Appendix 3.7
Calculations of Industrial Emission Rates
### Emission Inventory for Gaseous Pollutant

<table>
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<tr>
<th>Source</th>
<th>Type</th>
<th>X</th>
<th>Y</th>
<th>Exit Temperature</th>
<th>Exit velocity</th>
<th>Internal diameter</th>
<th>Stack Height / Release Height</th>
<th>NOx</th>
<th>SOx</th>
<th>RSP</th>
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<td><strong>Existing Chimneys</strong></td>
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</tbody>
</table>

Note:

[1] Referenced from the specified process (SP) license registered in March 2011 (No. A0700)
[2] Accounted for the potential growth of nos. of beds (as twice as that in Yr2009 at the Northern District Hospital)
[3] In accordance with the assumption of "2.5 staff per bed" stated in the TR8, the nos. of beds in the proposed Hospital in KTN will be at least 860.
[4] According to the implementation programme, the intake year for this proposed hospital is Yr 2029.

The exit temperature of CHP is assumed the same as the boiler due to their similar nature.

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**G:\env\project\25278\env_data\Air\201211_Stage4 EIA\Chimney\Chimney Emission Summary__Stage4.xlsx:Summary**
Calculations of Emission Factor for Existing Chimneys

**Fuel Oil Combustion**

Emission factor based on Section 1.3 of AP-42, USEPA

\[
\text{NO}_x \text{ Emission Factor} = \frac{20 \text{ lb}}{10^3 \text{ gal}} \quad \text{[ref. AP-42 Table 1.3-1]}
\]

\[
= \frac{2.4 \text{ kg}}{10^3 \text{ L}} \quad \text{[multiplied by 0.12 to convert from lb / 10^3 gal to kg / 10^3 L]}
\]

\[
\text{SO}_2 \text{ Emission Factor} = \frac{142S \text{ lb}}{10^3 \text{ gal}} \quad \text{[ref. AP-42 Table 1.3-1]}
\]

\[
= \frac{71 \text{ lb}}{10^3 \text{ gal}} \quad \text{[S is Weight % of Sulfur content in Oil; Maximum sulphur content is 0.5%]}
\]

\[
= \frac{8.52 \text{ kg}}{10^3 \text{ L}} \quad \text{[multiplied by 0.12 to convert from lb / 10^3 gal to kg / 10^3 L]}
\]

\[
\text{RSP Emission Factor} = \frac{2 \text{ lb}}{10^3 \text{ gal}} \quad \text{[ref. AP-42 Table 1.3-1]}
\]

\[
= \frac{0.24 \text{ kg}}{10^3 \text{ L}} \quad \text{[multiplied by 0.12 to convert from lb / 10^3 gal to kg / 10^3 L]}
\]

**Summary of Emission Rates**

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<th>Chimney ID</th>
<th>Fuel usage L/hr</th>
<th>NO\textsubscript{x} g/s</th>
<th>SO\textsubscript{2} g/s</th>
<th>RSP g/s</th>
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<td>0.133</td>
<td>0.473</td>
<td>0.013</td>
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</table>
Calculations of Emission Factor for North District Hospital

Towngas Combustion

Emission factor based on Section 1.4 of AP-42, USEPA

\[ \text{NO}_x \text{ Emission Factor} = 220 \text{ mg} / \text{kWh} \]

[ref. (AEIAR 142/2009) Provision of a Poultry Slaughtering Centre in Sheung Shui]

Towngas Consumption = 1,247,742 \text{ m}^3 \text{ per year}
0.040 \text{ m}^3 \text{ per second}

Towngas Consumption = 1,247,742 unit
6,837 MJ per hour
1,901 kWh per hour
1 kWh per second

Fuel Oil Combustion

Emission factor based on Section 1.3 of AP-42, USEPA

\[ \text{SO}_2 \text{ Emission Factor} = 142S \text{ lb} / 10^3 \text{ gal} \]

[ref. AP-42 Table 1.3-1]

\[ 0.71 \text{ lb} / 10^3 \text{ gal} \]

[S is Weight % of Sulfur content in Oil; Maximum sulphur content of ultra low sulfur diesel (ULSD) is 0.005%]

\[ 0.0852 \text{ kg} / 10^3 \text{ L} \]

[multiplied by 0.12 to convert from lb / 10^3 gal to kg / 10^3 L]

\[ 2 \text{ lb} / 10^3 \text{ gal} \]

[ref. AP-42 Table 1.3-1]

\[ 0.24 \text{ kg} / 10^3 \text{ L} \]

[multiplied by 0.12 to convert from lb / 10^3 gal to kg / 10^3 L]

Fuel Oil Consumption = 3190 L per year
0.0001 L per second

Total Emission Rate

Nos. of Bed: 607

[ref. Hospital Authority Statistical Report, 2009-2010]

Adopted Emission Rate for Each Stack (two stacks):

\[ \text{NO}_x \text{ Emission} : 5.81E-02 \text{ g} / \text{s} \]

\[ \text{SO}_2 \text{ Emission} : 4.31E-06 \text{ g} / \text{s} \]

\[ \text{RSP Emission} : 1.21E-05 \text{ g} / \text{s} \]

Calculations of Emission Factor for the Proposed Hospital in KTN B2-2

In accordance with the assumption of “2.5 staff per bed” stated in the TR8, the nos. of beds in the proposed Hospital in KTN will be at least: 860 beds

Adopted Emission Rate for Each Stack (assuming two stacks with reference to the North District Hospital):

\[ \text{NO}_x \text{ Emission} : 8.33E-02 \text{ g} / \text{s} \]

\[ \text{SO}_2 \text{ Emission} : 6.11E-06 \text{ g} / \text{s} \]

\[ \text{RSP Emission} : 1.72E-05 \text{ g} / \text{s} \]
Agreement No. CE61/2007(CE)
North East New Territories New Development Areas Planning and Engineering Study – Investigation

Projection of Biogas Consumption at Full Capacity of the Shek Wu Hui Sewage Treatment Works Expansion

According to the Outline Design Report of SWHSTW Further Expansion - Phase 1 and 2 (Final)(July 2012), the design criteria of daily biogas production is 12712 m$^3$/day at sewage flow 170000 m$^3$/day.

The latest design of SWHSTW Expansion is with sewage flow 190000 m$^3$/day. Assume the biogas production is directly proportional to the sewage treated, the projected biogas production

\[
\text{Projected biogas production} = 12712 \times \frac{190000}{170000} = 14207.53 \text{ m}^3/\text{day} = 591.98 \text{ m}^3/\text{hr}
\]

Based on the biogas usage data (From Aug 2011 to Dec 2012) from DSD,

- The biogas production (From Aug 2011 to Dec 2012) = 2139116 m$^3$
- Biogas used for combined heat and power generator (CHP) (From Aug 2011 to Dec 2012) = 1892230 m$^3$
- Biogas used for hot boiler (From Aug 2011 to Dec 2012) = 63746 m$^3$
- Biogas used for biogas burner (BGB) (From Aug 2011 to Dec 2012) = 183140 m$^3$

Assume the percentages of biogas used in different devices of the SWHSTW Expansion are the same as the existing SWHSTW. Since there are only CHP and biogas burner in the SWHSTW Expansion layout plan, the biogas used for hot boiler will be assumed to be used by CHP.

Therefore, the biogas usage of different devices in SWHSTW Expansion:

- Biogas used for CHP in SHWSTW Expansion: \[\frac{591.98 \times (88.46+2.98)}{100} = 541.307 \text{ m}^3/\text{hr}\]
- Biogas used for biogas burner in SHWSTW Expansion: \[\frac{591.98 \times 8.56}{100} = 50.674 \text{ m}^3/\text{hr}\]
Detailed Calculation of NOx, RSP and SO2 Emission from CHP and Biogas burner at SWHSTW Expansion

Estimated biogas used in the CHP = 541.307 m³/hr
Estimated biogas to be flared in biogas burner = 50.674 m³/hr

**NOx Emission**

By considering the similar chemical content of landfill gas and biogas generated from sewage treatment works, and their emission control devices, the emission factor of Table 4.4 of USEPA Air Emission from Municipal Solid Waste Landfills - Background Information for Proposed Standards and Guidelines, March 1991 (EPA-450/3-90-011a) are adopted for biogas.

**Secondary NOx emission from gas turbine (CHP) = 26.4 lb/MM scf LFG**
**Secondary NOx emission from enclosed flare (Biogas burner) = 4.9 lb/MM scf LFG**

Unit Conservation: 1 MM scf = 1000000 scf = 28316.847 scm

* scf = Standard Cubic Foot; scm = Standard Cubic Meter

Therefore,

**Secondary NOx emission from gas turbine (CHP) = 26.4 lb/MM scf LFG**

**Secondary NOx emission from enclosed flare (Biogas burner) = 4.9 lb/MM scf LFG**

Standard Conditions (US standard):

60 °F
= 15.6 °C
= 288.6 K

Assume Biogas at typical ambient temperature:

25 °C
= 298 K

By Ideal gas law, V1/V2 = T1/T2.

1 m³ at 25 °C
= 0.968 scm

Estimated Biogas used in gas turbine (CHP) at Proposed SWHSTW Expansion = 541.307 m³/hr

= 524.151 scm/hr

= 0.146 scm/s

**NOx Emission Rate = 0.062 g/s**

Estimated Biogas used in biogas burner (BGB) at Proposed SWHSTW Expansion = 50.674 m³/hr

= 49.068 scm/hr

= 0.014 scm/s

**NOx Emission Rate = 0.001 g/s**

**RSP Emission**

Similarly, with reference to Table 4.4 of USEPA Air Emission from Municipal Solid Waste Landfills - Background Information for Proposed Standards and Guidelines, March 1991 (EPA-450/3-90-011a):

**Secondary PM(RSP) emission from gas turbine (CHP) = 37.0 lb/MM scf LFG**

**Secondary PM(RSP) emission from enclosed flare (Biogas burner) = Negligible lb/MM scf LFG**

Estimated Biogas used in gas turbine (CHP) at Proposed SWHSTW Expansion = 541.307 m³/hr

= 524.151 scm/hr

= 0.146 scm/s

**RSP Emission Rate = 0.086 g/s**

Estimated Biogas used in biogas burner (BGB) at Proposed SWHSTW Expansion

**RSP Emission Rate = Negligible g/s**

**SO2 Emission**

Assume of the sulphur in the biogas is converted to SO2 in the emission. According to DSD, the typical concentration of H₂S in biogas is 210 ppm.

H₂S concentration in biogas = 210 ppm
Molecular weight (MW) of H₂S = 34
Molecular volume of air = 22.441 L/mol

Concentration of H₂S in biogas at 25°C = 210 ppm x MW /[22.414 x 298/273]/(1000) = 0.292 g/m³

Molecular ratio of H₂S to SO₂ (2 H₂S + 3 O₂ → 2 SO₂ + 2 H₂O) = 1.3
Molecular weight of SO₂ = 64
Mass of SO₂ in emission = 0.549 g/m³

According to the Outline Design Report of SWHSTW Further Expansion - Phase 1 and 2 (Final)(July 2012), the biogas will be desulphurized before being utilized by CHP, therefore

Estimated Biogas used in gas turbine (CHP) at Proposed SWHSTW Expansion

**SO₂ Emission Rate = Negligible g/s**

Estimated Biogas used in biogas burner (BGB) at Proposed SWHSTW Expansion

**SO₂ Emission Rate = 0.008 g/s**
Our Ref.: ADM/E8.1

ARUP

[Attn. Mr. Davis LEE] (Fax: 2683 8383)
(Total 6 pages)

Dear Mr. LEE,

Request for Fuel Consumption Data of NDH

I refer to your letter dated 23 August 2010 regarding the captioned and would like to append the information below:

a. Location and height of chimney
   Please refer to annex 1 &2; and
   Height of chimney is around 64.25 metres.

b. Types and quantity of fuel used
   1,247,742 unit of town gas and 3,190 litres of ultra low sulphur diesel oil were used for boilers and emergency generators in FY 09/10

(c. Temporal profile of the emission
   Please refer to annex 5, 6 and 7.

Yours sincerely,

(Edwin LO)
for General Manager (Admin. Services)
North District Hospital

cc CEDD [Attn. Mr. Joseph LO] (Fax: 2683 3187)
PlanD [Attn. Ms. April KUN] (Fax: 2683 8324)
TITLE: Predicted Annual SO₂ concentration at the selected ASRs

PROJECT: Formation and Servicing in Area 36, Fanling
Key Issue Report - Vol. 1 EIA

RHS Consultants Limited