

FIREWORKS

Date Initiated:

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Dates Modified / Updated:

PROCESS DESCRIPTION:

A firework is an object that produces an illuminating display by the combustion of explosive or flammable compositions. Fireworks are also referred to as pyrotechnic. Several metals are used in fireworks as explosives and/or to produce certain colors. For instance, potassium nitrate is used as an explosive; copper produces blue colors, barium provides green colors, and strontium generates red colors. Once exploded, fireworks are known to emit significant quantities of particulate matter 10 microns or less (PM10), which include many of these metals. Both the PM released during explosion and those used to create different colors can contain substances which are identified as air toxics.

EMISSIONS CALCULATIONS:

Emissions can be estimated with mass balance techniques based on purchase records, inventory records, waste records, and Safety Data Sheets (SDSs).

The standard estimation technique used by the District for emissions inventory purposes is a mass balance procedure based upon material usage and material composition:

$$E_a = (U_a - W_a) \times C_i \times (1 - e)$$

$$E_h = U_h \times C_i \times (1 - e)$$

Where:

E_a = Annual emissions of each listed substance per device per material, (lbs/year)

E_h = Maximum hourly emissions of each listed substance per device per material, (lbs/hour)

U_a = Total annual usage of each material containing a listed substance, (lbs/year)

U_h = Maximum hourly usage of each material containing a listed substance, (lbs/hour)

W_a = Annual amount of waste (i.e., spent, or unused) fireworks shipped off site, (lbs/year)

C_i = Concentration of each listed substance¹ in each material used, (lbs/lb)

e = Overall Control Efficiency ((device capture efficiency) X (device removal efficiency)), (%)

The District uses a default Particulate Matter (PM 10) Emission Factor value of 42.5 g

PM10/ kg gross weight of Fireworks, as published in literature¹.

EMISSIONS INFORMATION:

Information regarding material composition can be obtained from SDS documentation. Emissions are adjusted for waste disposal by estimating the weight of spent, or unused, fireworks shipped off-site or recycled. Facilities must estimate the amount of annual waste generated by each material used on-site. Usage estimates should be based on material purchases and changes in inventory.

$$U_a = (\text{Inventory (initial)} + \text{Purchases}) - \text{Inventory (final)}$$

The facility should estimate the weight of spent, or unused, fireworks shipped off-site using waste manifest records.

ASSUMPTIONS / LIMITATIONS:

- Emission calculations assume no reaction with the ambient air (i.e., any total organic gases (TOG); volatile organic compounds (VOC); oxides of nitrogen (NOx); carbon monoxide (CO); and oxides of sulfur (SOx) generated from the fireworks combustion are assumed to be negligible).
- All solids are calculated as particle sizes of PM10 or less.
- Most fireworks are exploded aurally outdoors, so the operation is assumed to be uncontrolled by default. Any control devices, methods and efficiencies must be identified (and control efficiencies substantiated and approved by the District staff) in the reporting portal to correctly calculate emissions.

REPORTING:

In general, a separate entry should be completed for EACH material used. Usage records for individual materials may be grouped together for reporting purposes as deemed appropriate by District staff.

¹ <https://onlinelibrary.wiley.com/doi/pdf/10.1002/rep.202000292>