



## Technical Brief

# ANSI/CAN/UL 2904: Standard Method for Testing and Assessing Particle and Chemical Emissions from 3D Printers

### Background

A two-year research study by UL Chemical Safety and Georgia Institute of Technology has found that three-dimensional (3D) printing generates both particles and volatile organic compounds (VOCs). Research has shown that high concentrations of ultrafine particles and over 200 VOC species can be emitted during 3D printing. Emission profiles vary with print conditions including printer and feedstock properties. These emissions can deteriorate indoor air quality and may result in adverse health impacts, especially when used in non-industrial indoor environments with minimal ventilation. Research indicated the need to provide a consistent and accurate test method for measuring these complex emissions and assessing their health impact. Full research reports on identification and characteristics of the emissions can be found on UL Chemical Safety's [website](#).

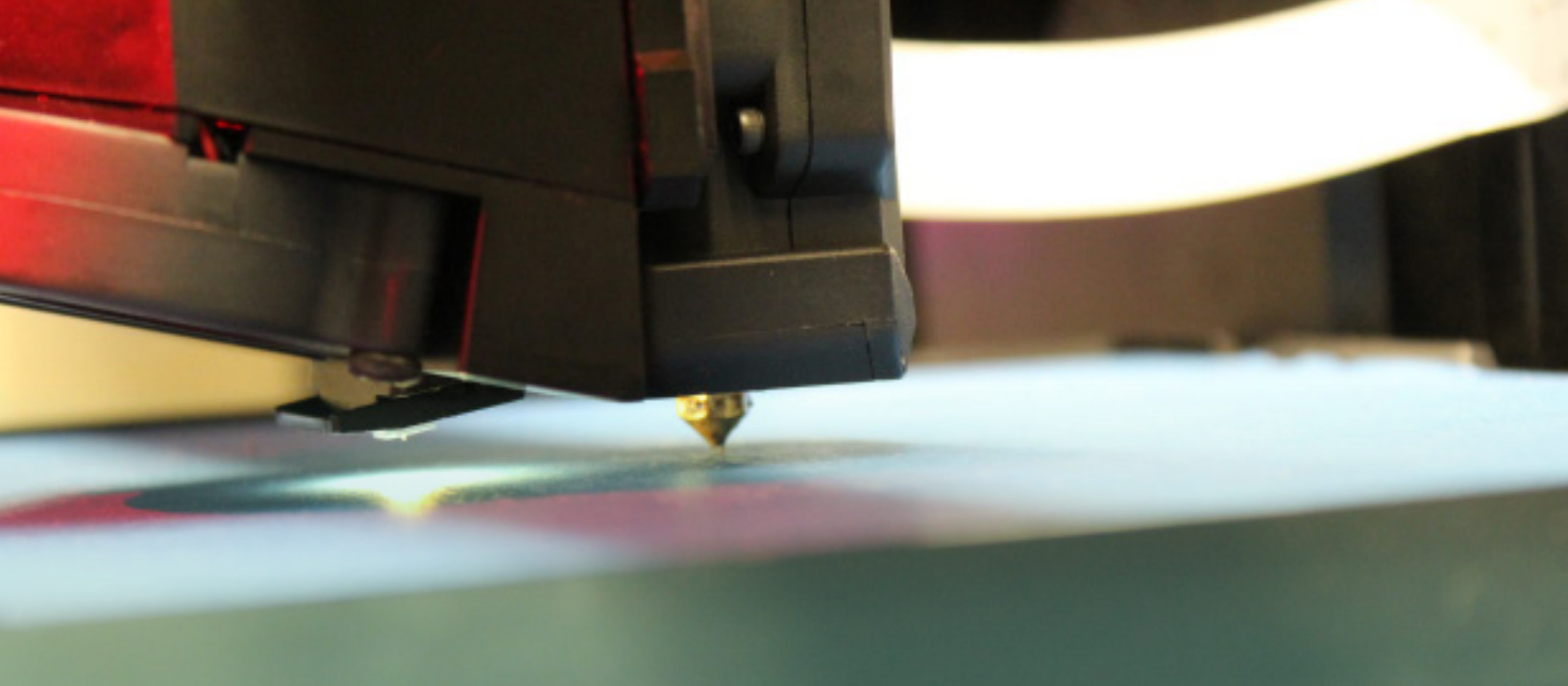
### ANSI/CAN/UL 2904

This is a joint Canada-United States National Standard developed through UL's consensus-based Standard Technical Panel process in accordance with the requirements of the American National Standards Institute (ANSI) and the Standards Council of Canada. The standard provides a systematic test method to identify and characterize 3D printer emissions and includes guidance on estimating exposure levels during the printing process. Chemical and particle emissions are measured during the operation of 3D

printers, enabling accurate and comparative measurement data across various machines and print media available in the marketplace. This Standard can be accessed on UL Standards' [website](#).

This standard primarily applies to measuring emissions from 3D printers operating with commercially available feedstocks, in classrooms, offices, libraries, residential settings, small and medium size enterprises, and other non-industrial indoor spaces. The test protocol is beneficial to comparing and evaluating the emissions from different print material, printed object, and printer hardware, as well as obtaining data for risk assessments or product claims. This standard includes methods to quantify emissions and requirements on laboratory quality management systems and measurement uncertainty estimation. This Standard can be used to generate data for product development, product comparisons, certification or verification, research, and risk assessments.

The Standard describes in detail processes for measuring total particle concentrations over a wide range of particle sizes (ultrafine, fine and coarse) during printing using a combination of particle size and concentration analyzers. The particle emission rates (emission per hour) and yields (emission per mass of feedstock used) are calculated from measured particle concentrations with adjustments made to account for particle loss.



#### Key elements of ANSI/CAN/UL 2904 include:

- A two-day test protocol, including preparation, pre-operating, printing and post-operating phases of the printer.
- Setup of a test environment that maintains a well-controlled background, including a test chamber and clean air supply system, along with criteria that the setup needs to comply.
- Processes for measuring total particle concentrations covering a wide range of particle sizes (ultrafine, fine and coarse) during emission tests at reasonable frequencies.
- Procedures for calculating particle emission rates (emission per hour) and yields (emission per mass of feedstock used).
- Processes for measuring VOCs in range of C<sub>6</sub> to C<sub>16</sub> (boiling points between 60°C and 290°C) and aldehydes like formaldehyde.
- Method of calculating exposure levels of VOCs and particles, based on detailed environment models. Specification of the office environment model for product certification or verification.
- Maximum allowable emission rate criteria for VOCs and total particle emissions.
- Provides a universal test method for assessing particle and VOC emissions from operating 3D printers.
- Provides a test method and criteria for third party verification or certification.



#### Health Tips: Using 3D Printers



Only operate 3D printers in well-ventilated areas



Set the nozzle temperature at the lower end of the suggested range for filament materials



Stand away from operating machines



Only use machines and filaments that have been tested and verified to have low emissions

Learn more about our initiatives at [ulchemicalsafety.org](https://ulchemicalsafety.org)