MÜLLER-BBM

Müller-BBM GmbH
Robert-Koch-Str. 11
82152 Planegg bei München

Telephone +49(89)85602 0
Telefax +49(89)85602 111

www.MuellerBBM.de

Dipl.-Ing. agr. Walter Grotz
Telephone +49(89)85602 305
Walter.Grotz@mbbm.com

2020-05-15
M156050/05 Version 1 GTZ/KOP

Air Dispersion Study
for a Waste incineration plant at
Zelenodolskiy /Republic of Tatarstan /
Russian Federation

Report No. M156050/05

Client:	NJP RECHTSANWÄLTE Mr. Nothelfer Bertolt-Brecht-Allee 22 01309 Dresden
Consultants:	Dipl.-Ing. agr. Walter Grotz M. Sc. Eva Siebenlist
Total number of pages:	In total 26 pages, 24 pages text part and 2 pages appendix

Müller-BBM GmbH
HRB Munich 86143
VAT Reg. No. DE812167190

Managing directors:
Joachim Bittner, Walter Grotz,
Dr. Carl-Christian Hantschk,
Dr. Alexander Ropertz,
Stefan Schierer, Elmar Schröder

Table of contents

Summary

With regard to the scope investigated, the first results indicate – from the consultant's point of view and the German methodology and assessment system – no evidence that the operation of the waste incineration plant at Zelenodolskiy /Republic of Tatarstan exceeds the Russian Environmental Quality Standards and could provoke harmful environmental impacts or other hazards, substantial disadvantages and considerable inconvenience for the general public and the neighbourhood.

This assumption will be reviewed in the final report.

Planegg, the 15th of May 2020

M.Sc. Eva Siebenlist
Project administration

Dipl.-Ing. agr. Walter Grotz
Project leader and general manager

MÜLLER - BBM GMBH
ROBERT - KOCH - STRASSE 11
82152 PLANEGG B. MÜNCHEN
TELEFON (089) 85602-0

ilac-MRA
DAkkS
Deutsche
Akkreditierungsstelle
D-PL-14119-01-01
D-PL-14119-01-02
D-PL-14119-01-03
D-PL-14119-01-04

Testing laboratory accredited by DAkkS according to DIN EN ISO/IEC 17025:2018.
The accreditation is valid only for the scope listed in the annex of the accreditation certificate.

1 Situation and task

The Republic of Tatarstan is planning to build and run a (municipal) waste incineration plant at Zelenodolskiy /Republic of Tatarstan, Russian Federation. Due to the resistance of citizens and NGOs, a second opinion on the environmental impacts on air quality, human health and treatment/possible usage of the ashes is requested by the Secretary of Environment of Tartastan.

The following Scope of work was offered and ordered:

Air dispersion study and impact on human health with the following contents:

- Assembling the required data regarding pollutant emissions and outlet conditions based on input data provided by the client (see also section 3 “Data base”).
- Assembling topographical and constructional conditions of the site in order to establish a site model (see also section 3 “Data base”).
- Compilation of meteorological time series AKTerm based on site-specific, measured meteorological input data (wind direction, wind speed, cloud coverage) provided by the client (see also section 3 “Data base”).
- Determination of the calculation area and execution of air dispersion calculations in the form of a one year simulation in hourly resolution according to Appendix 3 of the TA Luft (using the model AUSTAL2000) taking into account the influence of the area development and the topography of the site with an upstream three-dimensional diagnostic mesoscale wind field model.
- Tabular presentation of the parameters for the additional load
    - maximum additional GLC / PC,
    - additional GLC / PC at GLC monitoring stations,
    - additional GLC / PC at points with the maximum relevant load with regard to protected resources which are not only temporarily exposed to such load at this place,
    - number of exceedances of limit values (1 hour, 24 hours, year)) for NO_2 and SO_2.
- cartographic presentation of the parameters for the additional load in the assessment area.
- Consideration of the GLC baseline based on measured GLC-data provided by the client (see also section 3 “Data base”).
- Assessment of the results based on approved assessment values (TA Luft 2002 and the Russian Environmental Quality Standards) and brief assessment of the impact on human health.

In this Short report, the first results of the air dispersion modelling will be shown.

2 Regulatory Fundamentals

2.1 Air Dispersion Study

In terms of plant-related pollution control, the Technical Instructions on Air Quality Control (TA Luft) provide appropriate specifications and instructions, especially in Appendix no. 3 [2].

In the following chapters, the relevant requirements for this case [1], according to TA Luft Appendix no. 3, are listed.

2.1.1 TA Luft Appendix no. 3

2.1.1.1 General

The dispersion calculation for gases and particulate matter shall be carried out as a time series calculation over a period of one year respectively or on the basis of a frequency distribution of dispersion situations over a period of several years according to the procedure described herein using the particle model of the VDI Guideline 3945 Part 3 (September 2000 version) and under consideration of other Guidelines quoted further below.

When using a time series calculation the dispersion model yields the concentration of a substance (as mass/volume) and the deposition (as mass/(surface x time)) for each hour of the year at the specified grid points. When using a frequency distribution according to Chapter 12 in this Annex, the dispersion model yields the corresponding annual mean values.

The results of a calculation for a raster of grid points shall serve to select the assessment points.

The results at the assessment points represent the additional load and serve, together with the time series of the measured initial loads, to determine the total load [2].

2.1.1.2 Determination of Emissions

Emission sources are the points to be determined where air pollutants are released from the installation into the atmosphere. The release conditions prevailing at the discharge of the emission shall be taken into account. The emission parameters of the emission source (emission mass flow, waste gas temperature, waste gas volumetric flow) shall be specified as hourly mean values. If the emission parameters vary in time, e. g. in batch operation, they are to be indicated as time series. If such a time series is not available or cannot be used, the most unfavourable conditions with respect to clean air maintenance during normal operation shall be assumed. If the emission rate is dependent on the wind velocity (wind-induced sources), this shall be taken into account accordingly [2].

---

[1] The listing in this report only contains the relevant requirements according TA Luft Appendix 3 for this case and is not presented in full extent.

2.1.1.3 Dispersion Calculation for Gases

As to gases for which no immission values have been established for deposition, the dispersion calculation shall be carried out without taking into account the deposition.

The conversion times indicated in VDI Guideline 3782 Part 1 [9] shall be used to calculate the conversion of NO to NO_2.

2.1.1.3.1 Chemical Conversions

Most trace substances are subject to chemical conversion during their dispersion into the atmosphere.

Within a time range of less than about ten hours, the following trace substances especially convert chemically to a significant extent: nitrogen monoxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), propene, aldehydes and some unsaturated organic compounds[2].

In the atmosphere, NO and NO_2 undergo chemical reactions that depend on meteorological conditions and on the trace gas composition of the ambient air. The most important processes are the decomposition of NO_2 molecules through the effect of solar radiation ($h \cdot v$), with the formation of NO (Reaction (R1)) and the oxidation of NO by ozone (O_3) to NO_2 (Reaction (R3)). The consumed ozone is recycled via Reaction (R2), from an oxygen atom in the electronic ground state ($O(^3P)$) and molecular oxygen (O_2). The formation energy of Reaction (R2) is dissipated via the air molecule M.

$$NO_2 + h \cdot v \rightarrow O(^3P) + NO \qquad (R1)$$
$$O(^3P) + O_2 + M \rightarrow O_3 + M \qquad (R2)$$
$$O_3 + NO \rightarrow NO_2 + O_2 \qquad (R3)$$

This standard describes an extended reaction system which accounts for the chemistry of nitrogen oxides with sufficient accuracy, in order to allow a quantitative immission forecast as part of a chemistry and transport model. Using a lifetime concept, it offers options for simplifying the proposed reaction mechanism for particular applications [13].

The extent of the chemical conversions can be estimated via the concentrations of the trace substances and their reaction partners and physicochemical and meteorological parameters [9].

2 The calculation model AUSTAL2000 is an exemplary implementation of Appendix no. 3 TA Luft in which the conversion of NO to NO_2 according to VDI Guideline 3782 Part 1 shall be used. For other atmospheric chemically active pollutants, as listed above, the TA Luft immission values consider a tolerance range for the determination of indicators. The immission values shall also apply with several pollutants occurring simultaneously or if pollutants are subject to chemical or physical transformation [2].

To estimate the mean decomposition of nitrogen monoxide (NO) in plumes, the mean lifetimes obtained from measurements on four power stations are used in AUSTAL2000. These lifetimes thus include not only the reactions of NO with oxygen (O_2) and ozone (O_3) and secondary reactions due to sunlight but also the intensity of mixing.

Table 1. Mean NO-lifetimes in plumes obtained from measurements on four power stations [9].

Klug/Manier dispersion category[1)]	I	II	III/1	III/2	IV	V
Mean lifetime τ (h)	2.9	2.5	1.9	1.3	0.9	0.3

1) for a more detailed description see chapter 2.3.1.7.1.

2.1.1.4 Surface Roughness

The surface roughness of the terrain is described by a mean roughness length z_0. Such surface roughness shall be determined according to Table 14 on the basis of the land use classes of the CORINE Land Cover Inventory[3] (the indicated numbers correspond to the CORINE land cover nomenclature):

Table 2. Mean Roughness Length Subject to the Land Use Classes Indicated in the CORINE Land Cover Inventory [2].

z_0 (m)	**CORINE Classes**
0.01	Beaches, dunes and sand plains (331); Water bodies (512)
0.02	Landfills and Mining Dumps(132); Pastures (231); Natural Grassland (321); Sparsely vegetated areas (333); Salt marshes (421); Intertidal flats (423); Water courses (511); Estuaries (522)
0.05	Mineral extraction sites (131); Sport and leisure facilities (142); Non irrigated arable land (211); Glaciers and perpetual snow (335); Coastal lagoons (521)
0.10	Airports (124); Inland marshes (411); Peat bogs (412); Sea and ocean (523)
0.20	Road and rail networks and associated land (122); Green urban areas (141); Vineyards (221); Complex cultivation patterns (242); Land principally occupied by agriculture with significant areas of natural vegetation (243); Moors and heathland (322); Bare rock (332)
0.50	Port areas (123); Fruit tree and berry plantations (222); Transitional woodland scrub; (324)
1.00	Discontinuous urban fabric (112); Industrial or commercial units (121); construction sites (133); coniferous forest (312)
1.50	Broad-leaved forest (311); Mixed forest (313)
2.00	Continuous urban fabric (111)

3 Data on ground cover in the Federal Republic of Germany ("Daten zur Bodenbedeckung der Bundesrepublik Deutschland") provided by the Federal Statistical Office, Wiesbaden.

The roughness length shall be determined for an area that is located within a circle around the stack, drawn with a radius equal to 10 times the construction height of the stack. If such an area is composed of units having different surface roughnesses, a mean roughness length shall be determined by calculating the arithmetic mean weighting with respect to the proportion of the respective area unit and subsequently be rounded to the closest value in the table. It is to be examined whether the use of land has changed considerably since the inventory was drawn up, or whether a significant change with respect to the immission projection can be expected.

If the surface roughness varies strongly within the area under consideration, it shall be examined how the roughness length value affects the additional load calculated.

2.1.1.5 Effective Source Height

The effective source height shall be determined pursuant to VDI Guideline 3782 Part 3 [10]. The emitted heat flow ***M*** in MW shall be calculated using the following equation (1):

$$M = 1.36 \cdot 10^{-3} \cdot R' \, (T - 283.15\ \text{K}) \qquad (1)$$

M being the heat flow in MW, *R*' the waste gas volumetric flow rate (wet) under normal conditions in m^3/s and *T* the waste gas temperature in K. If waste gases are discharged via cooling towers, VDI Guideline 3784 Part 2 (March 1990 version) shall be applied accordingly.

2.1.1.6 Calculation Area Grid Points

The calculation area applied to a single emission source is the area that is located within a circle around the center of emission drawn with a radius equal to 50 times the stack height. If several sources contribute to the additional load, the calculation area is composed of the calculation areas of the individual sources. In cases of unusual terrain it may be necessary to select a larger calculation area. The raster for calculating concentration and deposition shall be selected in such a way that it will be possible to determine the location and amount of the maximum immission values in a sufficiently reliable way. As a rule, this is the case when the horizontal mesh size does not exceed the stack height. At distances from the source higher than 10 times the stack height, it is possible to select a proportionally larger horizontal mesh size. The concentration at the grid points shall be calculated as a mean value over the vertical interval from ground level up to 3 m above ground, and thus is representative of a grid point height of 1.5 m above ground. The mean values thereby calculated for a volume or a mesh of the calculation reticule shall be considered as valid point values for the grid points contained therein [2].

2.1.1.7 Meteorological Data

Meteorological data shall be specified as hourly mean values, with the wind velocity determined as a vector average. The values used should be characteristic for the location of the installation. If no measurements are available at the location of the installation, data shall be used from a suitable station of the German Weather Service (Deutscher Wetterdienst) or from another accordingly equipped station. It shall be examined whether these data can be transferred to the location of the installation; such an examination can be carried out e.g. by comparing the data to data determined in a location study. Measurement gaps that do not exceed more than 2 hourly values may be filled in via interpolation. Data availability shall be at least 90 per cent of the hours within a year.

The meteorological boundary-layer profiles required for the particle model shall be determined pursuant to VDI Guideline 3783 Part 8. In this context, the following values are required:

Table 3. Values for Meteorological Boundary-layer Profiles [2].

r_a	Wind direction in anemometer height h_a
u_a	Wind velocity in anemometer height h_a
L_M	Monin–Obukhov Length
h_m	Mixing layer height
z_0	Roughness length
D_0	Displacement height

2.1.1.7.1 Monin-Obukhov Length

The atmospheric stability (see also the following chapter) is specified by indicating the Monin–Obukhov Length L_M.

The following table shows the relationship between Monin–Obukhov Length, the roughness length and the dispersion categories according to Klug/Manier.

Tabelle 4. Relationship between Monin–Obukhov Length, the Roughness Length z_0 and the dispersion categories according to Klug/Manier.

Klug/Manier	Roughness Length z_0								
	0.01	**0.02**	**0.05**	**0.10**	**0.20**	**0.50**	**1.00**	**1.5.**	**2.00**
I	7	9	19	17	24	40	65	90	118
II	25	31	44	60	83	139	223	310	406
III/1	99999	99999	99999	99999	99999	99999	99999	99999	99999
III/2	-25	-32	-45	-60	-81	130	-196	-260	-326
IV	-10	-13	-19	-25	-34	-55	-83	-110	-137
V	-4	-5	-7	-10	-14	-22	-34	-45	-56

2.1.1.7.2 Klug/Manier dispersion classes

For practical applications in dispersion calculations, a series of dispersion category schemes have been developed which make it possible to assign turbulence properties to dispersion categories. It is a simplified characterization of the turbulence state and thus of the dilution capacity of the atmosphere, for example according to the Klug/Manier classification. The Klug/Manier classification is the chosen method in the TA Luft licensing procedures.

Deriving a Klug/Manier dispersion category relies on observations of cloud cover from manned or automated ground stations, e. g. those of the German Weather Service (DWD) and the wind velocity. The dispersion category is quoted as a time series of successive hourly means or in the form of a frequency distribution in which the individual situations are interpreted as stationary situations or as hourly means.

The following table shows the Klug/Manier dispersion categories and their designations.

Table 5. Klug/Manier dispersion categories.

Category	Atmospheric stability
I	very stable
II	stable
III/1	neutral/stable
III/2	neutral/unstable
IV	unstable
V	very unstable

The dispersion categories are determined according to guideline VDI 3782 Part 1 and Part 6 respectively.

2.1.1.8 Accounting for Building Influences

Influences of built-up areas on the immission in the calculation area shall be taken into consideration. If the stack height is 1.2 times higher than the height of the buildings or if buildings, for which this requirement is not met, are located at a distance of more than 6 times of their respective height from the emission source, the following can be applied as a rule:

a) If the height of the stack is more than 1.7 times the heights of the buildings, it suffices to account for the built-up area through the roughness length and the displacement height.

b) If the height of the stack is less than 1.7 times the heights of the buildings and if a free flow off can be ensured, the influences can be taken into account by using a diagnostic wind field model for airflow around buildings. Until a suitable VDI Guideline has been introduced, such wind field models shall be used whose suitability has been proved to the competent Land authority.

All buildings that are located at a distance of less than 6 times the stack height from the emission source shall be significant for evaluating the building heights pursuant to a) or b) [2].

2.1.1.9 Accounting for Complex Terrain

As a rule, complex terrain shall only be taken into account if within the calculation area, differences in elevation relative to the emission location exceed 0.7 times the height of the stack and slope gradients are in excess of 1 : 20. In this context the gradient shall be determined on the basis of the difference in elevation over a distance that corresponds to twice the height of the stack.

Generally, complex terrain can be taken into account using a mesoscale diagnostic wind field model provided that the gradient of the terrain does not exceed the value of 1 : 5 and if significant influences of local wind systems or other meteorological peculiarities can be ruled out [2].

3 Description of the local conditions

The planned waste incineration plant is located in Zelenodolskiy / Republic of Tatarstan, Russian Federation, approx. 1 km west of Novonikolaevskiy and 3 km northeast of Osinovo.

Figure 2 shows the location of the planned waste incineration plant.

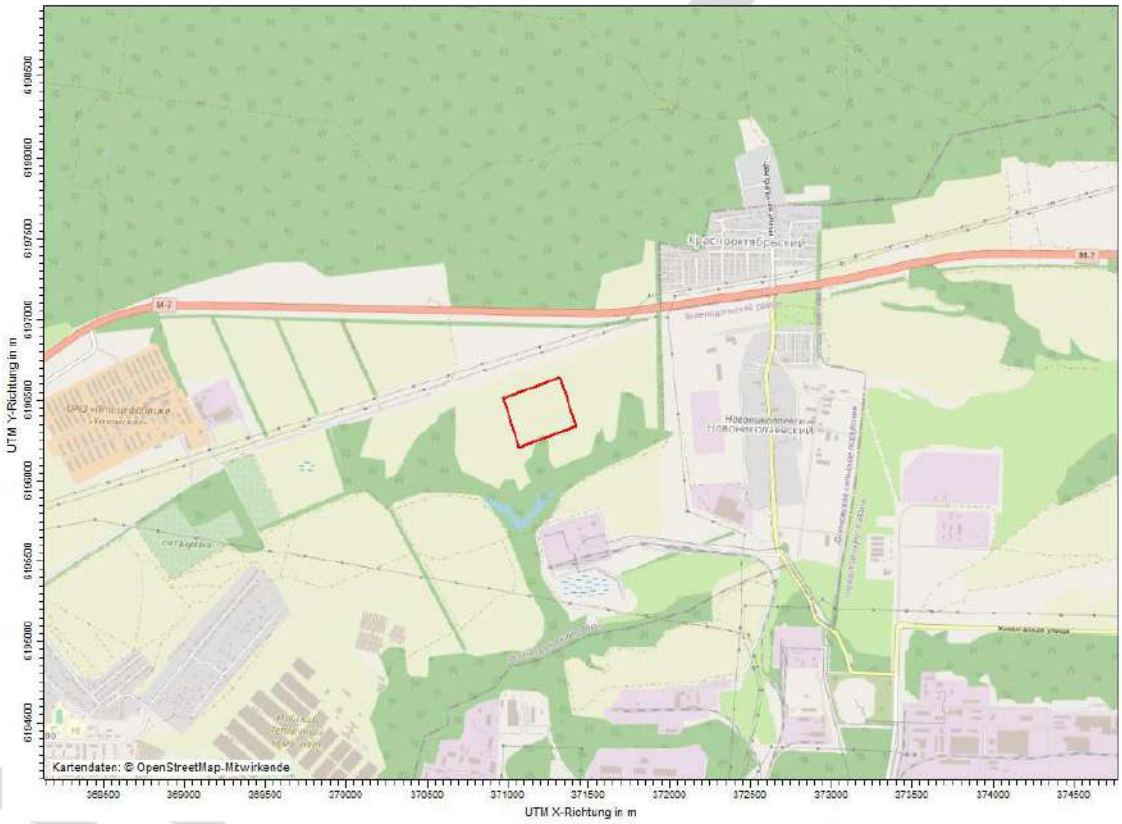

Figure 1. Location of the planned waste incineration plant (red framed) and surroundings [15].

4 Emission Sources

4.1 Emissions

For the purposes of the TA Luft 2002 No. 2.4, any data regarding the waste gas volume and the waste gas volumetric flow rate are referenced to standard conditions (273.15 K and 101.3 kPa) after subtraction of the water vapour content unless explicitly indicated otherwise.

For the purposes of the TA Luft 2002 No. 2.5, emissions shall be air pollutants originating from an installation. In this case, emissions shall be indicated as mass of substances or groups of substances emitted as related to the volume (mass concentration) of waste gas under standard conditions after subtraction of the water vapour content.

The following data are required to characterize the emission conditions:

- type of emitted trace substance,
- emission mass flux of the emitted trace substance,
- stack gas volumetric flow rate,
- stack gas exhaust temperature,
- source dimensions (length, width, height, inner diameter),
- coordinates of the source site.

4.2 Temporal characteristics of the emissions

The emissions of the sources are estimated to take place full-load at 7,725 annual hours .

4.3 Plume Rise

The emissions of a stack rise into the atmosphere due to their thermal buoyancy and mechanical momentum. The height above the top of the stack which the emissions reach at a certain source distance downwind, is called plume rise. In flat terrain, plume rise is defined as the height of the plume centre line above the stack height, after the mean plume has reached its "maximum" height, or if buoyancy and momentum do not lead to a further observable rise. The sum of plume rise and stack height is the effective source height.

The plume rise as well as the progressive rising of the plume before it reaches its mean "maximum" height, may be predicted by means of plume rise equations which are dependent on emission parameters and meteorological quantities.

The effective source height taken into account was determined programmatically according to the guideline VDI 3782 Bl. 3 [10] by the dispersion model Austal2000.

4.4 Emission mass flows

To calculate the emission mass flows, the most unfavourable operating condition and the maximum emission limit values of the air pollutants shall be used.

For the consideration and differentiation of NO, NO_2 and NO_x (indicated as NO_2), the emission mass flows of these components were calculated with the most unfavourable operating condition and the maximum emission limit values as it follows:

molar mass M(NO) = 30,01 g/mol
molar mass M(NO_2) = 46,01 g/mol

For the calculation of the NO_2 fraction in the exhaust gas, the proportion of NO_2 in the exhaust gas of the respective plant type is estimated (in this case the NO_2 proportion in the exhaust gas was estimated at 10 %) and then multiplied by the volumetric flow rate at standard conditions of the exhaust gas and the emissions limit value of NO_2.

For the calculation of the NO fraction in the exhaust gas, the molar mass ratio of NO and NO_2 is set in proportion and multiplied by the volumetric flow rate at standard conditions of the exhaust gas and the emissions limit value of NO_2.

The substance NO_x is treated by the calculation program AUSTAL2000 independently of the substances NO and NO_2. That means that for AUSTAL2000, the same emissions as with NO and NO_2, according to the calculation [6]

$$NO_x = NO_2 + 1.53 \cdot NO \qquad (2)$$

must be specified. With the term 1.53 the retroactive accounting of the molar mass takes place.

The following table shows the calculated mass emission rates.

Table 6. Emissions and discharge conditions of the planned waste incineration plant.

Waste incineration plant Tatarstan		
Betriebsart		Volllast
Brennstoff		EBS
max. Feuerungswärmeleistung	MW	90
Heizwert H_i	MJ/kg	9,1
Brennstoffeinsatz	kg/h	38,6
Schornstein		
Schornsteinhöhe nach TA Luft	m	98
Anzahl der Schornsteinzüge		2
Innendurchmesser	m	2,00
Innendurchmesser Schornsteinzug 2	m	2,00
Querschnittfläche	m²	6,28
Abgaskenngrößen im Schornstein		
Austrittsgeschwindigkeit (bei Betriebsbed. und Betriebs-O_2)	m/s	18,9
Austrittsgeschwindigkeit (bei Betriebsbed. und Bezugs-O_2)	m/s	18,9
Temperatur an der Mündung	°C	114
Wärmestrom (bezogen auf 283 K)	MW	11,83
Betriebssauerstoffgehalt (trocken)	Vol.-%	7,0
Bezugssauerstoffgehalt (trocken)	Vol.-%	11,0
Wasserdampfgehalt bei Bezugssauerstoffgehalt	kg/m³	0,138
Volumenstrom fe., Normbed., O_2-Gehalt: Betriebswert	m³/h	301.200
Volumenstrom tr., Normbed., O_2-Gehalt: Betriebswert	m³/h	249.200
Volumenstrom fe., Normbed., O_2-Gehalt: Bezugswert	m³/h	301.200
Volumenstrom tr., Normbed., O_2-Gehalt: Bezugswert	m³/h	354.400
Schwefeldioxid		
- maximale Konzentration [1]	mg/m³	50
- maximaler Massenstrom	kg/h	17,7
Stickstoffoxide		
- NO_2-Anteil im Abgas (Erfahrungswerte / Messdaten)	%	10
- max. NO_x-Konzentration (als NO_2) [1]	mg/m³	100
- maximaler NO-Massenstrom	kg/h	20,80
- maximaler NO_2-Massenstrom	kg/h	3,54
- maximaler NO_2-Massenstrom (mit 60%-Konvention) [2]	kg/h	22,68
- maximaler NO_x-Gesamtmassenstrom (als NO_2)	kg/h	35,44
Kohlenmonoxid (CO)		
- maximale Konzentration [1]	mg/m³	50
- maximaler Massenstrom	kg/h	17,7
Staub		
- maximale Konzentration [1]	mg/m³	5
- maximaler Massenstrom	kg/h	1,8
Hg		
- maximale Konzentration	mg/m³	0,03
- maximaler Massenstrom	kg/h	0,01063
Cd+Tl		
- maximale Konzentration	mg/m³	0,05
- maximaler Massenstrom	kg/h	0,0177
Σ Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V ,Sn		
- maximale Konzentration [1]	mg/m³	0,50
- maximaler Massenstrom	kg/h	0,17720
Σ As, B(a)P, Cd, Co ,Cr		
- maximale Konzentration [1]	mg/m³	0,05
- maximaler Massenstrom	kg/h	0,0177
Dioxine und Furane		
- maximale Konzentration [1]	mg/m³	1,00E-04
- maximaler Massenstrom	kg/h	3,54E-05
Ammoniak		
- maximale Konzentration [1]	mg/m³	9
- maximaler Massenstrom	kg/h	3,1896
Gesamt C		
- maximale Konzentration [1]	mg/m³	10
- maximaler Massenstrom	kg/h	3,54
gasf. anorg. Chlorverbindungen als HCL		
- maximale Konzentration [1]	mg/m³	10
- maximaler Massenstrom	kg/h	3,544
gasf. anorg. Fluorverbindungen als HF		
- maximale Konzentration [1]	mg/m³	1
- maximaler Massenstrom	kg/h	0,35

[1] Konzentrationsangaben jeweils bezogen auf trockenes Abgas im Normzustand sowie auf den Bezugssauerstoffgehalt

[2] Massenstromberechnung unter Berücksichtigung eines NO_2-Anteils von 10% und eines Umwandlungsgrades von NO zu NO_2 von 60 % (TA Luft Nr. 5.5.3)

5 Meteorological data

The meteorological boundary conditions at the site are of essential importance for the dispersion of pollutant emissions. As required in Appendix 3 of the TA Luft for air dispersion study meteorological data should be used that are characteristic for the site.

The meteorological dataset was obtained from Iowa Environmental Mesonet (IEM). The dataset for Kazan, time series of wind speed, wind direction and cloud coverage in hourly resolution, covered a time period of eight years (from 2012 to 2019). The year 2013 was determined as representative year (one year out of the period from 2012-2019 with least deviation of the long-term medium). The determination was executed by the guideline VDI 3783, part 20 [14].

Figure 11 shows the wind direction frequency distribution and the frequency distribution for wind velocity.

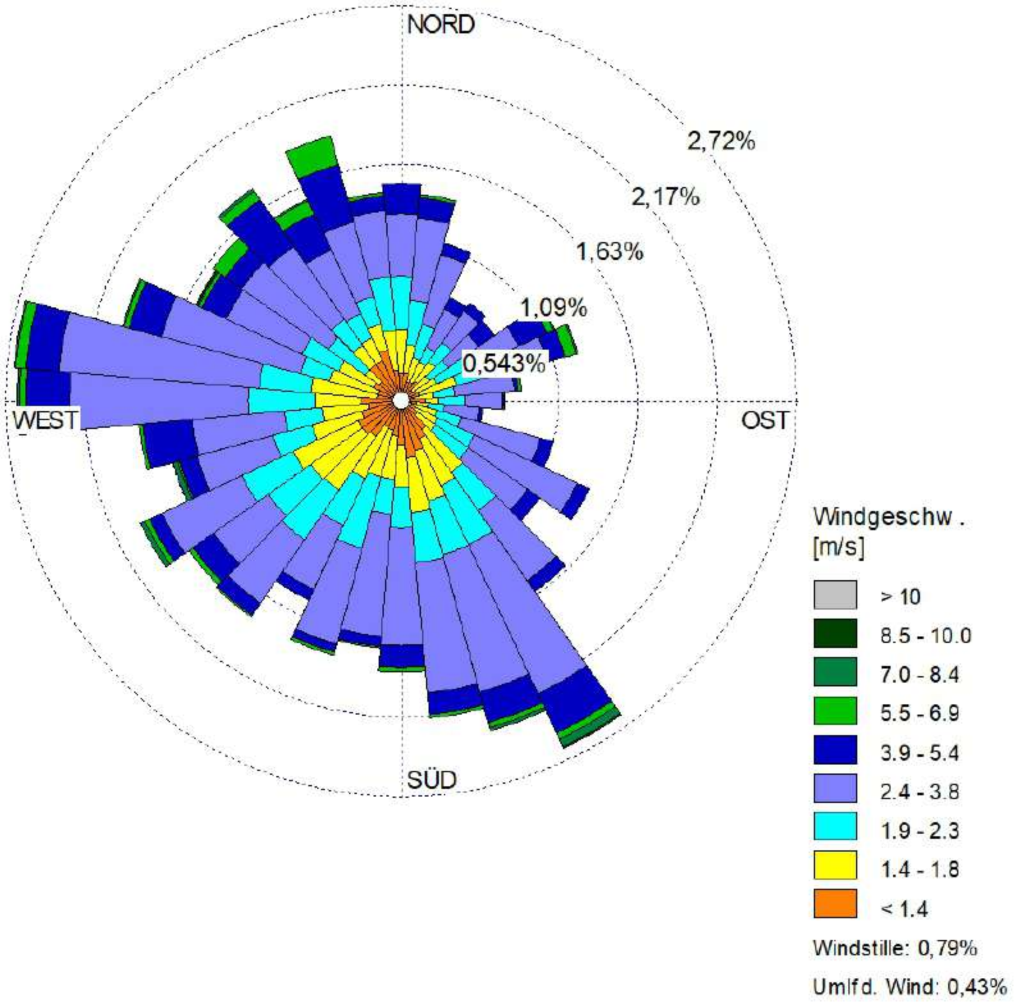

Figure 2. Wind direction frequency distribution for Kazan of the meteorological dataset for the representative year 2013.

S:\M\Proj\156\M156050\M156050_05_BER_1E_DRAFT1.DOCX:15. 05. 2020

In the figures below, the frequencies of wind velocity and dispersion classes are presented according to the TA Luft. Low-wind sites with wind velocities < 1.4 m/s occur in 9.1 % of the annual hours. With a share of almost 25 % in the frequencies of all dispersion classes the stable dispersion situations of classes I and II are dominant. Neutral dispersion classes (class III/1 and III/2) are represented in about 23 % of all dispersion classes.

PLEASE NOTICE: Meteorological Database is still under consideration. It might be a bit different in the final report.

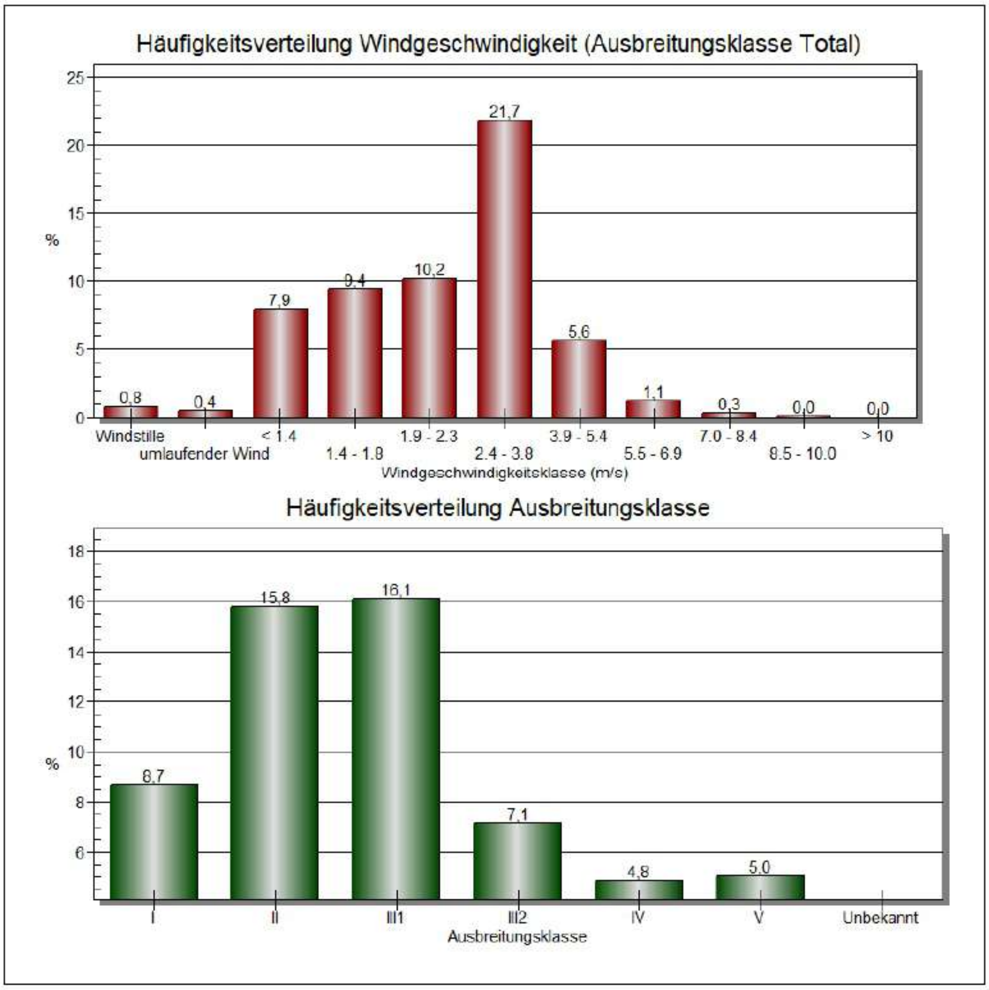

Figure 3. Frequency distribution of the wind velocity classes according to TA Luft (above) and frequency distribution of the dispersion classes according to Klug/Manier (below) of the meteorological dataset for the representative year 2013.

The meteorological boundary layer profiles needed by the particle model and the parameters required

- wind direction in anemometer height,

- Monin-Obukhov-length,
- mixing layer height,
- roughness length,
- displacement height

were determined according to guideline VDI 3783, Part 8, and in compliance with the conventions as determined in Appendix 3 of the TA Luft.

6 Dispersion model

For the air dispersion study, the model AUSTAL2000 [4] is used. AUSTAL2000 calculates the dispersion of pollutants and odours in the atmosphere. It is an implementation of Appendix no. 3 of TA Luft. The underlying model, on which AUSTAL2000 is based, is described in guideline VDI 3945 Part 3 [12]. For more detailed information of the physical model and the mathematical algorithms, please refer to the guideline VDI 3945 Part 3.

7 First results of the air dispersion calculation

The following figure shows the annual average additional load/contribution of the waste incineration plant for the pollutant fluorine in µg/m³ (J00) as an example.

Figure 4. Annual average additional load/contribution of the waste incineration plant J00 in µg/m³ for Sulfur dioxide. Monitoring sites are shown as pink dots; waste incineration plant yard shown as red rectangle

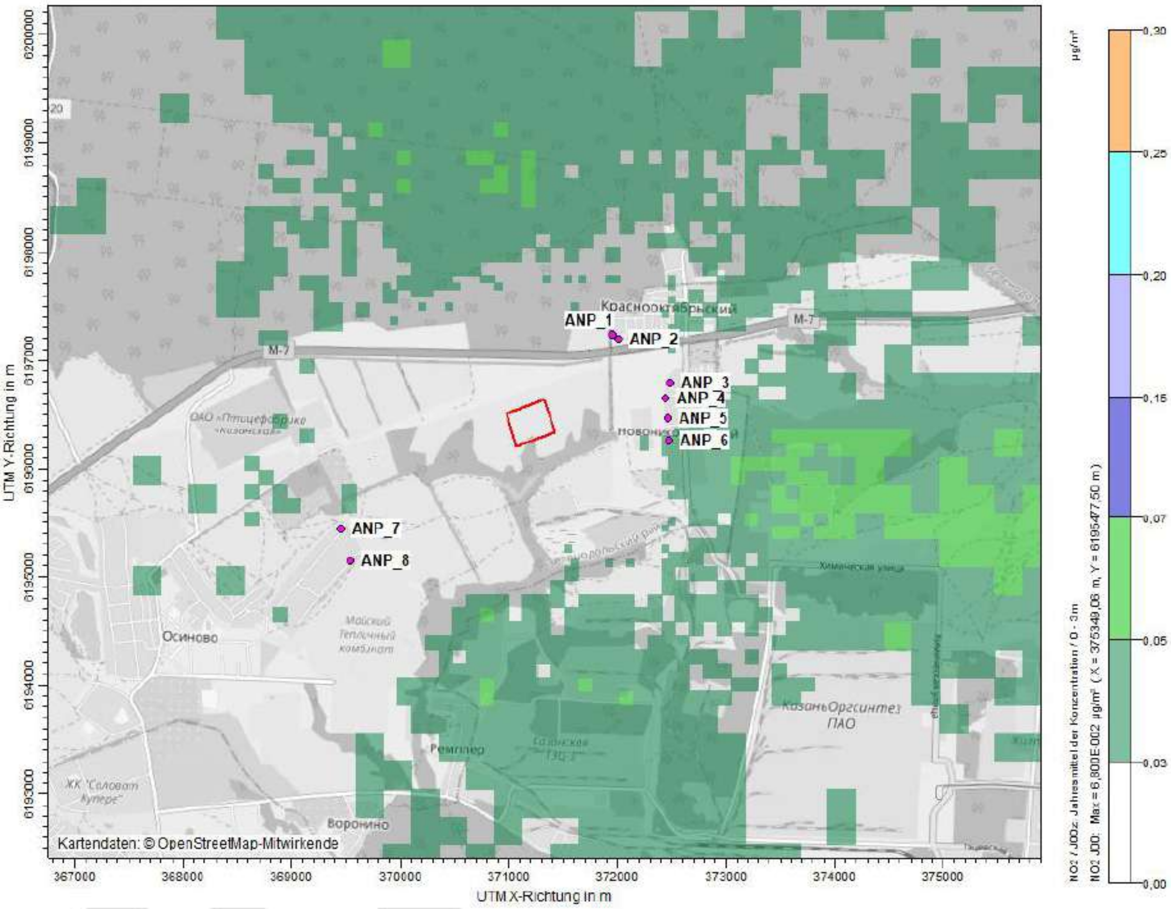

Figure 5. Annual average additional load/contribution of the waste incineration plant J00 in µg/m³ for Nitrogen dioxide. Monitoring sites are shown as pink dots; waste incineration plant yard shown as red rectangle

The results for all studied pollutants are shown in the following table.

Table 7. Annual average additional load/contribution of the waste incineration plant for the studied pollutants. For comparison the results of the second opinion are shown in brackets as far as known (attention: the unit of the results is unknown)

	unit	ANP_1	ANP_2	ANP_3	ANP_4
x-coordinate		371949,1	372007,86	372485,72	372442,63
y-coordinate		6197239,79	6197192,79	6196791,31	6196652,26
where		residential development point in Krasnooktyabrskiy settlement	residential development point in Krasnooktyabrskiy settlement	residential development point in the Novonikolayevskiy settlement	residential development point in the Novonikolayevskiy settlement
Dust (particulate matter, pm)	µg/m³	0,00 (0,01)*	0,00 (0,01)*	0,00 (0,01)*	0,00 (0,01)*
Dust deposition	g/(m²/d)	0,0	0,0	0,0	0,0
NO2	µg/m³	0,01 (0,63)*	0,01 (0,63)*	0,01 (0,65)*	0,02 (0,65)*
NOx	µg/m³	0,04 (0,08)*	0,07 (0,08)*	0,05 (0,08)*	0,07 (0,08)*
SO2	µg/m³	0,02 (0,01)*	0,03 (0,01)*	0,02 (0,01)*	0,04 (0,01)*
NH3	µg/m³	0,00 (0,02)*	0,01 (0,02)*	0,00 (0,02)*	0,01 (0,02)*
Hg deposition	µg/(m²*d)	0,011	0,015	0,014	0,019
Cd+Tl	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*
Cd+Tl deposition	µg/(m²*d)	0,035	0,038	0,038	0,039
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V ,Sn	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,00 (0,01)*	0,00 (0,01)*
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V ,Sn (deposition)	µg/(m²*d)	0,4	0,4	0,4	0,4
As, B(a)P, Cd, Co ,Cr (deposition)	µg/(m²*d)	0,04 (0,28)*	0,04 (0,28)*	0,04 (0,36)*	0,04 (0,36)*
dioxine and furane deposition	µg/(m²*d)	7,02E-05	7,54E-05	7,53E-05	7,75E-05
F	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*
HCl	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*

*(): maximum imissions in thise area of the other opinion, unit unknown!

	unit	ANP_5	ANP_6	ANP_7	ANP_8	Maximum in 1 km (SPZ)
x-coordinate		372468,09	372473,97	369454,03	369534,33	
y-coordinate		6196468,16	6196266,44	6195441,93	6195152,08	
where		residential development point in the Novonikolayevskiy settlement	residential development point in the Novonikolayevskiy settlement	the nearest residential development point of Osinovo settlement	the nearest residential development point of Osinovo settlement	
Dust (particulate matter, pm)	µg/m³	0,00 (0,01)*	0,00 (0,01)*	0,0 (0,0)*	0,0 (0,0)*	0,00 (0,01)*
Dust deposition	g/(m²/d)	0,0	0,0	0,0	0,0	0,0
NO2	µg/m³	0,02 (0,65)*	0,04 (0,65)*	0,02 (0,22)*	0,02 (0,22)*	0,02 (0,29)*
NOx	µg/m³	0,09 (0,08)*	0,18 (0,08)*	0,07 (0,03)*	0,06 (0,03)*	0,1 (0,04)*
SO2	µg/m³	0,04 (0,01)*	0,09 (0,01)*	0,03 (0,01)*	0,03 (0,01)*	0,1 (0,01)*
NH3	µg/m³	0,01 (0,02)*	0,01 (0,02)*	0,0 (0,02)*	0,0 (0,02)*	0,01 (0,02)*
Hg deposition	µg/(m²*d)	0,022	0,022	0,016	0,013	0,025
Cd+Tl	µg/m³	0,0 (0,0)*	0,0001 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0001 (0,0)*
Cd+Tl deposition	µg/(m²*d)	0,048	0,085	0,033	0,028	0,05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V ,Sn	µg/m³	0,00 (0,01)*	0,00 (0,01)*	0,0 (0,0)*	0,0 (0,0)*	0,00 (0,01)*
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V ,Sn (deposition)	µg/(m²*d)	0,5	0,9	0,3	0,3	0,4
As, B(a)P, Cd, Co ,Cr (deposition)	µg/(m²*d)	0,05 (0,36)*	0,09 (0,36)*	0,03 (0,05)*	0,03 (0,05)*	0,05 (0,19)*
dioxine and furane deposition	µg/(m²*d)	9,53E-05	1,70E-04	6,57E-05	5,51E-05	8,26E-03
F	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*
HCl	µg/m³	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*	0,0 (0,0)*

*(): maximum imissions in thise area of the other opinion, unit unknown!

8 Preliminary Conclusion

The first results of the air dispersion study have shown, that the additional load of pollutants caused by the waste incineration plant is very low. The results of the air dispersion modelling carried out with german standard model Austal2000 show lower ground level concentrations of the relevant pollutants than the results that were handed out in the information about the plant.

The absolute level of the calculated concentrations of pollutants seems to be very low, compared with results gained in air dispersion modelling studies for comparable plants. The (low) level of pollutant concentrations can be explained as follows:

- Stack height: The stack height of 98 m above ground is quite high compared with stack heights of similar plants. Thus, the impact of the buildings on plume rise are negligible as so called down-wash-effect are very unlikely to occur.
- Meteorological data: The wind direction frequency distribution shows a comparatively wide-ranging distribution of wind directions. So, there is no dominant ground level concentration maximum.

According to German Guideline “TA Luft 2002” the concentrations and depositions for the air pollutants are “not relevant”.

In the final report, the short time values according German and to the Russian Environmental Quality Standards will be analysed.

9 Literature

The following documents have been used for the elaboration of this report:

[1] Federal Immission Control Act - Act on the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena (BImSchG) in the version promulgated on 26 September 2002 (BGBl. I p. 3830).

[2] First General Administrative Regulation Pertaining the Federal Immission Control Act (Technical Instructions on Air Quality Control – TA Luft) of 24 July 2002m (GMBl. [Gemeinsames Ministerblatt – Joint Ministerial Gazette] p. 511.

[3] Time series AKTerm Kazan of 2016; meteorological dataset provided by the customer.

[4] Dispersion model AUSTAL2000, version 2.6.11-WI-x.
Copyright (c) Umweltbundesamt, Dessau-Roßlau, 2002-2014,
Copyright (c) Ing.-Büro Janicke, Überlingen, 1989-2014

[5] Program AUSTALView(TG), version 9.5.21 ArguSoft company, Mechernich.

[6] AUSTAL2000, Program description for version 2.6, status 2014-06-26, available from www.austal2000.de.

[7] Data provided by the client.

[8] Guideline VDI 3782 part 1, Environmental meteorology, Atmospheric dispersion models, Gaussian plume model for the determination of ambient air characteristics, January 2016.

[9] Guideline VDI 3782 part 3, Dispersion of Air Pollutants in the Atmosphere, Determination of Plume Rise, June 1985.

[10] Guideline VDI 3782 part 6, Environmental meteorology, Atmospheric dispersion models, Determination of Klug/Manier dispersion classes, April 2017.

[11] Guideline VDI 3945 part 3, Environmental meteorology, Atmospheric dispersion models, Particle model, September 2000.

[12] Guideline VDI 3783 part 19, Environmental meteorology, Reaction mechanism for the determination of the nitrogen dioxide concentration, April 2016.

[13] Guideline VDI 3783 part 20, Environmental meteorology, Testing the transferability of meteorological data for application within the context of TA Luft, March 2017.

[14] © OpenStreetMap-Mitwirkende. Creative-Commons-Lizenz - Weitergabe unter gleichen Bedingungen 2.0 (CC BY-SA) – www.openstreetmap.org/copyright .

10 Appendix: protocol of the calculation run - austal.log

```
2020-05-12 18:13:24 -----------------------------------------------------
TalServer:C:\Austal\P2_24683_2020-05-12_sieb_m156050_Tatarstan_RL05

  Ausbreitungsmodell AUSTAL2000, Version 2.6.11-WI-x
  Copyright (c) Umweltbundesamt, Dessau-Roßlau, 2002-2014
  Copyright (c) Ing.-Büro Janicke, Überlingen, 1989-2014

  Arbeitsverzeichnis: C:/Austal/P2_24683_2020-05-12_sieb_m156050_Tatarstan_RL05

Erstellungsdatum des Programms: 2014-09-02 09:08:52
Das Programm läuft auf dem Rechner "S-AUSTAL01".

============================= Beginn der Eingabe
============================
> ti "M156050_RL01"                'Projekt-Titel
> ux 39371125                'x-Koordinate des Bezugspunktes
> uy 6196374                'y-Koordinate des Bezugspunktes
> z0 0.50                'Rauigkeitslänge
> qs 2                'Qualitätsstufe
> az "Kazan_2013_z0_01.akt"                'AKT-Datei
> xa 293.94                'x-Koordinate des Anemometers
> ya 992.50                'y-Koordinate des Anemometers
> dd 4      8      16      32      64      128      256      'Zellengröße (m)
> x0 -264      -592      -608      -640      -1408      -2816      -5120      'x-Koordinate
der l.u. Ecke des Gitters
> nx 188      178      92      48      46      46      40      'Anzahl Gitterzellen in
X-Richtung
> y0 -344      -688      -704      -768      -1408      -2816      -5120      'y-Koordinate
der l.u. Ecke des Gitters
> ny 192      180      92      50      46      46      40      'Anzahl Gitterzellen in
Y-Richtung
> nz 44      56      56      56      56      56      56      'Anzahl Gitterzellen in
Z-Richtung
> os +NOSTANDARD+SCINOTAT
> hh 0 3.0 6.0 9.0 12.0 15.0 18.0 21.0 24.0 27.0 30.0 33.0 36.0 39.0 42.0 45.0 48.0 51.0 54.0
57.0 60.0 63.0 66.0 69.0 72.0 75.0 78.0 81.0 84.0 87.0 90.0 93.0 96.0 99.0 102.0 105.0 108.0
111.0 114.0 117.0 120.0 123.0 126.0 129.0 133.0 139.0 150.0 200.0 300.0 400.0 500.0 600.0
700.0 800.0 1000.0 1200.0 1500.0
> gh "M156050_RL01.grid"                'Gelände-Datei
> xq 7.71
> yq 0.13
> hq 98.00
> aq 0.00
> bq 0.00
> cq 0.00
> wq 0.00
> vq 18.86
> dq 2.83
> qq 11.830
> sq 0.00
> lq 0.0000
> rq 0.00
> tq 0.00
> so2  ?
> no   ?
> no2  ?
```

```
> nox  ?
> f    ?
> nh3  ?
> hg   ?
> pm-1 ?
> pm-2 ?
> pm-u ?
> hg-3 ?
> xx-1 ?
> xx-2 ?
> xx-u ?
> rb "poly_raster.dmna"                'Gebäude-Rasterdatei
============================== Ende der Eingabe
==============================

Existierende Windfeldbibliothek wird verwendet.
>>> Abweichung vom Standard (Option NOSTANDARD)!

Die maximale Gebäudehöhe beträgt 65.0 m.
Die maximale Steilheit des Geländes in Netz 1 ist 0.05 (0.05).
Die maximale Steilheit des Geländes in Netz 2 ist 0.10 (0.10).
Die maximale Steilheit des Geländes in Netz 3 ist 0.11 (0.11).
Die maximale Steilheit des Geländes in Netz 4 ist 0.11 (0.11).
Die maximale Steilheit des Geländes in Netz 5 ist 0.11 (0.09).
Die maximale Steilheit des Geländes in Netz 6 ist 0.07 (0.07).
Die maximale Steilheit des Geländes in Netz 7 ist 0.05 (0.05).
Existierende Geländedateien zg0*.dmna werden verwendet.
Die Zeitreihen-Datei "C:/Austal/P2_24683_2020-05-
12_sieb_m156050_Tatarstan_RL05/zeitreihe.dmna" wird verwendet.
Es wird die Anemometerhöhe ha=19.0 m verwendet.
Die Angabe "az Kazan_2013_z0_01.akt" wird ignoriert.

Prüfsumme AUSTAL   524c519f
Prüfsumme TALDIA   6a50af80
Prüfsumme VDISP    3d55c8b9
Prüfsumme SETTINGS fdd2774f
Prüfsumme SERIES   0313ee14

Bibliotheksfelder "zusätzliches K" werden verwendet (Netze 1,2).
Bibliotheksfelder "zusätzliche Sigmas" werden verwendet (Netze 1,2).

=========================================================================
======

TMT: Auswertung der Ausbreitungsrechnung für "so2"
TMT: 365 Tagesmittel (davon ungültig: 141)
TMT: Zulässige Überschreitungen auf 1 geändert.

Auswertung der Ergebnisse:
==========================

    DEP: Jahresmittel der Deposition
    J00: Jahresmittel der Konzentration/Geruchsstundenhäufigkeit
    Tnn: Höchstes Tagesmittel der Konzentration mit nn Überschreitungen
    Snn: Höchstes Stundenmittel der Konzentration mit nn Überschreitungen

Maximalwerte, Deposition
========================
```

```
NH3     DEP : 5.344e-002 kg/(ha*a) (+/- 58.9%) bei x=  414 m, y= -162 m (1:170, 46)
PM      DEP : 6.503e-006 g/(m²*d) (+/-  4.7%) bei x= 1984 m, y= -320 m (6: 38, 20)
HG      DEP : 5.217e-002 µg/(m²*d) (+/-  5.3%) bei x= 2496 m, y= -448 m (6: 42, 19)
XX      DEP : 1.300e-010 g/(m²*d) (+/-  4.7%) bei x= 1984 m, y= -320 m (6: 38, 20)
==============================================================================
======

Maximalwerte, Konzentration bei z=1.5 m
==========================================
SO2     J00 : 1.097e-001 µg/m³ (+/-  9.0%) bei x= 2624 m, y= -704 m (6: 43, 17)
SO2     T03 : 3.100e+000 µg/m³ (+/- 84.8%) bei x=   58 m, y= -262 m (1: 81, 21)
SO2     T00 : 8.357e+000 µg/m³ (+/- 99.9%) bei x=  -18 m, y=  382 m (1: 62,182)
SO2     S24 : 8.963e+000 µg/m³ (+/- 99.9%) bei x= -364 m, y=  620 m (2: 29,164)
SO2     S00 : 1.485e+002 µg/m³ (+/- 99.9%) bei x=  414 m, y=  -26 m (1:170, 80)
NOX     J00 : 2.195e-001 µg/m³ (+/-  9.0%) bei x= 2624 m, y= -704 m (6: 43, 17)
NO2     J00 : 6.800e-002 µg/m³ (+/- 11.1%) bei x= 4224 m, y= -896 m (7: 37, 17)
NO2     S18 : 7.710e+000 µg/m³ (+/- 66.1%) bei x= -576 m, y=-1728 m (6: 18,  9)
NO2     S00 : 1.125e+002 µg/m³ (+/- 99.9%) bei x=  174 m, y= -286 m (1:110, 15)
NH3     J00 : 1.579e-002 µg/m³ (+/-  8.0%) bei x= 1984 m, y= -448 m (6: 38, 19)
F       J00 : 2.168e-003 µg/m³ (+/-  9.0%) bei x= 2624 m, y= -704 m (6: 43, 17)
PM      J00 : 9.758e-003 µg/m³ (+/-  9.0%) bei x= 2624 m, y= -704 m (6: 43, 17)
PM      T35 : 4.224e-002 µg/m³ (+/- 47.6%) bei x= 2368 m, y= -704 m (6: 41, 17)
PM      T00 : 7.397e-001 µg/m³ (+/- 99.9%) bei x=  -18 m, y=  382 m (1: 62,182)
XX      J00 : 1.952e-013 g/m³  (+/-  9.0%) bei x= 2624 m, y= -704 m (6: 43, 17)
==============================================================================
======

2020-05-14 04:41:41 AUSTAL2000 beendet.
```