DISPERSION STUDY

Immission and Transmission Assessment of the Facility

"Radioactive Waste Incinerator "

Assessment of impacts on air quality by certain substances for the purposes of environmental impacts assessment under Act No. 24/2006 Coll.

Prepared by: **RNDr. Gabriel Szabó, CSc.**

Košice, 20 May 2013

T A B L E O F C O N T E N T S

1. Introduction

In general, air quality is determined by the content of pollutants in the outdoor air. The Act on Air Quality No. 137/2010 Coll. specifies the procedure for its assessment and for the air quality criteria in full compliance with EU directives, and also enables to use, besides the measurement of immissions, also mathematic modelling of air quality. The application of mathematical models can also simulate the impacts of the planned economic activity on air quality. Under the Slovak and European air protection legislation, mathematic models are among the main tools for air quality assessment. The models enable the following (in various space arrangements): area description of required characteristics of expected air pollution for various development scenarios; analysis of the share of significant sources causing pollution, calculation of expected air pollution for various scenarios of emissions development, etc. However, the application of these models has its limits. The legislation prescribes uncertainty of modelling for different pollutants. The quality of model calculations primarily depends on the quality of input data (both meteorological and emission data).

The aim of the dispersion study was to:

- perform an immission and transmission assessment of the dispersion of basic pollutants and other pollutants listed in the section “Information on emissions” from the assessed air pollution source “Radioactive Waste Incinerator” operated by JAVYS, a.s.;
- check whether the designed chimney height is sufficient for the “Radioactive Waste Incinerator” operated by JAVYS, a. s. to ensure sufficient dispersion of pollutants in the air.
- To determine the impacts of the air pollution source “Radioactive Waste Incinerator” on the quality of air of the assessed area after the reconstruction of the source.

The subject of the dispersion study is the immission and transmission assessment of the air pollution source Radioactive Waste Incinerator operated by JAVYS, a. s. on air quality within the affected area by basic pollutants and other pollutants produced during the process of waste incineration, as well as assessment of the distribution of the concentration field in the given area.

The dispersion study aims to assess the quality of air with a focus on space distribution of the concentration field of pollutants on the basis of the applied emission flows which are conservative (least favourable) from the point of view of minimum chimney height and immission burden. The basic characteristics for air quality assessment during the operation of the source were calculated. The air quality assessment was based on the parameters of the source provided by the client. All emissions declared as solid pollutants were considered as PM_{10} in model calculations under the conservative approach to the air quality assessment. Annual reports and reports on the air quality in the SR by the Slovak Hydrometeorological Institute (SHMU) and expert publications were used for assessment.

The calculations of concentrations of pollutants in the air were made using the MODIM´06 model which is applied for the assessment of air quality in the SR by the SHMU and by authorised assessors preparing expert opinions under Act No. 137/2010 Coll. MODIM´06 is a version for the local dimension of the CEMOD model for national (regional) assessment of air quality. The calculations were made for the area in the vicinity of the place of the assessed source up to the distance of 5km from the bottom of the chimney. The purposes of the analysis was to provide a complex picture of the impacts of the source during operation on the air quality of the assessed area on the basis of a model simulation of the space distribution of pollutants concentrations.

2. Assessed area and input information for assessment

Information on emissions:

The source parameters represent the main input data for a complex immission assessment of the air quality impacts of the source of air pollution "Radioactive Waste Incinerator" operated by JAVYS, a. s. within the affected area. The dispersion study assessed, using a mathematical model for the dispersion of air pollutants, the impact (contribution to the immission burden) of this source of pollution on the air quality of the area.

For the purposes of assessing this source, all emissions from the air pollution source technology after reconstruction were evaluated using the methodology for determining the chimney height to ensure sufficient dispersion of pollutants in the air. The parameters of the source and the emissions of basic pollutants and other specific pollutants were provided by the client.

The assessed source is located within the nuclear facilities site in Jaslovské Bohunice, building 808. Reconstruction/innovation of the incinerator has been recently performed in compliance with all required opinions, decisions and approvals (MoE SR, NRA SR, etc.), related to the treatment and cooling of flue gases, change of the commissioning and auxiliary fuel, and extending the incineration of liquid waste (which recently comprised only RA-oils) by saturated ion exchangers.

Table 1 Emissions of common pollutants at the level of the applied emission value and corresponding emissions of pollutants from the assessed incinerator at the volume of 2,400 Nm^{-3}/h of dry flue gases after reconstruction (least favourable – model condition).

Pollutant	Emission value applied [mg/m^3]	Per hourly emission	
TZL	60	0.22	[kg/h]
SO_2	600	2.16	[kg/h]
NO_x	1,000	3.61	[kg/h]
TOC	40	0.14	[kg/h]
HCl	60	0.22	[kg/h]
HF	4	0.01	[kg/h]
CO	200	0.72	[kg/h]
Hg, Tl, Cd total	0.24	0.000865	[kg/h]
As, Ni, Cr, Co total	1.2	0.004327	[kg/h]
Pb, Cu, Mn total	6	0.021636	[kg/h]
CDD/CDF	0.00000012	0.000433	[mg/h]

* Expected O_2 concentration in flue gases – 6% vol.

Besides flue gases from the incinerator (1,800 to 2,400 Nm^{-3}/h /dry gas/, temperature from 90°C to 106°C), air from the air-conditioning premises of the controlled zone in building 808 is also conducted to the chimney (max. 98,600 m^{-3}/h at a temperature of about 20°C). On the basis of the character of the assessed source, the minimum chimney height is assessed on the basis of table values, i.e. the determination of the minimum chimney height does not depend on the volume of supplied air. Given the small emission values and the small share in air pollution from the point of view of immission limits, the assessed source would meet the legal conditions in a model situation even without supplied waste air. Certainly, from the point of view of operation, such condition is excluded since, under the legislation, forced exchange of air including waste air extracted through the chimney must be ensured during the presence of radioactive materials in the controlled zone which comprises the premises of the radioactive waste incinerator.

The model calculations using the emission flows of the incinerator on the basis of the applied emission value is a very conservative method (more emissions mean a higher immission burden). In a similar way, higher emission flows require a higher minimum chimney height to ensure the dispersion of pollutants in the air.

Determination of minimum chimney height:

On the basis of emission flows of the assessed source of air pollution, it was examined whether the chimney height is sufficient to ensure the dispersion of emitted pollutants from the 40m height chimney with a diameter of 2.15m at the mouth. The chimney height was assessed in accordance with the laws and regulations listed in Annex A. Nitrogen oxides (NOx expressed as NO2) are the most important substances from pollutants emitted from the chimney (principal emission flow, taking into consideration the respective “S” values). When determining the minimum chimney height, it is not necessary to take into consideration other pollutants given their relatively smaller emission flow from the given source and their “S” value. The basic minimum chimney height is determined on the basis of the mass flow and “S” coefficient. In case more types of pollutants are discharged through one chimney, the minimum chimney height is determined according to the biggest height calculated for the different pollutants. The basic minimum chimney height for NO_x expressed as NO_2 from table values is 19m, i.e. the chimney height of 40m is oversized for the current incinerator´s needs.

The results of model calculations (taking into consideration the gradual chemical transformation of NO to NO_2) shown in Table 2 for this pollutant show that the maximum hourly concentration outside of the plant area reaches up to 1.5% of the “S” value (and also limit value), i.e. the requirement for a 50% reserve is met with a large margin, and a chimney height of up to 10m would be sufficient.

There is no limit value and “S” coefficient set for dioxins, and no such value has been recommended. The WHO proposes a concentration of 100 fg/m3 for dioxins as an indicative value for urban air. The results of model calculations for this substance, as indicated in Table 3, suggest that the maximum hourly concentration is less than 2% of this value.

List of reference documents and other documentation:

- Reference documents and input data for the dispersion study: spaľovňa emisie bež.ZL.xls from the e-mail address: jana.madarasova@ekosplus.sk;
- Methodological instructions for the calculation;
- Annual reports, reports and expert publications listed in the annex;
- Legal regulations and standards for air quality assessment listed in the annex.

3. Applied methodology and its brief description

Under the Slovak and European air protection legislation, mathematical models represent basic tools for the assessment of air quality. The models allow (from different space aspects) the following: general description of required characteristics of air pollution; analysis of the share of significant sources in pollution, calculation of expected air pollution for different scenarios of the development of emissions, etc. Under the EU legislation, autonomous application of the model is only possible for concentrations of pollutants under the lower limit for air quality assessment. In the case of higher levels, the modelling must be combined with monitoring. The Member States are recommended to apply national models. The European regional (background) level for air pollution, including trans-border transmissions, is assessed using models (and measurements) from the EMEP programme – for acidification, eutrofisation, ground-level ozone, heavy metals, and initial results also exist for persistent organic pollutants (POPs). Art. 7 of Act on Air Protection No. 137/2010 Coll. defines the procedure for air quality assessment on the basis of the criteria under the EU air protection legislation.

The model calculations of air pollution were performed using the MODIM'06 mathematical model. The MODIM'06 model is based on the MODIM model used nation-wide which applies the same methodology, but is revised to meet the new requirements of the Slovak legislation.
MODIM works on the basis of the US EPA – ISC methodology for the calculation of air pollution arising from stationary sources, and the US EPA – CALINE methodology for line (mobile) sources up to a distance of 30km from the sources. The model calculations for line sources contain algorithms by means of which the impacts of the density and structure of building lines (surface roughness) on the dispersion of pollutants in urban agglomerations are considered. MODIM allows the modelling of the dispersion of gaseous pollutants and fine dispersion particles with an aerodynamic average of up to 20 μm (e.g. PM_{10}). The chemical transformation of NO to NO_2 for all stationary sources is calculated in line with the TA-Luft 2002 methodology. MODIM also enables to determine the 8-hour, 24-hour and annual concentrations and excess percentiles. The model is an efficient tool for a fast mapping of air quality within areas or municipalities as a whole, for assessing the impacts of the measures, and for alternative studies.

Inputs for model calculations:

1. Emission flows for assessed pollutants;
2. Applied meteorological conditions for the dispersion of pollutants in the air;
3. Limit values for assessed pollutants.

Outputs from model calculations *for gaseous pollutants and solid particles (expressed as PM_{10}) by type of set limit values for different pollutants:*

1. Maximum hourly average concentrations for all assessed substances;
2. Maximum 8-hour averages (CO);
3. Maximum 24-hour averages (PM_{10});
4. Results of calculations in a table form – concentration values of different pollutants up to the distance of 5km;
5. Text form – expert assessment of model applications.

4. Model calculations for air quality assessment

General approach:

The results of measurements are always crucial for the air quality assessment, though the air quality cannot be assessed in a complex manner only through measurements. The models can help to objectively assess the spatial distribution of the concentration of pollutants over the given area, identify their origin, estimate the share of the different sources including changes in their structure, and assess the mechanisms of the dissemination of the pollution.

The calculations of the short-term concentrations of pollutants for the assessed source of air pollution by means of the MODIM´06 model are provided in Tables 2 and 3. These values were calculated for the conditions of the dispersion of pollutants in the air according to the methodology used to verify whether the chimney is high enough to ensure sufficient dispersion of substances in the air. Nitrogen oxides (NO_x) are not relevant to assess the impacts on human health (for vegetation purposes only – average annual concentration); nitrogen dioxide (NO_2) only is relevant to assess such impacts. Given the small emission flows and under the conservative approach to the assessment, the gradual chemical transformation has not been taken into account, and all emitted nitrogen oxides were considered as nitrogen dioxide (NO_2). When assessing the level of air pollution, the results of calculations were compared to the target limit values of pollutants.

The average annual concentrations would represent values several orders of magnitude lower than short-term concentrations as a result of the fluctuation of wind directions and speed as well as changes in the stability of air throughout the year. The source is not expected to be continuously operated throughout the year. For these reasons and because of the relatively small emission flows and calculated maximum short-term concentrations of pollutants in the air, no isolines of average annual concentrations are provided in the table or in the map. In such case, it is not necessary to consider the meteorological conditions for dispersion within the given area. The values of maximum short-term concentrations of all pollutants emitted from the 40m chimney form centric circles around the assessed source. The values of these concentrations as a function of the distance are provided in the table annex (Tables 2 and 3. These values can also serve to assess whether the designed chimney has a sufficient height. The legislation requires a 50% reserve from the limit value for other sources (sustainable development). This requirement has been fulfilled with a large margin.

Dispersion conditions:

The calculations were made for meteorological conditions suitable for the dispersion of pollutants in the air providing the least favourable results for the assessed source from the point of view of the environment. The highest concentrations from the given source according to the methodology used to determine the minimum chimney height will refer to slightly labile (C) level of air stability (under Pasquill´s classification), while taking into consideration all wind speed classes. In this case, maximum concentrations are found closer to the source and also take into account relatively high sources – chimneys, which, to a certain degree, reflect certain inversion conditions (elevated inversions) or situation with weak air circulation (calm). For the purposes of assessing the impacts of the source, short-term concentrations were calculated only for the C situation on the basis of the aforementioned assumptions. The source is located within a site with an open terrain and with good conditions for the dispersion of pollutants in the air.

The calculation was made on the basis of the parameters of the air pollution source provided in the chapter on emissions within the affected area at a distance of up to 5km from the bottom of the chimney. The data calculated according to the methodology for determining the minimum chimney height was also used (besides the table method) to determine whether the designed chimney height of the air pollution source is sufficient (Tables 2 and 3).

PM_{10} with fugitive leaks need not to be considered, as combusted waste is always handled packed due to its activity.

The spatial assessment of the air quality assessment is based on mathematic models for the calculation of the concentration field of pollutants. The modelling methods represent methods supported and recommended by the law for assessing the air quality.

Air pollution after the reconstruction of the incinerator:

The MODIM dispersion model was used to calculated the concentrations of emitted pollutants from the assessed source.

Basic pollutants:

- *PM_{10} - fine dispersion articles with a aerodynamic average of up to 10 «m,*
- *NO_2 - nitrogen dioxide (gradual chemical transformation of NO to NO_2),*
- *SO_2 - sulphur dioxide,*
- *CO - carbon monoxide*
- *TOC - total organic carbon*

Other pollutants:

- *Hg, Tl, Cd – total*
- *As, Ni, Cr, Co – total*
- *Pb, Cu, Mn – total*
- *CDD/CDF*
- *inorganic gases and vapours – HCl, HF.*

Tables 2 and 3 in the annex present the concentrations calculated at distances of up to 5km, referred to in further assessments. This data can be considered representative from the point of view of our conservative approach to the assessment of the air quality of the area.

All concentrations in Tables 2 and 3 are only a contribution of the assessed source after its reconstruction.

What is relevant to the assessment of the air pollution by basic pollutants is the percentiles, and not absolute maximum values. The percentiles specified in law and used for assessing the air quality give a more realistic view. A percentile means the remaining highest value after deducting the respective number of absolute maximum values (Annex B) for the given pollutant. Percentiles from maximum daily and maximum hourly data are much lower than the maximum hourly concentration in the given year (value lower by 30% to 50%). This means sporadic occurrence of situations creating the conditions for maximum values, i.e. parallel occurrence of all adverse factors from the point of view of air quality.

Basic pollutants:

Sulphur dioxide – SO_2

The calculated contribution of the assessed incinerator of the source to maximum hourly concentrations is max. 9.4 μg/m^3, which constitutes less than 3% of the limit value.

Nitrogen dioxide – NO_2

The calculated contribution of the assessed incinerator of the source to maximum hourly concentrations is max. 2.6 μg/m^3, which constitutes less than 1.3% of the limit value.

Fine suspended particles - PM_{10} :

The calculated contribution of the assessed incinerator source to maximum average daily values is maximum 0.8 μg/m^3, which is less than 1.6% of the limit value.

Carbon monoxide (CO):

With regard to this pollutant discharged from the assessed incinerator, the calculated 8-hour maximum concentrations are under 2.5 μg/m^3 during the day throughout the year. These values represent less than 0.25% of the limit value for CO. It is a negligible contribution to air contamination given the fact that the average annual background concentration for this area is around 250 to 350 μg/m^3.

Total organic carbon (TOC):

This pollutant does not have a limit value defined, and the model calculations are only provided to have a complex overview of the assessment. The maximum calculated hourly concentration for TOC is up to 0.6 μg/m^3, which represents approx. 1.2% of the limit value for organic gases and vapours, including in the strictest cases.

Other than basic pollutants:

The corresponding “S” values were used for pollutants which do not have any limit values set to determine the minimum chimney height. The maximum possible short-term concentration of pollutants was calculated for the least favourable meteorological dispersion conditions recommended for determining the minimum chimney height (urban dispersion regime, slightly labile condition of the atmosphere, all wind directions) and operating conditions (peak hour) where the impact of the source on air pollution is the biggest.

Tables 2 and 3 present the values of maximum short-term concentrations for these substances discharged from the assessed source of air pollution as a distance function of the area.

The HCL and HF contribution of the assessed source in the case of maximum hourly concentrations are relatively small compared to the “S” value for determining the minimum chimney height.

The “S” value for HC is 0.1 (corresponds to the derived limit value of 100 μg/m^3). The highest maximum hourly concentrations are under 1 μg/m^3, which is less than 1% of the limit value.

The “S” value for HF is 0.04 (corresponds to the derived limit value of 40 μg/m^3). The highest maximum hourly concentrations are around 0.04 μg/m^3, which is 0.11% of the limit value.

The strictest “S” value for the group of Hg, Tl, Cd is 0.005 (corresponds to the derived limit value of 5 μg/m^3). The highest maximum hourly concentrations reach up to 4 ng/m^3, which is less than 0.08% of the limit value.

With regard to the group of As, Ni, Cr, and Co, the strictest “S” value is 0.001 – for As (corresponds to the derived limit value of 1 μg/m^3). The highest maximum hourly concentrations are up to 19 ng/m^3, which is max. 1.9% of the limit value. It is a very conservative assessment, since the individual substances in the actual emission composition is under 20%. A limit value for an average annual concentration has only been set for As (6 ng/m^3). The annual average would actually be several orders of magnitude lower than 3.5 ng/m^3. The actual values for the individual substances would be even smaller, as substances are present in the actual emission compositions at a certain share.

The strictest “S” values for the group of Pb, Cu, Mn is 0.005 (corresponds to the derived limit value of 5 μg/m^3). The highest maximum hourly concentrations are up to 94 ng/m^3, which constitutes up to 1.9% of the limit value.

This is a highly conservative assessment for these groups, as a 100% occurrence of these elements with the strictest “S” value is assumed. A limit value for annual concentration is only set for the following elements: As (6 ng/m^3), Ni (20 ng/m^3), Pb (500 ng/m^3) and Cd (5 ng/m^3). The calculated annual averages for these pollutants as a result of the fluctuation of meteorological elements throughout the year would actually be several orders of magnitude smaller than these maximum hourly data, and the limit values would be observed. Due to the fact that incineration is not expected to take place continuously throughout the year, the calculated annual average values would be significantly smaller. The calculated average annual concentrations are not provided for not being representative.

In case of CDD/CDF, the “S” value is not set. The calculated maximum hourly concentrations are under 1.9 fg/m^3, which is 1.9% of the limit value recommended by the WHO

5. Conclusion

On the basis of the analysis, the results of assessment of the air quality impacts of the air pollution source “Radioactive Waste Incinerator” operated by JAVYS, a. s. can be summarised as follows:

- The chosen approach to the assessment of the air pollution source can be considered conservative from the point of view of the source operation regime throughout the year (see Chapter 2 – *Information on emissions)* and the choice of the strictest recommended limit values for the overall source assessment.
- The contribution of the assessed source of pollution in the case of maximum hourly concentrations of nitrogen dioxide (NO_2) is maximum up to 2.6 μg/m^3, which is less than 1.3% of the limit value, and in the case of SO_2 it is up to 9.4 μg/m^3 or less than 3%. The contribution to air pollution in the case of CO is negligible – less than 0.25% of the limit value.
- The calculated maximum contribution of the source to the daily average concentration of PM_{10} is maximum 0.8 μg/m^3, which represents up to 1.6% of the limit value.

- The contribution of maximum hourly concentrations from the assessed source for other than basic pollutants with a set "S" value to determine the minimum chimney height (HF, HCl, and groups of Hg, Tl, Cd and As, Ni, Cr, Co and Pb, Cu, Mn, – total) are under 2 % even in the case of the strictest "S" values. The calculated values in the case of HF and the group of Hg, Tl, Cd are under 0.1% of the "S" value.
- In case of CDD/CDF, the "S" value is not set. The calculated maximum hourly concentrations are under 1.88 fg/m^3, which is 1.9% of the limit value recommended by the WHO. The calculation of the maximum flows of pollutants was based on compliance with the emission limits.
- The maximum values of all assessed pollutants occur at a distance of about 400m from the bottom of the chimney and decrease exponentially with distance.
- In general, given the structure of existing air pollution sources and emissions of other technologies within the area of the assessed source, the short-term and the long-term air pollution regimes do not face substantial changes.
- The assessed source of air pollution with its emission and technological parameters meets all legal requirements even for the worst operating and dispersion conditions (conservative estimate).

In Košice, on 20 May 2013 RNDr. Gabriel Szabó, CSc.

Annexes:

A. Legal regulations and standards for the assessment of air quality:

Ref. no.	Requirement – condition – parameter	Legal, technical and other regulation specifying the requirement
a	Classification of air pollution sources	According to the NEIS code list (National Emission Inventory System)
b	Meeting the specified immission limits	Act on Air 137/2010 Coll.
c	Ensuring the dispersion of emissions	Act on Air 137/2010 Coll.
d	Meeting the emission limits	Act on integrated pollution prevention and control 245/2003 Coll. and Act No. 532/2005 on changing and amending this act as amended
e	Evaluation of air quality	Act on Air 137/2010 Coll.
f	General emission factors and emission dependencies	Bulletin of the MoE SR, No. 6/1996
g	Immission burden – dispersion of pollutants	Bulletin of the MoE SR, No. 5/1996 and updated in Bulletin No. 6/1999

B. Limit value and the criteria for air quality assessment

A limit value is the most permissible mass concentration of a pollutant in the air. The assessment of measured and model data follows this limit data for the different pollutants. The tables below provide the limit value only for the assessed substances.

Limit values and the limits of tolerance of the assessed pollutants per year

	Averaging interval	Limit value* [µg/m³]	Date of reaching the limit value	Limit of tolerance	Limit value + limit of tolerance [µg/m³]										
					Until 31/12/00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SO_2	1h	350 (24)	1/1/05	150 µg/m³	500	470	440	410	380	350					
SO_2	24h	125 (3)	1/1/05	-											
SO_2^e	1r, W[1]	20 (-)	19/07/01	-											
NO_2	1h	200 (18)	1/01/10	50%	300	290	280	270	260	250	240	230	220	210	200
NO_2	1r	40 (-)	1/01/10	50%	60	58	56	54	52	50	48	46	44	42	40
NOx^e	1r	30 (-)	19/07/01	-											
PM10	24h	50 (35)	1/01/05	50%	75	70	65	60	55	50					
PM_{10}	1r	40 (-)	1/01/05	20%	48	46	45	43	42	40					
CO	Max. 8 h daily value	10000 (-)	1/1/2003 (1/1/2005)		16000	16000	16000	14000	12000	10000					

[1] *Winter period (1 October – 31 March)*
[2] *For specified spot sources only*
[e] *For ecosystems protection*
** The permitted number of excesses is provided in the brackets*

Limit values, upper and lower assessment limits

	Receptor	Averaging interval	Limit value [µg/m³]	Assessment limit [µg/m³]	
				Upper*	Lower*
SO_2	Human health	1h	350 (24)		
SO_2	Human health	24h	125 (3)	75 (3)	50 (3)
SO_2	Vegetation	1r, 1/2r	20 (-)	12 (-)	8 (-)
NO_2	Human health	1h	200 (18)	140 (18)	100 (18)
NO_2	Human health	1r	40 (-)	32 (-)	26 (-)
NOx	Vegetation	1r	30 (-)	24 (-)	19,5 (-)
PM_{10}	Human health	24h	50 (35)	30 (7)	20 (7)
PM_{10}	Human health	1r	40 (-)	14 (-)	10 (-)
CO	Human health	8h (max.)	10,000 (-)	7,000 (-)	5,000 (-)

** The permitted number of excesses is indicated in brackets.*

C. Bibliography:

[1] *User’s guide for the Industrial Source Complex (ISC3) Dispersion Models,1995, Vol. I1., US EPA, Research Triangle Park, North Carolina 27711.*

[2] *Hodnotenie kvality ovzdušia za rok 20010, SHMÚ – Air Quality Department, Bratislava.*

[3] *Správa o kvalite ovzdušia a podiele jednotlivých zdrojov na jeho znečisťovaní v Slovenskej republike 2008 a 2009. MoE SR and SHMÚ Bratislava.*

[6] Szabó G., 2003: *Modelovanie kvality ovzdušia v zónach v súlade s rámcovou direktívou EÚ. Meteorologický časopis 6, 1, pp. 41-46.*

[7] Szabó G., 2004: *Supplementary methods used for air quality assessment in the Slovak republic. In: 9th Int. Conf. on Harmonisation within Atmospheric Dispersion modelling for Regulatory Purposes, pp. 233-237.*

[8] Szabó, G.,Hrdina,K.,2005: *Úprava a možnosti využitia modelu MODIM v zmysle požiadaviek novej legislatívy. In Program a zborník konference “Ovzdusí”. Brno 9-11.mája 2005, pp. 214-219. ISBN 80-210-3688-5*

[9] Szabó, G., 2006: *PM_{10} regional background level in the Slovak Republic – model estimation. In: Meteorologický časopis (Meteorological Journal), SHMÚ, 9, No.2, pp. 73-79 . ISSN 1335-339X*

Tables:

Table 2 Maximum short-term concentrations of basic pollutants (C stability level) as a function of distance in any direction from the source

Distance L [m]	Maximum 1-hour (NO_2, SO2, TOC), 24-hour (PM_{10}) and 8-hour (CO) concentrations (data provided in $\mu g/m^3$)				
	PM_{10}	NO_2	SO_2	CO	TOC
100	0.290	0.603	3.556	0.948	0.230
200	0.716	1.683	8.782	2.342	0.569
300	0.759	2.207	9.311	2.483	0.603
400	0.762	2.581	9.348	2.493	0.606
500	0.670	2.482	8.218	2.191	0.533
600	0.559	2.247	6.863	1.830	0.445
700	0.463	2.002	5.683	1.515	0.368
800	0.387	1.787	4.746	1.266	0.308
900	0.328	1.613	4.028	1.074	0.261
1,000	0.284	1.477	3.487	0.930	0.226
1,200	0.226	1.300	2.772	0.739	0.180
1,400	0.191	1.203	2.350	0.627	0.152
1,600	0.169	1.149	2.076	0.554	0.135
1,800	0.153	1.116	1.881	0.502	0.122
2,000	0.141	1.092	1.729	0.461	0.112
2,500	0.119	1.049	1.458	0.389	0.095
3,000	0.104	1.018	1.275	0.340	0.083
3,500	0.093	0.993	1.142	0.305	0.074
4,000	0.085	0.971	1.040	0.277	0.067
4,500	0.078	0.951	0.959	0.256	0.062
5,000	0.073	0.932	0.894	0.238	0.058

Tab. 3 Maximum short-term concentrations (C stability level) as a function of distance in any direction from the source of air pollution

Distance L [m]	**Maximum 1-hour concentrations of HCl, HF (** data provided in µg/m³**), Groups Hg, Tl, Cd, groups As, Ni, Cr, Co and groups Pb, Cu, Mn, (**data provided in ng/m³**) and CDD/CDF (**data provided in fg/m³**)**					
	HCl	**HF**	**Hg, Tl, Cd**	**As, Ni, Cr, Co**	**Pb, Cu, Mn**	**CDD/CDF**
100	0.3622	0.0165	1.4240	7.1235	35.6193	0.7128
200	0.8945	0.0407	3.5169	17.5925	87.9664	1.7605
300	0.9483	0.0431	3.7287	18.6522	93.2652	1.8665
400	0.9521	0.0433	3.7435	18.7263	93.6358	1.8739
500	0.8370	0.0380	3.2910	16.4626	82.3170	1.6474
600	0.6990	0.0318	2.7484	13.7482	68.7444	1.3758
700	0.5788	0.0263	2.2758	11.3844	56.9247	1.1392
800	0.4834	0.0220	1.9006	9.5074	47.5391	0.9514
900	0.4103	0.0186	1.6131	8.0691	40.3471	0.8075
1,000	0.3552	0.0161	1.3964	6.9853	34.9281	0.6990
1,200	0.2823	0.0128	1.1101	5.5530	27.7662	0.5557
1,400	0.2394	0.0109	0.9411	4.7076	23.5392	0.4711
1,600	0.2114	0.0096	0.8314	4.1587	20.7946	0.4162
1,800	0.1916	0.0087	0.7533	3.7681	18.8414	0.3771
2,000	0.1761	0.0080	0.6924	3.4636	17.3188	0.3466
2,500	0.1485	0.0068	0.5839	2.9207	14.6043	0.2923
3,000	0.1299	0.0059	0.5106	2.5541	12.7713	0.2556
3,500	0.1163	0.0053	0.4573	2.2877	11.4390	0.2289
4,000	0.1059	0.0048	0.4165	2.0834	10.4173	0.2085
4,500	0.0977	0.0044	0.3842	1.9217	9.6090	0.1923
5,000	0.0910	0.0041	0.3579	1.7903	8.9519	0.1792

Note: 1.fg/m^3 = 10^{-15} g/m^3