Technical Note

Element Materials Technology

To: Craig Turnbull (Nissan Motor Manufacturing UK)
From: Stephen Wigham (Element)
Date: 02 May 2024
Copy:
Our reference: EMT09468-N001_Rev0
Classification: Public

Subject: Stack Height Assessment – Proposed Pyrolysis Ovens, Sunderland Plant

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In support of a permit variation application to Sunderland City Council, please find enclosed the results of the Stack Height Assessment conducted in accordance with the HMIP Technical Guidance Note D1 *"Guidelines on Discharge Stack Heights for Polluting Materials"*, June 1993.

The proposed operation falls under guidance provided by Process Guidance Note 2/09(13), statutory guidance for metal decontamination processes and installations, July 2013.

Relevant site plans are provided in **Appendix A**.

Background Air Quality Data

The existing air quality in the vicinity of the Nissan site is influenced by a combination of national background levels, industrial sources and traffic on the local road network together with domestic and other commercial sources.

The Nissan site is located within the Sunderland City Council area, which has not declared an Air Quality Management Area (AQMA).

The PM_{10} concentration for the area is derived from the 2018 data set provided by UK AIR and adjusted for 2024. The average background value has been calculated for the nine 1 km x 1 km squares centred on 434500, 558500 (square occupied by the site). Estimates of VOC and HCl concentrations were derived from the UK Emissions Interactive Map.

The assumed background levels are provided in **Table 3**. The annual mean objective value is also given for comparison.

Table 1: Background concentrations

Pollutant		Predicted average figures	Annual mean objective (date) / EAL	
NO_2	µg/m³	12.53 (2023)	40	(2005)
VOC	mg/m³	0.028	---	---
HCl	mg/m³	0.0003	0.14	---

Background concentrations form approximately 31.33% and 0.21% of the PM_{10} air quality standard and HCL EAL in this area respectively.

Estimated process emissions

Using worst-case emission concentration data provided by the pyrolysis oven manufacturer, **Table 2** details the main emission parameters that have been used in the assessment.

Table 2: Estimated emission parameters

Proposed emission point	Mass emission PM_{10} (g/s)	Mass emission VOC (g/s)	Mass emission HCL (g/s)	Gas temp. (°C)	Diameter of duct at release point (m)	Efflux velocity flow rate (m^3/s)
PTR675 Pyrolysis Oven	0.001278	0.001611	0.000222	850	0.40	0.32003
PTR92 Pyrolysis Oven	0.000478	0.000597	0.000081	850	0.35	0.12001

Table 3: Permit limit requirements

Proposed emission point	PM_{10}		VOC		HCL	
	Estimated emission (mg/m^3)	Permit limit (mg/m^3)	Estimated emission (mg/m^3)	Permit limit (mg/m^3)	Estimated emission (mg/m^3)	Permit limit (mg/m^3)
PTR675 Pyrolysis Oven	4.0	20	5.0	20	0.7	10
PTR92 Pyrolysis Oven	4.0	20	5.0	20	0.7	10

All supporting information can be found in **Appendix B.**

Assessment

Using the background concentrations and above estimated process emissions, guidance provided in the HMIP Technical Guidance Note D1 states that a stack height calculation is not possible due to the very low stack flow rate, negligible estimated emission concentrations and subsequent very low D1 Pollution Index concentration. This is supported by Section 5.7 of PG Note 2/09(13), which states:

> *"…where an emission consists purely of air and particulate matter, (i.e. no products of combustion or any other gaseous pollutants are emitted) the above provisions relating to stack height calculation for the purpose of dispersion and dilution should not normally be applied."*

The negligible estimated emission concentrations presented in **Table 2** would comply with the above criterion and a D1 calculation is not necessary, and in accordance with D1 Guidance, would not be accurate.

However, to align with best practice, Nissan have advised that all stacks associated with the pyrolysis ovens should have an exit point located a **minimum of +3.0m** above the Pyrolysis Building roof height. In the absence of a D1 calculation, this proposed stack height of the pyrolysis oven emission points is considered acceptable.

I trust that you find the above to be acceptable; however, should you require any further information please do not hesitate to contact me at any time.

Best regards,

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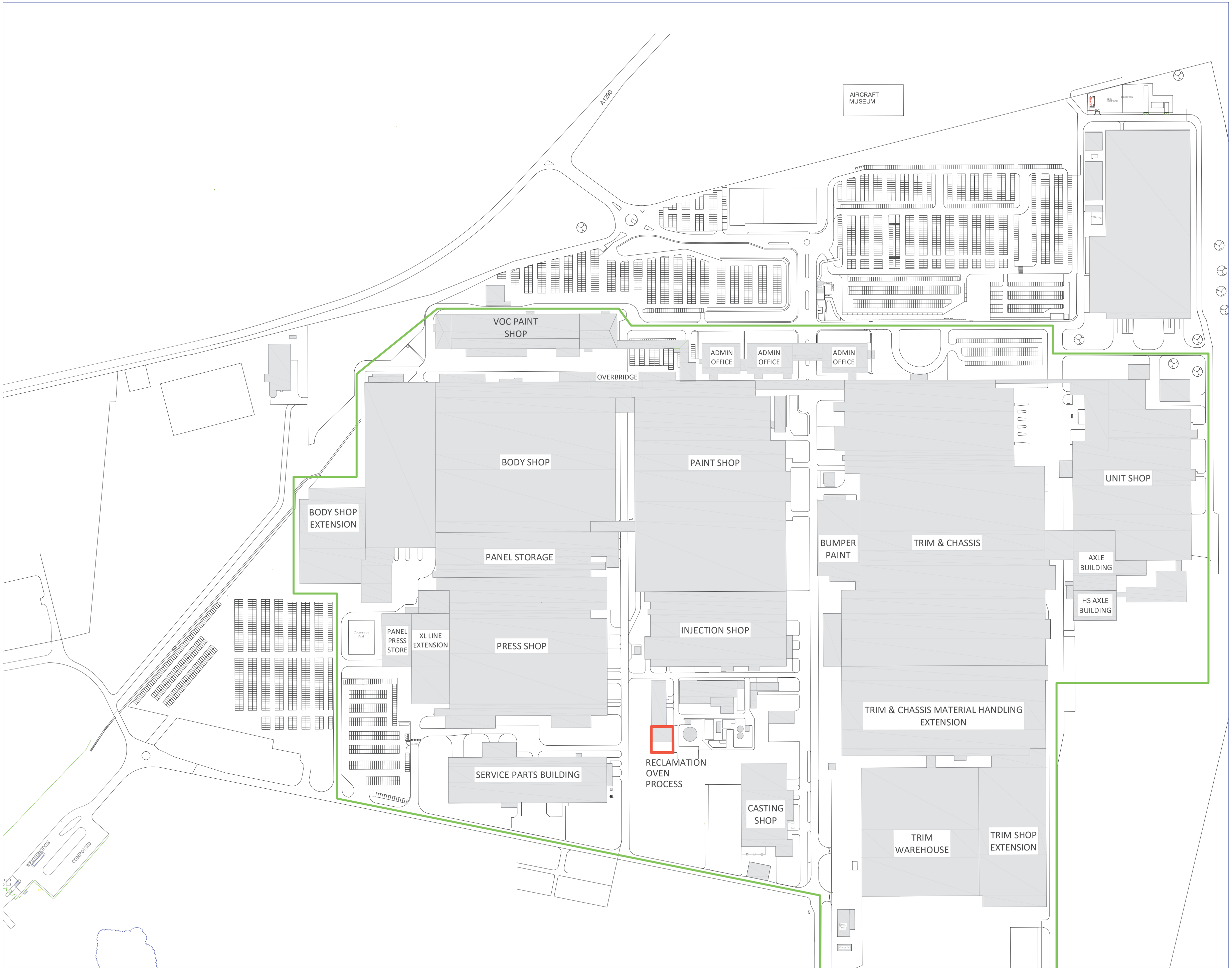
Appendix A Site Plans



REV	DATE	DRN	DESCRIPTION
APPROVED			NISSAN MOTOR MANUFACTURING (U.K.) LTD.
CHECKED			PROJECT **PYROLYSIS OVEN INSTALLATION (Fluidised bed replacement)**
DRAWN	CL		TITLE **Controlled Pyrolysis Cleaning Ovens**
DATE	Feb 24		
SCALE	NTS		DRAWING NO	SHEET

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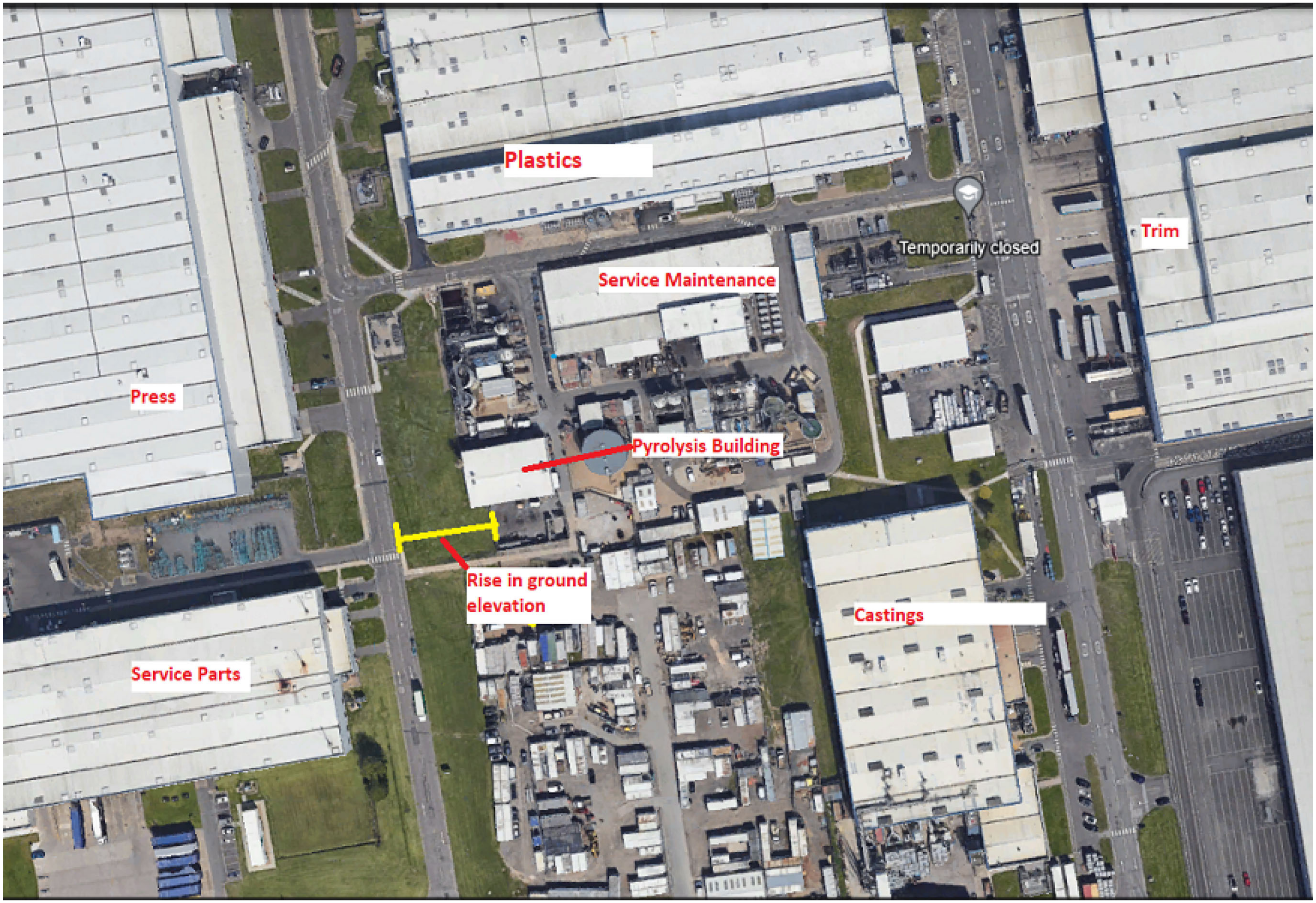
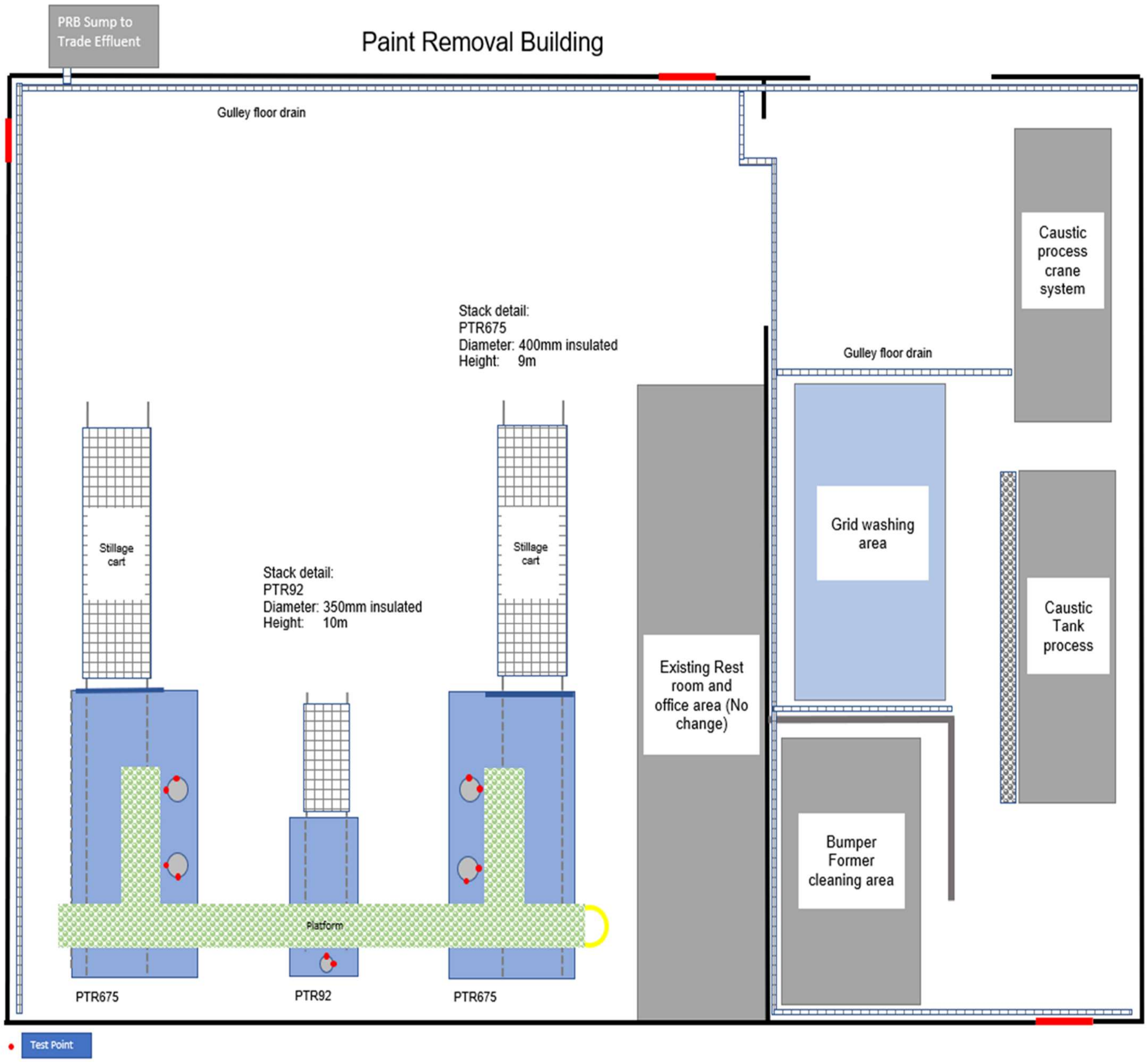


Plastics
Trim
Temporarily closed
Service Maintenance
Press
Pyrolysis Building
Rise in ground elevation
Castings
Service Parts



Revision	Original	
APPROVED RT / CT	DESCRIPTION NISSAN MOTOR MANUFACTURING (UK) LTD.	
CHECKED CT	PROJECT *PYROLYSIS OVEN INSTALLATION* *(Fluidised bed replacement)*	
DRAWN RT	TITLE	
DATE 08th Feb 24	*Controlled Pyrolysis Cleaning Ovens*	
SCALE NTS	DRAWING No RTCT080224	SHEET 1

Appendix B Emission Data

CONTROLLED PYROLYSIS™ FOR CLEANER AIR

ENVIRONMENTAL EMISSIONS

Listed below is information that relates to the latest results of emission tests carried out by BSI (British Standards Institute) for environment requirements on Pollution Control Furnaces. Listed below are the results from 2004,2010 and 2014 against current European limits.

Emission Standards

Component	Test Results 2004	Test Results 2010	Test Results 2014	Limit Values mg/m^3				
				UK	Germany	Netherlands	Belgium	Spain
Total Particulate mg/m^3 note 1	1.38	0.5	4	50	20	25	30	10
VOC as C mg/m^3 Organic compounds	5.5	5.0	1.2	20	20	50	30	10
CO Carbon Monoxide	0.0010%	0.0006%	0.0009%	100	100	100	100	100
$H^{2}O$ % Water vapour	3	3	3					
CO^{2} % Carbon Dioxide	5.7	7.6	7.4					9
O^{2} % Oxygen	11	11	11	11	11	11	11	
HCI mg/m^3 Hydrogen chloride	0.00	0.00	0.7	100	20	Unknown	Unknown	7
Afterburner Temperature	850°C	850°C	850ºC 2 second dwell period	850°C	850°C 2 second dwell period	850°C 2 second dwell period	850°C 2 second dwell period	850°C 2 second dwell period

<u>Notes</u>

1. **Values correspond to 2014 limits.**
2. **Results of emission concentrations expressed @ 11% oxygen, 273K, 101.0kPa dry gas per current EPA testing standards.**
3. **800ppm equals 100mg/m^3**

Volume calculation
for
Combustion Chamber Size

MODEL	PTR 675	JOB NUMBER							
VOLUME CALCULATION FOR AFTERBURNER CAPACITY OF FURNACES									
BASIC CALCULATION FOR VOLUME IS (P1/P2)X(T1XT2)=(V1/V2)								CELCIUS	KELVIN
PRESSURE ESTIMATE AS MEAN			1015		TEMPERATURE ESTIMATE FOI			25	298
FOR STD ATMOSPHERE					STANDARD OPERATING				
PRESSURE ESTIMATE AS MEAN			996		REQUIRED AFTERBURNER			850	1123
FOR FURNACE INTERIOR					TEMPERATURE				
RATIO OF VOLUME INCREASE THROUGH FURNACE					3.8403		66		
FURNACE FUEL USAGE PER HOUR					16				
SPLIT 55% SECONDARY/45% PRIMARY									
			STOICHIOMETRIC		50% EXCESS		100% EXCESS		TOTALS
BURNER		GAS	AIR		AIR		AIR		
PRIMARY		8.8	88		0		88		184.8
SECONDARY		7.2	72		36		0		115.2
TOTAL GASES PASSING THROUGH					VOLUME AT				
FURNACE PER HOUR			300		INCREASED TEMP		1152.103		
SPEED OF GASES PER SECOND			0.32003	M3/SEC					
REQUIRED HOLD TIME			2	SECONDS					
REQUIRED AFTERBURNER CAPACITY									
SQUARE SECTIOI		LENGTH							
300 X 300		7.11	METRES						
350 X 350		5.22	METRES						
400 X 400		4.00	METRES						
550 x 400		2.91	METRES						
450 X 450		3.16	METRES						
500 X 500		2.56	METRES						
550 X 550		2.12	METRES						
600 X 600		1.78	METRES						
680 X 680		1.38	METRES						
750 X 750		1.14	METRES						
800 X 800		1.00	METRES						
1000 X 400		1.60	METRES						
ROUND SECTION		LENGTH							
300 DIA		9.05	METRES						
350 DIA		6.65	METRES						
400 DIA		5.09	METRES						
450 DIA		4.01	METRES						
460 DIA		3.85	METRES						
500 DIA		3.26	METRES						
550 DIA		2.69	METRES						
600 DIA		2.26	METRES						

Volume calculation
for
Combustion Chamber Size

MODEL	**PTR 92**	**JOB NUMBER**							
VOLUME CALCULATION FOR AFTERBURNER CAPACITY OF FURNACES									
BASIC CALCULATION FOR VOLUME IS (P1/P2)X(T1XT2)=(V1/V2)								CELCIUS	KELVIN
PRESSURE ESTIMATE AS MEAN			1015		TEMPERATURE ESTIMATE FOI			25	298
FOR STD ATMOSPHERE					STANDARD OPERATING				
PRESSURE ESTIMATE AS MEAN			996		REQUIRED AFTERBURNER			850	1123
FOR FURNACE INTERIOR					TEMPERATURE				
RATIO OF VOLUME INCREASE THROUGH FURNACE					3.8403		66		
FURNACE FUEL USAGE PER HOUR					6				
SPLIT 55% SECONDARY/45% PRIMARY									
			STOICHIOMETRIC		50% EXCESS		100% EXCESS		TOTALS
BURNER		GAS	AIR		AIR		AIR		
PRIMARY		3.3	33		0		33		69.3
SECONDARY		2.7	27		13.5		0		43.2
TOTAL GASES PASSING THROUGH					VOLUME AT				
FURNACE PER HOUR			112.5		INCREASED TEMP		432.0388		
SPEED OF GASES PER SECOND			0.12001	M3/SEC					
REQUIRED HOLD TIME			2	SECONDS					
REQUIRED AFTERBURNER CAPACITY									
SQUARE SECTIOI		LENGTH							
300 X 300		2.67	METRES						
350 X 350		1.96	METRES						
400 X 400		1.50	METRES						
550 x 400		1.09	METRES						
450 X 450		1.19	METRES						
500 X 500		0.96	METRES						
550 X 550		0.79	METRES						
600 X 600		0.67	METRES						
680 X 680		0.52	METRES						
750 X 750		0.43	METRES						
800 X 800		0.38	METRES						
1000 X 400		0.60	METRES						
ROUND SECTION		LENGTH							
300 DIA		3.39	METRES						
350 DIA		2.50	METRES						
400 DIA		1.909479216	METRES						
450 DIA		1.50	METRES						
460 DIA		1.44	METRES						
500 DIA		1.22	METRES						
550 DIA		1.01	METRES						
600 DIA		0.85	METRES						

PCP OVEN SERVICES LTD

BASEPOINT BUSINESS CENTRE
HAYWARDS HEATH
WEST SUSSEX
RH16 1UA

Contents,

2-Second Retention Afterburner Calculations for a Model PRC 1508L Pyrolysis Furnace manufactured by Pollution Control Products Co And PCP Oven Services Ltd

These calculations are based on a standard mathematical calculation used throughout industry to obtain air and gas flow volumes through equipment.

Stack Heights and afterburner sizes use this method of "Stoichiometric Ratio" .

Enclosed is all the supporting documentation required to follow the methology of the calculation.

The Excel Spreadsheet marked shows the basic calculations and conclusions. The final figure of 5.09m is highlighted in green .

1. Shown is the mean atmospheric pressure divided by the estimated furnace interior pressure or (1015/996=1.02).

2. Standard operating temperature, this figure is determined due to the high levels of heat involved in painting lines, inline curing and drying ovens create a high ambient working temperature. This is divided into the required temperature of 850 degrees C. (1123/298= 3.77)

3. These two figures are then multiplied together to give the ratio of volume increase (1.02 x 3.77 = 3.8403).

4. Furnace fuel usage is calculated using the correlation between gas pressure and burner output. The burner head gas pressure was measured during commissioning of the equipment and recorded on the commissioning sheet (D). If you refer to the burner manuals on page three the graph will give you a guide Kilowatt value. We have assumed both of these values to be 80 kw per burner.

5. Given the combined fuel usage of 160 kw/hr this is multiplied by 0.097 (standard conversion kw to m^3) to give the figure $15.52m^3$/hr of gas.

6. For the purposes of the original calculation Pollution Control Products have added extra gas usage for a safety margin and rounded the figure to 16 m^3/hr.

7. The gas usage figure is then divided between the secondary and primary burners and the gas to air stoichiometric ratio is applied. The totals are added together to give the gases passing through the furnace per hour at 300m^3/hr. Multiply this by the volume increase ratio and you have your volume at increased temperature, (184.8+115.2*3.8403= 1152.1034)

8. The volume is then divided by 3600 to give you the speed of gases (1152.1034/3600=0.32003).

9. This figure is then multiplied by the 2 seconds required divided by the cross sectional area of the afterburner chamber to give a minimum length requirement shown for 400 ID stack as 5.09m.

10. Some variations can occur due to a damaged door seal the atmospheric pressure in the furnace chamber is equal to the outside, ambient temperature (winter time) would be 5ºC.

Conclusion and variation Summary.

The actual afterburner distance between inlet and temperature measurement point is 5.5 m.

Pollution Control Products Co consider the calculations to be correct and with the actual distance measured at 5.5m feel a good level of safety margin has been added.