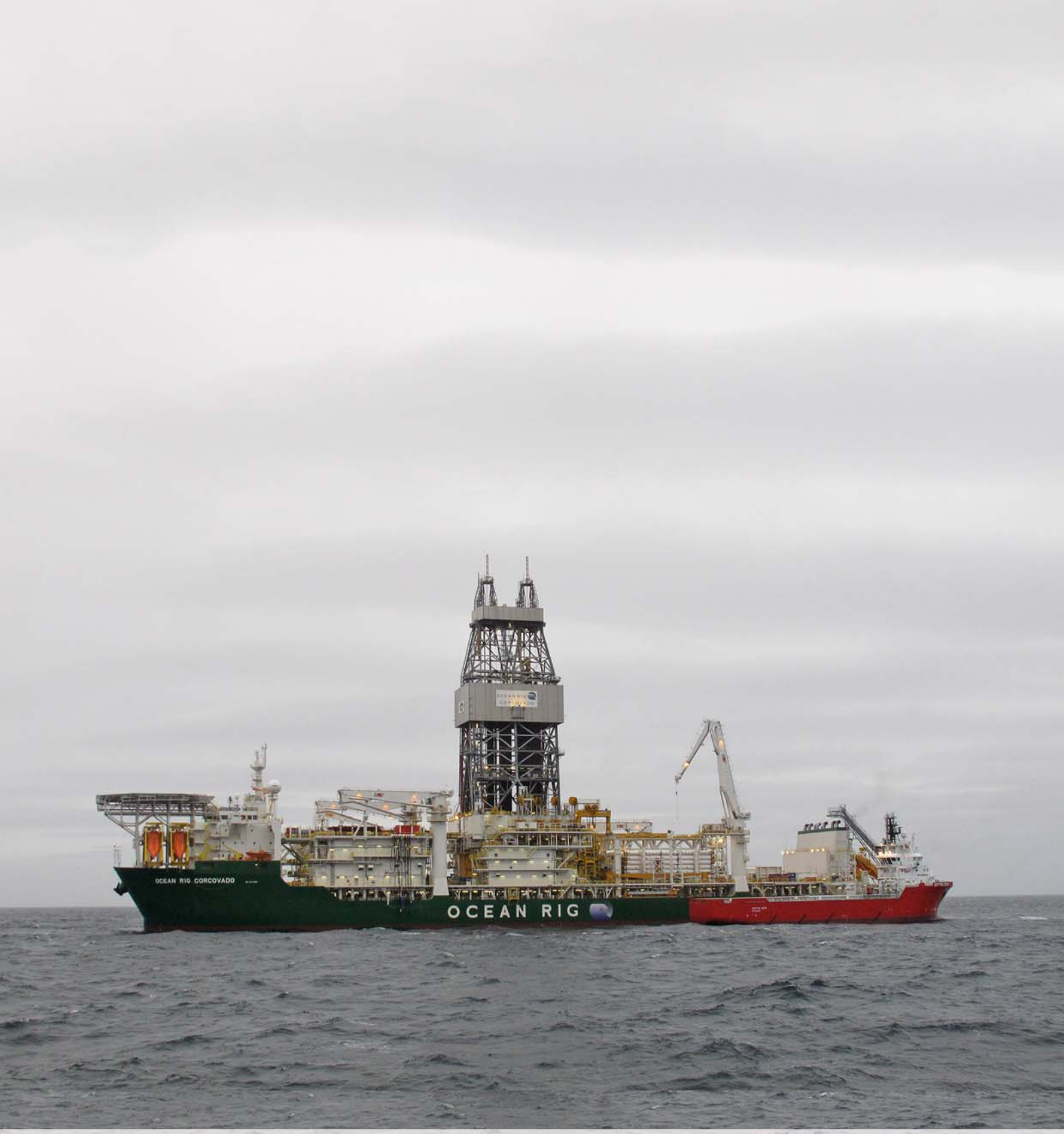

ENVIRONMENTAL PERFORMANCE EVALUATION FOR OIL COMPANIES

Technical Report from DCE – Danish Centre for Environment and Energy No. 94 2017

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Abstract: As part of license-rounds for exploration and exploitation of hydrocarbons in Greenland, the companies are requested to submit an application for qualification to be approved by the Greenland Government. This includes an evaluation of the company's environmental performance. The present report describes an environmental performance evaluation system, which includes a point system based on the company's statistical data on selected environmental indicators. The point system awards and summarizes point scores from a developed template in order to achieve an objective and transparent evaluation as possible of the company's environmental performance.

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Preface

As part of licence-rounds, the Greenland Government invites prospective applicants to submit applications for exclusive licences for exploration for and exploitation of hydrocarbons.

If a company applies for an exclusive licence for exploration for and exploitation of hydrocarbons in the Licensing Round, the company is required to submit an application to be approved by the Greenland Government as qualified to be operator for such licences for onshore or offshore areas in Greenland (Greenland Government 2014).

The Letter of requirements for qualification as operator for exclusive licences for exploration for and exploitation of hydrocarbons in offshore areas and onshore areas in Greenland (Greenland Government 2014) contains the requirements for qualification as operator for exclusive licences for exploration for and exploitation of hydrocarbons in offshore areas and onshore areas in Greenland.

The qualification procedure includes an evaluation of the environmental profile of the applicant company (Greenland Government 2014). Hence, the applicant company must document and demonstrate experience with environmental contingency measures under conditions which are similar to the conditions in the region applied for, all environmental statistics and detailed annual activity data, oil spill data and, if relevant, independent documentation of improvement of the applicant company's environmental performance after major environmental incidents.

These environmental data/information will be the basis for evaluation and comparison of an applicant company's or applicant companies' environmental performance(s) as described in this report.

DCE has developed an environmental performance evaluation system described in this report, including a point system, for transparent environmental performance evaluation of applicant companies for the Greenland Government.

Summary

As part of license-rounds for exploration and exploitation of hydrocarbons in Greenland, the companies are requested to submit an application for qualification to be approved by the Greenland Government. This includes an evaluation of the company's environmental performance. The present report describes an environmental performance evaluation system, which includes a point system based on the company's statistical data on selected environmental indicators. The point system awards and summarizes point scores from a developed template in order to achieve an objective and transparent evaluation as possible of the company's environmental performance.

Sammenfatning

I forbindelse med licensansøgninger vedrørende efterforskning og udvinding af kulbrinter i Grønland skal selskaberne fremsende en ansøgning om kvalifikationsgodkendelse til det Grønlandske Selvstyre. I denne godkendelse indgår bl.a. en vurdering af selskabernes miljøprofil. Nærværende rapport beskriver et system til at vurdere selskabernes miljømæssige performance, herunder et pointgivningssystem baseret på selskabernes statistiske data af udvalgte miljøindikatorer. Pointsystemet fordeler og sammenfatter point-scorer ud fra en fastlagt skabelon, hvorved en så objektiv og gennemsigtig vurdering som muligt af selskabernes miljøprofil kan opnås.

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1 Environmental performance evaluation

DCE has previously applied a score system when evaluating the environmental profiles for oil companies applying for licences. The system scores the operator's environmental performance, oil spill response and contributions to knowledge building. The score is used to evaluate a company's environmental performance expressed in temporal trends in environmental parameters and a relative comparison of operators based on the level of the environmental parameters. The score system is based on annual statistics and other information that has to be delivered by the companies. Also available public information is included.

The aim of this report is to document the score system in order to make the system operational and transparent. The score system follows international standards regarding environmental management such as Environmental Management Systems (ISO 14001) and the Guidelines on Environmental Performance Evaluation (ISO 14031). Also the guidelines by the forum Global Reporting Initiative (https: / / www.globalreporting.org) have been consulted.

The score system consists of two parts. Part one evaluates the temporal trends of environmental performance indicators and is used to evaluate the individual operator. Part two evaluates the levels of environmental performance indicators and is used when two or more operators are compared.

1.1 Environmental performance indicators

Information on environmental performance indicators is fundamental for the score system. They are defined in ISO 14031 as: "*A specific expression that provides information about an organization's environmental performance*".

ISO 14031 operates with three types of indicators: Management performance indicators (MPIs), which provide information about the management effort to influence an organization's environmental performance; Operational performance indicators (OPIs), which provide information about the environmental performance of an organization's operations; Environmental condition indicators (ECIs), which provide information about the condition of the environment.

The indicators have to be normalized in order to be cleaned from, e.g., differences in activity levels among years. Therefore, the indicators are relative and thus contain both a numerator as well as a denominator, which have to be selected.

When environmental performance indicators are available on annual bases and covering a sufficient period of years, it is possible to evaluate the temporal trend of the indicators. An appropriate statistical test to apply to time series of indicators is the non-parametric Mann-Kendall test for detection of trends. At least six years of data are needed for the Mann-Kendall test; otherwise the statistical strength for significance of trends is too low. For example, when the number of years in the time series is lower, e.g. five years, a significant decreasing trend would only be confirmed if the data of a year always are lower than the year before. If this pattern is broken by only one year's data being higher than the previous year, the trend would no longer be significant. Hence, this

would imply very strict requirements to the indicator and thereby the operators, and therefore all indicators must be given at an annual basis and for at least the last six years. See Appendix A for examples of statistical calculations.

1.2 Management performance indicators (MPI) for evaluation of trends

Oil spills statistics give an indicator of the management efforts to control an organization's environmental performance. The following MPIs indicators are required:

- Number of spills per production — number / barrels per day
- Amount of spills per production — tonnes / barrels per day.

An oil spill is defined as a spill of more than 1 barrel (159 L) that reaches the receiving environment (Bureau of safety and environmental enforcement (BSEE), http://www.base.gov/Inspection-and-Enforcement/Accidents-andincidents/Spills-Archive/). Production is the number of barrels produced per day. Other denominators than operation hours could be number of employees or number of vessels operating in the reporting period.

1.3 Operational performance indicators (OPIs) for evaluation of trends

Statistics of energy consumption and energy generated indicate the organization's energy efficiency. The following OPIs indicators are required:

- Fuel consumption per production — Giga joule (GJ) / barrels per day
- Oil content in discharged water — mg / litre (ppm)
- Total waste water (black and grey) discharged per production — m^3 / barrels per day

The fuel consumption is the total amount of fuel used to generate electricity and power on board the vessel(s) and drilling rig(s). The energy generated can be read, if available, from an electricity meter. Alternatively, equipment specifications can be used.

For oil in water discharged to the sea from ships, International Convention for the Prevention of Pollution from Ships (MARPOL) has given a limit of 15 mg l^{-1} outside special areas and no discharge inside special areas. The limit for oil discharged with produced water from oil and gas offshore installation is 15 mg l^{-1} for the Baltic Sea, (HELCOM 1997). OSPAR (2001) recommends the limit of 30 mg l^{-1} of oil in water discharged from oil-gas offshore installations. However, in Norway, the mean discharge of oil in produced water is ca 11 mg l^{-1} (http://www.norskoljeoggass.no/Documents/Milj%C3%B8ut-valget/Milj%C3%B8data_2012.pdf), and from oil company statistics (e.g., ENI) it appears that less than 8 mg l^{-1} can be achieved (http://www.eni.com/en_IT/sustainability/environment/water/water.shtml)

Waste water is defined as the amount of discharged water (black and grey, e.g., shower water, wash and toilet water, etc.).

1.4 Environmental condition indicators (ECIs) for evaluation of trends

Data of emissions provide information on contributions to phenomena as 'global warming' and 'acidification'. Also data about waste generation, both hazardous and non-hazardous, are informative. Hazardous waste is defined by local legislation but definitions are also given by OECD or the Basel Convention. The following ECIs indicators are required:

- Contribution to global warming per production CO_2 equi. / barrels per day
- Contribution to acidification per production SO_2 equi. / barrels per day
- Percentage of recycled, reused and recovered material.

Emissions of CO_2, CO, NO_x, N_2O, CH_4 and VOC (volatile organic compounds) all contribute to global warming. Conversion factors to CO_2 equivalent from fuel consumption can be found in IMCA SEL 010 (2004). Emissions of SO_x and NO_x contribute to the acidification and conversion factors to SO_2 are also found in IMCA SEL 010 (2004).

For waste handling the percentage of material recycled, reused and recovered is chosen as indicator. A high recycling percentage indicates a good performance. It should be noted that the MARPOL convention prohibits dumping of hazardous waste.

1.5 Evaluation based on received information

Information given on oil spill contingency in marine areas with ice as well as willingness to contribute to knowledge improvement will be evaluated according to the Letter of Invitation to apply for Exclusive Licences for Exploration for and Exploitation of Hydrocarbons in Greenland in a Licensing Round (Greenland Government 2014, Appendix 4):

"(5) The applicant's willingness and ability to contribute to the Greenland Government's continued development of hydrocarbon related strategic assessments within the areas of social sustainability and sustainable development, geology, environment, ice, oil spill and emergency preparedness."

And, as further stated (Greenland Government 2014, Appendix 4), the applicant company must document and demonstrate experience with environmental contingency measures under conditions which are similar to the conditions in the region applied for.

2 Part 1: Score system for evaluating trends

	Score system for evaluating trends	Max score
1	**Management performance indicators**	
A	Number of spills per production	20
B	Amount of spills per production	20
	Subtotal	40
2	**Operational performance indicators**	
A	Energy consumption per production	10
B	Oil content in discharged water	20
C	Total waste water discharged per production	10
	Subtotal	40
3	**Environmental condition indicators**	
A	Contribution to global warming per production	20
B	Contribution to acidification per production	10
C	Percentage of recycled, reused and recovered material	10
	Subtotal	40
	Total score	**120**

In the score system each environmental performance indicator is given a maximum score, which express the importance given to the indicator. This weight is rather subjective and tentative and may vary from case to case. The performance indicator values during the last six years are tested one by one by the Mann-Kendall trend test.

The general relationship between the statistical test results (trend and p-value) and the score is:

Performance indicators having a maximum score of 20:

Trend	Mann-Kendall test	Score
Decreasing	p<0.05	20
Decreasing	0.05<=p<0.10	18
Decreasing	p>=0.10	15
Increasing	p>=0.10	8
Increasing	0.05<=p<0.10	5
Increasing	p<0.050	0

Performance indicators having a maximum score of 10:

Trend	Mann-Kendall test	Score
Decreasing	p<0.05	10
Decreasing	0.05<=p<0.10	8
Decreasing	p>=0.10	5
Increasing	p>=0.10	3
Increasing	0.05<=p<0.10	1
Increasing	p<0.050	0

3 Part 2: Score system for evaluation of levels

	Score system for evaluating levels	Operator 1 Score	Operator 2 Score	Score to divide
1	**Performance indicator trends (from part one)**			
A	Indicator scores from evaluation of trends			60
2	**Management performance indicators**			
A	Number of spills < 40 m^3			20
B	Number of spills > 400 m^3			20
C	Amount of spills/Number of spills (40 m^3 < spill < 400 m^3)			20
	Subtotal			60
3	**Operational performance indicators**			
A	Oil content in discharged water (ppm)			20
B	Total waste water discharged per production			10
	Subtotal			30
3	**Environmental condition indicators**			
A	Contribution to global warming per production hours			10
B	Contribution to acidification per production			10
C	Percentage of recycled, reused and recovered material production			10
	Subtotal			30
4	**Evaluation based on received information**			
A	Oil spill contingency in marine areas with ice			10
B	Contribution to knowledge improvement			10
	Subtotal			20
	Total score			**140**

The score system for evaluating trends of performance indicators does not account for the level of the indicators. Hence, the evaluation of trends cannot stand alone for comparison between companies. For instance, an operator cannot demonstrate a positive trend of a performance indicator and get the maximum score, if the performance indicators already are at a satisfactory level for the evaluation period. In the same way it is possible for an operator to get a high score demonstrating an improvement of a performance indicator, although the levels of the indicator are unsatisfactory. It is therefore necessary to consider both the trends and the levels of the performance indicators.

For evaluating the level of performance indicators, most of the indicators are the same as used in the evaluations of trends, but instead of testing the temporal trends, the mean values of the indicators for the last six years are calculated. It is essential that the operators' performance indicators are comparable, which means that the data should be normalised as described above.

The scores obtained from the evaluation of temporal trends (Part 1) are transferred as the first indicator (1A). Three indicators operating with oil spills (2A, B, C) are included. Spills are divided into relatively minor, intermediary, and relatively major. The delimitation of these small and large spills follow the definition of minor and major oil spills in the guide developed for the Coast Guard (CG) and the Environmental Protection Agency (EPA) On-Scene Coordinators (OSC) (Gulf Strike Team 2008). The third oil spill indicator (2C) deals with the mean amounts of oil spills for the spills not classified as minor or major. The operational (3) and environmental condition (4) indicators are similar to those used in the temporal trend evaluation.

The principle is to divide a sum score proportionally between operators according to the means of the indicators. The sum score of each environmental performance indicator expresses the importance given to the indicator. This weight is rather subjective and tentative and may vary from case to case. When two operators are to be compared, the scores are allocated the operators according to the proportion of the mean value to the sum of the mean values for both operators.

For the obtained temporal trend scores (1A) the total of 60 is allocated proportional to their trend score. For example, if operator 1 has obtained a trend score of 90 and operator 2 a trend score of 60, operator 1 will get 90 / (90+60) × 60 = 36 and operator 2 will get 60 / (90+60) × 60 = 24.

For the other indicators, the allocating of scores must be opposite, as the operator having the highest value of the indicator performs worse than the operator having the lowest value of the indicator. The dividing of scores follows the equations (1) and (2). The scores are rounded to nearest integer value.

(1)

$$Score("worst") = \frac{("best")}{("worst") + ("best")} \times Total\ Score$$

(2)

$$Score("best") = \frac{("worst")}{("worst") + ("best")} \times Total\ Score$$

For example, if operator 1 has a mean oil concentration in produced water (3A) of 10 mg/l and operator 2 has a mean oil concentration of 15 mg/l and the total score to divide is 20, then the 20 scores to divide will provide operator 1 with 15/(10+15) × 20 = 12 and operator 2 with 10/(10+15) × 20 = 8.

The indicator "Oil spill contingency in marine areas with ice" (4A) and "Contribution to knowledge improvement" (4B) cannot be evaluated quantitatively, i.e., by specific numbers or statistical test. It is expected that oil companies contribute to knowledge building with regard to oil spill response in ice covered/arctic waters, and support the knowledge base for environmental regulation in the relevant areas. If the companies meet these expectations, the score is allocated equally; otherwise a subjective allocation is needed based on the available information from the applications.

This point score system can be expanded to evaluate three or more operators. The total score to divide has to be increased according to the number of operators. Each operator contributes with 5 or 10 points, which means that for two operators the total score may be 10 or 20, and hence for three operators, the total score will be 15 or 30 points. The calculations are then as shown in equations (3), (4) and (5).

(3)

$$Score("worst") = \frac{("best")}{("worst") + ("best") + ("worse")} \times Total\ Score$$

(4)

$$Score("best") = \frac{("worst")}{("worst") + ("best") + ("worse")} \times Total\ Score$$

(5)

$$Score("worse") = \frac{("worse")}{("worst") + ("best") + ("worse")} \times Total\ Score$$

For example, three operators showing data of mean oil concentration in produced water as 10, 12 and 15 mg/l, the total score to divide is 30. The "worst" operator (highest concentration) (equation 3) would have 10/(10+12+15) × 30 = 8 points allocated, the "best" operator (equation 4) would have 15/(10+12+15) × 30 = 12 points and the operator "worse" (equation 5) would have 12/(10+12+15) x 30 =10.

For several operators to be compared, the calculations of the scores would be analogue with the example shown above with three operators.

4 Information needed for trend and level evaluations

In order to compute the proposed environmental performance indicators, the company needs to provide the parameter data on the following list, on an annual basis and for at least a six-year period:

- Production (barrels per day)
- Number of spills (no)
- Number of spills > 40 m^3
- Amount of spills (tonnes) > 40 m^3
- Number of spills > 400 m^3
- Amount of spills > 400 m^3
- Fuel consumed for operations (m^3)
- Oil in discharged water (ppm)
- Total waste water discharged (m^3)
- Percentage of recycled, reused and recovered material
- CO_2 emissions (tonnes)
- CO emissions (tonnes)
- NO_x emissions (tonnes)
- N_2O emissions (tonnes)
- SO_x emissions (tonnes)
- CH_4 emissions (tonnes)
- VOC emissions (tonnes).

5 Cases with inadequate performance statistics

There may be cases where adequate (six years) performance statistics are not available because, e.g., the company has not operated during a six year period. In such cases, statistics may be completed, but may also need to be followed by an assessment based on an overall impression of the company's environmental profile from available information.

6 References and links

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. http://www.basel.int/Home/tabid/2202/mctl/ViewDetails/EventModID/8051/EventID/542/xmid/8052/Default.aspx

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Appendix A. Mann-Kendall trend test

The Mann-Kendall trend test is a non-parametric test. It counts the number of consecutive years where the performance indicator increases or decreases compared with the year before, but it does not take differences in the levels of the performance indicator into account. A more detailed description can be found in the statistical textbook by Helsel and Hirsch (1995).

In order to illustrate the Mann-Kendall trend test, test results in a hypothetical decreasing trend are shown as an example. The results are analogous if the trend was increasing.

Five years of data

	Year 1	Year 2	Year 3	Year 4	Year 5	p-value
Hypothetical indicator value	5	4	3	2	1	0.027

This example shows a decreasing trend with a significant (<0.05) Mann-Kendall trend test.

	Year 1	Year 2	Year 3	Year 4	Year 5	p-value
Hypothetical indicator value	5	4	3	2	2	0.043

In this example, the indicator values in the two last years are similar and the test is also significant (<0.05).

	Year 1	Year 2	Year 3	Year 4	Year 5	p-value
Hypothetical indicator value	5	4	3	2	2.5	0.086

In this example, the indicator value in the last year is higher than the year before and the test is not significant.

These examples illustrate that testing only five years of data, only the two first cases would lead to statistical significant trends and the presence of only one year not following the trend would lead to an insignificant trend.

It is assessed, for the Mann-Kendall trend test to be realistic, that at least six years of data must be available to evaluate trends of performance indicators:

Six years of data

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	p-value
Hypothetical indicator value	6	5	4	3	2	1	0.009
	6	5	4	3	2	2	0.013
	6	5	3	3	2	2	0.019
	6	5	4	3	2	2.5	0.024
	6	5	4	2	2	2	0.027
	6	4	4	3	2	2.5	0.035
	6	5	4	3	2	3.5	0.060

The hypothetical examples shown above illustrate the Mann-Kendall trend test when six years of data are available. Significant test results ($p<0.05$) are obtained in situations where two or three years have identical indicator values as well as if two years have identical indicator values twice. It also gives significant results when one year is higher than the preceding year even if there also are two identical years. However, if one year is higher than two preceding years, it leads to insignificant ($p>0.06$) test results.

On this background it is evaluated that the Man-Kendall trend test is useful to assess temporal trends of performance indicators based on at least six years of data.

Appendix B. Conversion factors for calculating global warming and acidification potentials

Global warming potential **CO_2 equivalent**

Halon: factor 64,600
Freon: factor 11,300
CO_2 : factor 1
CO: factor 2.3
NO_x: factor 244
NO: factor 328
SO_x: factor 218
CH_4: factor 30
VOC: factor 117

Acidification potential **SO_2 equivalent**

SO_x: factor 1
NO_x: factor 0.7

Appendix C. Prefixes and multiplication factors

Multiplication factor	Abbreviation	Prefix	Symbol
1 000 000 000 000 000	10^{15}	Peta	P
1 000 000 000 000	10^{12}	Tera	T
1 000 000 000	10^{9}	Giga	G
1 000 000	10^{6}	Mega	M
1 000	10^{3}	Kilo	k
100	10^{2}	Hecto	h
10	10^{1}	Deca	da
0.1	10^{-1}	Deci	d
0.01	10^{-2}	Centi	c
0.001	10^{-3}	Milli	m
0.000 001	10^{-6}	Micro	µ

Appendix D. Common conversion factors

To convert from	to	multiply by
US gal	litres (l)	3.78541
barrels (bbl)	litres (l)	158.987
barrels (bbl)	m^3	0.159
ft^3	m^3	0.0283168
US ton	tonne (t)	0.907186
lb	tonne (t)	0.000453592
$lb.ft^{-3}$	$kg.m^{-3}$	16.0185
Btu	kJ	1.05506
hp	kW	0.7457
$Btu.ft^{-3}$	$kJ.m^{-3}$	37.2589
psi	bar	0.0689476
$kgf.cm^{-3}$	bar	0.980665
atm	bar	1.01325
ins water	mbar	2.49089
mm water	mbar	0.0980665
ins Hg	mbar	33.8639
mm Hg	mbar	1.33322
1000 m^3 gas	tonne gas	0.8458
tonne heavy fuel	m^3 heavy fuel	1.190
tonne fuel oil	m^3 heavy fuel	1.176
tonne CO_2	m^3 CO_2	509

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