Responsible Care Performance Reporting – Performance Indicators Questionnaire 2017:
Definitions and Further Explanations

APPENDIX I

CORE PARAMETERS

1) Number of Fatalities (employees only)

- **Definition**: A fatality is an instantaneous work-related event or exposure, leading to death within one year.
- The parameter is expressed as **number of fatalities**.

Example:
In Company A in 2002, there was one incident resulted in the death of 2 employees in 2002. The "Number of Fatality for Employees" is therefore 2 for Company A in the year 2002.

2) Lost Time Injuries Frequency Rate *(employees only)*

- **Definition**: A lost time injury is an instantaneous bodily defect so that the individual is physically or mentally unable – as determined by a competent medical person – to work on a scheduled day or shift, resulting in at least 3 days off the job.
- The frequency rate is expressed as the **number of lost time injuries per million working hours**.
  $= \frac{a \times b}{c}$ where a = total number of accidents
  b = 1,000,000 man-hours
  c = total man-hours worked
- Employee is defined to include all permanent full or part-time employees.
- Contractor is defined as any non-company employee who is providing a service to the company on the company's premises. This definition does not differentiate between a contractor's direct employees and those of any sub-contractors.

3) Sulphur Dioxide (SO_x)

- **Definition**: Airborne emission of sulphur and its compounds formed during combustion, production or treatment processes.
- The parameter comprises SO_2 and SO_3 and is expressed as **tonnes SO_2**.

Formula for Method 1:
Sulphur Oxides can be calculated from the amount of Fuel Oil consumed in a year and the average concentration of Sulphur (S) in the Fuel Oil.

$$SO_2\ (Tons/year) = \frac{(Fuel\ Oil\ used\ (tons/year) \times Concentration\ of\ Sulphur\ in\ fuel\ oil\ (\%) \times 64}{32}$$

where the molecular weight of SO_2 = 64 and that of Sulphur = 32

Example:
The annual total consumption of Fuel Oil in Company A is 1250 tons, and the average concentration of Sulphur (S) in the Fuel Oil is 0.015%. Calculate the Sulphur Oxides released.
Amount of Fuel Oil (tons) = 1250 tons
% of Sulphur in Fuel Oil = 0.015%
Molecular Weight of Sulphur Oxides, MW_{SO2} = 64
Molecular Weight of Sulphur, MWs = 32
Sulphur Oxides released (tons) = 1250 (tons) x (0.015/100) x (64/32) = 0.375 (tons)

Formula for Method 2:
Sulphur Oxides can be calculated from the analysis result of Sulphur Oxides Concentration (either SO_2 or SO_3) in the stack gas, and the known flowrate of the stack gas.

$$\text{Sulphur Oxides (Kg/hour)} = \frac{\text{(Conc } SO_2 \text{ (ppm) x Mol wt}_{SO2} \text{ x Stack gas Flowrate } (M^3/hr)}{22.4 \times 10^6}$$

$$\text{Sulphur Oxides (Tons/year)} = \frac{\text{(Sulphur Oxides (kg/hour) x 24 hours x No of Working days/year}}{10^3}$$

Example:
Average SO2 concentration in a boiler stack gas is 1004 ppm. The stack gas flowrate is 4,467 m3/hour. Calculate the emission of SOx from the stack?

SO_2 (kg/hour)	= 1004 x 64 x 4467 (22.4 x 10^6)	=	12.81 kg/hour
SO_2 (Tons/year)	= 12.81 x 24 x 300 days/year/1000	=	92 tons/year

4) Nitrogen Oxides (NO_x)

- **Definition**: Airborne emission of compounds of nitrogen and oxygen from combustion, production or treatment processes.
- The parameter comprises NO and NO_2 and is expressed as **tonnes of NO_2.**

Formula for Method 1:
Oxides of Nitrogen (NO_x) can be calculated from the analysis result of NO_x Concentration in the stack gas, and the known flowrate of the stack gas.

$$NO_x \text{ (Kg/hour)} = \frac{\text{(Conc } NO_x \text{ (ppm) x Mol wt}_{NOx} \text{ x Stack gas Flowrate } (M^3/hr)}{22.4 \times 10^6}$$

$$NO_x \text{ (Tons/year)} = \frac{(NO_x \text{ (kg/hour) x Annual Operating Hours}}{10^3}$$

Example:
Average NO_x concentration in a boiler stack gas is 200.6 ppm. The stack gas flowrate is 4,491 m^3/hour and the annual operating hours of the boiler was estimated as 7200 hours. Calculate the emission of NO_x from the stack?

NO_x (kg/hour)	= 200 x 38 x 4491 / (22.4 x 10^6) =	1.52 kg/hour
NO_x (tons/year)	= 1.52 x 7200 hours/year / 1000 =	10.9 tons/year

Where molecular weight of NO_x = 38, NO = 30 and NO_2 is 46.

Convert NO to NO_2:
For NO_X emissions, the reporting requirement is to be expressed as NO_2, if your facility measuring NO it has to be divided with 0.6522 to convert to NO_2.

Example:
The concentration of NO and NO_2 in a stack gas is 50 and 200 ppm respectively. The stack gas flowrate is 4,000 m^3/hour. There was s shutdown in the continuous operating plant for two months. Calculate the emission of NO_X from the stack?

NO_X (kg/hour) = [(50/0.6522) + 200)] x 46 x 4000 / (22.4 x 10^6)	=	2.27 kg/hour
NO_X (Tons/year) = 2.27 x 24 hours/day x 30 days/month x 10/1000	=	16.3 tons/year

5) Chemical Oxygen Demand (COD)

- **Definition**: Chemical Oxygen Demand (COD) is the amount of oxygen required for the chemical oxidation of compounds in water, as determined using a strong oxidant (most standard methods use dichromate).
- The parameter is expressed as **tonnes of oxygen.**
- For sites that have their wastewater treated at a shared third party unit and cannot obtain individual data, the efficiency factor of the wastewater treatment unit should be taken into consideration when calculating the amount.

Formula:

Chemical oxygen demand can be calculated from the average concentration of the COD and the annual discharge of the effluent to outfall. We can also estimate total COD released to environment based on the carbon content in the waste.

Method #1 (COD emitted from the actual analytical data):

COD emitted (Tons/year) = (Ave COD conc. (mg/L x Total Liquid waste (tons/year) x 10^{-6}

Average COD concentration can be calculated by taking the average of the daily reading or take the average of random sample results during the year. In case of TOC results multiply the TOC results with ~3 (32/12) to estimate COD.

If the facility has more than one outfall need to calculate for different streams and add up for calculating total COD discharged during the reporting period.

Total COD emitted (Tons/year) = COD (tons/year) $_{\text{stream1}}$ + COD (tons/year) $_{\text{stream2}}$

Method #2 (Theoretical estimation):

The COD can be calculated from theoretically by knowing the waste characteristics. Below is a general equation for estimating COD from an organic waste.

Where $C_xH_yO_z$ is the molecular formula of the material and x, y, z in the number of atoms of

$$C_xH_yO_z + \left[x + \frac{y}{4} - \frac{z}{2}\right] O_2 \longrightarrow (x)\,CO_2 + \left[\frac{y}{2}\right] H_2O$$

Carbon, Hydrogen and Oxygen present in one molecule.

Example:

The average COD concentration of the effluent discharged in the site outfall for the year was 85 ppm and the daily total outfall flow rate was 5 tons. Calculate the total COD discharged to environment?

Daily Average Wastewater flow rate	=	*5 tons/day*
COD concentration	=	*85 ppm*
Quantity of COD in tons/year	=	*5 tons/day x 85/1000000 x 365 days/year*

6) Energy Consumption

- **Definition**: Energy consumption is the amount of fossil fuels and electricity (the result of purchased electricity plus self-produced **renewable** electricity minus electricity sold to the network). The unit for electricity is the GWh but in order to add them up, electricity should be converted to TOE.

- The theoretical conversion factors are: 2.3876 10^{-5} ktoe per GJ and 0.2332 ktoe per GWh.
- The parameter on energy consumption is expressed as **tonnes of fuel oil equivalent (TOE).**

Formula:
Energy Consumption = Energy Content of Fuel(s) + Electricity Consumed

To calculate Energy Content of Fuel(s), consider:

i) Energy Content of a fuel is the product of multiplication the Amount of Fuel Consumed (tons) and its Heat Value found in Table 1.
Example: 50 tons for Residual Fuel Oil, its Heat Value in Table 1 is 42 GJ/ton.
The Energy Content is therefore 50 (ton) x 42 (GJ/ton) = 2100 (GJ)

To convert to the right unit from GJ to toe, is to multiply 2.3876 x 10E-5. The Energy Content in this example is 2100 (GJ) x 2.3876 x 10E-2 = 50.1207 (toe).

ii) If two or more types of fuel are consumed, the total Energy Content is the summation of energy contents of their respective fuels consumed.

To calculate Electricity Consumed, consider:

i) Electricity Consumed is the net result of purchased electricity from the Electricity Generating Company minus electricity sold by the Reporting Company.

The unit for electricity consumed may be in kWh, MWh or GWh.
(1 GWh = 1,000 MWH = 1,000,000 kWH). For reporting purpose, Electricity Consumption should be converted to tons of fuel oil equivalent (toe).

Conversion: for simplicity, the theoretical conversion factors to be used are 2.3876 x 10E-5 ktoe per GJ and 0.2332 ktoe per GWh.

Example:
A Reporting Company consumed 1000 tons of fuel oil and 1,500 tons of natural gas per year to generate steam and small amount of electricity. In addition, it consumed 3,500 GWh of electricity purchased from the grid and sold 500 GWh of electricity to a nearby Company. Note that any electricity produced by the Reporting Company should be accounted for under fuel consumed

From Table 1 – Typical Heating Values of various fuel types
- Heating value of fuel oil = 42 GJ/ton
- Heating value of natural gas = 51 GJ/ton

Energy Content of Fuel(s) consumed per year
= 1,000 tons x 42 GJ/ton + 1,500 tons x 51 GJ/ton
= 118,500 GJ Convert GJ to toe

Energy Content of Fuel(s) consumed per year
= 118,500 GJ x 2.3876 x 10E-5
= 2.829 ktoe = 2829 toe

Electricity Consumed per year
= Purchased Electricity – Exported Electricity
= (3500 GWh – 500 GWh)
= 3000 GWh

(Convert to toe) Electricity Consumed per year
= 3000 GWh x 0.2332
= 699.6 ktoe
= 699,600 toe

Energy Consumption of the Reporting Company for the year
= Energy Content of Fuel(s) + Electricity Consumed
= 2829 toe + 699,600 toe
= 702,429 toe

7) Carbon Dioxide (CO_2)

- **Definition:** The major contribution to CO_2-emissions by the chemical industry is from the combustion of fuels both directly and indirectly associated with the usage of electricity. Therefore, these emissions are calculated on the basis of energy consumption.
- ***Direct Carbon Monoxide (CO_2):*** The direct emissions of CO_2 are calculated as tons of CO_2 equivalent by multiplying the amount of solid, liquid and gaseous fuels used for energy use and for the generation of self produced electricity, by corresponding CO_2-emission factors (see Annex I).
- ***Indirect Carbon Dioxide (CO_2):*** The indirect emissions of CO_2 are calculated as the multiplication of the amount of net purchased electricity by the average factor of CO_2 emissions per kwh produced.

Formula:
Carbon Dioxide = Direct Carbon Dioxide + Indirect Carbon Dioxide

- Direct Carbon Dioxide (CO_2)
  Direct CO_2 is emissions caused by the Reporting Company either burning fuel to generate electricity, steam or other purposes. Direct CO_2 emissions are calculated based on the sum total of all fuels consumed by the Reporting Company.

- Indirect Carbon Dioxide (CO_2)
  Indirect CO_2 is emissions of CO_2 from 3^{rd} parties that supply electricity of steam to the Reporting Company. As a result of fuels combustion by the 3^{rd} parties, CO_2 emissions are generated. Indirect CO_2 consists of the sum of net electricity purchased and net steam purchased.

  Net electricity purchased is the net of electricity purchased from the grid (Electricity Supply Company) minus electricity sold to the grid/others. Net steam purchased is the net of steam purchased from 3^{rd} parties minus steam sold to another 3^{rd} parties.

Example:
A Reporting Company consumed 1,000 tons of fuel oil and 1,500 tons of Natural Gas per year to generate its own steam and small amount electricity. In a year it consumed 3,500 GWh of electricity purchased from the grid and sold 500 GWh of electricity to a nearby Company. In addition, the Company imported 10,000 tons of steam in the year and exported 500 tons of the steam purchased to the nearby company. Note that any electricity produced by the Reporting Company should be accounted for under fuel consumed.

- Calculating Direct Carbon Dioxide

  For Fuel Oil:
  From Table 1, Heating value of Fuel Oil = 42 GJ/ton
  Therefore, Energy Content of Fuel Oil = 1000 tons x 42 GJ/ton = 42,000 GJ

  From Table 2, CO_2 Emission Factor for Fuel Oil is 77.4 (Kg CO_2 per GJ)
  Therefore, CO_2 emission from Fuel Oil Combustion = 42,000 GJ x 77.4 Kg/GJ = 3,250,800 Kg
  For Natural Gas:

From Table 1, Heating value of Natural Gas = 51 GJ/ton
Therefore, Energy Content of Fuel Oil = 1500 tons x 51 GJ/ton = 76,500 GJ

From Table 2, CO_2 Emission Factor for Natural Gas is 56.2 (Kg CO_2 per GJ)
Therefore, CO_2 emission from Natural Gas Combustion = 76,500 GJ x 56.2 Kg/GJ = 4,299,300 Kg

Total Direct Carbon Dioxide = 3,250,800 Kg + 4,299,300 Kg = 7,550,100 Kg = 7550.1 tons of CO_2

- Calculating Indirect Carbon Dioxide

a) For Electricity:
From Table 3, the International Electric Grid Factor for CO_2 is 0.575 tons CO_2 per MWh or 575 tons per GWh.

Net Electricity purchased = 3,500 GWh – 500 GWh = 3,000 GWh

Therefore, CO_2 emission due to Electricity purchased
= 3,000 GWh x 575 ton/GWh
= 1,725,000 tons of CO_2

b) For Steam:
Assume the steam is purchased from a 3rd party source firing natural gas

From Table 4, CO_2 Emission Factor for purchased steam = 0.14 tons CO_2 per ton Steam.

Net Steam purchased = 10,000 tons – 500 tons = 9,500 tons

Therefore, CO_2 emissions due to Steam purchased
= 9,500 tons x 0.14 = 1330 tons CO_2

Total Indirect Carbon Dioxides = 1,725,000 tons + 1,330 tons = 1,726.330 tons

Carbon Dioxide = Direct Carbon Dioxide + Indirect Carbon Dioxide
= 7542.5 tons + 1,726,330 tons = 1,733,872.5 tons CO_2

8) Other Greenhouse Gases

- **Definition**: Other Greenhouse Gases, listed in the Kyoto Protocol are:-
  (i) Methane (CH_4)
  (ii) Nitrous Oxide (N_2O)
  (iii) Hydrofluorocarbons (HFC's)
  (iv) Perfluorocarbons (PFC's)
  (v) Sulphur Hexafluoride (SF_6)
- Emission data for these gases should be reported **as tons of CO_2 equivalents**. The impact of the release of these gases on Climate Change is calculated by multiplying the tons release per year by its Global Warming Potential (GWP) relative to carbon dioxide, as published by the Intergovernmental Panel on Climate Change (IPCC).

Formula:
Other Greenhouse Gas = Tons of the Greenhouse Gas Emission x Global Warming Potential of the Greenhouse Gas.

Example:
A Reporting Company estimates a 15 tons of Methane (CH_4) emission last year.

From Table 5 – GWP for Methane (CH_4) = 23 equivalent to CO_2

Therefore, the Other Greenhouse Gases – Methane (CH_4) emission in that year = 15 tons x 23 equivalent to CO_2 = 345 tons CO_2 equivalent

9) Other Explanation

- **Tonne:** A tonne is a Metric Tonne equivalent to 1000 kg and equivalent to 1.10231 US Short tons weighing 2,204.6 pounds.

1 Tonne = 1,000 kilograms = 2,204.6 pounds = 1.10231 US Short Tons

1.10231 US Short Tons	=	1 tonne (metric tonne)	=	2,204.6 pounds	=	1 000 kilogram mes

- **Volume transported:** Tonnes of chemical product shipped via air, rail, road, sea, inland waterway or pipeline between the site of a supplier company and that of the final customer. Includes the transport and off-site loading/unloading at ports, airports, warehouses, etc. and excludes the transport and loading/unloading activities at the premises of the supplier chemical company and the final customer.

- **Conversion Factors and Formulas**

TABLE 1: Typical Heating Values for Various Common Fuels

Fuel Type	Heating Value (GJ/ton fuel)
Natural Gas	51
Gasoline	47
Distillate	45
Residual Fuel Oil	42
LPG	50
Typical Fuel Gas generated from a Refinery or Chemical Plant	50

TABLE 2: Carbon Dioxide Emissions Factors

Fuel	Carbon Emission Factors[1] (kg C/GJ)	Carbon Dioxide Emission Factor[1] (kg CO_2/GJ)	Carbon Dioxide Emission Factor[1] (tonne CO_2/toe)	Carbon Dioxide Emission Factor[2] (lb CO_2/MMBTU)
Crude Oil	20.0	73.4	3.1	160.60
Gasoline	18.9	69.4	2.9	151.77
Kerosene	19.6	71.9	3.0	157.39
Jet Fuel	19.5	71.6	3.0	156.59
Motor Gasoline	20.2	74.1	3.1	162.21
Residual Fuel Oil	21.1	77.4	3.2	169.43

Fuel	Carbon Emission Factors[1] (kg C/GJ)	Carbon Dioxide Emission Factor[1] (kg CO_2/GJ)	Carbon Dioxide Emission Factor[1] (tonne CO_2/toe)	Carbon Dioxide Emission Factor[2] (lb CO_2/MMBTU)
Naphtha	20.0	73.4	3.1	160.60
Bitumen	22.0	80.7	3.4	176.66
Lubricants	20.0	73.4	3.1	160.60
Refinery Feedstocks	20.0	73.4	3.1	160.60
Other Oil	20.0	73.4	3.1	160.60
Steam Coal	25.8	94.7	4.0	207.17
Coking Coal	25.8	94.7	4.0	207.17
Petroleum Coke	27.5	100.9	4.2	220.83
Lignite	26.1	95.8	4.0	209.58
Sub-bituminous Coal	27.6	101.3	4.2	221.63
Peat	28.9	106.1	4.4	232.07
BKB & Patent Fuel	25.8	94.7	4.0	207.17
Coke	29.5	108.3	4.5	236.89
Natural Gas (dry)	15.3	56.2	2.4	122.86
Natural Gas Liquids	15.2	55.8	2.3	122.06
LPG	17.2	63.1	2.6	138.12

Sources:

1. *Greenhouse Gas Inventory Workbook Volume 2; IPCC/OECD Joint Programme; see conversion example below.*
2. *Environmental Protection Agency, inventory of US Greenhouse Gas Emissions and sinks: 1990-2006, April 15, 2006; referenced from Intergovernmental Panel as Climate Change (IPCC), Second Assessment Report (SAR).*

Examples for Calculating CO2 Emissions:

	Carbon Emission Factor (kg C/GJ)	Molecular Weight Ratio of CO_2/C (44/12=3.67)	CO_2 Emission Factor (kg CO_2/GJ)	CO_2 Emission Factor (tonne CO_2/toe)
Steam Coal	25.80	3.67	94.69	3.961
Crude Oil	20.00	3.67	73.33	3.070
Natural Gas	15.30	3.67	56.15	2.349

Note: 1 toe = 41.868GJ

TABLE 3: International Electric Grid Emission Factors

Country	CO2	CH4	N20	Total (CO2 Equivalent)
Malaysia	0.575	2.67E-06	8.64E-06	0.578

TABLE 4: Carbon Dioxide Emission Factors for Purchased Steam

Fuel Type	Carbon Dioxide Emission Factor for Purchased Steam (tons CO_2 / ton steam)
Natural Gas	0.14
Fuel Oil	0.209

TABLE 5: Global Warming Potential (GWP) of Other Greenhouse Gases (GHG)

GHG	GWP (based on the effects of greenhouse gases over 100-year time horizon)
CO_2	1
CH_2	23
N_2O	296
HFC_S	From 97 to 12,000 – depending on the HFC
PFC_S	From 5,700 to 11,900 – depending on the PFC
SF_6	22,200

DIAGRAM 1: Electricity to Tonnes of Fuel Oil Equivalents

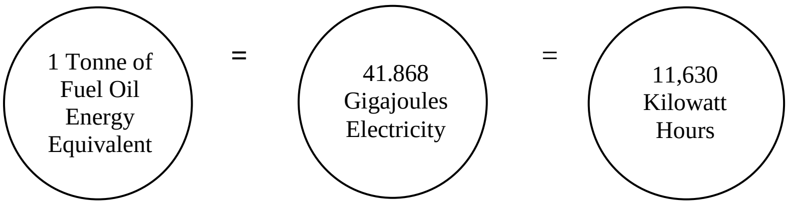
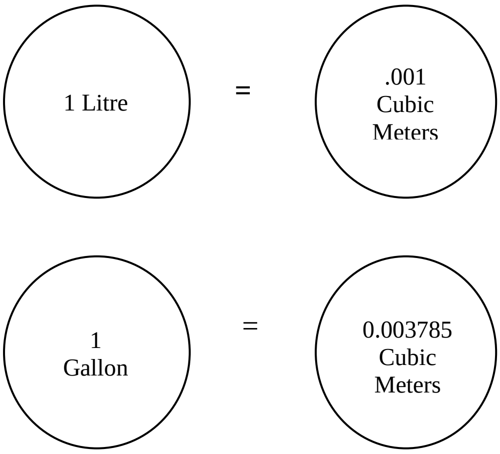


DIAGRAM 2: Water Consumption – Conversions to Cubic Meters



APPENDIX II

Transport Incidents

The distribution indicator relates to all incidents involving the movement of hazardous and non-hazardous chemicals. It covers the modes of transport by road and rail and includes the following:-

- death or injury
- spill or leakage
- property damage and/or material loss
- no spill or leak but public disruption
- adverse media attention

Incidents are categorized according to whether they were severe or less severe and whether distribution was by bulk or packaged cargoes.

Definition of Distribution Incidents Showing Breakdown by Severity		
Type of Incident	***Severe***	***Less Severe***
Death / Injury	Incident resulting in more than 3 days off from work	Incidents resulting in 1 – 3 days off work or treatment at approved medical centre
Spillage / Leakage	Hazardous material leakage of 200 kg or more Non-hazardous material leakage of 1000 kg or more	Hazardous material leakage of 10 kg or more but less than 200 kg. Non-hazardous material leakage of 100 kg or more but less than 1000 kg
Property Damage / Material - Loss including cost of environmental clean-up	In excess of RM50,000	Between RM5,000 and RM50,000
Public Disruption / Perceived Danger - Resulting in evacuation, road closure or other precautionary measures including attendance of emergency services	Last more than one hour	Last less than one hour
Adverse Media Coverage	National Level	Local Level

APPENDIX III

Total Worker Hours

RCLG Associations should report the total number of employee hours worked for each member company in their association **and** the total number of contractor hours worked for each member company as a **combined, single number**. For the purposes of this guidance document, each association should refer to their local and regional definitions for employee and contractor. The goal for reporting total hours is to include **all individuals** who are involved with chemical manufacturing, except where those individuals are tasked with major construction projects such as large scale investments with specific, one-time project organizations created for design, engineering, and construction of new or significant expansion to existing process facilities. When reporting total worker hours, companies should report the same hours used for reporting **personnel hours**. This way, companies can have the same data set for occupational and process safety. Personnel hours should include those hours from **all** chemical manufacturing operations, not just from facilities where a process safety incident occurred.

Process Safety Event

For the purposes of this ICCA Reporting, a process safety event has occurred when:

A. When a chemical substance or a chemical process is directly involved; **AND**

B. The incident occurred in production, distribution, storage, utility, pilot plant within the site boundaries of company's facility; **AND**

C. There was a release of material or energy (e.g. fire, explosion, implosion) from a process unit; **AND**

D. One or more of the following **Reporting Thresholds** have been met:

1. **Safety / Injury**
   - Injury resulting in a Recordable, Lost Time Accident or Fatality; or Hospital admission of anyone on or off site; **OR**

2. **Direct Damage Cost**
   - A fire, explosion or clean up necessary to avoid/remediate environmental damage resulting in a direct cost equal to or greater than $2,500 USDs; **OR**

3. **Shelter in Place / Evacuation**
   - An officially declared shelter in place (on or off site); **OR**
   - An officially declared evacuation (on or off site); **OR**
   - A precautionary off site shelter in place or evacuation **OR**

4. **Threshold Release**
   - The material released meets one of the GHS thresholds in **Table 1 – GHS Classification Table** *(measured in amount released during one hour)*

Health Hazards			
Acute Toxic (GHS 3.1) category:	1, 2	3, 4	5
Germ Cell Mutagenicity, Carcinogenicity, Reproductive toxicity, STOT-single exposure (GHS 3.5 – 8)			All categories
All other health hazards (GHS 3.x)			All categories
Physical Hazards (GHS 2.x)			All categories
Environmental Hazards (GHS 4.x)			All categories
Equivalent classification using GHS Hazard Statements:	H300, 310, or 330	H301, 302, 311, 312, 331 or 332	Any other H-Number
Release Thresholds (During 1 hour timeframe)	≥ 1 kg	≥ 10 kg	≥ 100 kg