Best Available Techniques Economically Achievable to address black carbon from gas flaring

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BATEA to address BC From Gas Flaring

REPORT OVERVIEW

• Provides technical guidance on possible black carbon abatement measures where associated gas is flared during oil extraction activities
• Updated and complete overview of existing options, addressed both to national administrations and businesses
• Intended users could include oil & gas field operators (and owners), investors or other decision-makers
• Can also assist national administrators contemplating enhanced environmental legislation regarding BC emission reductions from flaring
• Other stakeholders involved in or affected by oil and gas operations in the Arctic.
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REPORT OVERVIEW

➢ Hydrocarbon operations involve the separation and processing of reservoir fluid combinations of gas, oil and water (along with various other constituents)
➢ Systems used for this purpose incorporate flaring capability to release gases to the atmosphere (flaring specifically describes the situation in which gas is combusted upon its release via a flare header)
➢ Flaring recognized as a significant source of GHG emission and air pollution in the Arctic, for which risks must be managed accordingly!

Emissions from Flaring include:
▪ Carbon dioxide (CO$_2$)
▪ Carbon monoxide (CO)
▪ Methane (CH$_4$) & VOCs
▪ Sulphur oxides (SO$_x$)
▪ Nitrogen oxides (NO$_x$)
▪ Particles (black carbon, soot)

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REPORT OVERVIEW

Number of nation-wide APG flares (Arctic Countries)

*NOAA Flaring estimates produced by Satellite observations (VIIRS technology), 2016 data
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REPORT OVERVIEW

The report consists of 3 main sections in addition to the introduction:

1. Flare characteristics are highlighted including a presentation of categorization, relevance of gas composition, available volumes over time and the importance of geographical diversity of fields;

2. Each BATEA is described with a summary page presenting the key information, followed by a more detailed description provides additional insights;

3. A summary table of a review performed on existing technical guidance documents and related national legislation, highlighting some of the limitations of existing guidance documents with respect to emissions of black carbon from gas flaring.

*NOAA Flaring estimates produced by Satellite observations (VIIRS technology), 2016 data
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REPORT OVERVIEW

1st section: FLARE CHARACTERISTICS

Majority of flaring...
- caused by lack of market outlets
- shortage of local demand
- technical constraints
- poor economics

Minority of flaring...
- exploration flaring
- process flaring
- emergency flaring

CAUSES OF FLARING

- Lack of a gas utilization route for all or a share of the produced gas
- Pilot Gas
- Purge Gas
- Degassing of produced water and glycol circulation

MAIN MEASURES TO REDUCE GAS FLARING

- Develop or modify gas utilization routes
- Reduce pilot fuel consumption
- Reduce purge gas emissions
- Flare gas recovery system
- Technical measures to improve regularity
- Optimizing procedures and training personnel

Example for illustrative purposes only

Flaring volume

- Continuous flaring - lack of gas utilisation
- Continuous flaring - operational
- Intermittent flaring - Operational
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REPORT OVERVIEW

Associated gas utilization: Technical and geographical challenges

KEY CHALLENGES FOR GAS UTILISATION

- Production decline rate
- Short term volume variation
- Low pressure of the gas
- Distance from infrastructure
- Gas composition & quality
- Gas-Oil-Ratio (GOR) over time

Sizing APG recovery technologies
Decline curve considerations

Example for illustrative purposes only
Sizing APG recovery technologies: Gas utilization rates, remaining field life, technology scaling

Considerations:
- Lifetime sizing
- Lifetime average sizing
- Renting/leasing/flexible sizing

### Gas Composition

#### Field A
- **Carbon dioxide (CO₂):** 1.15%
- **Methane (CH₄):** 73.57%
- **Ethane (C₂H₆):** 9.32%
- **Propane (C₃H₈):** 9.27%
- **Butane (C₄H₁₀):** 4.44%
- **Pentanes (C₅H₁₂):** 1.34%
- **Hexanes (C₆H₁₄):** 0.18%
- **Heptanes (C₇H₁₄):** 0.00%
- **Nitrogen (N):** 0.77%
- **Water (H₂O):** 0.00%
- **Oxygen (O):** 0.00%
- **Hydrogen Sulfide (H₂S):** 0.00%
- **Net Calorific Value:** 1224.96 BTU/SCF

#### Field B
- **Carbon dioxide (CO₂):** 3.76%
- **Methane (CH₄):** 79.65%
- **Ethane (C₂H₆):** 7.26%
- **Propane (C₃H₈):** 5.31%
- **Butane (C₄H₁₀):** 2.69%
- **Pentanes (C₅H₁₂):** 0.56%
- **Hexanes (C₆H₁₄):** 0.09%
- **Heptanes (C₇H₁₄):** 0.00%
- **Nitrogen (N):** 0.57%
- **Water (H₂O):** 0.00%
- **Oxygen (O):** 0.00%
- **Hydrogen Sulfide (H₂S):** 0.11%
- **Net Calorific Value:** 1071.47 BTU/SCF

#### Field C
- **Carbon dioxide (CO₂):** 1.32%
- **Methane (CH₄):** 49.90%
- **Ethane (C₂H₆):** 15.31%
- **Propane (C₃H₈):** 19.40%
- **Butane (C₄H₁₀):** 9.24%
- **Pentanes (C₅H₁₂):** 2.05%
- **Hexanes (C₆H₁₄):** 0.26%
- **Heptanes (C₇H₁₄):** 0.08%
- **Nitrogen (N):** 0.01%
- **Water (H₂O):** 0.00%
- **Oxygen (O):** 0.65%
- **Hydrogen Sulfide (H₂S):** 0.00%
- **Net Calorific Value:** 1519.50 BTU/SCF

#### Field D
- **Carbon dioxide (CO₂):** 0.49%
- **Methane (CH₄):** 60.37%
- **Ethane (C₂H₆):** 2.39%
- **Propane (C₃H₈):** 2.55%
- **Butane (C₄H₁₀):** 14.17%
- **Pentanes (C₅H₁₂):** 10.11%
- **Hexanes (C₆H₁₄):** 0.00%
- **Heptanes (C₇H₁₄):** 0.00%
- **Nitrogen (N):** 0.00%
- **Water (H₂O):** 0.00%
- **Oxygen (O):** 0.00%
- **Hydrogen Sulfide (H₂S):** 0.00%
- **Net Calorific Value:** 1612.59 BTU/SCF

**Net Calorific Value:**
- **[Field A]:** 1224.96 BTU/SCF
- **[Field B]:** 1071.47 BTU/SCF
- **[Field C]:** 1519.50 BTU/SCF
- **[Field D]:** 1612.59 BTU/SCF

**Net Calorific Value (MJ/SCM):**
- **[Field A]:** 45.55 MJ/SCM
- **[Field B]:** 39.85 MJ/SCM
- **[Field C]:** 56.51 MJ/SCM
- **[Field D]:** 59.97 MJ/SCM
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REPORT OVERVIEW

Emission Factors:

![Graph showing emission factors with references]

APPROACH
- Laboratory
- Top-down
- McEwen formula
- Aircraft Sampling
- Literature
- Literature

LOCATION
- Canada
- NA
- Norway
- North Dakota
- Russia
- Ecuador
- Russia
- Global

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BEST PRACTICE FOR BC FROM GAS FLARING

OVERVIEW

Abatement measures identified have been described across 7 broader Best Available Techniques Economically Achievable (BATEA) and can be considered particularly relevant towards demonstration and feasibility projects in the Arctic Regions.

<table>
<thead>
<tr>
<th>INCREASE GAS UTILISATION</th>
<th>OPTIMISE COMBUSTION CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMISE LOCAL / ON-SITE USE</td>
<td>EXPORT MARKETABLE PRODUCTS</td>
</tr>
<tr>
<td>ELECTRICITY</td>
<td>HEAT</td>
</tr>
</tbody>
</table>

1 2 3 4 5 6 7
**BAT Overviews: “1-Page-Boxes”**

- Technology summary
- Applicability to the Arctic
- Effect on emissions
- Benefits
- Infrastructure requirements
- Technical & economic considerations
- Visual overview
- Links to further information

**BAT: Detailed information section**

- Detailed technology descriptions
- Detailed investment considerations
Thank you for your time

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