SLOVENSKI STANDARD
SIST-TS CEN/TS 17378:2019

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Inteligentni transportni sistemi - Mestni ITS - Upravljanje kakovosti zraka v mestnih območjih

Intelligent transport systems - Urban ITS - Air quality management in urban areas

Intelligente Verkehrssysteme - Urbane IVS - LuftqualitÃ¤tsmanagement in urbanen Gebieten

Systèmes de transport intelligents - STI-urbain - Gestion du qualité de l'air dans les zones urbaines

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ICS:

13.040.50	Emisije izpušnih plinov v prometu	Transport exhaust emissions
35.240.60	Uporabniške rešitve IT v prometu	IT applications in transport

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Intelligent transport systems - Urban ITS - Air quality management in urban areas

Systèmes de transport intelligents - STI-urbain - Gestion de la qualité de l'air dans les zones urbaines

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European foreword

This document (CEN/TS 17378:2019) has been prepared by Technical Committee CEN/TC 278 “Intelligent transport systems”, the secretariat of which is held by NEN.

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Introduction

Work on Urban ITS (U-ITS) is founded in the deliverable of PT1701 published as TR 17143 [1] and on the European Commission Decision of 12.6.2016 [2] in support of Directive 2010/40/EU [9].

As cities and urban complexes expand, and there is a significant trend from rural areas to cities around the world, pollution in these urban areas becomes an ever more significant problem. Traffic - vehicle movements within the urban complex - is not the only polluter, but is considered to be a major source of pollution. Other causes are air conditioning/central heating systems, coal and wood burning heating, factories, etc.

"Air pollution has a major impact on human health. It is associated with a range of deadly diseases including cancer, heart disease, strokes and asthma, and is the number one environmental cause of death in the EU, responsible for more than 430,000 early deaths in 2012 alone." [11]

"More than one fifth of the EU urban population are exposed to air pollution which exceeds EU limit values. As of 2013, exceedances of the PM10 daily limit value were registered in 22 EU Member States, while 19 remained in breach of limits for NO2. In theory, citizens in all those countries could go to court to demand that action is taken. In reality, national rules and procedures often make it very difficult for them to do so." EU law provides citizens with some possible solutions to these difficulties, by guaranteeing them rights to certain procedures. Domestic courts are obliged to give effect to EU law, even if this involves setting aside incompatible national laws. Domestic courts must give effect to EU law rights by providing effective remedies." [12]

This document provides guidance and identifies requirements and options on how to set up a policy and how to deploy reliable and scalable technologies to monitor air quality on continuous or regular basis and to react with adequate measures. This provides a means to measure the air quality required by relevant EU directives.

The most recent directive relating to ambient (outdoor) air quality is the DIRECTIVE 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe (the "Directive"), which was adopted in 2008 [13], and requires member states to:

— **Monitor and assess** air quality to ensure that it meets these objectives;

— **Report** to the Commission and the public on the results of this monitoring and assessment;

— **Prepare and implement** air quality plans containing measures to achieve the objectives.

This specification provides a means for urban administrations to demonstrate their progress to, and achievement of, EC required air quality.

1 Scope

This document provides information, guidance and specifications of requirements and options on how to set up an air quality (emissions) management policy, and how to deploy reliable and scalable technologies to monitor air quality on a continuous or regular basis, and to react with adequate measures.

This document defines technological concepts that provide reliable and open data, and defines the functional requirements on measurement devices that produce such data. This provides a means to measure the air quality required by relevant EU directives.

This document provides information and specifications enabling to specify air quality levels for triggering a scenario.

Specifically, this specification provides a toolkit of parameters and data definitions that a regulator can use to e.g.

— define proper air quality measures, suitable for a street, zone or the whole city

— inform a driver in advance of entry to a Controlled zone about air quality level and related policy measures expected to be in operation at a given time, e.g. higher parking price per location due to the adverse air quality; and of the time windows of the measure operation of the controlled zone

— inform the relevant city departments on the introduced measure, air quality levels and number of vehicles entered.

In order to maximize European harmonization, it is recommended that this specification is used in combination with a module of standardized data concepts, i.e. an “air quality management data dictionary” (AQMDD), however, this version of this document, which is focussed on policies and procedures, does not provide these data concept specifications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN/TS 17380:2019[1], *Intelligent transport systems - Urban-ITS - 'Controlled Zone' management using C-ITS*

EN 12341, *Ambient air - Standard gravimetric measurement method for the determination of the PM10 or PM2,5 mass concentration of suspended particulate matter*

EN 14211, *Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence*

EN 14662-3, *Ambient air - Standard method for the measurement of benzene concentrations - Part 3: Automated pumped sampling with in situ gas chromatography*

EN 12414, *Vehicle parking control equipment - Pay and display ticket machine - Technical and functional requirements*

[1] Under preparation. Stage at the time of publication: FprCEN/TS 17380

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

• IEC Electropedia: available at http://www.electropedia.org/

• ISO Online browsing platform: available at https://www.iso.org/obp

3.1
air quality monitoring station
equipment measuring air pollution, deployed ideally as a network, based on the reference methods for air quality monitoring as generally defined in Exchange of Information Decision (EO/ 97/101/EC)

3.2
emission management
application of regulations and policies for enabling controlled access of selected classes of vehicles to defined areas, and for controlled usage of such areas e.g. parking, in order to improve air quality in a given area

Note 1 to entry: The terms “emission management” and “air quality management” are used synonymously in this document.

3.3
fuel
combustible material in solid, liquid or gaseous form, determined by its producer for combustion to release the energy content of the material

3.4
geofencing
creating of a virtual geographic boundary

3.5
hackathon
design sprint-like event in which computer programmers and others involved in software development, including graphic designers, interface designers, project managers, and others, often including subject-matter-experts, collaborate intensively on software projects with the goal to create usable software

Note 1 to entry: Also known as a hack day, hackfest or codefest.

Note 2 to entry: Hackathons tend to have a specific focus, which can include the programming language used, the operating system, an application, an API, or the subject and the demographic group of the programmers.

3.6
particulate matter
issue with particles of solid and liquid material ranging from 1nm to 100µm, which remain for some time in the air

3.7
polluting matter
issue with any pollutant which, by its presence in the air, has or may have harmful effects on human health or the environment or annoys the odour

3.8
polluting
introduction of one or more pollutants into the air

3.9
traffic burden monitoring system
system applying traffic flow information technologies and AQMSs for providing wide area monitoring of a zone regarding traffic burden and air quality levels in the resolution of a street

3.10
volatile organic compounds
any organic compound or mixture of organic compounds, with the exception of methane having a vapour pressure of 0,01 kPa or more at 20 °C or a corresponding volatility under specific conditions of use

4 Symbols and abbreviations

AQMDD	air quality management data dictionary
AQMS	air quality monitoring station
BRT	bus rapid transit
CAMe	Comisión Ambiental de la Megalópolis English: Environmental Commission for the Megalópolis
FUA	functional urban area
ITS	intelligent transport systems
LEZ	low emission zone
NO	nitric oxide
NO2	nitrogen dioxide
NOx	nitrogen oxides
OBD	On-board diagnostic
P+B	park and bike
P+G	park and go
P+R	park and ride
PM	particulate matter
PM10	solid particles with aerodynamic diameter less than 10 µm
PM2.5	solid particles with aerodynamic diameter less than 2,5 µm
SUMP	sustainable urban mobility plan
VOC	volatile organic compounds
WHO	World Health Organization

5 Air quality (emissions) management context

5.1 Air quality

5.1.1 Background

The directive relating to ambient (outdoor) air quality 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe (the "Directive"), was adopted in 2008 [3]. The Directive consolidated a number of earlier directives and sets objectives for several pollutants which are harmful to human health.

It requires member states to:

— **Monitor and assess** air quality to ensure that it meets these objectives;

— **Report** to the Commission and the public on the results of this monitoring and assessment;

— **Prepare and implement** air quality plans containing measures to achieve the objectives.

NOTE Referenced background documents provide snap-shots behind the rational for the specifications of this document. Many of these references are liable to change over time.

5.1.2 Crucial process problems in air quality management in EU

In addition to the requirements to achieve the requirements of the regulation, some crucial problems in the whole process have been identified at various levels, see [19]:

— **Policy level: lack of supporting action**

Air quality plans often lack effective solutions, timeline and impact strategy, lack of long term vision and strategic goals, lack of synergic planning with other initiatives.

If the air quality levels are breached there are no consecutive obligatory steps to solve the problem, legal proceedings are delayed because legal actions can take several years to reach a conclusion.

— **Information level: lack of information**

The following points summarize the deficiencies in available information:

— **low density** of air quality monitoring stations (AQMSs) in cities,

— **lack of monitoring** on the most congested places,

— **lack of up-to-date information**, with data published a long time after breaches of limit values have occurred

— **technical presentation** of the measured data with low potential of public understanding

— **inconsistency** between "official" air quality data and other "unofficial" data

— **No "on trip" alerts** given to travellers, no warnings

— **No information on commitment** to achieve better air quality and the regular improvement status, lack of measures implementation and their real impacts

— **Air quality levels – limit values**

This specification proposes specific measurements, and recommends actions that can be taken when levels of air pollutions are rising (far before it is breached).

The strictest type of air quality objectives contained in the Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe [3] are known as "limit values." Limit values are set for:

— Particulate Matter (PM10 and PM2.5)

— Sulphur Dioxide (SO2)

— Nitrogen Dioxide (NO2)

— Lead

— Benzene

— Carbon Monoxide

Limit values are informed by guidelines set by the World Health Organization (WHO). However, in the case of PM10 and PM2.5, the limits presented in Table 1 are considerably higher (i.e. less stringent) than the WHO recommendations.

Table 1 — Limits defined by the Air Quality Directive [3]

Pollutant	**Obligation**	**Time period**	**Compliance deadline**	**Permitted annual excesses**
Nitrogen dioxide (NO_2)	Hourly limit value of 200 µg/m³	1 h	01/01/2010 (possible extension to latest 1/1 2015)	No more than 18
	Annual mean limit value of 40 µg/m³	Calendar year		n/a
Coarse particulate matter (PM_{10})	Daily limit value of 50 µg/m³	24 h	01/01/2005 (possible extension to latest 1/6 2011)	No more than 35
	Annual mean limit value of 40 µg/m³	Calendar year		n/a
	Annual mean limit value of 25 µg/m³	Calendar year	1/1/2015	n/a
Benzene	Annual mean limit value of 5 µg/m³	Calendar year		

5.2 Air pollution sources

Air pollution is caused by a variety of polluting matters from various sources; see Table 6. One of the main sources of city air pollution is traffic. Traffic emits various harmful matters, not just by combustion engines of cars and other vehicles but also so-called non-combustion pollutants including:

— particles derived by road surface abrasion,

— abrasion of tyres,

— mechanical components abrasion (braking pads, clutch lining),

— resuspension of dust laid on the road by the traffic,

— etc.

It is hard to identify the source of a particular matter as it can be emitted into ambient air by various sources. The following pollutants related to traffic are considered in this document as representatives for air quality related to traffic that can be monitored:

— nitrogen oxides,

— benzene,

— platinum metals,

— ultrafine dust particles.

Basic matter to be monitored are nitrogen oxides (NO, NO2, NOx) as they are emitted to the ambient air by all the high temperature combustion engines where fossil fuels are combusted at the temperatures higher than 1 300°C. In the urban environment, traffic is the dominant source of the pollutants except for areas with specific industry processes, e.g. producing Nitric acid.

The other two pollutants to be considered are dust particles and benzene.

5.3 Strategies and technologies

The introduction of new technologies brings potential for traffic management and management of air pollution, but sensors and networks of sensors suffer from the risk of unstable or uncertain data or even malfunction of the equipment.

Low-cost sensors enable the possibility of reliable, long term and low-cost traffic monitoring in large scale. This means that it becomes practicable for traffic to be monitored continuously in every street, which provides valuable data for decision making. It also provides valuable data about traffic densities, which can then be related to noise and air quality levels. The reliability of such data can be perceived as high and provides new possibilities to control traffic in an advanced way, to enable dedicated zones with geofencing and parking price regulation, e.g. in the event of smog.

Open data about the traffic burden will enable and encourage the citizens themselves to seek better traffic regulation and improved air quality.

Air quality monitoring is difficult. Low-cost electrochemical sensors can provide unstable and uncertain values of air quality, e.g. because changes of temperature and air pressure influence the quality of measurement significantly; see the report on real testing in the Czech Republic [21], where it was found that these sensors were unreliable and can become a source of “data noise”, see Figure 5. Therefore, specifically designed minimum requirements for AQMSs are necessary to enable to deploy systems that are reliable and that provide trustful data for city operational, as well as strategic, decision making, and to protect the public sector from buying unreliable sensor networks.

6 Considerations towards improved air quality

6.1 Introduction

The project SOLEZ [22] identified key elements of low carbon mobility policy and traffic regulation. The following steps are found to positively influence air quality, decrease the levels of noise, reduce congestion and achieve the goals of a 'Sustainable Mobility Plan' (SUMP).

The implementation of any or all of these recommendations is at the determination of a local jurisdiction, or to comply to European regulations. In order to claim compliance with this European Specification, where implemented, shall be implemented consistently in conformance to the specifications herein.

The findings can be classified as presented in 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7.

6.2 Policy

The consideration and the adoption of carefully thought out long term environmental goals is important. Insufficient or wrong policy can lead to even worse conditions. Odd and even licence plate numbers days supported buying of a second car in Athens, which worsened the situation. By comparison, the "Amsterdam Climate Programme and Energy Strategy 2040" and tactical urbanism in Barcelona (superblock) have produced improvements in air quality. The political commitment setting vision with long term goals is a corner stone for air quality improvement, and, importantly, for public acceptance of the adopted policies.

The ease of low carbon mobility tools implementation is strongly influenced by appropriate national legislation. The setting of long term goals and deadlines, with step-by-step (year-by-year) milestones is recommended. Policies, such as the introduction of parking zones, should be considered.

6.3 Infrastructure

The policy measures should be supported by suitable infrastructure. For example, zoning provides a jurisdiction with clear view on where the supporting infrastructures should be situated – mainly at the edge of the zones. The edge of the zone is a natural place for travel exchange therefore, parking facilities (P+R, P+B and P+G), bike sharing stations, bike parking, public transport stops, logistics drop-off and other supportive infrastructures, e.g. green corridors, are best placed there.

6.4 Technology

Reliable infrastructure should be based on multiple technologies. Single technology deployment is commonly insufficient to fulfil the requirements of reliability.

EXAMPLE 1 Siena upgraded automatic number plate recognition enforcement with infrared readings as a back-up technology which makes the solutions automatic and reliable.

EXAMPLE 2 Amsterdam has interconnected P+R ticket with PT ticket enforcing P+R use to distinguish the purpose of travelling to the city centre from just parking.

Geofencing specified in CEN/TS 17380:2019[2] may be a means to manage controlled zones.

6.5 Alternative transport modes

The parking provisions and controls are best accepted and effective if complemented with provision of alternative means of transport, enabling to exchange seamlessly and within one single fare. The introduction of a traffic regulating scheme brings a great potential for development of alternative transport modes.

EXAMPLE The Copenhagen wheel, i.e. a self-contained rear wheel electric bicycle system originally developed at MIT's Senseable City Lab in 2009 in partnership with the city of Copenhagen, and unveiled at the 2009 United Nations Climate Change Conference, provides an example of how long-term low carbon strategy can have positive impacts on local business and innovations in green economy.

6.6 Public acceptance

Public acceptance of regulating schemes is improved by communications strategies that provide information about publicly declared long-term plans and related services. Technology can be used to support smart parking, availability of alternative transport (access to and availability of quality public transport, bike sharing schemes etc.), digital payment and related loyalty programmes. *(Amsterdam's Mobility fund demonstrates that "equal" division of funding among all the transport modes gained the*

[2] Under preparation. Stage at the time of publication: FprCEN/TS 17380

support required for car traffic restrictions, and its P+R price motivation scheme is regarded as an innovative benefit). Public acceptance relates strongly to data availability and continuous evaluation.

6.7 Evaluation

It is recommended that regulating schemes are supported by periodic evaluation of key performance indicators. This could be derived from vehicle counting, people counting etc. or from measurement of air quality. It is recommended that results of evaluation are presented to the public and may provide strong arguments for low emission zone (LEZ) extensions.

EXAMPLE Vicenza region is evaluating the air quality in the long term view; and based on the results the region has decided to extend the zone.

7 Means for air quality management

7.1 Two philosophies

There are two philosophies how to approach the regulation and relevant technologies for air quality management:

— Access control and enforcement, i.e. active geofencing, may be applied as specified in CEN/TS 17380:2019 using C-ITS;

— Traffic burden monitoring may be applied as specified in this document, see 7.2.

7.2 Traffic burden monitoring as an enabler of air quality management

7.2.1 General context

Traffic burden monitoring is a conceptual and technological tool for delivering big data on traffic flows and air quality within defined zones of a city. The general approach for the deployment is specified in the following steps:

STEP 1: Air quality policy – vision and goals (part of SUMP and/or air quality action plan); see 7.2.2.

STEP 2: Design of potential parking zones; see 7.2.3.

STEP 3: Traffic burden monitoring architecture design and the concept deployment; see 7.2.4.

STEP 4: Big data analysis and opening of data; see 7.2.5.

STEP 5: Required organization and technical tools implementation (mobility fund, simulation tools, hackathon, parking terminals with flexible pricing, etc.); see 7.2.6.

STEP 6: Required information tools implementation (variable message signs (VMS), web cameras, and streets´ web pages with values, etc.); see 7.2.7.

STEP 7: Customized set of air quality measures specification (based on previous findings of a particular city); see 7.2.8.

STEP 8: Campaign on air quality; see 7.2.9.

STEP 9: Evaluation (feedback on every component of traffic burden monitoring); see 7.2.10.

STEP 10: Investment plan (new tools and infrastructure deployment plan); see 7.2.11.

This specification briefly describes all these steps for context understanding purposes.

7.2.2 STEP 1: Low Carbon Mobility Policy – vision and goals

Smart cities are usually built on a long-term vision of city development that is often expressed in numbers comparing the existing and the future values. For the transport and traffic domain it is suggested to express the vision, for at least 25 years forward, by modal split percentage. The mobility vision does not represent how people will travel in 25 years' time, but it serves for evaluation of actual investments and as such it provides qualitative criteria. The mobility vision is an integral part of a SUMP.

7.2.3 STEP 2: Design of potential parking zones

Low carbon mobility vision is a part of the design phase of a SUMP. It provides long-term goals with a target modal split of the traffic in the city. To achieve ambitious goals based mainly on the shift to low carbon mobility, it is usually necessary to set up particular zones with specific rules for traffic and transport, i.e. controlled zones as defined in CEN/TS 17380:2019[3].

Zoning usually starts, and usually has prime focus, on the city centre. The defined zone should contribute to air quality objectives. The zone borders usually will have to be defined around the existing road network. The borders are often tangential roads enabling to travel around the city centre or natural borders, such as a river.

Each zone is defined by specific rules that meet the objectives of its SUMP. For example, a city may elect to increase air quality by offering cycling infrastructures, free of charge public transport and strict parking policy – high parking charges and strict residential parking policy; it may elect to levy a single parking fee that applies to all the public spaces where people can park (and usually, off street parking is preferred to on-street). Parking policy may choose to levy parking zones with a common single fee; see Figure 1 for Amsterdam.

The borders of the defined zone are natural places where to build necessary infrastructures for travel exchange as park and bike (P+B) and park and go (P+G) facilities, bike sharing stations, public transport stops etc. The borders are also locations where to deploy relevant technologies to create geofencing and/or triggering travellers' motivation and/or rewarding schemes. All these should form part of the city investment plan (STEP 10).

To enable successful transformation of cities to "cities for people", technology deployment is required in order to monitor the traffic burden permanently and to evaluate investments, based on data. Zoning provides the capability to implement an air quality strategy in consecutive (zone by zone) and sensible steps.

[3] Under preparation. Stage at the time of publication: FprCEN/TS 17380