Request for exemption – E-Bulb

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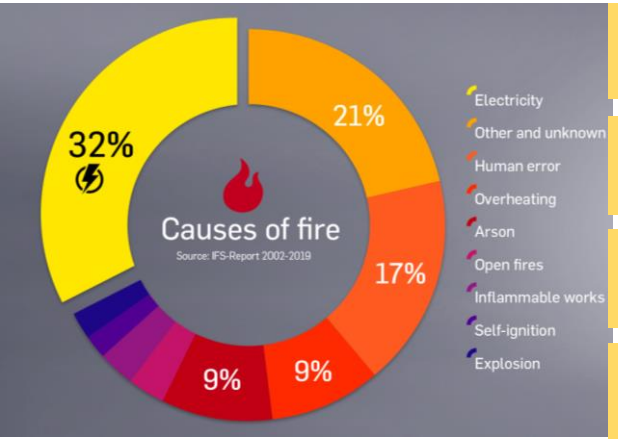
Summary of request for exemption – E-Bulb

Why we believe an exemption for E-Bulb can be justified:

Goal of this presentation:	**Request for exemption, unlimited**
Relevance for society:	**High** because E-Bulb reduces the risk of fires caused by electricity and enables digitalization in sensitive areas
Impact for environment:	**Low** Expected emissions in the air by 2030: 92,50 mL(**mililiters**!)
Number manufacturers:	One. JOB GmbH is the only manufacturer worldwide to manufacture E-Bulbs

The environmental damage of a developed fire is
expected to be tremendously bigger than PFAS emission (0,37 mL) due to E-Bulbs

Fires caused by electricity

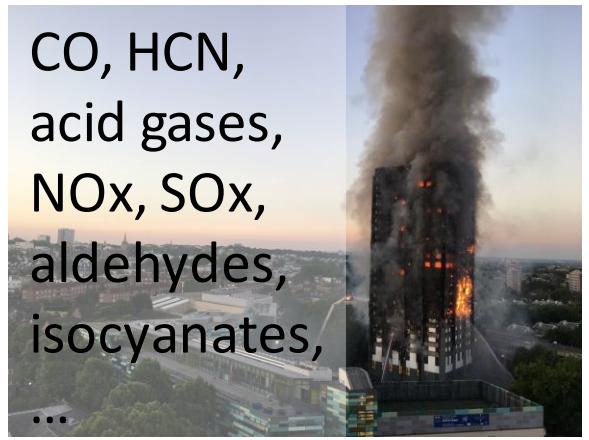


Every year, over **5,000 people die** from residential fires in Europe.

About 200.000 reported house fires in **Germany** p.a.

1 in every 3 fires are caused by electricity

Many fires start inside electrical devices



„When a modern building burns, there are a large variety of hazardous substances that can be released. These substances may include contaminants such as: general pollutants/indicators, metals, particulates, polycyclic aromatic hydrocarbons (PAHs), chlorinated dioxins and furans, brominated dioxins and furans, polychlorinated biphenyls (PCBs) and polyfluorinated compounds."

AXA insurance white paper: Fire: Environmental exposures and risk management.

Trends

„Number of electrical fires remain stable"

- Electronic designs get better and should decrease number of cases
- However, number of electrical devices in the field increase (digitalization)
- Number of electrical devices in standby increase
- Number of lithium ion based rechargeable electronics increases

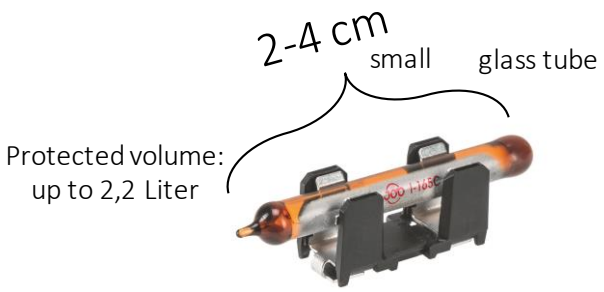
Pollution due to fires remain high due to:

- Number of fires and released hazardous substances
- Current fire protection concepts start to extinguish the fire when the fire left the electrical device (too late?)

While electrical designs get better, the number of fires caused by electricity remains the same. An increasing number of electrical devices in the field and more and more devices in standby can be seen as a reverse movement. One good idea to tackle this situation: „Device-integrated Fire Protection" - Extinguishing fires at source of origin from inside utilizing e.g. E-Bulb technology.

E-Bulb – the world‘s smallest fire extinguisher*

*a CIRCUIT INTERRUPTER WITH FIRE EXTINGUISHING AGENT, UL 60692

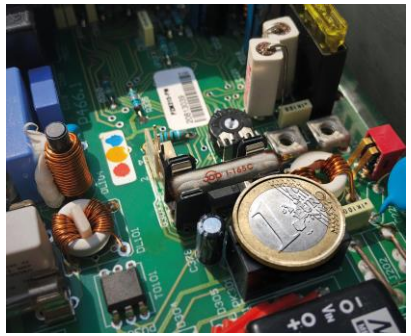


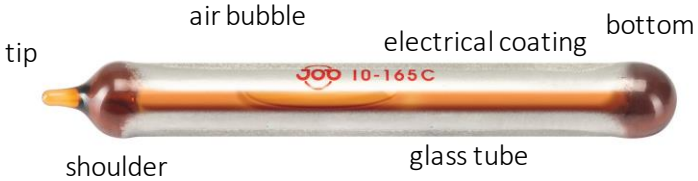
How does an E-Bulb function:

JOB’s E-Bulb is a glass bulb (like a fire sprinkler bulb), coated with a conductive layer and filled with FK-5-1-12. This non-toxic, non-conductive extinguishing liquid is released into the electrical enclosure when the defined temperature is reached (e.g. fire) and the E-Bulb bursts.

After being initiated, the E-Bulb extinguishes the fire, and interrupts the electric current. The extinguishing agent immediately converts into gas. As a result of cooling and (partly) by oxygen reduction, a fire on a PCB or within an enclosure will be extinguished within seconds. And, because the current flow over the E-Bulb is interrupted, the electric fire cannot re-ignite!

E-Bulb





Watch E-Bulb video
https://youtu.be/gWCyjGd9NuU

E-Bulb got intensively tested and is widely accepted and certified by:

E-Bulb capabilities:

- ✓ Inside the electrical device (on the pcb)
- ✓ Directly at source of highest risk!
- ✓ **Irreversibly cuts power supply**
- ✓ Stops re-ignition!
- ✓ **Extinguishes the fire!**

E-Bulb benefits for manufacturers:

- ✓ Safer products - securing lifes, property and lowering business interruption
- ✓ Reduce flame retardant materials
- ✓ Cost saving – Lowering the risk of product recalls and lower product recall costs
- ✓ Acceptance by insurances

Simply. More. Safety.

Extinguishing agent FK-5-1-12 is perfluoro(2-methyl-3-pentanone) (in short PFMP)

To determine the environmental fate of perfluoro (2-methyl-3-pentanone) (in short PFMP) and define its potential long-term effects in the environment, this Scientific Opinion (Step 1) evaluates classification drivers of ecotoxicity, such as absence of degradability, mobility, and potential for bioaccumulation (see 'FATE' in Table 1 1) as well as ecotoxiological information on short or chronic aquatic toxicity (see 'ECOTOX' in Table 1 1). The intrinsic properties of PFMP-are presented using key parameters. Where information was available on the agreed classification and labelling in relation to environmental effects, this data was also included in Table 1 1 (see 'Nature and level of risks').

Table 1-1: Overview of main ecotoxicological properties

	FATE		ECOTOX		PBT or vPvB	Nature and level of risks
Substance	Persistence *1	Bioaccumulation *2	Aquatic toxicity *3	*3	*4	*5
			Acute	Chronic	REACH	GHS
PFMP	□#$	□ accumulation is not expected	□	□	No	Aquatic Chronic 3 H412&

□ or □□: very low or low hazard; ■ or ■■: moderate or high ecotoxicologically hazard, arbitrary scaling of severity grade;
$ Biodegradation studies cannot be performed with PFMP as it hydrolyses upon contact with water.
# Rapid direct photolysis in the atmosphere and fast hydrolysis to PFPA in water; refer to Section

Summary of Research

The data summaries from recognized, peer reviewed sources or published reliable test data provide sufficient level of information (and validity of the data) regarding PFMP. The integrated overview explaining the conclusions can be found in the comprehensive research document (Section 6).

In brief, PFMP has a very low solubility in water and due to its volatile properties, PFMP can be considered mobile in the air, but not in the aquatic environment; hence water is not a relevant environmental compartment for PFMP. In addition, there is good evidence for degradation of PFMP by direct photolysis in the atmosphere associated with a short degradation half-life (dominant degradation pathway) and by hydrolysis (insignificant degradation pathway), and absence of persistence of PFMP itself. The bioaccumulation potential of PFMP is predicted to be low. Thus, there is no potential for secondary poisoning, e.g. for birds eating mussels or worms, for mammals eating worms or fish, and for fish eating invertebrates. In addition, PFMP has virtually no risk of aquatic toxicity. Regardless, PFMP was classified in the category 'Chronic Hazard 3' under the Globally Harmonized System (GHS) based on in silico analyses using quantitative structure-activity relationship (QSAR).

Based on these consideration, preliminary assessment (also refer to document, section 5.1.1.5) indicates that PFMP itself should not be considered a substance that is persistent in the environment or mobile in the aquatic environment or toxic (i.e. PFMP itself is not PMT), nor as a substance that would be very persistent in the environment and very mobile in the aquatic environment (vPvM) or bioaccumulative (B). Therefore, PFMP itself does not pose an inherent hazard to drinking water resources and no secondary poisoning along the food chain is expected. Overall, current data (as of June 2023) indicate a low potential for increases in PFMP concentrations in the environment and/or potential irreversible exposure of wildlife and humans via the environment.

E-Bulb applications and case studies


Media Technology


Medical Technology


Home Appliances

Power Adapters


Automotive

Media Technology

E-Bulb in media technology enables digitalization in sensitive areas (e.g. airports, trainstations, hospitals, fairs, etc.)

new: VdS 6024 guideline

Describes how digitalization in sensitve areas can be enabled using integrated fire protection

Case study - LED wall at airport Frankfurt terminal 1

Situation: Due to digitalisation initiatives more and more screens want to be installed in sensitive areas. In escape and emergency routes additional fire load (e.g. LED walls) need additional fire protection.

Solution: Integrated fire protection and E-Bulb can enable digitalisation.

The LED wall from SAMSUNG with integrated E-Bulbs fullfills all fire protection requirements and was allowed to be installed above the passenger walkway. Many similar projects have been completed at German airports, hospitals, train stations, shopping centers and apartment blocks.

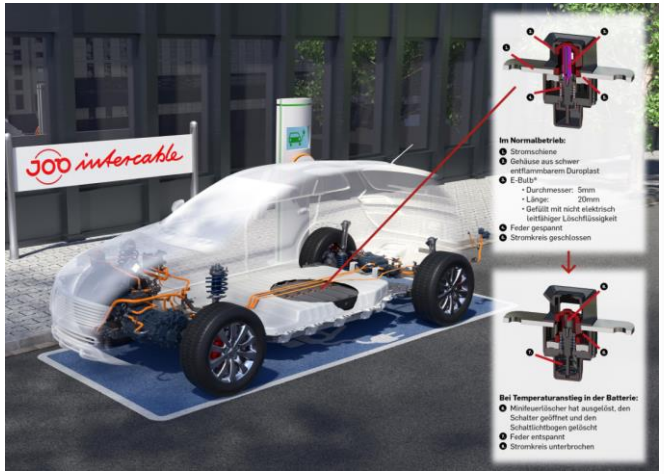
E-Bulb are used in different applications

Home appliances:

E-Bulbs are used in refrigeration, television and dishwashers to mitigate the risk of electrical fires and make safe home appliances safer.

Automotive:

Increasing demand for emobility also increases the risk of fires due to technical failures of lithium ion batteries. E-Bulb integrated in a TP-link (see AutoBild article) can mitigate the risk of a thermal runaway of lithium ion batteries causing devastating fires.



→ watch video how the technology works
→ read AutoBild article

E-Bulb in context to PFAS

E-Bulbs are filled with FK-5-1-12 (CAS: 756-13-8)

- One E-Bulb is filled with just 0,37 mL of FK-5-1-12
- 500.000 E-Bulbs are currently in the field and designed in electronics (just 185 Liter! in total)

E-Bulbs are **not planned to be released during product lifetime** (see REACH and RoHS)

Statistically it can be expected that **about 10 ppm** of E-Bulbs **will be activated** due to fire incidents.

Equals 5 E-Bulbs and 2 mL of FK-5-1-12

In other words

In London nearly one fire a day involving white goods

Source: London Fire Brigade

The environmental damage of a developed fire is expected to be tremendously bigger than PFAS emission (0,37 mL) due to E-Bulbs

Expected Emissions

a.) Activations in the field
b.) Emissions due to improper recycling
c.) Emissions during production process (audits at JOB factories welcome)

Activations in the field

Year	E-Bulbs in the field	FK-5-1-12 in the field (worst case)	Expected released FK-5-1-12 (realistic case, 10 ppm)
2024	2 mio. pcs	740 Liter	7,4 mL (milliliters!)
2026	6 mio. pcs	2.220 Liter	22,20 mL
2028	8 mio. pcs	2.960 Liter	29,60 mL
2030	9 mio. pcs	3.330 Liter	33,30 mL

Emissions due to improper recycling

- We expect that about 90% of all home appliances in Europe get properly recycled / delivered at recycling center.
- 10% get impropperly recycled and would be a future potential for emission of FK-5-1-12 from E-Bulbs
- A circular economy process needs to be setup

Emissions during production process

- Further details see next slide

E-Bulb production

E-Bulb production simply explained:

- Raw glass gets formed into bone shape structure
- Glass tube gets filled with FK-5-1-12
  - The filling process is done under vaccuum to limit emmisions.
- The glass tube welding process seales the FK-5-1-12 in the glass tube
- The E-Bulb gets coated for electrical conductivity
- The E-Bulb gets checked and packed

Room for improvement to lower FK-5-1-12 emissions

- FK-5-1-12 gets delivered in large canisters and decanted into the filling machine. Some leakage can occur
- During the filling and sealing process the bulb is open to one side and some leakage can occur
- All emmisions get distributed in the air (life time in air < 36 hrs). No direct distribution in water cycles possible.

- About 10-20% of quantity needed for production is lost by emission
  - 2024: improvement potential 10%
  - 2026: improvement potential 8%
  - 2028: improvement potential 6%

Why is the E-Bulb technology important to society

Enabling digitalization in sensitive areas:
Improved fire protection allows installation in sensitive areas.
In areas where many people come together (shopping centers, train stations, airports, fairs, hospitals, museums, etc.) electrical devices (e.g. fire loads that can self ignite due to electricity) need additional measures to mitigate risk of fires. Integrated fire protection and E-Bulbs can enable installations also in escape and emergency routes. The newly written VdS 6024 standard provides legal certainty for all stakeholders involved in such installations.

<u>Many projects made possible already:</u>
Airport Frankfurt, Airport Hamburg, Main train station Hamburg, Messe Berlin, UKE Eppendorf (hospital), Charité Berlin (hospital), etc. by et al SAMSUNG, Sharp / NEC, Daktronics, …
We expect that in the future about 70% of all media technology installed in sensitive areas will be equipped with integrated fire protection.

<u>Expected numbers:</u>
By 2030 about 60% of all digital signage projects in Europe at sensitive locations will be equipped with integrated fire protection (i.a. E-Bulbs). E-Bulbs enable digitalization.

Why is the E-Bulb technology important to society

Safer home appliances and electrical power supplies → less damages

For example the Grenfell Tower (2017, London) case caused by faulty refrigeration causing 72 fatalities.

About 10 ppm of home appliances catch fire. These fires not only lead to devastating environmental damages, but moreover destroy lifes and property. Imagine, in 2030 about 9 million E-Bulbs can mitigate the risk of fires and save lifes and property. This advantage is confronted by the risk of 3.330 Liter of FK-5-1-12 in the field (but sealed inside E-Bulbs) and probably only 33,3 mL of FK-5-1-12 emitted in the air.

Safer e-mobility possible

The number of electrical vehicals will increase over the next years. Further, also the fires caused by electrical vehicales will increase. Many times the route cause is a faulty lithium ion battery. It`s almost impossible to stop a lithium ion battery fire. However there are two main measures possible: a.) controlled burn out b.) stop thermal runaway before it starts.

E-Bulb integrated in a TP-Fuse can stop a thermal runaway before it gets out of control. E-Bulb integrated in electrical vehicle seires will mitigate the risk of of lithium ion battery fires.

If you want to know how it works: watch the video or read AutoBild article

Benefits for society

- ✓ Safer products - securing lifes, property and lowering business interruption
- ✓ reduction of flame retardant materials possible
- ✓ lower risk of fire hazards
- ✓ lower risk of fire caused fatalities,
  - ✓ Every year, over 5.000 people die from residential fires in Europe (see europeanfiresafetyalliance.org)
- ✓ increased safety for fire fighters
  - ✓ Every year, between 40-70 fire fighters die in Europe on duty
- ✓ less damage costs
- ✓ less insurance claims
- ✓ increase in GDP

Requirements of capabilities of extinguishing agent

Ranked descending to importance

Capabilities/Agents	Reason
little space for storage needed	E-Bulbs form factor requires little space for storage of the agent
high heat absorbing capacity	Small form factor of E-Bulb requires high heat absorbation capacity of extinguishing agent to cope with fire situation
non-conductive	Aim to extinguishing electrical components. Non-conductivity needed to avoid short circuits due to extinguishing process
liquid with low boiling point (> 35°C, < 80°C)	Fast transition into gas and vaporization needed to quickly extinguish a fire inside electronics
zero ODP	Zero ODP reduces the impact on environment
no/low global warming potential	No/low global warming potential reduces the impact on environment
non-corrosive	E-Bulb many times is used to extinguish in sensitive areas where collateral damage needs to be avoided
absorption of gas molecules in the liquid under pressure in closed space	In order for the E-Bulb to activate ambient temperature heats up internal liquid agent. Agent begins to expand due to heat increase. Air bubble compresses. At the moment of no air bubble internal pressure starts to increase until bulb bursts
non-flammable	Surrounding environment will mostlikely be highly flammable, non-flammable agent is needed
high molecular weight (> 200)	Uniform heat absorption and future recyling processes
high mobility (capability of distribution in closed environment)	Due to its small form factor, a fast distribution of gas within the enclosure is necessary in order to fast and reliably extinguish the fire
low compressibility of the liquid	Physical functionalities of the E-Bulb requires fast vanishing of air bubble, hence low compressibility of liquid is necessary

Alternative check for E-Bulb?

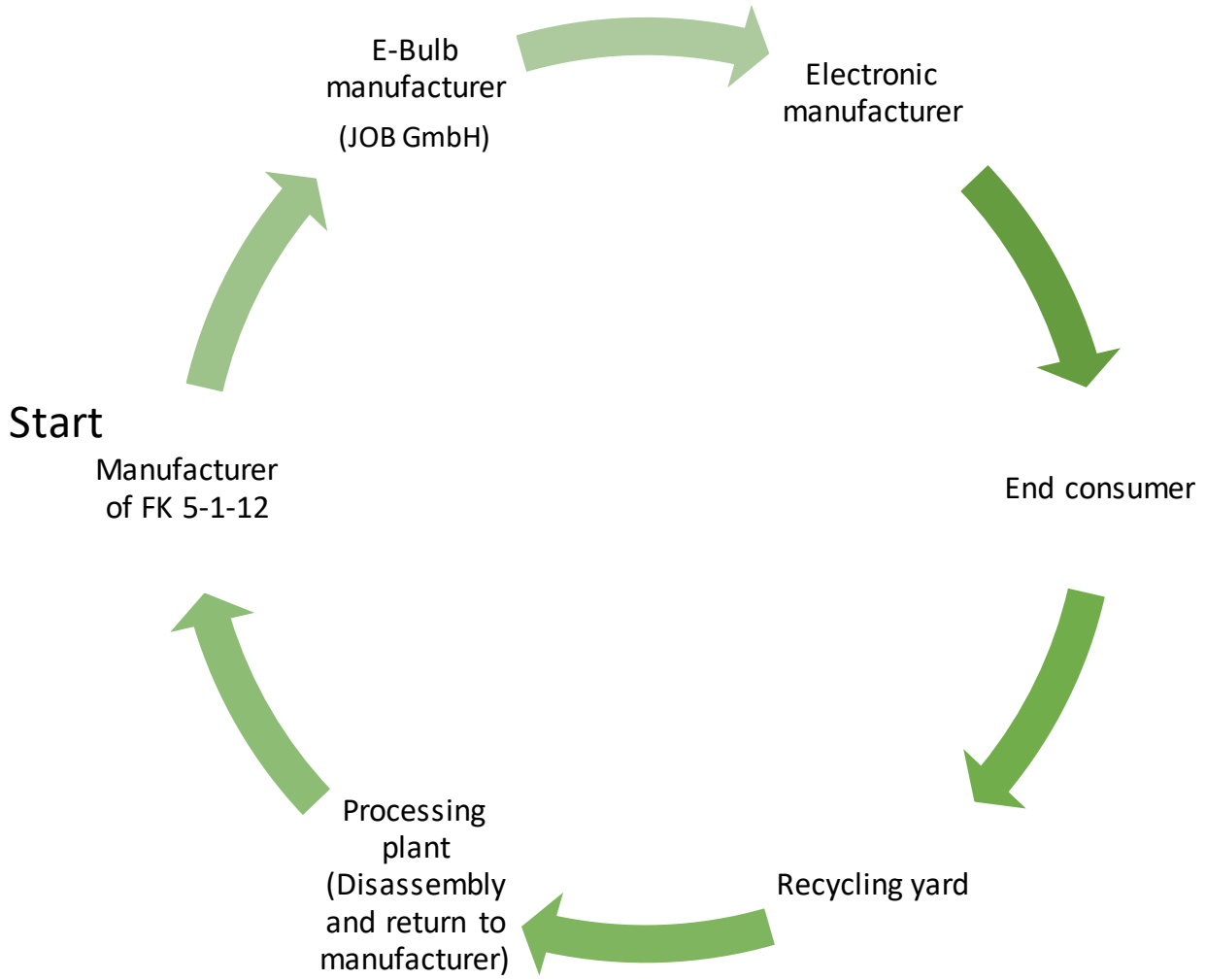
Ranked descending to importance

Capabilities/Agents	FK-5-1-12	CO2	Water	Halon	Fluorinated extinguishing foams	chlorinated hydrocarbons	Inert gas (e.g. Argon, N2, …)	Powder
high heat absorbing capacity*	√	X	(√)	(√)	(√)	(√)	X	X
non-conductive*	√	√	X	(√)	X	X	√	√
Liquid with low boiling point (> 35°C, < 80°C)	√	X	X	(√)	X	X	X	X
zero ODP	√	√	√	X	X	X	√	√
no/low global warming potential	√	X	√	X	(√)	X	√	√
non-corrosive	√	X	√	√	√	√	√	√
absorption of gas molecules in the liquid under pressure in closed space	√	X	√	(√)	X	√	X	X
non-flammable	√	√	√	√	√	√	√	√
high molecular weight (> 200)	√	X	X	X	(√)	(√)	X	(√)
high mobility (capability of distribution in closed environment)	√	√	X	√	X	√	√	X
low compressibility of the liquid	√	X	√	(√)	X	√	X	X

*based upon internal analysis

➔ No alternative available for device integrated fire protection

FK-5-1-12 possible recycling cycle for E-Bulb



This process will be feasible in case other FK-5-1-12 users participate.
Alternative: high temperature waste treatment process followed by a chemical filter step to mineralize the flourine content

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