SNAP CODE: **090206**

SOURCE ACTIVITY TITLE: **WASTE INCINERATION**
Flaring in Gas and Oil Extraction

NOSE CODE: **109.03.14**

NFR CODE: **1 B 2 c**

1 ACTIVITIES INCLUDED

Flaring is gas combusted without utilisation of the energy. SNAP 090206 include all flaring for extraction and first treatment of gaseous and liquid fossil fuels. Flaring in oil refineries and other industry is described in SNAP 090203 and 090204, respectively. Emissions to air from incineration after a well testing should be reported in snap 090206 as well.

This section also includes flaring in gas terminals.

2 CONTRIBUTION TO TOTAL EMISSIONS

This source is significant for countries which produce oil and gas. For example:

	CO_2	NO_x	NMVOC	CH_4
Norway :[1]	2.3	1.7	0.0	0.0
UK:[2]	1.0	1.0	0.7	0.4
Average CORINAIR 1990:				

1 Statistics Norway and the State Pollution Control Authority
2 Passant 1993. UK National Atmospheric Emission Inventory

This activity is not believed to be a significant source of $PM_{2.5}$ (as of December 2006).

3 GENERAL

3.1 Description

Gas is flared on oil and gas production installations for safety. The main reasons are lack of process or transport capacity for gas, a continuous surplus gas flow, start up, maintenance and emergency (need for pressure relief). The gas is led through a pipeline to a flare tip located high above and away from the platform.

Well testing is performed as a part of the exploration activity. After a discovery the well is tested to check the production capacity and the composition of the reservoir fluid. Due to lack of treatment, storage and transport facilities the oil or gas extracted may be disposed by burning.

3.2 Definitions

Blanket gas:	Gas used to maintain a positive pressure in an atmospheric tank in order to avoid air ingress.
Glycol regeneration:	A process that reduces the water content in glycol by heating and gas stripping.
Pilot flame:	Flame that burns continuously in connection with a flare tip. The pilot burner is independent of the flare system. It is used to ensure re-ignition even if the main burner is extinguished.

3.3 Techniques

The combustion in the flare will depend on the gas composition, gas velocity (efficiency of the flare) and wind conditions. There are several types of flare burners which also may give different emissions. The design of the flare is determined primarily by the safety considerations.

3.4 Emissions/Controls

The emissions of pollutants from flaring are either unburned fuel or by-products of the combustion process. Different burner design may influence the characteristic of the emissions. Increased efficiency of combustion may reduce the CH_4 and NMVOC emissions. However, this might not reduce the NO_x emissions and will not reduce the CO_2 emissions. Major emissions from flaring are best reduced by reducing the amount of flared gas, without increasing the amount of gas directly vented.

Currently all flaring cannot be eliminated, but there is potential for substantially reducing the amount flared and technologies are now tested to reduce flaring further. Possibilities are:

High integrity pressure protection systems (HIPS): gas leakages are collected and brought back to the process system. The flare is only ignited when really necessary.

Use of nitrogen as a purge gas (to avoid explosions (blanking) and deoxygenation of water (stripping)).

Alternative methods for glycol regeneration

Re-injection of gas into gas reservoirs

Increased possibilities for transport and storage capacity of gas

Reduced requirements for a pilot flame.

4 SIMPLER METHODOLOGY

Emissions may be estimated from general emission factors applied to the volume of gas flared.

5 DETAILED METHODOLOGY

Field studies in collaboration with the industry to evaluate an emission factor for each flare. It is currently difficult to measure the actual emission from a flare. However, a better accuracy of the emission estimate may be achieved by judging the sort of flare, the intensity of the flare and the actual amount flared for each installation.

6 RELEVANT ACTIVITY STATISTICS

The volume of gas flared is the most relevant activity statistics. The volume of flare gas may be measured instrumentally or calculated. In Norway about 70 % of the platforms have metering systems, but this fraction is probably lower in most other countries. The uncertainty may be as high as 5-30 percent even if the gas is metered. A mass balance approach may be equally accurate.

Of ten Norwegian platforms the percentage of the gas production flared varied from 0.04 to 15.9. The volume of gas flared is usually higher on an oil production platform than on a gas production platform, since it is preferred to sell the gas rather than to flare it if there is a choice. Generally, the volume flared is higher on new platforms than on the old because the elder have had time to develop better procedures, have fewer shut downs and practice more direct venting of the gas. These figures show that most countries/platforms have a substantial potential for reducing flaring. The large range given of percentage of gas flared, shows the need for making inquiries to find the actual value. If this is not feasible, the higher value should be used.

For well testing the amount of oil and gas incinerated will be the activity statistics. However, it is unlikely that these data are readily available.

7 POINT SOURCE CRITERIA

The location of oil and gas production facilities are associated with specific oil and gas fields, where practical these fields should be considered as point sources.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

8.1 Simpler Methodology

There have been relatively few measurements of emissions from flares. In the OLF study laboratory scale measurements were performed (OLF 1993). The emissions measured were extrapolated to the emissions from a real flare.

The CO_2 emission factor may be calculated from the average gas composition. If the average gas composition is not known, then the suggested default emission factor is 2300 g/Sm^3 gas (IPCC default emission factor for natural gas, IPCC 1994).

Emission factors for flaring:

Unit: g/Sm^3 gas

Country	SO_2	CO_2	NO_x	CO	NMVOC	CH_4	N_2O	Quality code
Norway[1]	0.0	2430	12	1	0.1	0.2	0.02	C
UK[2]	0.1	2360	10	10	10	10	0.004	D
Neth'ds[3]	-	-	-	-	14	2	-	D

[1] OLF 1993
[3] Brown and Root 1993. UK Digest of Energy statistics
[2] TNO

The OLF emission factors are recommended because they are based on documented measurements. However, more measurements of emissions from flares are needed to establish a more accurate set of emission factors. The reason for the low NMVOC and methane emission factors in the Norwegian study is that measurements have shown that unburned hydrocarbons are combusted while leaving the flare.

It may generally be assumed that fields with a high level of flaring have a more efficient flare.

Emission factors for well testing:

Unit: g/kg oil burned

Country	CO_2	NO_x	CO	VOC[2]	Quality code:
Norway[1]	3200	3.7	18	3.3	C

1 OLF 1993 2 Mainly methane

If gas is incinerated in the well testing, the general emission factors for flaring are recommended.

8.2 Detailed Methodology

The CO_2 emissions should be calculated from the average gas composition of each field. The gas composition may vary significantly from field to field.

For NO_x, the flare may be classified according to its flow rate. The lower the flow rate the lower the NO_x emission factor. The following equation may be used if better data are not available.

$$g\ NOx/Sm^3 = X + 20 \qquad \text{Equation 1}$$

Where X is the gas flow rate in terms of million m^3/day (Celius 1992).

For NMVOC, CH_4 and CO the emissions will be dependent on the load, and subsequent the efficiency of the flare, although no data are available. It may be assumed that the emissions of these compounds run against the NO_x trend.

9 SPECIES PROFILES

For the NMVOC no data are available.

10 UNCERTAINTY ESTIMATES

The CO_2 emission factor for the simplified methodology is within an accuracy of 10 percent. Emission factors for the other pollutants will vary considerably depending on the gas composition, loading and flare type. As a consequence use of the simplified methodology may result in an uncertainty much greater than 100 percent, depending on the pollutant. Celius 1992 has quoted an uncertainty of 50 % for the NO_x emission factor and a higher uncertainty for the other pollutants.

The uncertainty in the volume of gas flared is 5-30 % if measured, and about 30 % if calculated.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The suggested emission factors are based on few measurements. More representative measurements and full scale flare measurements are required to relate the emissions of the various pollutants with the flare conditions, i.e. the gas loading, gas composition and flare type.

Better accuracy on the volume of gas flared may be achieved through the use of more accurate measuring techniques and more measurement as opposed to calculation of gas flows. Each field should report the following:

- The volume of gas flared
- The composition of the gas
- The type of flare used

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

All fields, off-shore and on-shore, may be defined geographically to a precise location. Where possible, therefore, quote emissions per field.

13 TEMPORAL DISAGGREGATION CRITERIA

Flaring does not depend on diurnal or seasonal factors. However, the volume of gas flared will change over the lifetime of the field. Monthly flaring data if available will be most accurate. Monthly production data are available in major oil and gas exporting countries. If this information is not available, emissions may be assumed equally temporally distributed. Equal temporal distribution night/day may generally be assumed.

14 ADDITIONAL COMMENTS

There are a number of developments in emission estimation methodologies in this area e.g. IPCC, OLF and UK OOA. This draft will have to be revised in the coming years in light of this.

15 SUPPLEMENTARY DOCUMENTS

Storemark, G., S. Lange, S. Knutsen and R.R. Christensen, Gas flaring analysis Report, OLF report C04. 1993.

16 VERIFICATION PROCEDURES

Compare metered and calculated flaring volumes.

17 REFERENCES

Brown and Root Environmental atmospheric emissions from UK oil and gas exploration and Production facilities in the continental shelf area. United Kingdom Offshore Association Limited. 1993.

Celius H.K., Emissions of non-CO_2 Greenhouse gases from Offshore Installations. SINTEF 1992. 35.3938.00/01/92.

IPCC and OECD, Greenhouse Gas Inventory Reference Manual. IPCC Draft Guidelines for National Greenhouse Gas Inventories. First Draft. 1994.

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Statistics Norway. Natural Resources and the Environment. Statistical analysis no 3. 1994.

Passant N.R., Emissions of Volatile Organic Compounds from Stationary Sources in the UK. Warren Spring. ISBN 0 85624 850 9. 1993. Available from AEA Technology, NETCEN, Culham Laboratory, Abingdon OX14 3DB, United Kingdom.

18 BIBLIOGRAPHY

19 RELEASE VERSION, DATE AND SOURCE

Version : 2.2

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Source : Kristin Rypdal
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20 POINT OF ENQUIRY

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