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Risk Management in Air Protection in the Republic of Croatia

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A B S T R A C T

In the Republic of Croatia, according to the Air Protection Act, air pollution assessment is obligatory on the whole State territory. For individual regions and populated areas in the State a network has been established for permanent air quality monitoring. The State network consists of stations for measuring background pollution, regional and cross-border remote transfer and measurements as part of international government liabilities, then stations for measuring air quality in areas of cultural and natural heritage, and stations for measuring air pollution in towns and industrial zones. The exceeding of alert and information threshold levels of air pollutants are related to emissions from industrial plants, and accidents. Each excess represents a threat to human health in case of short-time exposure. Monitoring of alert and information threshold levels is carried out at stations from the state and local networks for permanent air quality monitoring according to the Air Quality Measurement Program in the State network for permanent monitoring of air quality and air quality measurement programs in local networks for permanent air quality monitoring. The State network for permanent air quality monitoring has a developed automatic system for reporting on alert and information threshold levels, whereas many local networks under the competence of regional and local self-governments still lack any fully installed systems of this type. In case of accidents, prompt action at all responsibility levels is necessary in order to prevent crisis and this requires developed and coordinated competent units of State Administration as well as self-government units. It is also necessary to be continuously active in improving the implementation of legislative regulations in the field of crises related to critical and alert levels of air pollutants, especially at local levels.

Key words: *air pollution control method, alert and information threshold levels, air pollutants, crisis*

Introduction

Air quality of a certain region depends directly on the number and type of emission sources which are located within a narrow and wider environment. Different aspects of air pollution from emission sources influence the environment at global, regional and local levels. In the Republic of Croatia, according to the Air Protection Act, air pollution assessment is obligatory on the entire State territory. For individual regions and populated areas in the State a network has been established for permanent air quality monitoring. The State network consists of stations for measuring background pollution, regional and cross-border remote transfer and measurements as part of international liabilities of the State, then stations for air quality measuring in the areas of cultural and natural heritage, and stations for measuring air pollution in towns and industrial zones[1]. Currently, as part of the State network the measurements are carried out at eight stations in towns and industrial zones.

Air quality data from the State network are public and are published on the Internet pages of the Ministry for Environmental and Nature Protection, which at the same time coordinates all the activities of the State network and cooperates with other State administration bodies that participate on the basis of special regulations in air quality monitoring. These are especially institutions responsible for the protection of human health, protection of nature, meteorological conditions monitoring, and the units of local and regional self-government[1]. Air quality data from local networks are also public and published once a year in Official Gazette or on the Internet pages of local and regional self-government in a summarized form and made understandable to a wide public.

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Both groups of data represent thus a part of the information system on air quality managed by the Environmental Protection Agency of the Republic of Croatia.

The quality assurance of measurements done on instruments for continuous air quality monitoring, due to specific measurements themselves and the nature of data is of extreme importance. Continuous measurements mean that all the phases in the analytical process from sampling through measurements, and often the publishing of unofficial results occur automatically without the presence of the analytics. This sets additional requirements for the quality assurance in all the phases of the analytic process. The basic procedures for meeting these requirements are divided into current maintenance of instruments and the verification of the measuring system functionality and the quality of measurements themselves. The current maintenance of instruments is performed according to SOP determined schedule which is defined according to the equipment manufacturer's instructions and the requirements of standardised methods[2–4]. Part of the procedures regarding verification of the measurement quality is carried out during the method validation whereas a part is performed routinely according to the plan for measurement quality assurance. The dynamics and the content of these procedures are defined by SOP harmonised with the requirements of the standardised methods. The aim of this study was to highlight the role of permanent air quality monitoring according to the Air Quality Measurement Program in the State network, and for permanent monitoring of air quality and air quality measurement programs in local networks for permanent air quality monitoring.

Material and Methods

Air quality monitoring is carried out by organizing network units – stations and their assignment to a particular area. Network for monitoring air quality measuring systems consisting of measuring stations each computer connected to the central computer, which with the help of software applications communicate with stations, downloads and keeps score. Equipment necessary for the creation of a network of air quality monitoring must be such as to permit obtaining measurement data quality objectives. In short, it must allow continuous measurements defold methods with as little interruption and with the greater accuracy and measurement within the specified uncertainty.

The reference method for the measurement of sulfur dioxide is ultraviolet (UV) fluorescence. This method is standardized (norm HRN EN 14212)[2] and regulations prescribed by the Croatian and the European Union. In the European Union adopted the 2005th year, and in Croatia 2006th. The method is based on fluorescence radiation of molecules SO_2 if the molecules are exposed to ultraviolet (UV) radiation. Because UV exposure SO_2 molecule goes from normal in the excited state and then returns to the normal state of the emitting fluorescent radiation.

The reference method for the measurement of NO and NO_2 is chemiluminescence. The method was standardized (HRN EN 14211)[3] and regulations prescribed by the Croatian (adopted in 2006.) and European Union (adopted 2005th year). The basic principle of the method (chemiluminescence) is the appearance of emitting energy (radiation) which is the result of a chemical reaction that occurs in this case because of the reaction of nitric oxide with ozone.

The reference method for the measurement of ozone is ultraviolet (UV) photometry. The method was standardized (HRN EN 14625)[4] and regulations prescribed by the Croatian (adopted in 2006.) and European Union (adopted 2005th year). The method is based on the capacity of ozone that absorbs UV radiation.

Targeted quality measurement is given legal minimum requirements for quality data obtained by measurements of air quality in one year. Only data that can be used to document the quality of the target can be used to run any legally prescribed procedures. As almost all measurements of air quality regulatory or inspection is determined, it is achieving and documenting the target quality data sets as the main goal of all QA/QC procedures in a network.

Results and Disscussion

Alert and information threshold levels of air polutants

The exceeding of alert and information threshold levels of air pollutants is mainly related to the emissions from industrial plants, but may be related also to accidents. In the Act on Protection and Rescue of the Republic of Croatia, »accident« is defined as accident that is related to a technical and technological process or traffic and with consequences that exceed the frames of technical and technological plant at which the accident has occurred[9]. Each excess represents a threat for human health at short-time exposure. The monitoring of alert and information threshold levels is performed at stations within the State and local networks for permanent air quality monitoring according to the Air Quality Measurement Program in the State network for permanent air quality monitoring and air quality measuring programs in local networks for permanent air quality monitoring. The Regulation on alert and information threshold levels of pollutants brought by the Government of the Republic of Croatia encompasses three pollutants: sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3)[5].

Sulphur dioxide

Sulphur dioxide (SO_2) is a colourless gas that can be smelled by the majority of people in the range of concentrations from 1,000 to 3,000 $\mu g/m^3$ of air. In higher concentrations (above 10,000 $\mu g/m^3$ of air) the smell is irritating. Today, in many European cities the average annual values of sulphur dioxide concentrations in the air are much below 50 $\mu g/m^3$, whereas the daily mean values

are mainly below 100 μg/m^3. However, in spite of such reduction in average values, the peak concentrations in cities may reach very high values for short periods of time (smog episodes). On the other hand, background concentrations in rural areas range mainly around 5 μg/m^3 and reach only occasionally the value of about 25 μg/m^3. This improvement of air quality in the majority of countries members of the United Nations Economic Commission for Europe in the recent several decades has been the result of the implementation of national and international regulations. The ambient concentrations of SO_2 do not represent a threat to human health, except at places where the concentrations are higher at industrial smelting plants. The tests carried out on volunteers have shown that the first symptoms occur when breathing concentrations exceed 14,000 μg/m^3, and these are values that are several orders of magnitude higher than ambient ones. The highest measured 1-hour average concentration in Europe in the period from 1990–1999 amounted to 587 μg/m^3, and the highest 24-hour average had the value of 327 μg/m^3[3,6,7].

Nitrogen dioxide

Nitrogen dioxide (NO_2) is a reactive pollutant, which results from nitrogen oxidation emitted into the atmosphere in fuel combustion processes at high temperatures and represents the crucial component in the creation of secondary toxic pollutants (nitrogen acid, nitrate part of secondary inorganic aerosols and photo oxidants including also ozone). According to the data of the World Health Organization (WHO) the global annual average urban concentrations of NO_2 range between 20 and 90 μg/m^3. Long-term monitoring of NO_2 in the air at the European stations shows a decline in the average annual concentrations, even by 12% in the period from 1997–2001. The ambient concentrations of NO_2 do not cause negative health effects. However, the increased concentrations in the range from 300–3,000 μg/m^3 which are found in tunnels at short-time exposure may cause inflammatory reactions in lung tissue as well as reduction of the pulmonary function. In patients suffering from asthma and obstructive pulmonary diseases, the concentrations of 190 μg/m^3 can cause significant stricture of respiratory paths, whereas in patients with mild form of asthma a 30-minute exposure to concentrations of 380–560 μg/m^3 causes reversible reduction of the lung function[8].

Pursuant to Article 3 of the Regulation on alert and information threshold levels of air pollutants, alert and information threshold levels for sulphur dioxide (SO_2) and nitrogen oxide expressed as NO_2 in the air are presented in Table 1. Exceeding of the alert and information threshold levels has to be measured during at least three successive hours[5].

Ozone

Ground-level ozone is the most significant photo-chemical oxidising agent in the troposphere. It is a secondary pollutant since it is not emitted directly from a source, but rather formed by photochemical reactions (with participation of shortwave radiation from the Sun) from nitrogen dioxide (NO_2) and volatile organic compounds (VOC) in the troposphere. Ozone shows significant spatial variations that depend on the prevailing wind directions, on the tendency of achieving higher concentrations in suburban and rural areas and at higher above-sea-levels. In the vicinity of big nitrogen oxide emission sources, the ozone concentrations are lower because of the chemical reactions between them. This results in higher ozone concentrations in suburban and rural regions than in the areas along busy roads. The annual mean values of ozone measured in Europe have shown that the highest values are at background stations (49 μg/m^3) and stations located in rural areas (57.1 μg/m^3). The values measured in urban areas and along big roads are by about 24% lower. The values of 1-hour maximal ozone concentrations measured in urban environments of different continents range between 100–380 μg/m^3, except for South America, where these are much higher (200–600 μg/m^3), ozone is responsible for a number of serious effects on the health, which can be related to acute and chronic exposure. Acute exposure to ozone causes negative systemic effects on the pulmonary tissue and cardiovascular system, whereas chronic exposure causes reduction in the pulmonary function, development of atherosclerosis, asthma, and shortened life expectancy. According to the recommendations of the World Health Organization (WHO), a boundary concentration of ambient ozone has been set referring to 8-hour mean daily maxima in case of which there should be no occurrence of disease in the majority of persons. Even below these concentrations negative health effects can occur in extremely sensitive persons. The higher ozone concentrations compared to the above mentioned boundary values, cause the more serious and the more frequent health effects affecting larger part of the population[7,8].

Pursuant to Article 4 of the Regulations on alert and information threshold levels of pollutants in the air, alert and information threshold levels for ozone (O_3) in the air are presented in Table 2. Exceeding of alert and informa-

TABLE 1
ALERT AND INFORMATION THRESHOLDS LEVELS FOR SULPHUR AND NITROGEN DIOXIDE

Pollutant	Averaging time	Alert threshold
SO_2	Three-hour moving average	500 μg m^{-3}
NO_2	Three-hour moving average	400 μg m^{-3}

TABLE 2
ALERT AND INFORMATION THRESHOLDE LEVELS FOR OZONE

Purpose	Averaging time	Level
Information	One-hour	180 μg m^{-3}
Alert	One-hour	240 μg m^{-3}

tion threshold levels for ozone shall be measured or forecast for three successive hours[5].

Intervention plan in protection of health of people and environment

Exceeding of alert and information threshold levels of pollutants in the air represents a crisis which seriously threatens the health and safety of people and the environment. Crisis understands every specific situation that threatens the safety and life of a community, its fundamental values, interrupts its regular functioning and sets new unusual requirements which cannot be resolved by regular procedures and forces, but rather requires fast decision-making within limited period of time with the application of special measures.

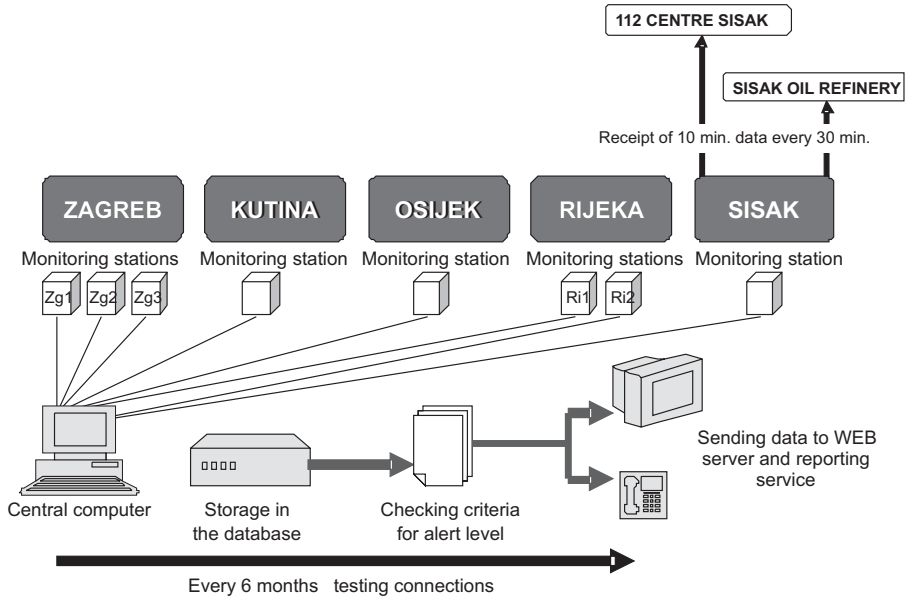

Fig. 1. Scheme of automatic data and information transfer from the point of measurement to the customer as designed in the State network for air quality monitoring. Source: EKONERG.

TABLE 3
INFORMING AND ALARMING IN CASE OF EXCEEDING THE ALERT AND INFORMATION THRESHOLDE LEVELS OF POLLUTANTS IN STATE NETWORK FOR AIR QUALITY MONITORING (EKONERG)

Zagreb	County centre 112 Zagreb
	City of Zagreb: Municipal office for physical planning, environmental protection, city construction, civil engineering, communal matters and transport
	Environmental protection inspection of Ministry for Environmental and Nature Protection
Kutina	County centre 112 Sisak
	Mayor's office
	County eco-headquarters
	Environmental protection inspection of Ministry for Environmental and Nature Protection
Osijek	County centre 112 Osijek
	City of Osijek: Administrative department for urbanism, civil engineering and environmental protection
	Environmental protection inspection of Ministry for Environmental and Nature Protection
Rijeka	County centre 112 Rijeka
	Mayor's office
	Environmental protection inspection of Ministry for Environmental and Nature Protection
Sisak	County centre 112 Sisak
	Mayor's office
	County eco-headquarters
	Environmental protection inspection of Ministry for Environmental and Nature Protection

In accordance with the subsidiary principle of delegating responsibilities, the responsibility for urgent response in case of crisis event or crisis occurrence is allocated to the local units that are closest to the crisis hot spot, and depending on the requirements, they are joined by other units from the neighbouring districts and towns, of the county or the state. The responsibilities have to be delegated depending on the seriousness and scope of the emergency event or situation[9,10].

In case of exceeding the alert and information threshold levels of sulphur and nitrogen dioxide, and the alert and information threshold levels of ozone, the Zagreb City Council, towns and districts in the area where the excess has occurred shall undertake regulated special measures for the protection of people's health and environment according to the Intervention plan in environmental protection, and shall inform the public through public media. In this process the 112 Service plays a special role by collecting and processing information and data from the field, informing and, if necessary, alarming the citizens, legal entities, state administration bodies, rescue services, responsible services of civil protection and other responsible entities of Government administration about all the discovered dangers and their consequences (Figure 1, Table 3)[11].

Information need to contain data on the date, hour, place and causes of the event. It is also necessary, based on the information about the change in the concentrations of sulphur and nitrogen oxides as well as ozone in the air, to inform about the improvement, stabilisation or deterioration of the condition, and to inform the endangered population about the precautionary measures that need to be undertaken.

Figure 1 shows a system used to deliver the information about the measured alert and information threshold levels at the State network stations for air quality monitoring automatically to the competent services. This system has proved in practice as efficient in cases of exceeding the critical levels of SO_2 in Sisak. Unfortunately, many local networks under the responsibility of regional and local self-governments still have no fully set systems of this type.

Conclusion

Air pollution today represents a serious public health problem. In case of accidents prompt response at all levels of responsibilities is required in order to prevent crisis and this requires developed and coordinated responsible units of State Administration as well as local self-government units. It is also necessary to be continuously active in improving the implementation of legislative regulations in the field of crises related to alert and information threshold levels of pollutants in the air, especially at local levels, where information system needs to be established, such as the one established at the stations in the State network. Continuous measurements mean that all the phases in the analytic process, ranging from sampling via measurements, and often publishing of unofficial results develop automatically, without the presence of the analytics. This sets additional requirements for quality assurance in all the phases of the analytic process.

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UPRAVLJANJE RIZICIMA U ZAŠTITI ZRAKA U REPUBLICI HRVATSKOJ

SAŽETAK

U Republici Hrvatskoj, prema Zakonu o zaštiti zraka, procjena zagađenja zraka je obavezna na cijelom državnom teritoriju. Za pojedina područja kao i naseljena područja u državi uspostavljena je mreža za trajno praćenje kakvoće

zraka. Državna mreža sastoji se od postaja za mjerenje pozadinskog onečišćenja, regionalnog i prekograničnog onečišćenja, mjerenja u okviru međunarodnih obveza države, zatim postaja za mjerenje kakvoće zraka u područjima kulturnog i prirodnog nasljeđa i postaja za mjerenje onečišćenja zraka u gradovima i industrijskim zonama. Prekoračenja razina pragova upozorenja i obavješćivanja onečišćujućih tvari u zraku najčešće se odnose na emisije iz industrijskih postrojenja i nakon akcidenata. Svako prekoračenje predstavlja opasnost za ljudsko zdravlje u slučaju kratkog vremena ekspozicije. Praćenje razina pragova upozorenja i obavješćivanja provodi se na postajama iz državne mreže i lokalnih mreža za trajno praćenje kakvoće zraka prema Programu mjerenja kakvoće zraka u državnoj mreži za trajno praćenje kakvoće zraka i mjerenje kakvoće zraka u programima lokalnih mreža za trajno praćenje kakvoće zraka. Državna mreža za trajno praćenje kakvoće zraka ima razvijen automatski sustav za izvještavanje o razinama pragova upozorenja i obavješćivanja, dok mnoge lokalne mreže iz nadležnosti regionalnih i lokalnih samouprava još uvijek nemaju instalirane sustave toga tipa. U slučaju nesreće, brzo djelovanje na svim razinama odgovornosti potrebno je kako bi se spriječila kriza, a to zahtijeva razvijene i koordinirane nadležne jedinice državne uprave, kao i samouprave. Također je potrebno uspostaviti stalnu aktivnost u poboljšanju provedbe zakonskih propisa u oblasti kriza u vezi s razinama pragova upozorenja i obavješćivanja onečišćujućih tvari u zraku, posebno na lokalnoj razini.