

Environment in practice

## GUIDELINE

# Air Pollution Control at Construction Sites

Construction Guideline Air



Swiss Agency for  
the Environment,  
Forests and  
Landscape  
SAEFL



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at Construction Sites**

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# 1 Purpose

This Construction Guideline Air shall enable a consistent implementation of the prescribed precautions to protect air quality at construction sites. The Guideline defines the generally formulated directives in Figure 88 Annex 2 of the Swiss Ordinance on Air Pollution Control (OAPC). Moreover, this Guideline shows how construction sites are categorised in the framework of the approval procedures. The categories are based on planned activities and anticipated emissions. These determine the precautionary measures that are required.

## 2 Scope

The Construction Guideline Air is applicable to all construction sites with the exception of:

- Transport on public roads, which are relevant to the construction sites, and are subject to road traffic legislation<sup>1</sup>;
- Sources of building material, e.g. gravel pits and stone quarries, as well as installations preparing<sup>2</sup> building materials, provided such activities do not occur at a construction site;
- Corrosion protection works<sup>3</sup>; and
- Sites where emergency work is needed to restore public safety and order, e.g. due to catastrophes.

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<sup>1</sup> Such transports shall comply with the pertinent BUWAL publication on protecting air quality during construction site transports «Luftreinhaltung bei Bautransporten» Vollzug Umwelt, 2001

<sup>2</sup> Such installations shall comply with the stipulations of OAPC Annex 1.

<sup>3</sup> Such works shall comply with:

- Cercl'Air Recommendation No.14 on surface protection of outdoor objects «Oberflächenschutz an Objekten im Freien», 1996;

- BUWAL publication on OAPC concept for corrosion protection outdoors «Mitteilungen zur LRV Nr. 12, Korrosionsschutz im Freien, Konzept» Vollzug Umwelt, 2002,

- BUWAL publication on environmental protection during corrosion prevention works: «Umweltschutz bei Korrosionsschutzarbeiten - Planungsgrundlagen» Vollzug Umwelt, 2002.

# 3 Ordinance on Air Pollution Control (OAPC) Stipulations

## 3.1 Defining Installation

According to Article 7 Paragraph 7 of the Federal Law relating to the Protection of the Environment (FLPE), installations are buildings, highways and other fixed installations as well as modifications of the land. Installations are equal to appliances, machines, vehicles, ships and aircraft.

The OAPC Art. 2 elaborated the definitions. The Ordinance distinguishes between three types of installations: stationary installations (Article 2 Paragraph 1), vehicles (Article 2 Paragraph 2) and transport infrastructure (Article 2 Paragraph 3). According to Article 2 Paragraph 1, Stationary installations are:

- a. buildings and other fixed structures;
- b. site alterations;
- c. devices and machinery;
- d. ventilating installations which collect vehicle exhaust gases and discharge them into the environment as exhaust air.

Thus, the entire site (Letter b.), including its constituent buildings and fixed installations, e.g. conveyor belts or demolition equipment (Letter a.), as well as the deployed equipment and machines (Letter c.) are all classified as stationary installations.

## 3.2 Preventive limitation of emissions

Stationary installations must comply with the general substance specific limitations of emissions of OAPC Annex 1 (valid for all installations emitting substances listed in Annex 1). Moreover, they must also comply with any enhanced or variant installation-specific stipulations in OAPC Annexes 2 to 4 (valid for all special installations explicitly listed in Annexes 2 to 4).

Supplementary to the general stipulations in Annex 1, the OAPC (modified on 15<sup>th</sup> December 1997 and valid from 1<sup>st</sup> March 1998) specifies in Annex 2 (Additional or different emission limits for specific installations) new preventive directives for building sites (Figure 88):

<sup>1</sup> 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.

<sup>2</sup> The emission limits laid down in Annex 1 shall not apply to construction plant and building sites.

Paragraph 2 explicitly specifies that *the emission limits of OAPC Annex 1 do not apply*. However, all other stipulations are applicable, e.g. measures relating to

treatment, storage, transshipment and transport (Annex 1 Figure 43) and the minimization imperative for emissions of carcinogenic substances, e.g. diesel soot (Annex 1 Figure 82 Paragraph 1).

### **3.3 Emission declaration**

Constructionsites, defined as installations in the OAPC, must comply with OAPC Article 12. If a project is subject to an environmental impact assessment, the environmental impact statement contains all the information necessary to assess the potential deterioration in air quality due to the anticipated site emissions. For all other projects, the authorities can require the applicant to provide an emission declaration for the particular constructionsite.

### **3.4 Stricter emission limits**

The OAPC Ambient air quality standards (e.g. standards for fine dust PM10, see OAPC Annex 7) effectively prevent human respiratory diseases, other health problems and discomfort. If the OAPC standards are exceeded, particularly at large and prolonged constructionsites and at building sites in congested traffic and city centers, then stringent preventive measures must be enforced to abate emissions (see OAPC Article 5).

This Guideline does not describe the consequential stricter countermeasures. The executive authorities must clarify and issue additional directives, which are suitable for abating specific emissions at a particular worksite.

### **3.5 Compatibility of Stipulation G8 with the Federal Law on Technical Barriers to Trade<sup>4</sup> (TBT)**

Technical barriers to trade are treated in the Swiss Federal Law TBT of 6th October 1995. After a transition period, all diesel-powered machines and equipment at category B constructionsites must (Stipulation G8 of this Guideline) have particle trap systems (PTS) fitted to clean engine exhausts. This is a technical directive according to the TBT (Article 3 b). The TBT nevertheless allows such regulations, despite eventual technical trading barriers, when the following conditions are fulfilled. There must be a predominant public benefit and the directive is neither an arbitrary discrimination nor a hidden trading barrier. The Swiss Federal Cabinet considers that the deployment of PTS fitted equipment and machines is necessary to safeguard health, save lives and protect the natural environment. Hence, the Swiss Government declares the stipulation G8 to be compatible with the TBT (see also Swiss Parliament Proceedings 01.3585, Interpellation Estermann).

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<sup>4</sup> Bundesgesetz über die technischen Handelshemmnisse THG vom 6. Oktober 1995. SR 946.51  
Swiss Federal Law on Technical Barriers to Trade

# 4 Assessing air pollutant emissions at constructionsites

## 4.1 Definition of countermeasure stages

Categories A and B define the stipulations for preventive curtailment of air pollutants at constructionsites. Stage A comprises basic stipulations and represents the «good building practices». Stage B has supplementary stipulations for further specific precautions.

Both countermeasure categories generally envisage *low emission construction and processes*.

Table 4.1: Countermeasure stages and pertinent general stipulations

| Stage | Machines, equipment and processes represent:                   | Countermeasure                                 |
|-------|--|--|
| A     | At least the standard equipment and usual applicable processes | <i>Good building practice</i> (basic measures) |
| B     | Best available technology, as per OAPC Article 4               | Basic and specific countermeasures             |

## 4.2 Categorizing construction proposals

A *construction proposal* is categorized depending on the specific emissions and the site environment. The pertinent project specific parameters (**duration, type and size of the constructionsite**) are obtainable from the planning request. The building and population densities determine the parameter **location**. The project is categorized as «B» (basic plus specific countermeasures), when any **one** criterion (duration, area, or cubatures) is fulfilled for the pertinent project location class (see Table 4.2). Otherwise, the site is categorized «A» (basic countermeasures).

Table 4.2: Criteria to categorize constructionsites for countermeasures stage B

|                 |                     | Duration* of constructionsite | Type and Size of constructionsite |                        |
|-----------------|---------------------|-------------------------------|-----------------------------------|------------------------|
|                 |                     |                               | Area*                             | Cubature*              |
| Site* location: | Rural               | >18 months                    | >10'000 m <sup>2</sup>            | >20'000 m <sup>3</sup> |
|                 | Urban / city center | >12 months                    | >4'000 m <sup>2</sup>             | >10'000 m <sup>3</sup> |

**The authorities can make specific decisions for unusual circumstances (e.g. short duration but very high emissions, extremely high nuisance for nearby residents).**

# 5 Measures for abatement of emissions at construction sites

The following list of measures shall support the authorities, owners, planners and builders to promote the practical implementation of the OAPC stipulations at construction sites. The checklist specifies the general and constructional countermeasures to control air pollution, from planning till execution. Other countermeasures and preventives are not excluded, if they are proven to attain an equivalent reduction of emissions.

The basic countermeasures «A» represent «good building practice». These must be implemented at every construction site (see summary in Annex 6). Construction sites categorized «B» must implement in addition the countermeasures marked «B» in the table below.

## 5.1 Preparation and verification

|    |   |   |   |
|----|---|---|---|
| V1 | Define in a construction proposal: the type, quantity and duration of polluting construction activities.  | A | B |
| V2 | Contact the responsible office for air quality to clarify site specific questions and interpret the Construction Guideline Air.                                   |   | B |
| V3 | Clarify comprehensively the deployment of suitable machines and equipment; also planning of the pertinent construction style and methods.                         |   | B |
| V4 | Formulate site specific countermeasures and prerequisites for the tendering. Thus, facilitate practicable entrepreneurial solutions under competitive conditions. |   | B |
| V5 | Determine the monitoring and correctional criteria.   |   | B |
| V6 | Prepare fallback concept of countermeasures for unexpected events (e.g. breakdown of dust collectors, fire, etc.).  |   | B |

## 5.2 Mechanized work processes

Dust and aerosols at construction sites, originating from spot or diffuse sources (deployment of machines and equipment, transport on site trails, earthmoving, mining, preparation and transfer of materials, wind blown dust, etc.), must be curtailed with adequate prevention at the source. The following countermeasures must be implemented for dusty activities, e.g. grinding, milling, drilling, abrading, blasting, chipping, sharpening; demolition, crushing, heaping, dumping, separating, screening, loading, unloading, grasping, transporting, etc.:

**Material preparation and transfer**

|    |   |   |   |
|----|---|---|---|
| M1 | Bind dust through moistening the material, e.g. with controlled water spraying.   | A | B |
| M2 | Deploy crushers that cause as little dust as possible, and which crush using pressure instead of pounding.  |   | B |
| M3 | Equip pulverizers with dust traps. For powders >5mm, use separators and filter the dust from the exhaust air. For powders <5mm, encapsulate the installation, trap and dispose the dust. Sometimes the material type, particle size or envisaged subsequent processing may not permit moistening. In such situations, or if the emission suppression is inadequate, then other countermeasures can be employed, which enable equivalent emission abatement. |   | B |
| M4 | Employ transfer processes with small dump heights, low exit velocities and closed receptacles.  | A | B |
| M5 | Cover outdoor stretches of conveyor belts to abate dust. Encapsulate all transfer points.   |   | B |
| M6 | Minimize trimming, i.e. scraping and pushing rubble heaps on transfer sites. Also wind fence such workplaces to confine fugitive dust.  |   | B |
| M7 | Apply spray concrete preferably using a wet spray process with non-alkaline additives. Discuss exceptions with the authorities.   |   | B |

**Material storage**

|     |  |  |   |
|-----|--|--|---|
| M8  | Encapsulate the filling and emptying mechanism of silos storing dusty or powdery materials. Filter the air displaced from the silos.   |  | B |
| M9  | Prevent wind blowing dust away from deposits of rubble, e.g. road debris, concrete wreckage and recycled gravel sand, which are frequently shifted. Possible tactics are adequate moistening, protective walls or stopping work during unfavorable weather conditions. |  | B |
| M10 | Shield infrequently accessed dumps from wind exposure by covering with mats or tarpaulins, and greening with vegetation.   |  | B |

**Traffic surfaces at building sites**

|     |  |   |   |
|-----|--|---|---|
| M11 | Bind dust from unpaved trails, e.g. with compaction or water sprinklers.   | A | B |
| M12 | Restrict maximum speed on construction site pathways, e.g. to 30 km/h.   | A | B |
| M13 | Stabilize intensively used trails with suitable dust abating surfacing, e.g. asphaltting or greening. Regularly clean the trails and bind dust to prevent dirt accumulating. |   | B |
| M14 | Equip the exits, from the construction site, with effective dirt traps, e.g. wheel washing.  |   | B |

**Demolition and dismantling**

|     |   |   |   |
|-----|---|---|---|
| M15 | Dismantle demolition objects in large pieces, with appropriate dust binding, e.g. wetting.  | A | B |
| M16 | Provide intensive sprinkling or water curtains to bind dusts from large-scale demolitions and blasting, when enclosing is impossible. |   | B |

### 5.3 Thermal and chemical work processes

Gases and smoke are emitted from some thermal work processes at construction sites, e.g. heating (surfacing), torch-cutting, hot coating, welding and detonation. Emission abatement is important during hot processing bitumen (road asphalt, sealing, hot adhesion) and welding.

Solvents and other substances are emitted during processing products containing solvents or during chemical (detaching) processes at construction sites. Critical activities are: coating, gluing, dissolving, foaming, painting, spraying, etc.

#### Surfacing and sealing

Processing road surfacing materials

|    |  |   |   |
|----|--|---|---|
| T1 | Prohibit thermal preparation (e.g. hot-remix) of tar-based coating and materials at building sites.  | A | B |
| T2 | Use bitumen having low emission rates of air pollutants (smoke tendency).  | A | B |
| T3 | Substitute bitumen emulsions instead of bitumen solutions (road surfacing work). Discuss exemptions with the authorities before deploying. | A | B |
| T4 | Lower the processing temperature through appropriate choice of binding material.   | A | B |

Poured asphalt, hot casting, hot bitumen (mobile cauldron)

|    |  |   |   |
|----|--|---|---|
| T5 | Use poured asphalt and hot bitumen having lower smoke tendency. The processing temperature should not exceed the following values: <ul style="list-style-type: none"> <li>• Poured asphalt mechanically applied: 220 °C</li> <li>• Asphalt poured manually: 240 °C</li> <li>• Hot bitumen: 190 °C</li> </ul> | A | B |
| T6 | Deploy closed cauldrons with thermostats.  | A | B |
| T7 | Enclose repair and mounting work on bridges. Capture, extract and filter aerosols using best available technology.   |   | B |

Sealing work

|     |  |   |   |
|-----|--|---|---|
| T8  | Employ bitumen strips having lower smoke tendency.                     | A | B |
| T9  | Avoid overheating the bitumen strips used in hot sealing:              | A | B |
| T10 | Observe precautions T5–T7 when gluing sealing strips with hot bitumen. | A | B |

Arc and gas welding metals

|     |   |  |   |
|-----|---|--|---|
| T11 | Abate welding emissions: capture, extract (e.g. spot suction) and filter the emitted fumes. |  | B |
|-----|---|--|---|

Chemical work processes

|     |   |   |   |
|-----|---|---|---|
| T12 | Choose environmentally friendly products for surface treatment (grounding, undercoating, isolation coating, filling putty, painting, plastering, sticking, priming, etc.), as also gluing and sealing gaps. | A | B |
|-----|---|---|---|

Detonation

|     |   |   |   |
|-----|---|---|---|
| T13 | Employ low emission explosives, e.g. formulated as emulsion, slurry or water gel. | A | B |
|-----|---|---|---|

## 5.4 Stipulations for machines and equipment

|    |   |   |   |
|----|---|---|---|
| G1 | Deploy low-emission equipment, e.g. powered with electrical motors.   | A | B |
| G2 | Equip and maintain combustion-engine powered machines and tools according to the manufacturers' specifications.   | A | B |
| G3 | Display inspection stickers confirming the scheduled maintenance of machines and equipment powered by combustion engines <18 kW.  | A | B |
| G4 | All machines and vehicles with combustion engines $\geq 18$ kW must: <ul style="list-style-type: none"> <li>• be identifiable;</li> <li>• be periodically inspected as per Annex 2, and have an applicable exhaust gas test document; and</li> <li>• exhibit an exhaust- inspection sticker.</li> </ul>   | A | B |
| G5 | Directive 97/68 EG or the ECE Directive No. 96 are mandatory for new machines after the validity date. However, vehicles with traffic number-plates are subject to the road transport rules.  | A | B |
| G6 | Equipment powered with 2-stroke gasoline engines, or 4-stroke gasoline engines without catalytic converters, must be fuelled with special equipment gasoline certified to standard SN 181 163 (see vendor list obtainable from EMPA Dübendorf, Dept. 133, <a href="http://www.empa.ch">www.empa.ch</a> ).   | A | B |
| G7 | Employ low-sulfur fuels (sulfur content <50ppm) for machines and equipment powered with diesel engines.   | A | B |
| G8 | At constructionsites categorized B, diesel-powered machines and equipment must, depending on their power rating, have engines fitted with particle trap systems (PTS) complying with recommendations in the Filter List (BUWAL, Suva <sup>5</sup> ) or equivalently effective emission curtailment traps.<br><br>Transition periods:<br>After this Guideline is promulgated, there is a grace period as follows:<br>One year for engines rated >37 kW, or<br>Three years for engines rated 18–37 kW.<br><br>Exempt from particle-trap fitting are seldom (maximum one working day per site annually) deployed machines and equipment.<br>Excluded are combustion engine powered machines and equipment deployed in underground mines <sup>6</sup> . |   | B |
| G9 | Implement dust abatement (e.g. wetting, trapping, suction, filtering <sup>7</sup> ) for dusty mechanical working (e.g. sawing, grinding, etc.) of building materials. Constructionsites categorized A must enforce this Construction Guideline Air within 5 years of promulgation.  | A | B |

<sup>5</sup> See this Internet page for the updated Filter-list:

[www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg\\_luft/vorschriften/industrie\\_gewerbe/filter/](http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/vorschriften/industrie_gewerbe/filter/)

<sup>6</sup> Underground it has been mandatory since 1 Jan. 2002, to retrofit all deployed diesel-powered vehicles and equipment with particle trap systems. See Suva Communiqué AS456 of 30 April 2001 and the Suva Internet page on particle-trap imperative:

[www.suva.ch/scripts/suva/suvapro/partikelfilterobligatorium\\_d.asp](http://www.suva.ch/scripts/suva/suvapro/partikelfilterobligatorium_d.asp)

<sup>7</sup> See Suva Internet page on technical products «Produkte für die Technik»: [www.suva.ch/sapros](http://www.suva.ch/sapros) and the list of approved equipment: [www.BIA-HANDBUCHdigital.de/fs.html](http://www.BIA-HANDBUCHdigital.de/fs.html) under the Number 510'210

## 5.5 Tendering

|    |  |   |   |
|----|--|---|---|
| A1 | Specify the stipulations of this Construction Guideline Air in the tender documents, with project specific deliverables for compliance.  | A | B |
| A2 | Request bidders for entrepreneurial remedies (equipment, methods, and materials) to curtail emissions. (The aim is to elicit competitive practical proposals. The project owner should define the specific and weighted criteria for awarding the contract.) |   | B |

## 5.6 Construction fulfillment

Planning, preparation and inspection (implementation of emission abatement)

|    |   |   |   |
|----|---|---|---|
| B1 | Optimum scheduling.<br>Ensure punctual availability of the appropriate machines and equipment. The contractor must submit the pertinent list (see example in Annex 3) before work commences, and subsequently update the list periodically.                         |   | B |
| B2 | The project owners, or their nominated expert, must supervise the correct implementation of the emission abatement measures that are prescribed in the construction permit, in the specific deliverables for Guideline compliance and in the construction contract. | A | B |
| B3 | Compile the emission abatement measures in a specific Project Quality Management (PQM) system, e.g. with verification concept, inspection schedule and audits.  |   | B |

Training site crew in environmental correctness

|    |  |   |   |
|----|--|---|---|
| B4 | Instruct the workers about the origin, dispersal, impact and abatement of airborne pollutants. Promote awareness how they can individually decrease air pollution and contribute towards lower site emissions. | A | B |
|----|--|---|---|

Organizational arrangements, informing third parties

|    |   |  |   |
|----|---|--|---|
| B5 | <p>The project owners or their competent nominee (site management, environmental consultant) shall together with the contractor prepare a concept for duties and responsibilities comprising:</p> <ul style="list-style-type: none"> <li>• Definition of how and when to contact the air quality authorities:             <ol style="list-style-type: none"> <li>a) in normal operation,</li> <li>b) when complaints occur,</li> <li>c) under exceptional circumstances of increased air pollution;</li> </ol> </li> <li>• Suggestions/ decision of supplementary, enhancing or correctional countermeasures;</li> <li>• Delay and deadlines until the «corrections» are effective;</li> <li>• Information and contact center for the affected neighbors:<br/>The information center must quickly and comprehensively communicate with the sufferers of the site originated air pollution. Thus, misunderstandings can be avoided and trust achieved. The information must at least state:             <ul style="list-style-type: none"> <li>- the total construction time,</li> <li>- anticipated heavy emissions and their duration,</li> <li>- envisaged countermeasures to abate emissions;</li> </ul> </li> <li>• Contact point for complaints (hotline telephone number) and more detailed information.</li> </ul> |  | B |
|----|---|--|---|

# Annex

## Annex 1: Evaluation aids for «Building Emissions»

This list identifies building activities (without claiming completeness), which could cause high emission levels. The list is structured according to the Swiss construction-costing scheme (NPK and BKP, see Glossary).

The aim is to increase awareness of the possible quantitative and qualitative aspects of air pollution from building processes. The evaluation aid is based on the authors' and Guideline consultative working group's experience and assessment of prevalent building practice (2001).

Anticipated impact of air pollutant emissions from building processes:

◆ High or very high      ❖ medium      ♦ insignificant

| Emissions from   | BKP              | NPK                                      | Non-engine Emissions |                             | Engine Emissions   |
|--|------------------|--|----------------------|-----------------------------|--|
|  |                  |  | Dust                 | VOC, gases, (solvents etc.) | NO <sub>x</sub> , CO, CO <sub>2</sub> , VOC, HC, particle etc. |
| Site infrastructure, particularly roads  |                  | 113                                      | ◆                    | ♦                           | ❖  |
| Site clearance   |                  | 116                                      | ❖                    | ♦                           | ❖  |
| Demolition and disassembly   |                  | 117                                      | ◆                    | ♦                           | ❖  |
| Building securing, particularly drilling and spray concrete  |                  | 120                                      | ❖                    | ♦                           | ❖  |
| Sealing subterranean constructions and bridges   |                  | 172                                      | ❖                    | ◆                           | ♦  |
| Earthmoving (inclusive surroundings, topsoil and drainage)   |                  | 211                                      | ◆                    | ♦                           | ◆  |
| Excavation   |                  | 212                                      | ◆                    | ♦                           | ◆  |
| Hydraulic engineering  |                  | 213                                      | ◆                    | ♦                           | ◆  |
| Foundation layers and material extraction  |                  | 221                                      | ◆                    | ♦                           | ◆  |
| Surfacing  |                  | 223                                      | ❖                    | ◆                           | ◆  |
| Rail track laying  |                  | 225                                      | ❖                    | ♦                           | ◆  |
| In situ concrete   |                  | 241                                      | ♦                    | ♦                           | ❖  |
| Underground mining   |                  | 260                                      | ◆                    | ❖                           | ◆  |
| Trail preparation, particularly traffic marking  |                  | 280                                      | ♦                    | ◆                           | ♦  |
| Concrete and reinforced concrete   | 211.5            | 313                                      | ♦                    | ♦                           | ❖  |
| Building maintenance and protection of concrete, core drilling and grinding.   | 211.7<br>211.7   | 131<br>132                               | ◆                    | ♦                           | ♦  |
| Working natural and artificial stone   | 216              | 345–46                                   | ❖                    | ♦                           | ♦  |
| Roofing, plastic and elastic surface sealing   | 224              | 362, 364                                 | ♦                    | ◆                           | ♦  |
| Special sealing and damming  | 225              | 318                                      | ♦                    | ◆                           | ♦  |
| Exterior plastering  | 226.1/272        | 348                                      | ❖                    | ❖                           | ♦  |
| Painting (exterior and interior)   | 227.1/<br>285.1  | 672<br>673–74                            | ❖                    | ◆                           | ♦  |
| Floor, wall and ceiling cladding with wood, artificial and natural stone, synthetics, textiles and mineral fibers (sprayed fibers) | 281, 282,<br>283 | 603, 661–65,<br>641/2, 345/6,<br>651–657 | ❖                    | ❖                           | ♦  |
| Site cleaning  | 287              | 682                                      | ❖                    | ❖                           | ♦  |

## Annex 2:

### **Curtailing emissions from combustion engines at construction sites**

The emissions from construction machines must be periodically inspected (see Chapter 5, countermeasure G4). The exhaust inspection document is updated when the stipulations described below are fulfilled.

Regularly registered road vehicles are exempt.

#### **1 Diesel engines**

Measuring the smoke emission<sup>8</sup>:

- Smoke is measured as peak value of the exhaust gas opacity, during free acceleration<sup>9</sup>.
- Use calibrated opacity meters and the procedures defined in the directive for combustion engine exhaust instrumentation (VAMV)<sup>10</sup>.

The Swiss Federal Office for Metrology and Accreditation (METAS) publishes the list of approved calibration instruments.<sup>11</sup>

##### **1.1 Diesel engines without particle trap systems**

The Guideline stipulation is fulfilled when the measured opacity coefficient  $k$  is less than  $2.5 \text{ m}^{-1}$  for aspirated engines and less than  $3.0 \text{ m}^{-1}$  for supercharged engines<sup>12,13</sup>.

##### **1.2 Diesel engines with particle trap systems**

The Guideline stipulation is fulfilled when the measured opacity coefficient  $k$  is less than  $0.24 \text{ m}^{-1}$ .

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<sup>8</sup> To verify the emission stability, it is recommended to also measure the exhaust-gas composition according to the Guideline on exhaust-gas instrumentation for worksite machines, dated 17 March 2000.

Measure the exhaust-gas components oxygen ( $\text{O}_2$ ), carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide ( $\text{NO}_2$ ) and hydrocarbons (HC) at lower idling, upper idling and at full load.

The guideline can be obtained from METAS or downloaded from the Internet.

<sup>9</sup> This method is identical with the test procedure for periodic exhaust-gas inspection of road vehicles pursuant to Art. 59a of the road transport directive Verkehrsregelnverordnung (VRV) of 13 Nov 1962, SR 741.11. Also the directive on vehicle smoke emissions "Verordnung über Wartung und Nachkontrolle von Motorwagen betreffend Abgas- und Rauchemissionen" of 22 Dec. 1993, SR 741.437.

<sup>10</sup> Instrument Specifications: directive on measuring engine exhaust-gases "Verordnung für Abgas-messgeräte für Verbrennungsmotoren (VAMV)" of 20 Oct 1993, SR 941.242; METAS directives of 27 Oct 1993. Verordnung über die Qualifizierung von Messmitteln (Eichverordnung) 17 Dec 1984, SR 941.210.

<sup>11</sup> Publication on the METAS web-site: <http://www.metas.ch/>

<sup>12</sup> Guideline 96/96/EG of the European Council dated 20 December 1996 on harmonizing the legislation of member states pertaining to technical inspection of motor vehicles and trailers.

<sup>13</sup> Verification of engine setting is recommended when the opacity coefficient  $k$  exceeds  $1.6 \text{ m}^{-1}$ .

## 2 Spark ignition engines (e.g. gasoline engines)

Following gas components must be measured during idling:

- Carbon monoxide (CO)
- Hydrocarbons (HC).

Measuring the exhaust gas composition:

- Use calibrated instruments and the procedures defined in the directive for combustion engine exhaust instrumentation (VAMV).
- METAS publishes the list of approved calibration instruments for gas composition<sup>14</sup>.

The Guideline stipulation is fulfilled when the following limits are not exceeded<sup>15</sup>:

- CO: 35'000 cm<sup>3</sup>/m<sup>3</sup>
- HC: 500 cm<sup>3</sup>/m<sup>3</sup>

## 3 Engine inspection

At each emission measurement, the emission-relevant fittings should also be inspected.

The exhaust gas inspection document must include a confirmation that the exhaust gas after-treatment system is correctly installed and gas tight.

## 4 Inspectors and documentation

The OAPC executive authorities or a designated specialist center shall perform the measurements. The authorities can also delegate this task to trained employees of the contractor.

The measurement results and the inspection findings must be recorded in the exhaust gas inspection document with date and signature of the inspector, according to the official printout from the exhaust-measuring instrument.

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<sup>14</sup> Published on the METAS web-site: <http://www.metas.ch/>

<sup>15</sup> Directive of 22 Dec 1993 on vehicle maintenance and inspection for exhaust-gas and smoke emissions "Wartung und Nachkontrolle von Motorwagen betreffend Abgas- und Rauchemissionen", SR 741.437

**Annex 3: List of machines and equipment deployed at the site**  
(Example)

The contractor shall prepare a list with information content as illustrated below. The list must be submitted to the project owners (large sites, categorized «B») *before construction begins* and periodically updated.

|                                   |   |                             |  |
|-----------------------------------|---|-----------------------------|--|
| <b>Owner</b>                      | <i>ARGE</i>   |                             |  |
| <b>Inventory Number</b>           | <i>xx</i>   |                             |  |
| <b>Equipment</b>                  | <b>Description</b>  | <i>truck with crane</i>     |  |
|                                   | <b>Type</b>   | <i>Astra Mod. HD7 64.38</i> |  |
|                                   | <b>Manufacture year</b>   | <i>2000</i>                 |  |
|                                   | <b>Weight</b>   | <i>xx</i>                   |  |
|                                   | <b>Fuel</b>   | <i>Diesel</i>               |  |
|                                   | <b>Power kW</b>   | <i>xx</i>                   |  |
|                                   | <b>Particle trap / cat.converter type</b>                               | <i>CRT System</i>           |  |
|                                   | <b>Emissions data<br/>- NO<sub>x</sub>, CO, HC<br/>- Particle/smoke</b> | <i>xxx</i>                  |  |
|                                   | <b>Noise emissions</b>  | <i>xxx</i>                  |  |
|                                   | <b>Number of units</b>  | <i>2</i>                    |  |
| <b>Anticipated arrival</b>        | <i>15.03.00</i>   |                             |  |
| <b>Arrived at site</b>            | <i>31.03.00</i>   |                             |  |
| <b>Commissioned</b>               | <i>10.04.00</i>   |                             |  |
| <b>Expected end of deployment</b> | <i>01.10.01</i>   |                             |  |
| <b>Duration months</b>            | <i>17.6</i>   |                             |  |

## Annex 4:

## Glossary

### **Aerodynamic diameter:**

characterizes the size of particles (aerosols, dusts) whose form and density are difficult to define. The aerodynamic diameter is the equivalent diameter of a spherical particle of density 1 g/cm<sup>3</sup> that has the same settling velocity as the observed particle.

### **Aerosols:**

are dispersed particles (solid or droplets) suspended in air or exhaust gases.

### **Asphalt:**

is natural or manufactured mixtures of bitumen or bituminous binders and mineral substances together with further materials and additives.

### **Asphalt (poured):**

is a dense mass of crushed stone, sand, filler and hard road-quality bitumen. When hot, it can be poured and leveled.

### **Best Available Technology (BAT):**

for emission curtailment is defined in OAPC Article 4. It represents the equipment, machines, procedures, methods and products that are successfully deployed in Switzerland and other countries. Moreover, it includes technology that is successfully demonstrated in test investigations and could be extended to other applications.

### **Bitumen:**

are complex hydrocarbon molecules (crude oil basis) as well as components of natural asphalt that are soluble in sulfur hydrocarbons.

### **Bitumen emulsions:**

are anionic or cationic emulsions with low solvent content (often aliphatic hydrocarbons).

### **Bitumen solutions:**

are solutions of bitumen in >20% solvents (volatile oil-refinery distillates).

### **Bitumen strips:**

are strips of substrate (felt, fleece, textiles) soaked with bitumen, or coated on both sides with bitumen paste and covered with mineral material.

### **BKP Construction Cost Plan (see also NPK)**

BKP and NPK are Swiss builders' methodology to characterize, catalog, tender, implement and invoice construction projects. The methodology is largely (BKP) or completely (NPK) based on craftsmen's differentiation. The BKP construction cost plan is common for small to large constructions.

### **Cold bitumen:**

is a bitumen solution of hard road-quality bitumen. The viscosity is lowered using volatile solvents.

**Construction machines:**

are all stationary and mobile machines and equipment, with or without road registration, deployed at the construction site (including road vehicles with mounted machines, e.g. concrete pumps, and transport vehicles).

**Construction procedure:**

defines the intended technology and methods to erect/demolish a construction or auxiliary construction. Usually, the contractor decides it.

**Construction style:**

defines the technical concept of the structures and the construction method. Usually, the planner decides it.

**Construction works:**

are all activities at a construction site that erect, modify or maintain constructions.

**Construction works with emissions:**

are works, to erect, modify or maintain constructions, which emit airborne pollutants, in particular:

- Deployment of machines and tools powered with combustion engines;
- Detonation and demolition;
- Dismantling, dumping, transferring, transporting within the site perimeter (particularly on unpaved roads);
- Milling, sawing, grinding and blasting, as also
- Torch cutting, chemical stripping, coating and gluing.

**Cubature:**

The parameter «cubature» is used to categorize construction sites and is the sum of:

- a) Demolition or dismantled volume, plus
- b) Excavation volume including earth moving, plus
- c) Building volume above ground.

**Duration:**

is the elapsed time for all building activities from groundbreaking until hand-over.

**Dusts:**

are dispersed airborne particles.

**Engine emissions:**

are emissions (particles, NO<sub>x</sub>, HC, CO, CO<sub>2</sub>) originating from combustion and wear in engines (diesel, gasoline, gas).

**Equipment gasoline:**

is a special fuel for equipment that is free of benzene and aromatics (as per standard SN 181 163).

**Equipment with combustion engines**

Building tools powered by 2- or 4-stroke combustion engines, e.g. shakers, pumps, generators, compressors, power saws and other handheld tools. Exhausts from handheld tools powered by 2-stroke-gasoline engines have very high HC and CO concentrations.

**Location:**

is for site categorization broadly distinguished between «rural» and «urban/city center».

**Rural:** is a zone of low population and construction density.

**Urban/city centers** are zones of medium to high population and building density. This includes the suburbs.

**Non-engine emissions:**

occur at construction sites through mechanical (physical) and thermal/chemical work processes that create, release and/or blow around dust, fine dust, smoke and/or gaseous substances.

**NPK (Standard Positions Catalog, see also BKP):**

is a Swiss methodology that describes and numbers all construction activities. It is widely used in large building and other civil engineering projects.

**Particles:**

are dust particles emitted from pollutant sources or wind blown or indirectly formed from precursor gases (e.g. sulfate particles from SO<sub>2</sub>).

**PM10:**

are particles with an aerodynamic diameter <10 µm.

**Surface area**

The parameter «area» to categorize the construction project is based on the size of:

- a) Road surface area, or
- b) Trench area, or
- c) Facade area, or
- d) Site area.

**Tar:**

is a product from the dry distillation of shale, lignite or wood.

**VOC:**

are volatile organic compounds and comprises all organic compounds that have a vapor pressure ≥ 0.1 mbar at 20°C.

## Annex 5:

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General environmental best practices include, whenever the construction enables, choosing ecological (durable, low or zero toxicity, recyclable, easily disposable, etc.) building materials that are also not energy intensive (i.e. low energy requirements in manufacturing and disposal). There are many publications on this topic, which are partially classified according to NPK or BKP.

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## Annex 6: Basic countermeasures to protect air quality at construction sites categorized «A»

(Abstract from Guideline Chapter 5)

|                                     |    |  |   |   |
|-------------------------------------|----|--|---|---|
| <b>Preparation and Verification</b> | V1 | Define in a construction proposal: the type, quantity and duration of polluting construction activities. | A | B |
|-------------------------------------|----|--|---|---|

### Mechanized work processes

|  |    |  |   |   |
|--|----|--|---|---|
| <b>Material preparation and transfer</b> | M1 | Bind dust through moistening the material, e.g. with controlled water spraying.                | A | B |
|  | M4 | Employ transfer processes with small dump heights, low exit velocities and closed receptacles. | A | B |

|                                    |     |  |   |   |
|------------------------------------|-----|--|---|---|
| Traffic surfaces at building sites | M11 | Bind dust from unpaved trails, e.g. with compaction or water sprinklers. | A | B |
|                                    | M12 | Restrict maximum speed on construction site pathways, e.g. to 30 km/h.   | A | B |

|                            |     |  |   |   |
|----------------------------|-----|--|---|---|
| Demolition and dismantling | M15 | Dismantle demolition objects in large pieces, with appropriate dust binding, e.g. wetting. | A | B |
|----------------------------|-----|--|---|---|

### Thermal and chemical work processes

|   |    |  |   |   |
|---|----|--|---|---|
| <b>Surfacing and sealing</b><br>Processing road surfacing materials | T1 | Prohibit thermal preparation (e.g. hot-remix) of tar-based coating and materials at building sites.  | A | B |
|   | T2 | Use bitumen having low emission rates of air pollutants (smoke tendency).  | A | B |
|   | T3 | Substitute bitumen emulsions instead of bitumen solutions (road surfacing work). Discuss exemptions with the authorities before deploying. | A | B |
|   | T4 | Lower the processing temperature through appropriate choice of binding material.   | A | B |

|  |    |  |   |   |
|--|----|--|---|---|
| Poured asphalt, hot casting, hot bitumen (mobile cauldron) | T5 | Use poured asphalt and hot bitumen having lower smoke tendency. The processing temperature should not exceed the following values: <ul style="list-style-type: none"> <li>• Poured asphalt mechanically applied: 220 °C</li> <li>• Asphalt poured manually: 240 °C</li> <li>• Hot bitumen: 190 °C</li> </ul> | A | B |
|  | T6 | Deploy closed cauldrons with thermostats.  | A | B |

|              |     |  |   |   |
|--------------|-----|--|---|---|
| Sealing work | T8  | Employ bitumen strips having lower smoke tendency.                         | A | B |
|              | T9  | Avoid overheating the bitumen strips used in hot sealing:                  | A | B |
|              | T10 | Observe precautions T5 and T6 when gluing sealing strips with hot bitumen. | A | B |

**Chemical work processes**

|     |   |   |   |
|-----|---|---|---|
| T12 | Choose environmentally -friendly products for surface treatment (grounding, undercoating, isolation coating, filling putty, painting, plastering, sticking, priming, etc.), as well as gluing and sealing gaps. | A | B |
|-----|---|---|---|

**Detonation**

|     |   |   |   |
|-----|---|---|---|
| T13 | Employ low emission explosives, e.g. formulated as emulsion, slurry or water gel. | A | B |
|-----|---|---|---|

**Stipulations for machines and equipment**

|    |  |   |   |
|----|--|---|---|
| G1 | Deploy low-emission equipment, e.g. powered with electrical motors.  | A | B |
| G2 | Equip and maintain combustion-engine powered machines and tools according to the manufacturers' specifications.  | A | B |
| G3 | Display inspection stickers confirming the scheduled maintenance of machines and equipment powered by combustion engines <18 kW.   | A | B |
| G4 | All machines and vehicles with combustion engines $\geq 18$ kW must: <ul style="list-style-type: none"> <li>• be identifiable;</li> <li>• be periodically inspected as per Annex 2, and have an applicable exhaust gas test document; and</li> <li>• exhibit an exhaust -inspection sticker.</li> </ul>      | A | B |
| G5 | Directive 97/68 EG or the ECE Directive No. 96 are mandatory for new machines after the relevant validity date. However, vehicles with traffic number-plates are subject to the road transport rules.  | A | B |
| G6 | Equipment powered with 2-stroke gasoline engines, or 4-stroke gasoline engines without catalytic converters, must be fueled with special equipment gasoline certified to standard SN 181 163 (see the vendor list obtainable from EMPA Dübendorf, Dept. 133, <a href="http://www.empa.ch">www.empa.ch</a> ). | A | B |
| G7 | Employ low-sulfur fuels (sulfur content <50ppm) for machines and equipment powered with diesel engines.  | A | B |
| G9 | Implement dust-abatement (e.g. wetting, trapping, suction, filtering <sup>16</sup> ) for dusty mechanical working (e.g. sawing, grinding, etc.) of building materials. Constructionsites categorized A must enforce this Construction Guideline Air, within 5 years of promulgation.                         | A | B |

**Tendering**

|    |  |   |   |
|----|--|---|---|
| A1 | Specify the stipulations of this Construction Guideline Air in the tender documents, with project specific deliverables for compliance | A | B |
|----|--|---|---|

<sup>16</sup> See Suva Internet page on technical products «Produkte für die Technik» [www.suva.ch/sapros](http://www.suva.ch/sapros) and see list of approved equipment: [www.BIA-HANDBUCHdigital.de/fs.html](http://www.BIA-HANDBUCHdigital.de/fs.html) under the Number 510'210

### Construction fulfillment

Planning, preparation and inspection (implementation of emission abatement)

|    |   |   |   |
|----|---|---|---|
| B2 | The project owners, or their nominated expert, must supervise the correct implementation of the emission abatement measures that are prescribed in the construction permit, in the specific deliverables for Guideline compliance and in the construction contract. | A | B |
|----|---|---|---|

Training site crew in environmental correctness

|    |  |   |   |
|----|--|---|---|
| B4 | Instruct the workers about the origin, dispersal, impact and abatement of airborne pollutants. Promote awareness how they can individually decrease air pollution and contribute towards lower site emissions. | A | B |
|----|--|---|---|