UTM
UNIVERSITI TEKNOLOGI MALAYSIA

STUDY ON EFFECTIVENESS OF COMMERCIAL AND RESIDENTIAL NATURAL GAS ODORISATION SYSTEM IN PENINSULAR MALAYSIA

MEASUREMENT RESULTS METHODOLOGY AND OUTCOMES

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ST Office

Maximum Theoretical Odorant Injection Calculation

Natural gas supply capacity as provided by GMB for;

i. Serdang Station , QNG = 700,000 SCMD (Standard Cubic Meter per Day) or Sm^3/day
ii. Glenmarie Station , QNG = 85,000 SCMH (Standard Cubic Meter per Hour) or 2,040,000 Sm^3/day

$$Q_o = \frac{(Q_{NG})(C_o)}{(24)(60)(1000)(SG)} \quad \ldots\ldots\ldots \frac{ml}{min}$$

Odorant injection rate;

Where,

Qo = maximum odorant injection rate (ml/min)
Co = desired odorant injection concentration (mg/Sm3)
Q_{NG} = natural gas flow rate (SCMD)
SG = specific gravity of odorant

Maximum Theoretical Odorant Injection Calculation

Table 4.1: Maximum Theoretical Odorant Injection Rate

Station	Q_o	
	(mL/min)	(Liter/day)
Serdang	2.98	4.29
Glenmarie	8.68	12.5

Table 4.2: Actual Odorant Injection Rate

Station	Odorant Line Pressure	Odorant Dripping Rate	
	(psig)	(ml/min)	(Liter/day)
Serdang	~240	~ 5.96	~ 8.58
Glenmarie	~ 580 - 725	~ 16-20	~ 23-28.8

- Comparison of the theoretical and actual flow rates of the odorant injected at both Glenmarie, Shah Alam and Serdang stations seem to indicate that the current odorant injection is 100 % in excess.
- Thus, it can be concluded that the current odorant concentration in the gas is extremely sufficient to provide adequate odour smell to the gas.

Measurement Methods: SEWERIN EX-TEC OD 4

- The sensor is filled with a liquid (electrolyte), which makes it very sensitive to high temperatures. The unit only allow a maximum storage temperature of 40 °C.
- Electrochemical processes constantly take place inside the measurement cell, requiring the EX-TEC OD 4 to be permanently supplied with battery power at an adequate voltage.
- The EX-TEC OD 4 measures the concentration in mg/m^3 of Tertiary-Butyl Mercaptan (TBM) in natural gas main stream.
- It requires a special sampling hose/tube according to required sampling pressure.
- The unit is having a threshold reading of 3.8 mg/m^3 which is equivalent to 1 % of natural concentration in air.

Measurement Methods: SEWERIN EX-TEC OD 4

Figure 4.2: EX-TEC OD4 Site Measurement

Figure 4.1: SEWERIN EX-TEC OD4 Main Unit

Measurement Methods: LENGTH OF STAIN TUBE

- The use of length of stain tube to instantaneously detect the presence of mercaptans in the fuel gases is largely elaborated in Section 3 by the ASTM D1988 – "Standard Test Method for Mercaptans in Natural Gas Using Length-of-Stain Detector Tubes".
- The length of stain tube selected to operate by respectively measure the concentration (mg/m3) of Tert-Buthyl Mercaptan (TBM) and Dimethyl-Sulfide (DMS) in natural gas. It requires a special sampling hose/tube according to required sampling pressure.
- Both types of odorants are measured separately using different type of tubes having similar physical dimension.
- In order to record the measured value of odorant, the demarcation of colour changes of the chemical is carefully observed and cross-referred to the outside scales located at the tube surface right at the very front of the tube.

Measurement Methods: LENGTH OF STAIN TUBE

Figure 4.3: Length of Stain Tubes and GASTEC Precision Pump

Measurement Methods: LENGTH OF STAIN TUBE

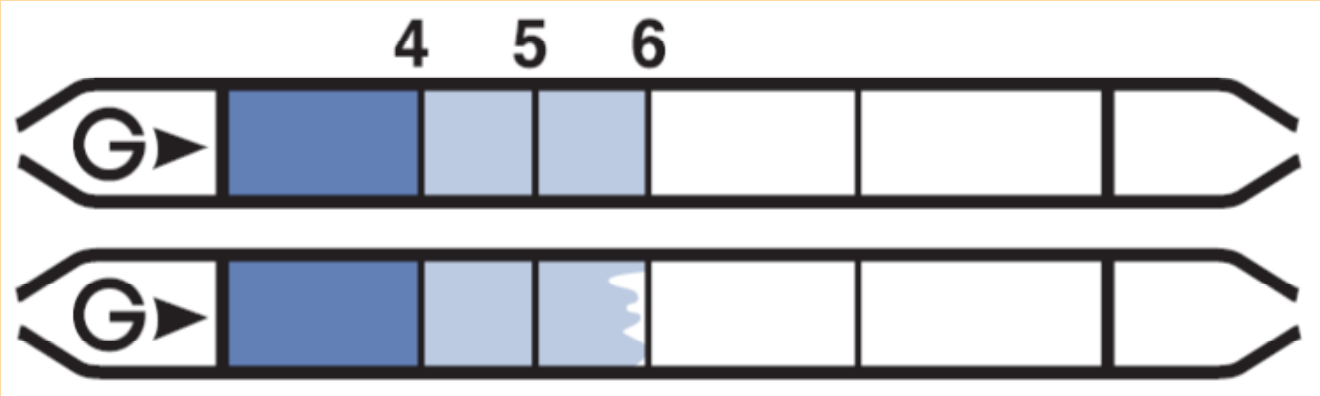
Figure 4.3: Length of Stain Tubes Apparatus

Measurement Methods: LENGTH OF STAIN TUBE

Figure 4.5: Pump Intake Stroke for Gas Sampling Measurement

Measurement Methods: LENGTH OF STAIN TUBE

- When the end of the colour change is slanted, read the value in the middle of the slanted portion of the slant. In this exaggerated example, the reading should be 5, which is in the middle of 4 and 6.



- When the demarcation of the colour change layer is pale, read the value in the middle between the dark layer end and the pale layer end. In this exaggerated example, the reading should be 5, which is in the middle between 4 and 6.

Measurement Methods: ODORATOR

- The odorator reading to percentage of natural gas concentration in air is available based on information provided by the manufacturer.
- The odorator mixes natural or propane gas with air in concentrations from zero to approximately 2 % for natural gas or 1 % for propane.
- The operator slowly opens the linear flow metering valve which allows the sample gas to enter the instrument, while at the same time sniffing the blower output with his nose placed close to the exhaust port.
- The use of such equipment highly relies upon sensitivity and skills of the odorator operator.
- When odorant in the exhaust flow is detected, the operator simply depresses the "read" button to observe the percentage of gas concentration on the digital display.

Measurement Methods: ODORATOR

Figure 4.6: The "Smelling" Process of Odorator for Gas Detection

Figure 4.7: Odorator for Gas Detection Control and Monitoring Console

Sites Selection and Their Categories

Criteria	Sampling location	Notes/ Comments
High Storey Apartment/ Condominium	Hampshire Park Condominium, Ampang Park	Block A : 30 floors Block B : 30 floors
	Hijauan Kiara Condominium, Mount Kiara	Block B : 26 floors Block C : 29 floors
	Harmony Putra Flat, Putrajaya	Block C : 13 floors
	Smart Home Condominium, Cyberjaya	Block A2 : 12 floors
Medium Storey Apartment/ Condominium	D'Melor Condominium	Block A : 4 floors
	Hijauan Kiara Condominium, Mount Kiara	Block G : 6 floors
Commercial Building	Berjaya Times Square (BTS)	Food Court (4th flr. & Ground Level)
	Solaris Mount Kiara Shoplots	Occupied and vacant lots
	Alamanda Shopping Complex Shoplot	
	Giant Kelana Jaya	
Industry	SGL CARBON Company	
	F&N Industries	
	DEWINA Food Ind. - SS	
	PARAGON CARPET Manufacturer	
Others	Kelab Golf Negara Subang, Kelana Jaya	
	Mines Resort	

New Sites Sampling Locations

Location	Sampling Point	Comments
Corrus Hotel	Service Station	13.5 m^3/hr
Intercontinental Hotel	Commercial station	115 m^3/hr
Sheraton Imperial Hotel	Commercial station	9 m^3/hr
Taiko Condominium	Regulating station	NA
Kirana Condominium	Service Station	NA
Kuarter Kastam Diraja, Kelana Jaya	Area Station	NA

Data Analysis: Gas Consumption Rate

Place / Location		Consumption rate		Data Source
Hampshire Park (HP) Condominium	Block B	Not Available		Not able to trace
Hijauan Kiara (HK) Condominium	Block B	Ave. = 5.08 m^3/month	Ave. = 6 m^3/month (0.0083 m^3/h)	HK Management
	Block C	Ave. = 6.9 m^3/month		
	Block G	Ave. = 5.67 m^3/month		
Single Storey House	SSH1-PRES. 9	1. 125 m^3/hr		Site Measurement (Meter clocking)
Solaris Mount Kiara	SMK-SHOP2 (Halal Meat Restaurant)	3.273 m^3/hr		Site Measurement (Meter clocking)
Berjaya Times Square (BTS)	BTS-FC-LG (Food Court – Lower Ground)	2.835 m^3/hr		Site Measurement (Meter clocking)
Times Publishing Service Station	SS-TIMES	~ 17 – 20 m^3/hr		Site Measurement (Meter clocking)
Kelab Golf Negara Subang District Station	DS-KGNS	~ 11 m^3/hr		Site Measurement (Meter clocking)
F & N Industries, Petaling Jaya	SS-PJ F&N IND.	~ 515m^3/hr		Site Measurement (Meter clocking)
SGLC, Banting	SS-SGLC	~ 70 m^3/hr		Site Measurement (Meter clocking)
Carpet Manufacturer	SS-Paragon	~ 70 m^3/h		Site Measurement (Meter clocking)
Alamanda District Station	DS-ALAMANDA	3600 SCMH		GMSB

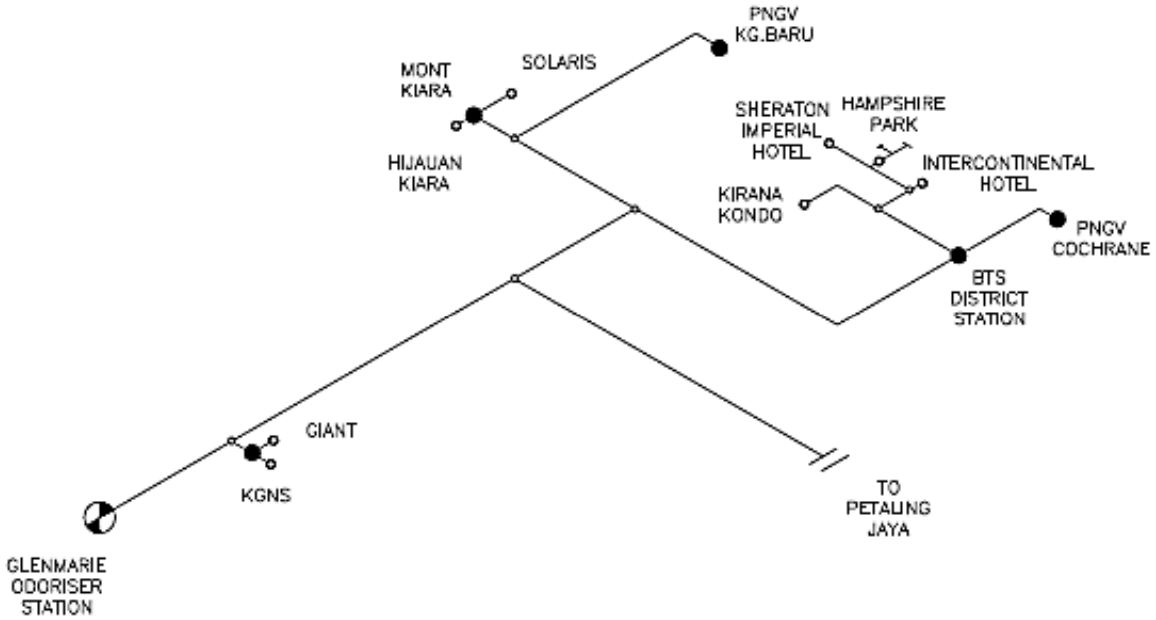
Glenmarie odorisation Station Network: Sampling Locations

Place	Sampling Location	Notation	Note/ Comment
Berjaya Times Square (BTS)	District Station	DS-BTS-AM	Morning reading (~ 11 am)
	District Station	DS-BTS-PM	Evening reading (~7pm)
	Service Station	SS-BTS	
	Food Court, Level 4	BTS-FC-L4	
	Food Court, Ground Level	BTS-FC-LG	(~ 2.835 m^3/hr)
	Service Station	SS-HK	Active customer (Data provided by the management for the month of Feb. 2012) Block B – 13 (average consumption = 5.08 m^3/month) Block C – 17 (average consumption = 6.9 m^3/month) Block G – 4 (average consumption = 5.67 m^3/month)
Hijauan Kiara (HK) Condominium/ Apartment	Block B, Level 26	HK-B-L26	
	Block B, Level 13	HK-B-L13	
	Block B, Level 1	HK-B-L1	
	Block C Level	HK-C-L29	
	Block C, Level	HK-C-L1	
	Block G Level 6	HK-G-L6	
	Block G, Level	HK-G-L1	
Solaris Mount Kiara (SMK) Commercial/ Shoplots	Service Station	SS-SMK	
	Shop 1 (SHOP1)	SMK-SHOP1	Unoccupied lot (pipe not in use)
	Shop 2 (SHOP2)	SMK-SHOP2	Meatwork Halal Restaurant (~ 3.273 m^3/hr)

Glenmarie odorisation Station Network: Sampling Locations

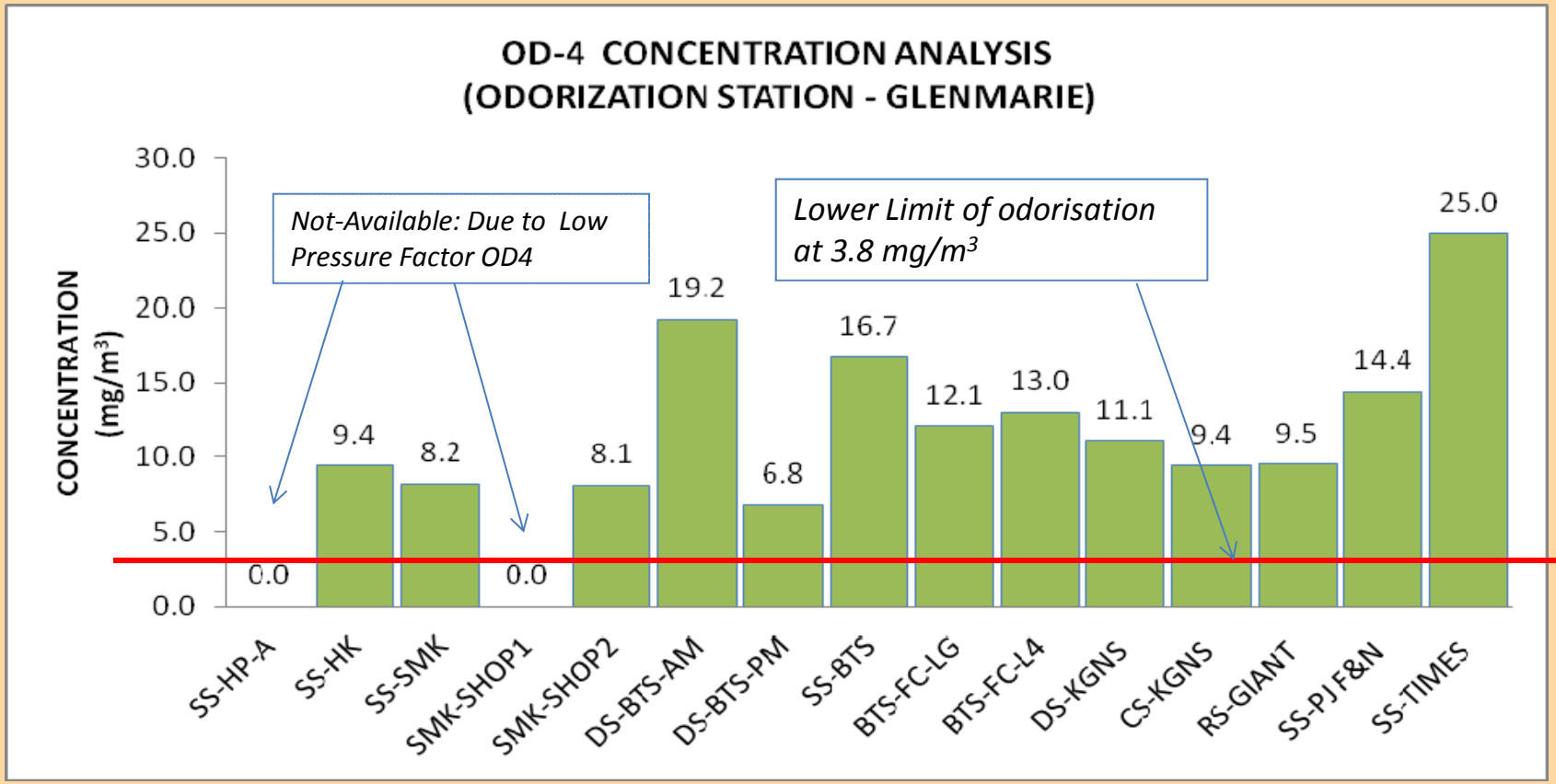
Place	Sampling Location	Notation	Note/ Comment
Hampshire Park (HP) Residence	Service Station (SS)	SS-HP	Only DMS detected, not TBM
	Block A, Level 5 (A-L5)	HP-A-L5	OD_4 not measured due to unavailable low pressure (i.e. 3 kPa) test hose
	Block B, Level 1 (B-L1)	HP-B-L1	
	Block B, Level 4 (B-L4)	HP-B-L4	
	Block B, Level 16 (B-L16)	HP-B-L16	
	Block B, Level 30 (B-L30)	HP-B-L30	
	Block B, Level 4 @STOVE, APT. 3-03	HP-B-L4-APT	Low flow & very low DMS-like smell
Times Publishing	Service Station (SS)	SS-TIMES	Direct from odorisation Station; ~ 17 – 20 m^3/hr
Kelab Golf Negara Subang (KGNS), Kelana Jaya	District Station (DS)	DS-KGNS	~ 11 m^3/hr
Kelab Golf Negara Subang (KGNS), Kelana Jaya	Commercial Station (CS)	CS-KGNS	From KGNS-DS
Giant, Kelana Jaya	Regulating Station (RS)	RS-GIANT	From KGNS-DS
F & N Industries , Petaling Jaya	Service Station (SS)	SS-PJ F&N IND.	Direct from odorisation Station; ~ 515 m^3/hr

Glenmarie odoriser Station: Site Measurement Mapping Layout

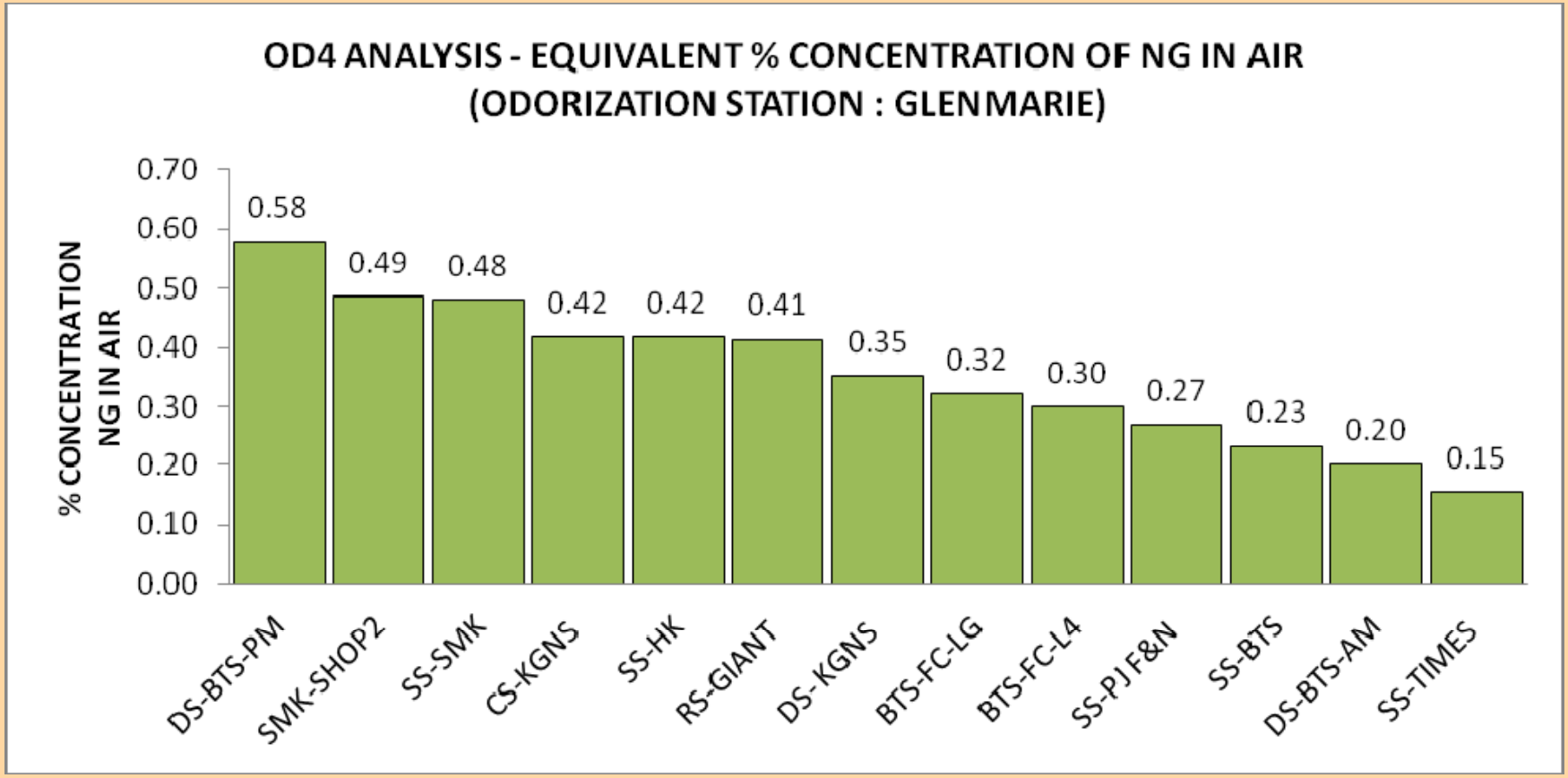


LEGEND	
●	DISTRICT STATION
○	SERVICE STATION
◐	ODORISER STATION
TEST POINT	
LOCATION	CATEGORY
BERJAYA TIME SQUARE	COMMERCIAL
KIRANA KONDO	RESIDENTIAL HIGH RISE BUILDING
INTERCONTINENTAL HOTEL	COMMERCIAL
HAMPSHIRE PARK	RESIDENTIAL HIGH RISE BUILDING
SHERATON HOTEL	COMMERCIAL
HIJAUAN KIARA	RESIDENTIAL HIGH RISE BUILDING
SOLARIS	COMMERCIAL

TBM Concentration Analysis Using OD4



Equivalent Percentage Concentration of Natural Gas in Air at Various Sampling Points Using OD4



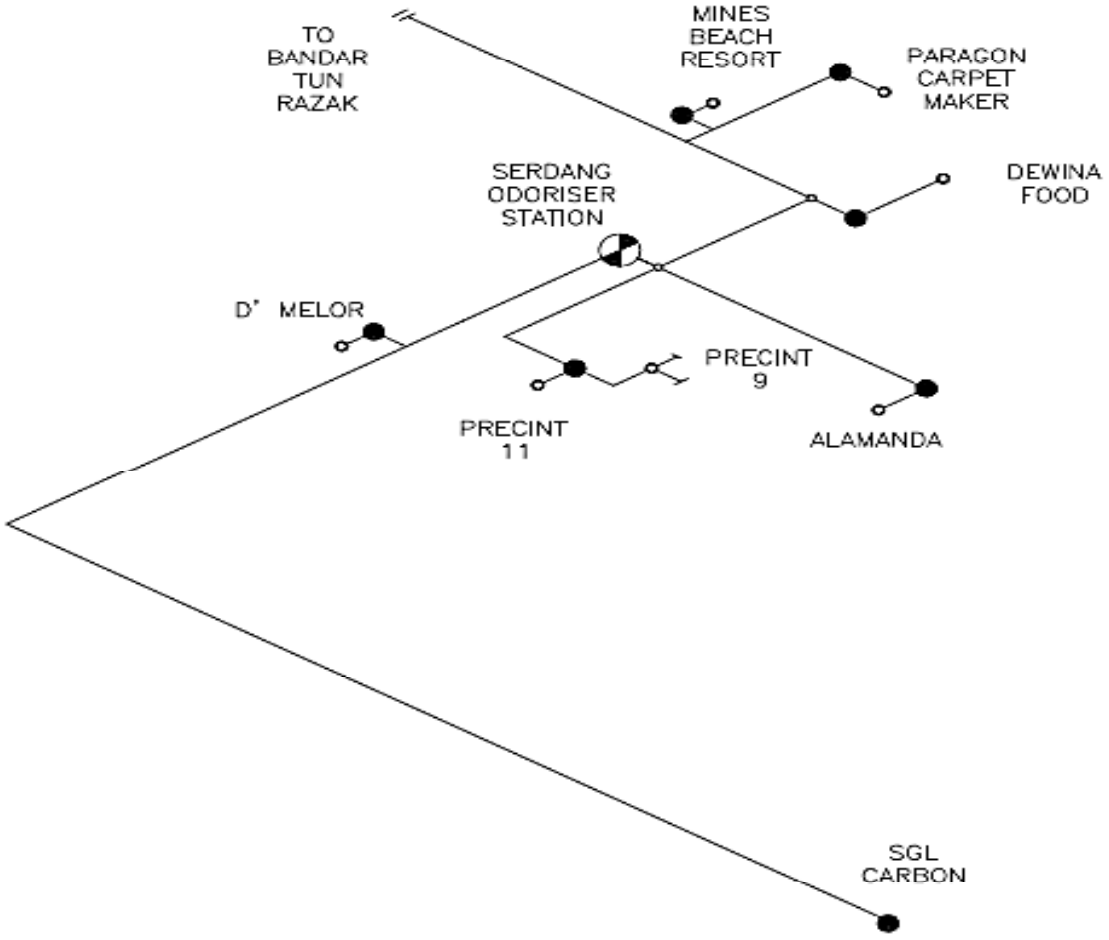
Serdang odorisation Station Network: Sampling Locations

Place	Sampling Location	Notation	Note / Comment
	Alamanda District Station	DS-ALAMANDA	
	Alamanda Shopping Complex Regulating Station	RS-ASC	
	Presint 15, Area Station	AS-PRES. 15	
	Manhattan Fish Market Kitchen	ASC-FS	
	Presint 9, Area Station	AS-PRES. 9	
Putrajaya	Single Storey House (21 Jln P9D/2 , Presint 9)	SSH1-PRES. 9	The only user at this street
	Single Storey House (7 Jln P9D/3, Presint 9)	SSH2-PRES. 9	Only 2 users at this street
	Flat, Presint 9 (Putra Harmony - Block C1-L11)	PHF-C-L11-PRES.9	Only 2-3 gas meters installed at this level
	Flat, Presint 9 (Putra Harmony - Block C1-L6)	PHF-C-L6-PRES.9	
	Flat, Presint 9 (Putra Harmony - Block C1-L1)	PHF-C-L1-PRES.9	Only 5 gas meters installed at this level
	Area Station 3 – Presint 11C	AS-PRES. 11C	Very few customers < 10 ; Pipe age ~ 1-3 yrs
	Single Storey House, Presint 11 (47 Jln P11 C/14, Presint 11)	SSH1-PRES. 11	
	Single Storey House, Presint 11 (11 Jln P11 C/14, Presint 11)	SSH2-PRES. 11	

Serdang odorisation Station Network: Sampling Locations

	Service Station	SS-SHC	
Cyberjaya (Smart Home Condominium)	Smart Home Condo-Block A3-Level 11	SHC-A3-L11	Odorant detected after 3-5 minutes of continuous purging ; OD_4 detected increased concentration while purging & rapidly decreased concentration when purging stopped.
	Smart Home Condo-Block A3-Level 6	SHC-A3-L6-WOP	WOP – Measurement without purging
	Smart Home Condo-Block A3-Level 6	SHC-A3-L6-PIP	PIP – Measurement while purging
	Smart Home Condo-Block A3-Level 6	SHC-A3-L6-PS	PS – Measurement at the end of purging
Cyberjaya (Four-Storey D'Melor Condo-Condominium)	Area Station	AS-DMC	
	Level 2	DMC-L2	
	Lower ground	DMC-LG-WOP	WOP – Measurement without purging
	Lower ground	DMC-LG-PS	PS – Measurement after purging
Cyberjaya	Vacant Shoplot	VS-CJAYA-PS	PS – Measurement at the end of purging
Banting	Service Station SGL CARBON Company	SS-SGLC	~ 70 m^3/h ; End point consumer of Serdang Odo. Station; Sampling pressure ~ 1.5bar
Bangi	Service Station D100 – Dewina Food Ind.	SS-Dewina	
Balakong	Service Station – Paragon Carpet	SS-Paragon	End point consumer of Cheras Ind. Estate; ~ 70 m^3/h
Serdang	Commercial Station – Mines Resort	CS-Mines	

Serdang odoriser Station: Site Measurement Layout Mapping



LEGEND	
●	DISTRICT STATION
○	SERVICE STATION
◐	ODORISER STATION
TEST POINT	

LOCATION	CATEGORY
SGL CARBON	INDUSTRIAL
PARAGON CARPET MAKER	INDUSTRIAL
DEWINA FOOD S/B	INDUSTRIAL
MINES BEACH RESORT	COMMERCIAL
ALAMANDA	COMMERCIAL
PRECINT 9	RESIDENTIAL HIGH RISE BUILDING
D'MELOR	RESIDENTIAL MEDIUM RISE BUILDING
PRECINT 9	RESIDENTIAL TERRACE HOUSE
PRECINT 11	RESIDENTIAL TERRACE HOUSE

TBM Concentration at Various Sampling Points Using OD4

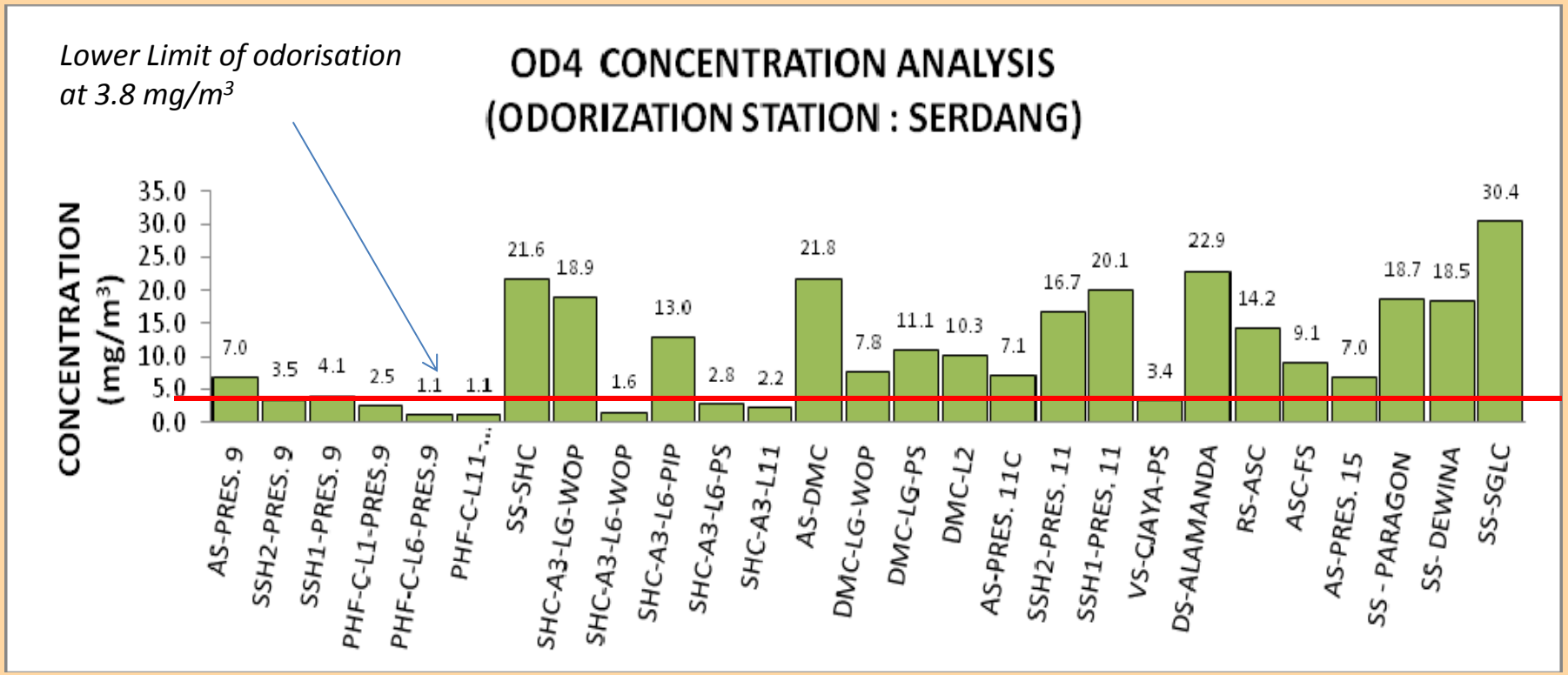


Table 5.9: Simulated Gas Flow Conditions

Flow Conditions	Description of Sampling	Notation	Interpretation
Stagnant flow	Immediate sampling at gas source point without disturbing gas flow.	WOP	Without Purging
Active gas consumption	Sampling at gas source point while gas constantly purged.	PIP	Purging In Progress
Immediate after stop of operation	Immediate sampling after the purging process stop.	PS or AP	Purging Stop of After Purging
Post gas consumption	Sampling at gas source point immediate after purging. Usually sampling period is about 4.5 minutes or longer	AP	Reading recorded immediately after purging stopped
		AP - 4.5 or APS -4.5	Reading recorded with sampling time of 4.5 minutes after purging stopped
		AP – 9 or APS - 9	Reading recorded with sampling time of around 9 minutes after purging stopped

Table 5.10: Comparison of Odorant Concentration

Location	Sampling Location	July' 12			Sept' 12	
		OD4			OD4	
		mg/m^3	% NG		mg/m^3	% NG
KLANG VALLEY						
BERJAYA TIMES SQUARE	DS-BTS	19.2	0.20		22.7	0.17
	SS-BTS	16.7	0.23		23.4	0.17
SS-CORRUS HOTEL	SS-CH				26.5	0.15
RS-TROIKA CONDO	RS-TC				23.4	0.17
CS-INTERCONTINENTAL HOTEL	CS-INTH				20.1	0.19
CS- SHERATON IMP HOTEL	CS-SIH				23.4	0.17
SS-KIRANA CONDO	SS-KC				21.5	0.18
HIJAUAN KIARA	SS-HK	9.4	0.42		16.9	0.23
SOLARIS MONT KIARA	SS-SMK	8.2	0.48		21.2	0.18

Table 5.10: Comparison of Odorant Concentration

Location	Sampling Location	July' 12			Sept' 12	
		OD4			OD4	
		mg/m^3	% NG		mg/m^3	% NG
PUTRAJAYA						
ALAMANDA	DS-ALAMANDA	22.9	0.17		29.6	0.13
RS-ALAMANDA SHOPPING COMPLEX	RS-ASC	14.2	0.27			
AS-PRESINT 9	AS-PRES. 9	12.5	0.31			
	AS-PRES. 9-WOP				7.1	0.56
	AS-PRES. 9-AP				12.7	0.31
PRESINT 11	AS-PRES. 11	6.1	0.64			

Table 5.10: Comparison of Odorant Concentration

Location	Sampling Location	July' 12			Sept' 12	
		OD4			OD4	
		mg/m^3	% NG		mg/m^3	% NG
PRESINT 15	**AS-PRES. 15**	**7.0**	**0.56**			
	AS-PRES. 15-WOP				4.4	0.87
	AS-PRES. 15-AP-4.5 MIN				20.9	0.19
	AS-PRES. 15-AP-9 MIN				17.3	0.22
CYBERJAYA						
CYBERJAYA	SS-SHC	21.6	0.18			
CYBERJAYA	AS-DMC	21.8	0.18		28	0.14
CYBERJAYA	RS-LTC				29.3	0.13

Table 5.10: Comparison of Odorant Concentration

Location	Sampling Location	July' 12			Sept' 12	
		OD4			OD4	
		mg/m^3	% NG		mg/m^3	% NG
PETALING JAYA & KELANA JAYA						
PETALING JAYA	SS-TIMES	25.0	0.15			
PERTALING JAYA	SS-PJ F&N	14.4	0.27			
AS- KASTAM KELANA JAYA	AS-KDR				19.8	0.20
KELANA JAYA	CS-KGNS	9.4	0.42			
	RS-GIANT	9.5	0.41			
	DS-KGNS	11.1	0.35			
	RS-ASC	14.2	0.27			
OTHERS						
BANGI	SS- DEWINA	18.5	0.21			
BANTING	SS-SGLC	30.4	0.13			

Table 5.11: Comparison of Odorant Concentration Level at Hampshire Park

Location	Sampling Location	July' 12			Sept' 12	
		OD4			OD4	
		mg/m^3	% NG		mg/m^3	% NG
KLANG VALLEY						
HAMPSHIRE PARK	SS-BLK B	NT	-			
	SS-BLK B- WOP				>100	-
	SS-BLK B - AP - 1^{ST}				9.1	0.43
	SS-BLK B - AP - 2^{ND}				6.8	0.58
	SS-BLK B - AP - 3^{RD}				5.2	0.75

Table 5.12: Comparison of Odorant Concentration Level at Hampshire Park

JULY. 2012				SEPT. 2012			
Sampling Pressure (kPa)	Sampling location	mg/m^3	% NG in Air	Sampling location	mg/m^3	% NG in Air	% TBM DECAYED
3	HP-A-L5	NT	-	HP-A-L5	3.6	1.05	60.4
				HP-A-L31	3.2	1.18	64.8
3	HP-B-L1	NT	-	HP-B-L1	7.7	0.51	15.4
3	HP-B-L16	NT	-	HP-B-L16	5.7	0.69	37.4
3	HP-B-L30	NT	-	HP-B-L30	4.5	0.86	50.5
3	HP-B-L4	NT	-				
3	HP-B-L4-APT						

ODORIZATION CONCENTRATION OBSERVATION: HAMPSHIRE PARK

- The exercise conducted for the purpose of verification of the preliminary site measurement of the odorization level had enabled to derive the following analysis:
- Significant difference of TBM readings at service station was recorded between the first and second round measurements.
- TBM was not detected during the first round measurement.
- TBM was moderately detected at second round measurement; nevertheless, the levels moderately surpassed the threshold limit (3.8 mg/m^3)
- Again, the important effect of height of sampling points, i.e. pipe gas elevation, on the odorant concentration levels was observed, i.e. odorant concentrations decreased with increasing elevation
- Percentage of odorant loss was high (with respect to TBM reading at service station) and proportionate with the height of the sampling source.

Table 5.13: Comparison of Odorant Concentration Level at Hijauan Kiara

JULY. 2012				SEPT. 2012			
Sampling Pressure (kPa)	Sampling location	mg/m^3	% NG in Air	Sampling location	mg/m^3	% NG in Air	% TBM DECAYED
30	SS-HK	9.4	0.42	SS-HK	16.9	0.23	REFERENCE
3	HK-BLK B-L1	NT	-				
				HK-B-L1-WOP	2.7	1.39	84.0
				HK-B-L1-AP-MAX	4.4	0.87	74.0
				HK-B-L1-AP-4 MIN	3.6	1.05	78.7
3	HK-BLK -L13	NT	-				
				HK-B-L13-AP-MAX	3.3	1.15	80.5
				HK-B-L13-AP-4MIN	2.7	1.39	84.0
30	HK-BLK B-L26	NT	-				
				HK-B-L26-WOP	2.3	1.63	86.4
				HK-B-L26-AP-MAX	3.5	1.08	79.3
				HK-B-L26-AP-4MIN	2.8	1.34	83.4
3	HK-BLK C-L1	NT	-				
				HK-C-L1-WOP	6.9	0.57	59.2

Table 5.13: Comparison of Odorant Concentration Level at Hijauan Kiara

JULY. 2012				SEPT. 2012			
Sampling Pressure (kPa)	Sampling location	mg/m^3	% NG in Air	Sampling location	mg/m^3	% NG in Air	% TBM DECAYED
3	**HK-BLK C-L29**	**NT**	**-**				
				HK-C-L29-WOP	2.6	1.44	84.6
				HK-C-L29-AP	3.5	1.08	79.3
3	HK-BLK G-L1	NT	-				
				HK-G-L1-WOP	2.3	1.63	86.4
				HK-G-L1-AP-MAX	4.0	0.96	76.3
				HK-G-L1-AP-4MIN	3.0	1.26	82.2
30	HK-BLK G-L6	NT	-				
				HK-G-L6-WOP	3.3	1.15	80.5

Table 5.14: Odorant Concentration Level at Kirana Condominium (New Site)

SEPT. 2012				
Sampling Pressure (kPa)	Sampling location	mg/m^3	% NG in Air	% TBM DECAYED
30	SS-KC	22.8	0.17	REFERENCE
3	KC-L1	21.7	0.18	4.8
3	KC-L10	21.5	0.18	5.7
3	KC-L20-WOP	1.3	2.76	94.3
3	KC-L20-AP	4.0	0.96	82.5

Table 5.17: Odorant Concentration Level at Smart Home Condominium

JULY. 2012				
Sampling Pressure (kPa)	Sampling Location	mg/m^3	% NG in Air	% TBM DECAYED
3	SS-SHC	21.6	0.18	REFERENCE
3	SHC-A3-LG-WOP	18.9	0.20	12.50
3	SHC-A3-L6-WOP	1.6	2.31	92.59
3	SHC-A3-L6-PIP	13	0.30	39.81
3	SHC-A3-L6-PS	2.8	1.34	87.04
3	SHC-A3-L11-AP	2.2	1.70	89.81

Table 5.18: Odorant Concentration Level at Smart Home Condominium

JULY. 2012				
Sampling Pressure (kPa)	Sampling Location	mg/m^3	% NG in Air	% TBM DECAYED
3	AS-DMC	21.8	0.18	REFERENCE
3	DMC-BLK A - LG-WOP	7.8	0.51	64.22
3	DMC-BLK A - LG-PS	11.1	0.35	49.08
3	DMC-BLK A - L2	10.3	0.38	52.75

Table 5.19: Odorant Concentration Level at Kuater Kastam Diraja, Kelana Jaya (New Site)

SEPT. 2012			
Sampling location	mg/m^3	% NG in Air	% TBM DECAYED
AS-KDR	19.8	0.20	REFERENCE
KDR-BLK A-LG-RISER-WOP	0.6	4.57	96.97
KDR-BLK A-LG-RISER-AP	9.2	0.43	53.54
KDR-BLK A-LG-RISER-APS-4.5	4.4	0.87	77.78
KDR-BLK A-LG-RISER-PIP	17.4	0.22	12.12
KDR-BLK A -LG-RISER-APS-4.5	9.8	0.40	50.51
KDR-BLK A-L6	0.3	5.86	98.48
KDR-BLK B-LG-WOP	1.2	2.95	93.94
KDR-BLK B-LG-PIP	15.1	0.26	23.74
KDR-BLK B-LG-APS-4.5	7.6	0.52	61.62
KDR-BLK B-L6-WOP	0.4	5.38	97.98

Table 5.20: Odorant Concentration at Various Commercial Sites in July 2012

JULY. 2012			
Sampling Location	mg/m^3	% NG in Air	% TBM DECAYED
RS-ASC	14.2	0.27	REFERENCE
ASC-FS	9.1	0.43	35.9
SS-BTS	16.7	0.23	REFERENCE
BTS-FC-L4	13.0	0.30	22.2
BTS-FC-LG	12.1	0.32	27.5
SS-SMK	8.2	0.48	REFERENCE
SMK-SHOP1-RISER	NT	-	
SMK-SHOP2	8.1	0.49	1.2

Table 5.20: Odorant Concentration at Various Commercial Sites in September 2012

SEPT. 2012				
Sampling Location	mg/m^3	% NG in Air	% TBM DECAYED	Note
RS-LTC	29.3	0.13	REFERENCE	
CJAYA-SHOP2	5.5	0.71	81.2	Vacant Lot
CJAYA-SHOP3	29	0.13	1.02	0.29 m^3/hr
SS-SMK	21.2	0.18	REFERENCE	
SMK-SHOP2	20.0	0.19	5.66	
SMK-SHOP3-WOP	3.4	1.11	83.96	Vacant Lot near SMK-SHOP2
SMK-SHOP3-AP-MAX	8.7	0.45	58.96	
SMK-SHOP3-APS-4 MIN	3.6	1.05	83.02	

Site Measurement Conclusion

From preliminary site measurements (conducted in July, 2012 and September, 2012) at selected sampling locations along Serdang and Glenmarie distribution lines, few factors have been predominantly identified to have caused the quality of natural gas odorization:.

- ***Gas Flow or/and Consumption Rates***
- At gas stations gas flow is much higher as compared to the locations at commercial and residential premises. Furthermore, the gas service, commercial and regulation stations are located adjacent to the district station which receives gas supply from pipeline directly connected to the odorization station. Higher gas flow means less gas contact time with pipe wall and thus minimizing factors contributing to odorant losses such as adsorption and oxidation.
- In addition, distribution pipe lines which are in intermittent service may experience a non-equilibrium condition in which excessive odorant is adsorbed on the pipeline walls resulting in loss of vapor phase odorant concentration.

Altitude Position of Pipeline (i.e. Vertical /Horizontal Distribution Pipeline)

- Low gas consumption rates at higher floors of the high-rise residential building would result in further odorant fade due to buoyancy effect.
- The specific gravities (air =1) of natural gas, TBM and DMS are around ~ 0.6, ~ 3.1 and ~ 2.1, respectively. This means TBM and DMS are 3.5 to 5 times heavier natural gas and TBM is ~ 1.5 times heavier than DMS. Under very low or flow stagnation condition the gravitational effect would cause more TBM to settle at ground level as compared to DMS. This might explains the reason for the presence of or higher DMS concentrations at certain lower gas flow of higher altitude location.
- Vertical distribution lines with intermittent gas flow or passive/dead end lines (where no gas is ever used and the flow is stagnant) experience more loss of vapor odorant due to buoyancy effect.
- In addition, odorant loss may have also taken place inside horizontal distribution lines for low, intermittent or stagnant flow due to odorant adsorption on the pipeline.

THANK YOU