ‘T’, the carbon dioxide contained within the natural gas is separated by a complex chemical process. The extracted carbon dioxide are then compressed and injected into a water filled sandstone reservoir 1000 m
below the seabed. Using this system, over 1 million tonnes per year of carbon dioxide is being pumped below the ocean floor instead of the atmosphere.

This technology is still in its infancy, and much will be learned from its use on Sleipner. The owners of the field have agreed that an international programme is to be formed in order to monitor and research the performance of this facility so that the underground storage of carbon dioxide can be more fully understood. The International Energy Agency’s Greenhouse Gas Research and Development Programme is working with Statoil to establish and manage this programme. The major task for this group will be to monitor the stability of the underground reservoir and to observe the development of the expanding carbon dioxide bubble in order to ensure that the gas remains within the reservoir.

Case study 3: Technical innovations in flare design – the Gullfaks Project

Technological innovations pioneered in Norway could, in some situations, provide a means of eliminating the small amount of ‘pilot’ gas which is currently needed on conventional flare systems. The technique, which has been pioneered on the North Sea Gullfaks field, involves routing gas which was previously flared back to an existing gas export system through pipework with a valve which can quickly divert the flow to the flare stack if the pressure starts to increase. As an added safety measure, the piping contains an extra loop with a rupture disk to provide a second fail-safe escape route if the valve does not open.

An automatic ignition system, comprising a gun fitted at the top of the flare stack to shower specially-formulated pellets at a steel plate, provides sparks to light the flare when it is needed. Under normal conditions, the piping in the flare stack is protected against a build up of explosive mixtures by being filled with an inert gas from a nitrogen generation plant.

A critical factor in developing the system was being able to convince the Norwegian safety regulator that the system would meet their requirements. The breakthrough was achieved when it was decided to add the loop with the rupture disk. This ensured that there would be two possible routes by which gas could reach the flare stack in an emergency.

After a number of start-up problems, the Gullfaks ‘C’ platform flare has now been extinguished while flaring on Gullfaks ‘A’ is down by 60% and will end in the near future. If the experience proves positive, steps to reduce flaring on some other platforms are likely. However, the technique is only suitable for use with inclining flare stacks rather than the vertical stacks fitted on many of the existing oil developments around the world.

Case study 4: Local factors influence flare design in Venezuela

PDVSA, the Venezuelan national oil company, uses a high-pressure gas injection system to improve oil recovery in its operations in the eastern part of the country. The high-pressure gas injection system employs the largest high-pressure gas compressors for well injection in the world. One of the necessary components of this system is equipment which will safely flare the compressed gas in the event of either planned or unplanned shutdowns.

In the case of this gas injection project, several local environmental constraints presented a unique set of problems for system designers:

- Due to the very high profile nature of the project and the plant’s location near a major industrial/residential city, a 100% smokeless flare operation was required.
- A relatively small plot was available on which to site the flare system. The compression plant is situated near a major highway and is surrounded by existing production and oil processing plant facilities.
  - Due to the proximity of a nearby international airport, and other local safety considerations, there was a need to restrict such factors as flare stack height and heat radiation intensity.
  - The system needed to be capable of handling a wide range of gas flowrates.
  - An unreliable local power supply produced the requirement that all flare system controls be fail-safe with a 24-hour automatic battery back-up.

One of the key design considerations was the need for smokeless operation within the limitations imposed by stack height and radiation. A flare design had to be selected which would not only provide optimal mixing of gas and air to produce virtually smokeless operation over the entire flowrate range, but would also produce a
small but very intense flame with low radiation effects. To handle the full flow range, a three-stack array was installed that included two high-pressure and one low-pressure flare tip.

Before installation, the flares were tested individually and collectively and performed smokelessly within the radiation limits over the full specified range of operation. Pre-installation checks also included a check of the battery back-up system and the instant re-light system that immediately re-ignites the flare (or shuts in the gas flow) if the flare goes out for any reason.

Appendix B – references


3. IEA Report No. PH2/7 (Jan 1997), Methane Emissions from the Oil and Gas Industry.


7. OGP Report No. 2 66/216 (Dec 1994), Atmospheric Emissions from the Offshore Oil and Gas Industry in Western Europe.


What is OGP?

The International Association of Oil & Gas Producers encompasses the world's leading private and state-owned oil & gas companies, their nationaland regional associations, and major upstream contractors and suppliers

Vision

• To work on behalf of all the world’s upstream companies to promote responsible and profitable operations.

Mission

• To represent the interests of the upstream industry to international regulatory and legislative bodies.

• To achieve continuous improvement in safety, health and environmental performance and in the engineering and operation of upstream ventures.

• To promote awareness of Corporate Social Responsibility issues within the industry and among stakeholders.

Objectives

• To improve understanding of the upstream oil and gas industry, its achievements and challenges, and its views on pertinent issues.

• To encourage international regulators and other parties to take account of the industry’s views in developing proposals that are effective and workable.

• To become a more visible, accessible and effective source of information about the global industry, both externally and within member organisations.

• To develop and disseminate best practices in safety, health and environmental performance and the engineering and operation of upstream ventures.

• To improve the collection, analysis and dissemination of safety, health and environmental performance data.

• To provide a forum for sharing experience and debating emerging issues.

• To enhance the industry’s ability to influence by increasing the size and diversity of the membership.

• To liaise with other industry associations to ensure consistent and effective approaches to common issues.