

New Swiss guideline "Air Pollution Control at Construction Sites" requires retrofitting particle traps to new and old construction equipment, deployed at large worksites

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Based on the Environmental Protection legislation and the subsequent ordinance on air pollution control in Switzerland, the national environmental authority BUWAL issued the guideline "Air Pollution Control at Construction Sites". The guideline was written in close cooperation with cantonal authorities and specialists from the construction industry.

For the first time, there is a comprehensive package of measures and methods for the reduction of air pollutants from construction activities. These pertain to high intensity emissions from construction techniques and processes, e.g. roadwork, surface coatings and machining of building materials. Moreover, the guideline contains instructions aimed at curtailing emissions from combustion engines. The measures include: low-sulfur diesel fuel, benzene-free gasoline, compliance with EU-Guideline 97/68, regular exhaust checks, and finally, fitting and retrofitting particle traps to new and old construction equipment, deployed at large worksites.

1 Off-road particulate emissions

The Swiss Ordinance on Air Pollution Control (OAPC) specifies effective immission limits to prevent respiratory diseases and other health problems caused by fine dusts. Maximum annual averages are prescribed for ultrafine particles (diameter < 10 µm, so-called PM10). More than 60 % of the Swiss population reside in areas where the annual average PM10 limits are exceeded. Under such circumstances, the OAPC stipulates additional countermeasures to curtail emissions. The emission excesses cause health damages estimated to cost billions of Swiss Francs, within the country.

The study "Public-health impact of outdoor and traffic-related air pollution: a European assessment" (The Lancet, September 2, 2000) states the consequences of manmade air pollution (PM10) on Swiss **Mortality and Morbidity**:

- Mortality: 3'300 cases annually
- Bronchitis in children: 45'000 cases annually

Particularly in residential areas, urgent steps are needed to curtail impermissibly high fine-dust concentrations in the ambient air. Particle emissions must be substantially reduced throughout the country to diminish the PM10 impact to a hygienically tolerable level.

Diesel soot is carcinogenic

The diesel soot, too, is part of the PM10. The OAPC classifies diesel soot as carcinogenic, i.e. minimizing it is imperative. The authorities are obliged to act. There is no known safe threshold, below which diesel soot is not carcinogenic. Hence, countermeasures must be continuously updated to benefit from the best available technology. The toxicity of diesel soot makes economic feasibility secondary to the legal obligation.

Recent research findings, on the toxicity of ultrafine particles, impel the responsible Swiss authorities to the following standpoint:

Swiss position

From the public health perspective, it is important to measure not only the mass but also the concentration count and the surface area of the ultrafine particles, in the range 20 – 300 nanometer. These emissions must be controlled and curtailed using appropriate methods.

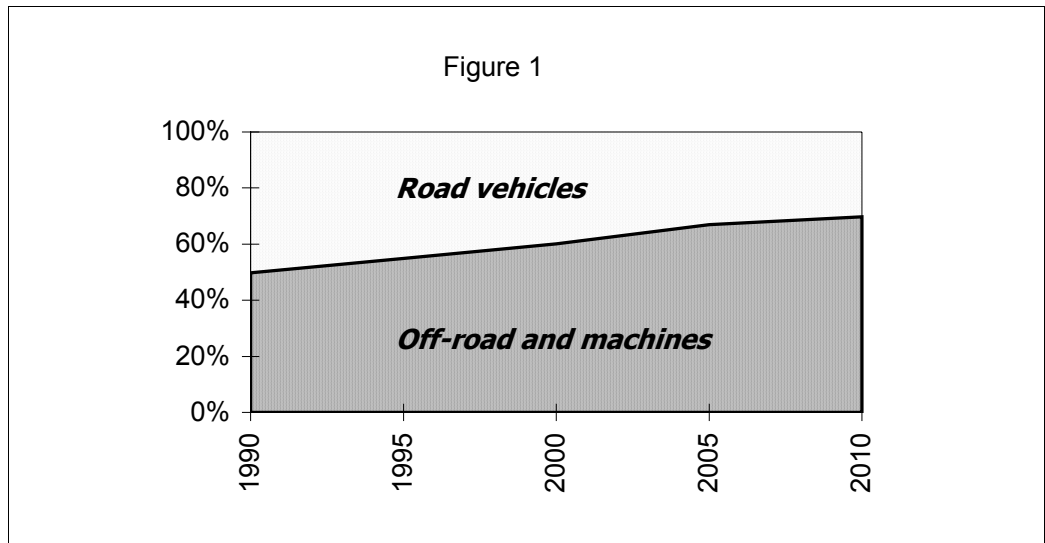


Figure 1 shows the significance of the diesel particulate emissions in the off-road sector, compared to Swiss road traffic emissions. Included are benefits from the emission limits enacted in 1995. More than half the total particulate emissions of combustion engines originate from machines at construction sites, or from Diesel engines that are not subject to the exhaust gas restrictions of road vehicles. The forecast is that in the year 2010, the off-road fraction would increase to 70 %, unless effective preventives are mandated.

2 Diversity of the off-road-sector

The "**off-road sector**" comprises all mobile combustion engines that are not in road vehicles. The sector includes:

a. **Transportation:**

- Rail
- Ships
- Aircraft

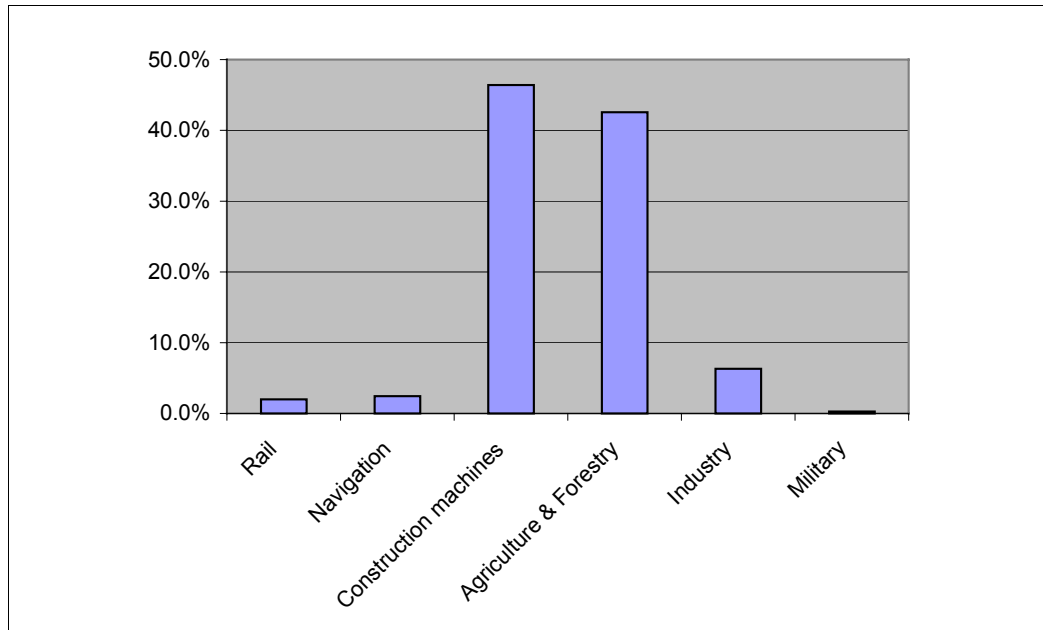
b. **Machines and equipment for:**

- Construction
- Agriculture
- Forestry
- Industry and trade
- Garden and hobby
- Military

The off-road sector, with its remarkable heterogeneity of equipment and machines, was till now largely excluded from mandated preventives to curtail airborne pollutants. Hence, it is justifiably called the "forgotten sector".

Diesel particulate emissions from construction machines

Figure 2 illustrates 1995 data for the relative contribution of different pollution sources in the off-road sector. This distribution is still valid today. The emissions from construction machines exceed 40% and are the biggest source of Diesel particulate emissions off-road.



3 Construction machines are a significant source of emissions

A 200 kW-bulldozer, deployed some years, can emit during continuous operation at a worksite about 2 - 3 kg of diesel particles per working shift (10 hours).

The VERT Project

The VERT project targeted curtailing emissions from Diesel engines at tunnel worksites. The German, Austrian and Swiss authorities directed the project, performed during 1994 to 2000. At tunnel sites, there are many powerful diesel-driven machines. Yet, inadequate ventilation results in insufficient dilution and diesel soot exceeded the statutory limits at tunnel sites.

The VERT project proved that retrofitting particle-traps can diminish the particularly toxic ultrafine diesel-soot particles emitted, both from new and older Diesel engines, by a factor 100 to 1'000. Comparable curtailment is not even somewhat possible with most modern engine technologies or new fuel formulations or oxidation catalytic converters.

Lessons from the VERT project

Retrofitting construction site machines, with particle-trap systems, eliminates more than 95% of carcinogenic diesel soot that would be emitted from new and older engines or diminish the particle number by a factor 100 to 1'000.

Particle-trap imperative of the SUVA

Particle-trap systems are mandatory since 1st March 2000 for subterranean engines. After a transition period, effective 1st January 2002 it is compulsory to retrofit all underground diesel-powered machines and equipment with particle-trap systems.

Soot filters are declared best available technology, i.e. will be mandatory for many other applications, e.g. large-scale earthmoving, gravel pits, stone quarries and industrial vehicles. Guidelines for protecting air quality at worksites and deployment of construction machines

4 Air Pollution Control regulations for construction sites

Large construction sites are a substantial source of pollutants. The major sources are:

- Building demolition
- Mechanical work process (grinding, drilling)
- Debris dumping and storage
- Dirty roads and pathways
- Diesel engines powering construction machines

The above can cause excessive health impact, on population in the vicinity, from airborne dust and respirable ultrafine particles.

These findings motivated the Swiss Federal Government in 1997 to promulgate the Ordinance on Air Pollution Control prescribing emission limits for construction sites. The Ordinance empowered the Swiss environmental authority BUWAL to issue pertinent guidelines with specific countermeasures.

OAPC Article 88, Appendix 2

Building Sites

Emissions from building sites shall be limited as much as technology and operational conditions will allow, provided this is economically acceptable, particularly **by means of emission limits for the machines and equipment used** and appropriate working methods.

Account shall be taken of the type, size and location of the building site and the time of building work.

The Swiss Agency shall issue guidelines.

Enforcement is the responsibility of the cantonal authorities. The Swiss cantons have begun to enforce pollution control countermeasures, particularly at **large sites**, e.g.

- Enlargement of Zurich airport.
- New Gotthard alpine transit tunnel.
- Extension of the Swiss national railway network, etc.

Particle-trap systems are prescribed also for construction machines at the above sites. As of Spring 2002, more than 1'500 construction site machines are deployed with particle-trap systems.

5 Guideline Air Pollution Control at Construction Sites¹

The Swiss environmental authority (BUWAL) prepared the guideline within the framework of the Ordinance on Air Pollution Control (OAPC) and drew on the practical experience obtained. Further inputs came from the cantonal specialists and construction industry experts. The draft guideline was widely circulated for comments. These comments were considered, to the extent possible, in finalizing the guideline. It will be valid from 1st September 2002.

During the draft consultation process, parliamentarians submitted 2 interpellations on the topic of deploying particle-trap systems on construction machines at worksites.

- The interpellation "Emission limits for diesel soot" questioned the legality and therefore EU computability of mandatory diesel-soot filters. The initiators wanted the legislation postponed till the EU issued guidelines on particle-trap deployment.

The Swiss Government answered on 18 June 2002 that the deployment of particle-traps on construction machines was in the paramount interest of public and occupational health. Moreover, the deployment is economically beneficial. Analyses² show that these precautions have an attractive cost to benefit ratio. Retrofitting particle-traps is expected to cost the construction industry about 1.4 billion Swiss Francs, till 2020. The anticipated benefits, in lower health costs during that period, are estimated at about 4 billion Swiss Francs.

- The interpellation "Soot particle-trap" presumed that the particle-trap technology was not yet mature. Hence, the initiators demanded that deployment of particle-traps be postponed till the technology matured and new machines were delivered with factory-fitted particle-traps.

The Swiss Government answered on 19 December 2001 that the deployment of particle-traps was both affordable and also technically and operationally feasible. Exempting existing construction machines from retrofitting has the disadvantage that curtailment of diesel soot pollution would be noticeable only after 10 to 20 years.

¹ The Guideline Air Pollution Control at Construction Sites is accessible at:

http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/vorschriften/industrie_gewerbe/index.html

² BUWAL "Retrofitting construction site machines with particle-traps: cost/benefit perspective UM-148-D, 2002

6 The Contents of the new Guideline

The guideline describes pragmatic technical and organizational measures that can sustain diminished worksite emissions, at the source. Conforming to the OAPC, the guideline recognizes the pertinent factors, i.e. the type, size and location of the worksite as also the construction duration.

Examples of **basic precautions** (for all worksites):

- Wetting the dusty materials.
- Prohibit hot re-mixing of tar based road surfacing.
- Employ low-emission explosives.
- Periodically inspect exhaust emissions from engines ≥ 18 kW.
- Use low-sulfur (< 50 ppm) diesel fuel.

Supplementary **specific precautions** are needed at **large worksites**.

Examples of **specific precautions** (for large worksites):

- Enclose conveyor belts
- Extract and filter gases from welding
- Fit particle-trap systems to machines and power-tools ≥ 18 kW

Worksites are classified as **large** when:

- **At rural locations:**
 - > 1.5 years duration, or
 - > 10'000 square meter surface, or
 - > 20'000 cubic meter volume.
- **At urban and inner-city locations:**
 - > 1 year duration,
 - > 4'000 square meter surface, or
 - > 10'000 cubic meter volume.

Stipulations for combustion engine powered machines and tools

For all worksites:

- Deploy electric powered tools, whenever possible.
- Obligatory maintenance of machines with combustion engines.
- New machines must comply with Guideline 97/68 EG.
- Fuel gasoline engines with aromatics-free equipment gasoline (excepting 4-stroke engines with catalytic converter).
- Run Diesel engines with low-sulfur (<50ppm) diesel fuel.

All machines and vehicles with combustion engines ≥ 18 kW must be:

- identifiable;
- periodically inspected and have the pertinent exhaust maintenance document;
- affixed with the pertinent exhaust certification sticker.

All machines and equipment rated ≥ 18 kW at large sites must be operated with particle-trap systems approved in the Filter-list.

- Machines >37 kW by 1 September 2003
- Machines 18 - 37 kW by 1 September 2005
- Permitted are only particle-trap systems that passed the suitability tests:
 - Penetration <5% (Concentration count in the range 10-500 nm),
 - No relevant secondary emissions, e.g. NO₂, Dioxin and PAH,
 - Prolonged test (>2000 hours)

7 Outlook

Fitting and retrofitting is initially only mandatory at large worksites. Moreover, machines rated <18 kW are exempted. Nevertheless, it is anticipated that contractors will begin to progressively retrofit their equipment to attain maximum flexibility in deploying construction machines at both large and small sites. Thus, construction-site machines fitted with particle-trap systems will be increasingly deployed at small worksites, although it is not compulsory.

The enforcement authorities must compel more stringent preventives when excessive pollution (e.g. fine dust, PM10) is detected. Excesses are likely at worksites near heavy traffic or in urban and inner city zones. The Swiss Ordinance on Air Pollution Control authorizes mandating stringent countermeasures to combat excessive pollution. Some possibilities are: shortening the transition period, mandatory particle-trap retrofitting also of smaller machines and at small sites.

The BUWAL, since some years, finances technical support and consultation³ for enterprises retrofitting construction site machines with particle-trap systems.

The thorough field testing during the VERT-project revealed that not all particle-trap systems are the best available technology. Some are inadmissible for retrofitting. Hence, suitability tests were defined to assess filtering capability.

The suitability test verify that a particular trap type has a filtration efficiency > 95% (criterion is particle count). Moreover, the trap shall not synthesize secondary emissions and its efficiency must be guaranteed during 2'000 hours.

Only systems that successfully complete the entire suitability test are enrolled in the VERT Filter list⁴ and approved for deployment on construction machines. The AKPF (trap manufacturers' working group) provides a VERT identification label for machines equipped with approved particle-trap systems.

³ TTM Technik Thermische Maschinen, A. Mayer, Diplomingenieur
Fohrhölzlistr. 14b, CH-5443 Niederrohrdorf, Switzerland (Tel: 0041 56 496 64 14)

⁴ The Filter list is accessible at:

http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/vorschriften/industrie_gewerbe/index.html