Occupational Exposure Air Quality Datasheet

Fortus® 360/400/380/450/900mc systems
Comparative Evaluation of Emissions

Occupational exposure limits vary greatly with local and regional regulatory requirements. In some locations, mechanical venting may be required to meet the local requirements. You should check with the local regulatory agency overseeing occupational exposure to ensure the system installation meets local standards.

The values provided in Table 1 through Table 8 represent a conservative assessment of the possible contaminants released during operation of the Fortus® systems as directed. The comparisons are provided for reference, and are made to exposure limits based on current American Conference of Governmental Industrial Hygienist's Threshold Limit Value (ACGIH-TLV) and OSHA Permissible Exposure Limits (OSHA-PEL), whichever is more restrictive. These limits represent the concentration of a chemical to which nearly all workers may be exposed day after day, without adverse health effects. Local jurisdiction may require comparison to different limits. The OSHA ceiling concentration referenced in Table 5, Table 6 and Table 8 is the concentration of the chemical that should not be exceeded during any part of the workday.

These results represent measurements taken under the room conditions present at the time of the testing. Results may vary under different conditions. Exact emissions measurements for a specific installation need to be tested on that installation.

Area air samples were taken at the operator control panel along the edge of the door opening and opposite the exhaust fan vents, and were considered representative of an 8-hour exposure. Samples for the various chemicals were collected and analyzed according to the following methods:

- acrylonitrile, ethylbenzene, methyl methacrylate, styrene, and VOCs - OSHA 7
- butadiene - OSHA 56
- methacrylic acid - OSHA 28 and an OSHA in-house method
- triphenyl phosphate - NIOSH 5038
- hydrogen cyanide - WOHL method WI009cn.9 based on NIOSH 6017
- phenol – OSHA 32
- nitrogen dioxide – Dräger Detector or OSHA ID-182 (NO2) and OSHA ID-190 (NO)
- nitrogen oxide - OSHA ID-182 (NO2) and OSHA ID-190 (NO)
- phosphorus oxide – WOHL method WI002ia.12 based on NIOSH 7903
- diesel particulates – WOHL method WG029.12 based on NIOSH 5040 and Chapter Q
- carbon fibers – NIOSH method 7400 Asbestos and Fibers (B Rules)
- ammonia – WOHL method WI003amm.9 based on OSHA ID-188
- sulfur dioxide - WOHL method WI026.3 based on NIOSH 6004

The analysis was performed by a laboratory certified by the American Industrial Hygiene Association.

Table 1 P430 ABS-M30 Model Material and SR-30 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
P430 ABS-M30 / SR-30 Support	styrene	Operator Panel	<0.11	20
		Exhaust Vent	<0.11	
	acrylonitrile	Operator Panel	<0.12	2
		Exhaust Vent	<0.12	
	butadiene	Operator Panel	<0.38	1
		Exhaust Vent	<0.38	
	methyl methacrylate	Operator Panel	<0.54	50
		Exhaust Vent	<0.54	
	n-butyl acrylate	Operator Panel	<0.17	2
		Exhaust Vent	<0.17	
	naphtha (Coal Tar)	Operator Panel	<0.10	100
		Exhaust Vent	0.12	
	petroleum distillates	Operator Panel	<0.83	500
		Exhaust Vent	<0.84	
	methacrylic acid	Operator Panel	<0.012	20
		Exhaust Vent	<0.011	
	phenol	Operator Panel	<0.0020	5
		Exhaust Vent	<0.0018	

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Table 2 PC Model Material and SR-100 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
PC / SR-100 Support	acetone	Operator Panel	<0.13	500
		Exhaust Vent	<0.13	
	methyl methacrylate	Operator Panel	<0.56	50
		Exhaust Vent	<0.57	
	n-butyl acrylate	Operator Panel	<0.18	2
		Exhaust Vent	<0.18	
	naphtha (Coal Tar)	Operator Panel	<0.11	100
		Exhaust Vent	0.13	
	petroleum distillates	Operator Panel	<0.088	500
		Exhaust Vent	<0.088	
	methacrylic acid	Operator Panel	<0.011	20
		Exhaust Vent	<0.011	
	phenol	Operator Panel	<0.0017	5
		Exhaust Vent	<0.0015	

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Table 3 PC-ABS Model Material and SR-20 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
PC-ABS / SR-20 Support	styrene	Operator Panel	<2.9	20
		Exhaust Vent	<2.9	
	acrylonitrile	Operator Panel	ND	2
		Exhaust Vent	ND	
	butadiene	Operator Panel	<0.20	1
		Exhaust Vent	<0.17	
	methyl methacrylate	Operator Panel	<0.57	50
		Exhaust Vent	<0.57	
	naphtha (Coal Tar)	Operator Panel	<0.11	100
		Exhaust Vent	<0.11	
	petroleum distillates	Operator Panel	<0.088	500
		Exhaust Vent	<0.089	
	methacrylic acid	Operator Panel	<0.013	20
		Exhaust Vent	<0.012	
	triphenyl phosphate	Operator Panel	<0.045 mg/m^3	3 mg/m^3
		Exhaust Vent	<0.046 mg/m^3	

ppm = parts per million

mg/m3 = milligrams per cubic meter

ND = non-detectable concentration

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Table 4 Ultem 9085 Model Material and Ultem Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
Ultem 9085 / Ultem Support	naphtha (Coal Tar)	Operator Panel	<0.11	100
		Exhaust Vent	<0.11	
	petroleum distillates	Operator Panel	<0.089	500
		Exhaust Vent	<0.089	
	phenol	Operator Panel	<0.0017	5
		Exhaust Vent	<0.0015	
	hydrogen cyanide	Operator Panel	<0.076	10
		Exhaust Vent	<0.076	

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Table 5 Nylon 12 Model Material and SR-110 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
Nylon 12 / SR-110 Support	Hydrogen cyanide	Operator Panel	<0.072	10
		Exhaust Vent	<0.075	
	Methacrylic acid	Operator Panel	<0.027	20
		Exhaust Vent	<0.026	
	Methyl methacrylate	Operator Panel	<0.72	50
		Exhaust Vent	<0.72	
	Nitrogen dioxide	Operator Panel	<0.026	0.2
		Exhaust Vent	<0.027	
	Nitrogen dioxide (Dräger Detector)	Operator Panel	0.0	5 Note 1
		Exhaust Vent	0.0	
	Nitric Oxide	Operator Panel	<0.30	25
		Exhaust Vent	<0.28	
	Acetone	Operator Panel	0.0063	1000
		Exhaust Vent	0.0068	
	Aldehydes	Operator Panel	Note 2	Various
		Exhaust Vent		
	VOCs	Operator Panel	Note 2	Various
		Exhaust Vent		

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Note 1: OSHA ceiling concentration limit as measured using the Dräger Detector method

Note 2: Multiple analytes were tested in the category of Aldehydes and VOCs with various exposure limits. The test results for these analytes, if present, are at a level too low to be accurately quantified by the method used and in each case are below the exposure limits.

Table 6 ASA Material and SR-30 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
ASA / SR-30 Support	Methacrylic acid	Operator Panel	<0.018	20
		Exhaust Vent	<0.018	
	Methyl methacrylate	Operator Panel	<0.55	50
		Exhaust Vent	<0.55	
	Nitrogen dioxide	Operator Panel	<0.026	0.2
		Exhaust Vent	<0.026	
	Nitrogen dioxide (Dräger Detector)	Operator Panel	0.0	5 Note 1
		Exhaust Vent	0.0	
	Nitric Oxide	Operator Panel	<0.20	25
		Exhaust Vent	<0.22	
	Acetone	Operator Panel	0.011	500
		Exhaust Vent	0.010	
	Formaldehyde	Operator Panel	0.011	0.75
		Exhaust Vent	0.011	
	Acrylontrile	Operator Panel	<0.13	2
		Exhaust Vent	<0.13	
	N-butyl acrylate	Operator Panel	<0.17	2
		Exhaust Vent	<0.17	
	Styrene	Operator Panel	<0.11	20
		Exhaust Vent	<0.11	
	VOCs and Alcohols	Operator Panel	Note 2	Various
		Exhaust Vent		
	Aldehydes	Operator Panel	Note 2	Various
		Exhaust Vent		

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Note 1: OSHA ceiling concentration limit as measured using the Dräger Detector method

Note 2: Multiple analytes were tested in the category of Aldehydes, VOCs and alcohols with various exposure limits. The test results for these analytes, if present, are at a level too low to be accurately quantified by the method used and in each case are below the exposure limits.

Table 7 Nylon 12 CF Model Material and SR 110 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
Nylon 12 CF / SR-110 Support	Methacrylic acid	Operator Panel	<0.024	20
		Exhaust Vent	<0.023	
	Methyl methacrylate	Operator Panel	<0.12	50
		Exhaust Vent	<0.13	
	Nitrogen dioxide	Operator Panel	<0.26	0.2
		Exhaust Vent	<0.27	
	Nitric Oxide	Operator Panel	<0.20	25
		Exhaust Vent	<0.27	
	Ammonia	Operator Panel	<0.42	25
		Exhaust Vent	<0.41	
	Elemental carbon (diesel particulates)	Operator Panel	<4.2 ug/m3*	20 ug/m3* 120 ug/m3**
		Exhaust Vent	<4.3 ug/m3*	
	Fibers	Operator Panel	0.010 fibers/cc***	None (for carbon)
		Exhaust Vent	0.0060 fibers/cc***	
	Hydrogen cyanide	Operator Panel	<0.093	10
		Exhaust Vent	<0.092	
	Isopropyl alcohol	Operator Panel	<0.17	200
		Exhaust Vent	0.23	
	Phosphorus oxide	Operator Panel	<0.0066	None
		Exhaust Vent	<0.0067	
	VOCs	Operator Panel	Note 1	Various
		Exhaust Vent		
	Aldehydes	Operator Panel	Note 1	Various
		Exhaust Vent		

ppm = parts per million, ug/m3 = micrograms per cubic meter, f/cc = fibers per cubic centimeter

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

Note 1: Multiple analytes were tested in the category of Aldehydes, VOCs with various exposure limits. The test results for these analytes, if present, are at a level too low to be accurately quantified by the method used and in each case are below the exposure limits.

* Proposed ACGIH TLV for diesel particulate as element carbon. Withdrawn in 2003.

** MSHA (Mine Safety and Health Administration) PEL for diesel particulate matter as elemental carbon.

*** No fibers were detected in the sample that in any way resembled any kind of graphite or carbon fibers

Table 8 Ultem 1010 Model Material and Ultem 1010 Support Material

Filament/Support Material	Chemical	Location	Measured Conc. (ppm)	ACGIH-TLV or OSHA-PEL (ppm)
Ultem 1010 / Ultem 1010	Hydrogen cyanide	Operator Panel	<0.081	10
		Exhaust Vent	<0.081	
	Nitrogen dioxide	Operator Panel	<0.024	0.2
		Exhaust Vent	<0.024	
	Nitrogen dioxide (Dräger Detector)	Operator Panel	0.00	5 Note 1
		Exhaust Vent	0.00	
	Nitric oxide	Operator Panel	<0.20	25
		Exhaust Vent	<0.20	
	Phenol	Operator Panel	<0.0014	5
		Exhaust Vent	<0.0014	
	Sulfur dioxide	Operator Panel	<0.0043	5
		Exhaust Vent	<0.0042	
	VOCs	Operator Panel	Note 2	Various
		Exhaust Vent		

ppm = parts per million

< means less then. The analyte, if present, is at a level too low to be accurately quantitated by the method used. The actual amount is less than the reported value.

C means ceiling concentration

Note 1: OSHA ceiling concentration limit as measured using the Dräger Detector method

Note 2: Multiple analytes were tested in the category of Aldehydes, VOCs with various exposure limits. The test results for these analytes, if present, are at a level too low to be accurately quantified by the method used and in each case are below the exposure limits.