

Indoor Air Quality Report

Performance details of HP Multi Jet Fusion Technology



HP Jet Fusion 300/500 (Color) 3D Printer series

operated with HP 3D HR CB PA12 material



Indoor air quality (IAQ) is of great interest in the workspace. Therefore, devices of the HP Jet Fusion 300/500 (Color) 3D Printer series¹ are designed to enable customers to maintain a high level of IAQ performance. This report provides essential details and checks them against relevant environmental and safety requirements – to support customers in their purchase decision.

HP Multi Jet Fusion Technology is thoroughly tested

Users expect HP to make information available about the IAQ performance of their 3D printing solution. Therefore, devices of the HP Jet Fusion 300/500 (Color) 3D Printer series are comprehensively checked for a range of potential emissions. Testing applies latest scientific measurement technology and a dynamic 31.1 m³ test chamber which fulfils the specifications of standard international procedures such as ASTM D 6670 and ISO/IEC 28360, with an air exchange rate set to 10 ± 1 h⁻¹. Results are then calculated to predicted exposure concentrations, assuming a room size of 35 m³ and a ventilation rate of 6 h⁻¹ over eight continuous hours of printing during an average eight-hour work day.

These assessment conditions can be regarded as a representative high-use scenario, with the 35 m³ room size being at the lower recommended minimum for the devices. For details, users should refer to the recommendations for installation, placement and maintenance as laid out in their device's Site Preparation Guide or the respective User Guide.

Using these test conditions, experts of the accredited Underwriters Laboratories' UL Environment Inc. (UL) carried out testing and evaluation on behalf of HP.² In addition to ozone, fine dust and ultrafine particles emissions, five major quantitative individual volatile organic substances (iVOCs) contributors were considered on this basis. The emission rates for all these key IAQ performance indicators typical for the tested printing equipment are set out below.

Rates based on emissions testing (mg/h)

| | | | |
|---|------------------------------------|----------------------------------|------|
| Ozone | BQL | | |
| iVOCs | | | |
| 2-Pyrrolidinone | 2,332 | 5-Methyl-3-Heptanone | 64.9 |
| Triethylene glycol | 145 | N-(2-Hydroxyethyl)-2-pyrrolidone | 23.1 |
| Cyclododecanone | 82.1 | | |
| Fine dust (PM₁₀ / PM_{2.5}) | 14.9 / 7.62 | | |
| Ultrafine particles (UFPs) numbers | 8.6 x 10 ¹¹ particles/h | | |

iVOCs = individual Volatile Organic Compounds (the five major quantitative iVOCs contributors were selected); BQL = below quantifiable level.

For evaluation of these results, detected rates of the above key IAQ performance indicators can be converted into concentrations and compared against applicable limit and guide values^{3,4,5,6,7,8}. Determined ultrafine particles rates can be assessed using the precautionary particle number guide value of the German Blue Angel eco label, which was established for awarding office printing equipment with particularly low contributions to indoor air concentrations.

Detected emissions meet applicable safety requirements

Under the assumptions for testing and evaluation described above, IAQ key performance indicators can be compared against binding and indicative exposure and occupational limit and guide values. They provide reference for evaluating ozone and fine dust release. Also, they cover the release of individual volatile organic compounds (iVOCs) which are typical for the assessed printing systems and which are their major VOC contributors.

In detail, predicted exposure concentrations of emissions of ozone (8-hour TWA) and fine dust (24-hour TWA) from HP Jet Fusion 300/500 (Color) 3D Printer series devices are well below applicable U.S. Permissible Exposure Limits³, German Occupational Exposure Limit Values⁴, Australian Workplace Exposure Standards⁵ and Singapore Occupational Exposure Levels of Toxic Substances⁶.

Regarding major iVOCs contributions to indoor air, the substances 2-Pyrrolidinone, 5-Methyl-3-Heptanone and N-(2-Hydroxyethyl)-2-pyrrolidone easily meet applicable EU Derived No-Effect Level values⁷. Cyclododecanone and Triethylene glycol meet the U.S. 8-hour TWA value for workplace and environmental exposure⁸.

Concentrations of the aforementioned IAQ key performance indicators calculated from the results of HP commissioned testing are as follows:

Predicted exposure concentrations (mg/m³)

| | | | |
|---|---------------|----------------------------------|------|
| Ozone | BQL | | |
| iVOCs | | | |
| 2-Pyrrolidinone | 11.11 | 5-Methyl-3-Heptanone | 0.31 |
| Triethylene glycol | 0.69 | N-(2-Hydroxyethyl)-2-pyrrolidone | 0.11 |
| Cyclododecanone | 0.39 | | |
| Fine dust (PM₁₀ / PM_{2.5}) | 0.023 / 0.012 | | |

iVOCs = individual Volatile Organic Compounds (the five major quantitative iVOCs contributors were selected); BQL = below quantifiable level.

Accordingly and based on indicative testing as described above, no adverse health effects from the considered key IAQ performance indicators should be expected when HP Jet Fusion 300/500 (Color) 3D Printer series devices are installed, operated and maintained according to manufacturer instructions. Particularly, to reduce airborne dust exposure during part extraction, users should follow the parts retrieval guidelines outlined in the “Cooling and part retrieval” section of the respective device’s User Guide.



HP Jet Fusion 580 Color 3D Printer

Expert guidelines provide additional proof points

As there are no mandatory workplace exposure limits available for the number of released particles in the ultrafine size range (UFPs), the precautionary guide value of the German Blue Angel eco label for laser and ink office printing equipment⁹ can be used as an auxiliary reference. In fact, indoor air contributions from devices of the HP Jet Fusion 300/500 (Color) 3D Printer series are far below the Blue Angel guide value of 3.5×10^{11} particles per 10 minutes of printing as defined by the DE-UZ 205 award criteria^{9,2}.

Please note that the requirements of this eco label are defined for office printing equipment in typical office environments. As devices of the HP Jet Fusion 300/500 (Color) 3D Printer series are intended for use in working environments starting at room volumes of 35 m³ and beyond, the Blue Angel scenario represents worst-case conditions. And please also note that the following number was determined in a 60 minutes test run, which is six times longer and, thus, significantly more stringent than the required 10 minutes print run of this guide value:

| Emissions rate (particles/10 min) | |
|---|-----------------------|
| Ultrafine particles (UFPs) numbers | 1.43×10^{11} |

Based on these observations and the indicative testing performed no health risks due to UFPs release from devices of the HP Jet Fusion 300/500 (Color) 3D Printer series have to be expected under intended conditions of use as well.

Supporting references:

¹ This document refers to the following series models: HP Jet Fusion 340 3D Printer, HP Jet Fusion 540 3D Printer, HP Jet Fusion 380 Color 3D Printer, HP Jet Fusion 580 Color 3D Printer. ² HP commissioned indicative testing of HP Jet Fusion 300/500 (Color) 3D Printer series devices operated with HP 3D HR CB PA12 material, carried out by UL Environment Inc., Marietta (GA), USA, 2018. ³ Permissible Exposure Limits (PELs-TWA), 29 CFR 1910.1000 Z-1 and Z-2, U.S. Occupational Safety and Health Administration (OSHA), 2006. ⁴ Workplace limits (AGW), TRGS 900, German Ordinance of Hazardous Substances (GefStoffV), German Committee on Hazardous Substances (AGS), 2006 (as amended). ⁵ Workplace Exposure Standards for Airborne Contaminants (WES), Safe Work Australia, 2013. ⁶ Permissible exposure levels of toxic substances, in: Workplace Safety and Health (General Provisions) Regulations (G.N. No. S 134/2006), Singapore Government, 2006 (as amended). ⁷ Derived No-Effect Level (DNEL) Values as introduced by the REACH regulation, appendix 1, no. 1.0.1., 1 July 2007. ⁸ Workplace Environmental Exposure Level (WEEL) 8-hour TWA, U.S. Occupational Safety and Health Administration (OSHA). ⁹ Basic criteria for award of the German Blue Angel environmental label for Office Equipment with Printing Function, DE-UZ 205, RAL gGmbH.

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