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Date: 28 August 2013

Report No: 130431r

Terminals Pty Ltd
Gate 38B, 45 Friendship Rd
Port Botany NSW 2036

Emission Testing – August 2013
EPA 4 – Benzene Combustor Inlet/Outlet Testing

Dear Mr G Millard,

Tests were performed 10th August 2013 to determine emissions from the Benzene Combustor Inlet and Outlet at the Port Botany plant of Terminals Pty Ltd.

Yours faithfully
Emission Testing Consultants

David Corbett Ba/BCom
Client Manager

dc@emission.com.au

LICENCE COMPARISON

EPA No.	Location Description	Pollutant	Unit of measure	Licence limit	Test 1 Concentration	Test 1 Concentration (corrected to 3% O_2)	Test 2 Concentration	Test 2 Concentration (corrected to 3% O_2)
4	Benzene Combustor	Solid particles	milligrams per cubic meter (mg/m^3)	50	< 2	< 4	< 2	< 4
		Nitrogen dioxide	milligrams per cubic meter (mg/m^3)	350	54	110	110	210
		Volatile organic compounds (VOCs)	milligrams per cubic meter (mg/m^3)	20	< 0.7	< 2	< 0.7	< 1
		Hydrogen sulphide	milligrams per cubic meter (mg/m^3)	5	< 0.03	< 0.07	< 0.03	< 0.07

Note: All analytes are below the Licence Limit set by the NSW EPA as per licence 1048 (last amended on 6-May-2013). Results for the Benzene Combustor Outlet (stack) have also been corrected to 3% Oxygen as stipulated in Part 3, Schedule 5 of the *Protection of the Environment Operations (Clean Air) Regulation, (NSW)* 2010.

EXECUTIVE SUMMARY

Emission Testing Consultants (ETC) was engaged by Terminals Pty Ltd to perform emission monitoring as required by their NSW EPA Environment Protection Licence (number 1048). Monitoring was performed at 2 locations, twice, for the following parameters:

Discharge point	Selection of sampling positions	Flow rate	Velocity	Temperature	Moisture	**Particulate matter**	Dry gas Density	Molecular weight	**Carbon dioxide (CO2)**	**Oxygen (O2)**	**Carbon monoxide (CO)**	**Nitrogen oxides (NOx) as NO2**	**Sulphur dioxide (SO2)**	**Hydrogen sulphide (H2S)**	**Volatile organic compounds (VOC)**
EPA 4 - Benzene Combustor Outlet	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Benzene Combustor Inlet	✓	✓	✓	✓	✓		✓	✓	✓	✓					✓

Testing commenced approximately half way through the benzene ship discharge period after notification from Terminals Pty Ltd personnel.

The methodologies chosen by ETC are those stipulated by Terminals Pty Ltd Licence (1048). There were no technical issues in terms of sampling on the days of testing. Plant operating conditions have been noted in the report.

RESULTS

Benzene Combustor Inlet (Test 1)

10 August 2013

Flow Results	Measured MW	EPA 4 - Benzene Combustor (Inlet) Test 1130431	
Time of flow test		2100 & 2213	hrs
Stack dimensions at sampling plane		210	mm
Velocity at sampling plane		6.5	m/s
Average temperature		20	°C
Moisture content		< 1	% v/v
Flow rate at discharge conditions		0.22	m³/sec
Flow rate at wet NTP conditions		0.21	m³/sec
Flow rate at dry NTP conditions		0.21	m³/sec
Dry gas density		1.3	kg/m3
Molecular weight of stack gas, dry basis		29	g/g-mole

Volatile Organic Compound (VOC) Results	EPA 4 - Benzene Combustor (Inlet) Test 113043113	**Sampling Times**	**Concentration at NTP**		**Mass rate**	
Hexane		2110-2210	1.8	mg/m3	0.023	g/min
Cyclohexane		2110-2210	1.5	mg/m3	0.019	g/min
n-Butyl Acetate		2110-2210	13	mg/m3	0.16	g/min
Benzene		2110-2210	4,000	mg/m3	51	g/min
Toluene		2110-2210	160	mg/m3	2.0	g/min
m/p-Xylene		2110-2210	6.9	mg/m3	0.088	g/min
Styrene (Vinyl benzene)		2110-2210	2.3	mg/m3	0.030	g/min
o-Xylene		2110-2210	0.85	mg/m3	0.011	g/min
Total VOCs (as n-propane)		2110-2210	2,300	mg/m3	30	g/min

Note: If not listed above, the following compounds were not detected above the analytical range of the instrument. Please contact ETC should you wish to discuss detection limits of specific undetected compounds; Acetone (2-propanone), Propylene Oxide, Acrylonitrile, Methylene Chloride, MEK (2-butanone), Hexane, Ethyl Acetate, 1,2-dichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, Ethyl Acrylate, Trichloroethene (Trichloroethylene,TCE), 1,4-Dioxane, Epichlorohydrin, MIBK (4-methyl-2-pentanone), Toluene, Tetrachloroethene (Perchloroethylene,PCE), n-Butyl Acetate, Chlorobenzene, Ethylbenzene, m/p-xylene, Styrene (Vinyl benzene), o-xylene, Cyclohexanone, Nonane, Isopropylbenzene (Cumene), DIBK (Diisobutyl Ketone), α-Methylstyrene, Decane, Benzyl Chloride (α-chlorotolune), Benzoyl Chloride, Naphthalene, Dodecane

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

EPA 4 – Benzene Combustor Outlet (Test 1)

10 August 2013

Flow Results	Measured MW	EPA 4 - Benzene Combustor (Outlet) Test 1130431	
Time of flow test		2055 & 2215	hrs
Stack dimensions at sampling plane		1010	mm
Velocity at sampling plane		9.5	m/s
Average temperature		771	°C
Moisture content		<1	% v/v
Flow rate at discharge conditions		7.6	m³/sec
Flow rate at wet NTP conditions		2.0	m³/sec
Flow rate at dry NTP conditions		2.0	m³/sec

Volatile Organic Compound (VOC) Results	EPA 4 - Benzene Combustor (Outlet) Test 1130431120	Sampling Times	Concentration at NTP		Concentration at 3% O2		Mass rate	
Hexane		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Cyclohexane		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
n-Butyl Acetate		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Benzene		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Toluene		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Ethybenzene		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
m/p-Xylene		2110-2210	< 0.6	mg/m3	< 1	mg/m³	< 0.07	g/min
Styrene (Vinyl benzene)		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
o-Xylene		2110-2210	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Total VOCs (as n-Propane)		2110-2210	< 0.7	mg/m3	< 2	mg/m³	< 0.09	g/min

Note: In addition to those listed above, the following compounds were not detected above the analytical range of the instrument. Please contact ETC should you wish to discuss detection limits of specific undetected compounds; Acetone (2-propanone), Propylene Oxide, Acrylonitrile, Methylene Chloride, MEK (2-butanone), Hexane, Ethyl Acetate, 1,2-dichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, Ethyl Acrylate, Trichloroethene (Trichloroethylene,TCE), 1,4-Dioxane, Epichlorohydrin, MIBK (4-methyl-2-pentanone), Toluene, Tetrachloroethene (Perchloroethylene,PCE), n-Butyl Acetate, Chlorobenzene, Ethylbenzene, m/p-xylene, Styrene (Vinyl benzene), o-xylene, Cyclohexanone, Nonane, Isopropylbenzene (Cumene), DIBK (Diisobutyl Ketone), α-Methylstyrene, Decane, Benzyl Chloride (α- chlorotolune), Benzoyl Chloride, Naphthalene, Dodecane

Non Isokinetic Sampling Results	EPA 4 - Benzene Combustor (Outlet) Test 1130431120	Sampling Times	Concentration at NTP		Concentration at 3% O2		Mass rate	
Hydrogen sulphide		2105-2206	< 0.03	mg/m3	< 0.07	mg/m3	< 0.004	g/min

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

EPA 4 – Benzene Combustor Outlet (Test 1)

10 August 2013

Continuous Analyser Results EPA 4 - Benzene Combustor (Outlet) Test 1130431120	**Sampling Times**	**Concentration at NTP**		**Concentration at 3% O2**		**Mass rate**	
Oxygen (dry basis)	2115-2214	12.4	% v/v	-		-	
Carbon dioxide (dry basis)	2115-2214	3.6	% v/v	-		-	
Dry gas density	2115-2214	1.3	kg/m3	-		-	
Molecular weight of stack gas, dry basis	2115-2214	29	g/g-mole	-		-	
Nitrogen oxides as NO_2	2115-2214	54	mg/m3	110	mg/m3	6.4	g/min
Sulphur dioxide as SO_2	2115-2214	64	mg/m3	140	mg/m3	7.6	g/min
Carbon monoxide as CO	2115-2214	< 2	mg/m3	< 5	mg/m3	< 0.3	g/min

Isokinetic Sampling Results EPA 4 - Benzene Combustor (Outlet) Test 1130431120	**Sampling Times**	**Concentration at NTP**		**Concentration at 3% O2**		**Mass rate**	
Solid Particles	2105-2210	< 2	mg/m3	< 4	mg/m3	< 0.2	g/min
No. of sampling points			*12*				
Length of sampling, min			*60*				
Stack gas molecular weight, g/g-mole (wet)			*29*				
Stack gas density, kg/m³ at wet NTP			*1.3*				

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

Benzene Combustor Inlet (Test 2)

10 August 2013

Flow Results	Measured MW	EPA 4 - Benzene Combustor (Inlet) Test 2 130431	
Time of flow test		2320 & 0030	hrs
Stack dimensions at sampling plane		210	mm
Velocity at sampling plane		6.6	m/s
Average temperature		20	°C
Moisture content		<1	% v/v
Flow rate at discharge conditions		0.23	m^3/sec
Flow rate at wet NTP conditions		0.22	m^3/sec
Flow rate at dry NTP conditions		0.22	m^3/sec
Dry gas density		1.3	kg/m3
Molecular weight of stack gas, dry basis		29	g/g-mole

Volatile Organic Compound (VOC) Results	EPA 4 - Benzene Combustor (Inlet) Test 2 13043113	**Sampling Times**	**Concentration at NTP**		**Mass rate**	
Hexane		2325-0025	3.3	mg/m3	0.042	g/min
Cyclohexane		2325-0025	3.1	mg/m3	0.040	g/min
n-Butyl Acetate		2325-0025	9.1	mg/m3	0.12	g/min
Benzene		2325-0025	6,900	mg/m3	89	g/min
Toluene		2325-0025	290	mg/m3	3.8	g/min
Ethybenzene		2325-0025	0.35	mg/m3	0.0045	g/min
m/p-Xylene		2325-0025	10	mg/m3	0.14	g/min
Styrene (Vinyl benzene)		2325-0025	3.3	mg/m3	0.042	g/min
o-Xylene		2325-0025	1.3	mg/m3	0.016	g/min
Total VOCs (as n-Propane)		2325-0025	4,000	mg/m3	52	g/min

Note: If not listed above, the following compounds were not detected above the analytical range of the instrument. Please contact ETC should you wish to discuss detection limits of specific undetected compounds; Acetone (2-propanone), Propylene Oxide, Acrylonitrile, Methylene Chloride, MEK (2-butanone), Hexane, Ethyl Acetate, 1,2-dichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, Ethyl Acrylate, Trichloroethene (Trichloroethylene,TCE), 1,4-Dioxane, Epichlorohydrin, MIBK (4-methyl-2-pentanone), Toluene, Tetrachloroethene (Perchloroethylene,PCE), n-Butyl Acetate, Chlorobenzene, Ethylbenzene, m/p-xylene, Styrene (Vinyl benzene), o-xylene, Cyclohexanone, Nonane, Isopropylbenzene (Cumene), DIBK (Diisobutyl Ketone), α-Methylstyrene, Decane, Benzyl Chloride (α-chlorotolune), Benzoyl Chloride, Naphthalene, Dodecane

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

EPA 4 – Benzene Combustor Outlet (Test 2)

10 August 2013

Flow Results	Measured MW	EPA 4 - Benzene Combustor (Outlet) Test 2 130431	
Time of flow test		2320 & 0030	hrs
Stack dimensions at sampling plane		1010	mm
Velocity at sampling plane		11	m/s
Average temperature		866	°C
Moisture content		<1	% v/v
Flow rate at discharge conditions		8.5	m³/sec
Flow rate at wet NTP conditions		2.0	m³/sec
Flow rate at dry NTP conditions		2.0	m³/sec

Volatile Organic Compound (VOC) Results	EPA 4 - Benzene Combustor (Outlet) Test 2 130431120	Sampling Times	Concentration at NTP		Concentration at 3% O2		Mass rate	
Hexane		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Cyclohexane		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
n-Butyl Acetate		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Benzene		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Toluene		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Ethybenzene		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
m/p-Xylene		2325-0025	< 0.6	mg/m3	< 1	mg/m³	< 0.07	g/min
Styrene (Vinyl benzene)		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
o-Xylene		2325-0025	< 0.3	mg/m3	< 0.6	mg/m³	< 0.03	g/min
Total VOCs (as n-Propane)		2325-0025	< 0.7	mg/m3	< 1	mg/m³	< 0.09	g/min

Note: In addition to those listed above, the following compounds were not detected above the analytical range of the instrument. Please contact ETC should you wish to discuss detection limits of specific undetected compounds; Acetone (2-propanone), Propylene Oxide, Acrylonitrile, Methylene Chloride, MEK (2-butanone), Hexane, Ethyl Acetate, 1,2-dichloroethane, Benzene, Carbon tetrachloride, Cyclohexane, Ethyl Acrylate, Trichloroethene (Trichloroethylene,TCE), 1,4-Dioxane, Epichlorohydrin, MIBK (4-methyl-2-pentanone), Toluene, Tetrachloroethene (Perchloroethylene,PCE), n-Butyl Acetate, Chlorobenzene, Ethylbenzene, m/p-xylene, Styrene (Vinyl benzene), o-xylene, Cyclohexanone, Nonane, Isopropylbenzene (Cumene), DIBK (Diisobutyl Ketone), α-Methylstyrene, Decane, Benzyl Chloride (α- chlorotolune), Benzoyl Chloride, Naphthalene, Dodecane

Non Isokinetic Sampling Results	EPA 4 - Benzene Combustor (Outlet) Test 2 130431120	Sampling Times	Concentration at NTP		Concentration at 3% O2		Mass rate	
Hydrogen sulphide		2325-0025	< 0.03	mg/m3	< 0.07	mg/m3	< 0.004	g/min

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

EPA 4 – Benzene Combustor Outlet (Test 2)

10 August 2013

Continuous Analyser Results EPA 4 - Benzene Combustor (Outlet) Test 2 130431120	**Sampling Times**	**Concentration at NTP**		**Concentration at 3% O2**		**Mass rate**	
Oxygen (dry basis)	2329-0028	11.6	% v/v	-		-	
Carbon dioxide (dry basis)	2329-0028	4.2	% v/v	-		-	
Dry gas density	2329-0028	1.3	kg/m3	-		-	
Molecular weight of stack gas, dry basis	2329-0028	29	g/g-mole	-		-	
Nitrogen oxides as NO_2	2329-0028	110	mg/m3	210	mg/m3	13	g/min
Sulphur dioxide as SO_2	2329-0028	99	mg/m3	190	mg/m3	12	g/min
Carbon monoxide as CO	2329-0028	< 2	mg/m3	< 5	mg/m3	< 0.3	g/min

Isokinetic Sampling Results EPA 4 - Benzene Combustor (Outlet) Test 2 130431120	**Sampling Times**	**Concentration at NTP**		**Concentration at 3% O2**		**Mass rate**	
Solid Particles	2320-0025	< 2	mg/m3	< 4	mg/m3	< 0.2	g/min
No. of sampling points		*12*					
Length of sampling, min		*60*					
Stack gas molecular weight, g/g-mole (wet)		*29.1*					
Stack gas density, kg/m ^{3} at wet NTP		*1.3*					

Refer to "SAMPLE PLANE OBSERVATIONS" on page 9.

SAMPLING PLANE OBSERVATIONS

EPA 4 – Benzene Combustor Inlet

The sampling plane had 2 x 4 inch flange port(s). The location was determined to be “ideal” as per AS4323.1. It was more than the required 2 duct diameters upstream from a bend. It was more than the required 6 duct diameters downstream from a junction. The sampling plane passed the flow assessment (items (a) to (f) of AS4323.1) and was therefore “compliant”.

EPA 4 – Benzene Combustor Outlet

The sampling plane had 2 x 4 inch flange port(s). The location was determined to be “ideal” as per AS4323.1. It was more than the required 2 duct diameters upstream from the exit. It was more than the required 6 duct diameters downstream from a junction. The sampling plane passed the flow assessment (items (a) to (f) of AS4323.1) and was therefore “compliant”.

PLANT OPERATING CONDITIONS

Plant operating conditions were supplied by Terminals Pty Ltd personnel. Plant operating conditions were representative of stable operation for the duration of sampling.

Testing was performed during the benzene (BTX) ship loading operation at a time deemed to provide peak load rate.

Test 1 was performed when the Benzene combustor was operating with a combustion zone temperature set point of 790 °C.

Test 2 was performed when the Benzene combustor was operating with a combustion zone temperature set point of 890 °C.

TEST METHODS

The following methods are accredited with the National Association of Testing Authorities (NATA) and are approved for the sampling and analysis of gases unless otherwise stated. Specific details of the methods are available on request.

All sampling and analysis will be conducted in accordance with the test methods (TM) prescribed in NSW EPA's *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales,* Jan 2007 and in accordance with the *Protection of the Environment Operations (Clean Air) Regulation* 2010 unless otherwise specified.

All parameters are reported adjusted to dry NTP conditions unless otherwise stated.

Parameter	Sampling			Analysis			
	NATA	NSW TM Method	Sampling Method	NATA	Analytical Laboratory	Analytical Method	Analytical Laboratory Report Number(s)
Selection of sampling positions	Yes	TM-1	AS4323.1	Yes	NA	NA	130431r
Flow rate	Yes	TM-2	USEPA 2	Yes	NA	NA	130431r
Velocity	Yes	TM-2	USEPA 2	Yes	NA	NA	130431r
Temperature	Yes	TM-2	USEPA 2	Yes	NA	NA	130431r
Moisture	Yes	TM-22	USEPA 4	Yes	NA	NA	130431r
Particulate matter	Yes	TM-15	USEPA 5	Yes	Emission Testing Consultants	USEPA 5	130431r
Dry gas Density	Yes	TM-23	USEPA 3A	Yes	Emission Testing Consultants	USEPA 3A	130431r
Molecular weight	Yes	TM-23	USEPA 3A	Yes	Emission Testing Consultants	USEPA 3A	130431r
Carbon dioxide (CO_2)	Yes	TM-24	USEPA 3A	Yes	Emission Testing Consultants	USEPA 3A	130431r
Oxygen (O_2)	Yes	TM-25	USEPA 3A	Yes	Emission Testing Consultants	USEPA 3A	130431r
Carbon monoxide (CO)	Yes	TM-32	USEPA 10	Yes	Emission Testing Consultants	USEPA 10	130431r
Nitrogen oxides (NO_x) as NO_2	Yes	TM-11	USEPA 7E	Yes	Emission Testing Consultants	USEPA 7E	130431r
Sulphur dioxide (SO_2)	Yes	TM-4	USEPA 6C	Yes	Emission Testing Consultants	USEPA 6C	130431r
Hydrogen sulphide (H_2S)	Yes	TM-5	USEPA 11	Yes	MGT-LabMark Environmental Pty Ltd	USEPA 11	389203-A
Volatile organic compounds (VOC)	Yes	TM-34	USEPA 18	Yes	SGS Australia Pty Ltd	AN467	63138

DEFINITIONS

The following symbols and abbreviations are used in test reports:

BSP	British standard pipe.
Concentration	Mass of analyte per cubic metre expressed at NTP dry conditions (ng, µg or mg/m^3).
Flow rate at discharge conditions	Volume of gas flow per unit time expressed at discharge temperature, pressure and moisture content (m^3/min).
Flow rate at wet NTP conditions	Volume of gas flow per unit time expressed at 0°C, an absolute pressure of 101.325 kPa and discharge moisture content (m^3/min).
Flow rate at dry NTP conditions	Volume of gas flow per unit time expressed at 0°C, an absolute pressure of 101.325 kPa and 0% moisture content (m^3/min).
Mass rate	Mass of analyte per unit time (µg, mg or g/min).
Moisture content	Percentage of gaseous moisture in the gas expressed on a volume / volume percentage basis. This does not include moisture in the gas stream that is in the liquid phase (free moisture).
NA	Not applicable.
NTP	Normal temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified.
ppm	Parts per million expressed on a volume / volume wet basis.
Sampling plane	Location at which measurements were conducted.
Velocity	Gas velocity expressed at discharge temperature, pressure and moisture content (m/s)
VOC	Any chemical compound based on carbon in the boiling range 36 to 126°C, with a vapour pressure of at least 0.010kPa at 25°C (or having a corresponding volatility under the particular conditions of use) that adsorb onto activated charcoal and desorb into CS_2, or that can be collected in a tedlar bag and be quantitatively recovered, and that are detected by GCMS. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are CO, CO_2, carbonic acid, metallic carbides and carbonate salts.
>	Greater than.

<	Less than the minimum limit of detection using the specified method.
~	Approximately.

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