Air Quality Annual Report 2013

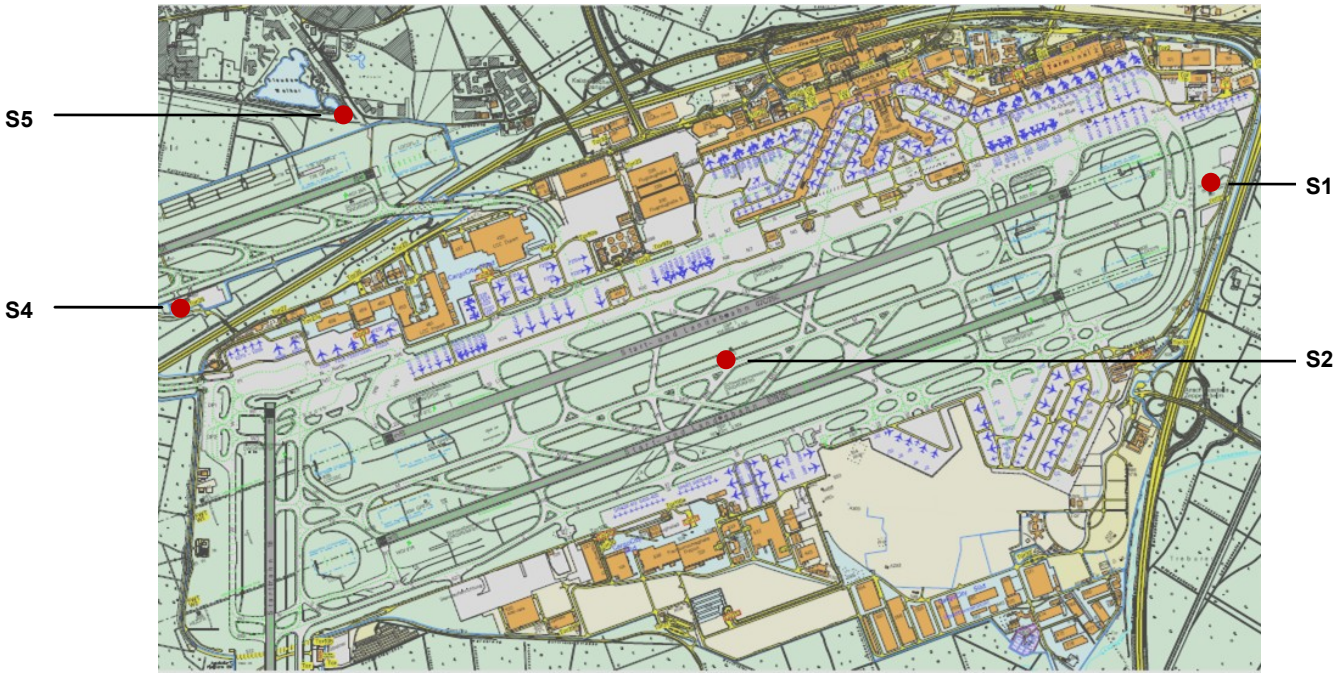
Report on Ambient Air Quality Monitoring at Frankfurt Airport

This report documents the results of the annual air pollution monitoring as usual. In addition, we discuss some further details referring to Runway Northwest. As in previous years, the measuring values do not show any particular outcome typically related to the airport, neither regarding time-dependent behavior nor compared to the stations of the public monitoring network.

A central topic of this edition is monitoring and assessment of ambient odor. We present the results of the one-year odor monitoring program that had been implemented as a condition by the zoning approval decision for the new runway in 2008. Although it is also commonly referred to as ”measurement“, there are very special framework conditions to be considered in this regard. Odor can neither be detected on an ongoing basis nor is it possible to standardize its recording as strictly as in the case of a technical measurement. On the other hand odor is directly perceptible and often also identifiable with respect to its source.

The latest odor monitoring campaign around the airport did not reveal any unexpected results. In the neighborhood kerosene odor was found, but not more frequently than permissible according to the respective standards and within the range predicted during the expansion approval procedure.

Sites of Ambient Air Quality Monitoring Stations in 2013



Annual Mean Values Compared to Air Quality Standards

		Measured Value	Air Quality Standard*
NO	S1	37	200 [1]
	S2	20	
	S4	20	
	S5	15	
NO_2	S1	47	40 [2]
	S2	35	
	S4	34	
	S5	32	
SO_2	S1	2	50 [3]
	S2	3	
CO	S1	0.3	- [4]
	S2	0.3	
O_3	S1	37	- [4]
	S2	44	
PM10	S1	20	40 [2]
	S2	18	
	S4	21	
	S5	20	
Benzene	S1	0.8	5 [2]
	S2	0.9	
Toluene	S1	1.6	30 [5]
	S2	1.6	
m/p-Xylene	S1	1.0	30 [5]
	S2	1.0	
Ethylbenzene	S1	0.4	20 [1]
	S2	0.3	
Benzopyrene	S1	0.3	1 [2]
	S2	0.4	
Arsenic	S1	0.4	6 [2]
Lead	S1	4.6	500 [2]
Cadmium	S1	0.1	5 [2]
Nickel	S1	1.6	20 [2]

Measuring unit: µg/m³, CO: mg/m³, benzopyrene, arsenic, lead, cadmium and nickel: ng/m³

PM10 = particles, passing a size selective airflow inlet with separation efficiency of 50% at aerodynamic diameter of 10 µm

** Reference values used:*

[1] Reference value according to HLUG (Hessisches Landesamt für Umwelt und Geologie, Hessian State Agency for the Environment and Geology)
[2] Limit value 39. BImSchV (German ordinance transposing Air Quality Directive 2008/50/EC into national law); arsenic, cadmium, nickel and benzopyrene: target value
[3] Limit value TA Luft 2002(German Technical Instructions on Air Quality Control, for plants requiring licensing)
[4] No annual mean defined for assessment by respective regulations
[5] LAI recommendation (LAI = Länderausschuss für Immissionsschutz, Ambient Pollution Control Committee of German States)

The reporting coverage of data exceeded 95% for all pollution species.

Exceedance Frequency of Short-Term Standards

		Short-Term Standard	Reference Interval	Recorded Exceedance Number per Year	Permissible* Exceedance Number per Year
NO_2	S1	200	1 Hour	8	18
	S2			0	
	S4			0	
	S5			0	
SO_2	S1	350	1 Hour	0	24
	S2			0	
CO	S1	10 [1]	8 Hours	0	0
	S2			0	
O_3	S1	180 [2]	1 Hour	9	0
	S2			23	
	S1	240 [3]	1 Hour	0	0
	S2			0	
	S1	120 [1]	8 Hours	12 [4]	25 [4]
	S2			17 [4]	
PM10	S1	50	24 Hours	9	35
	S2			2	
	S4			13	
	S5			10	

Measuring Unit: µg/m³, CO: mg/m³
** Short-term standards according to 39. BImSchV (for explanation on "permissible" refer to "Lufthygienischer Jahresbericht 2004"):*

[1] Maximum permissible eight-hour floating mean of the day derived from hourly means (ozone: target value)
[2] Threshold for the information of the public by responsible authorities in case of exceedance within their network
[3] Threshold for setting off alert in case of exceedance within the public network
[4] Three-year average (2011, 2012, 2013)

Corresponding short-term values for the assessment of particle constituents, NO, benzene, toluene, m/p-xylene, and ethylbenzene are not available.

Regarding temperature, duration of sunshine and precipitation, the year 2013 was comparable to average climatologic conditions[5]. However, considerable deviations were observed during single months. The seasonal temperature cycles were well-marked, displaying minimum values in spring and higher values in the second half of the year. In July, the weather was particularly warm and dry. An exceptionally high amount of precipitation fell during May and October.

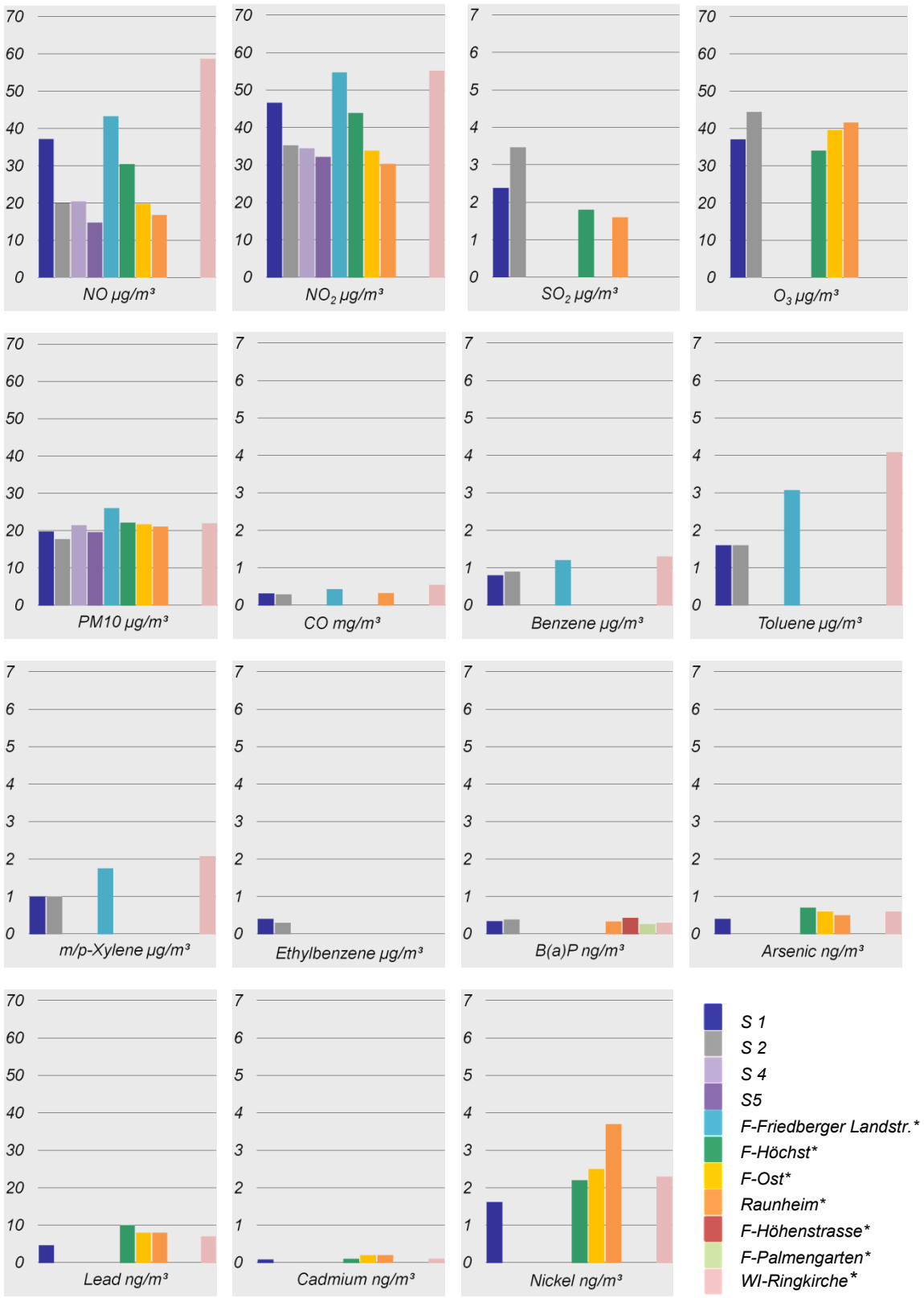
High pressure weather conditions led to prevalent exceedance of the ozone information threshold, particularly during the second half of July. At the S1 site, the information threshold was exceeded nine times on four days and at S2 23 times on eight days.

Apart from the ozone exceedance of the information threshold, only the annual NO_2-mean at S1 continued to be higher than the reference value in the reporting period. Compared to the previous year, the annual mean has slightly increased there, whereas it was somewhat lower than before at the other three Fraport sites. The short-term threshold was exceeded eight times at S1, while 18 hourly average values higher than 200 µg/m^3 per year would still be permissible, even in case of corresponding exposition. Except for one occasion during the early morning hours, exceedance occurred only during the evening rush hours on six days with prevailing easterly and northeasterly wind direction. Thus, airport-related emissions can be excluded as a considerable cause.

Exceedance of the PM10 short-term threshold of 50 µg/m^3 on a daily average was more frequent than during the previous year and approximately corresponded to the urban background results within the public network. Observed in thirteen cases, exceedance was most frequent at S4 again. For details see p. 6.

[5] 1981-2010 at the airport station of the German weather service

Annual Means at Airport Sites Compared to Values from Near Sites of Public Network (HLUG*)



No bar = species not available at site, F = Frankfurt/Main, WI = Wiesbaden

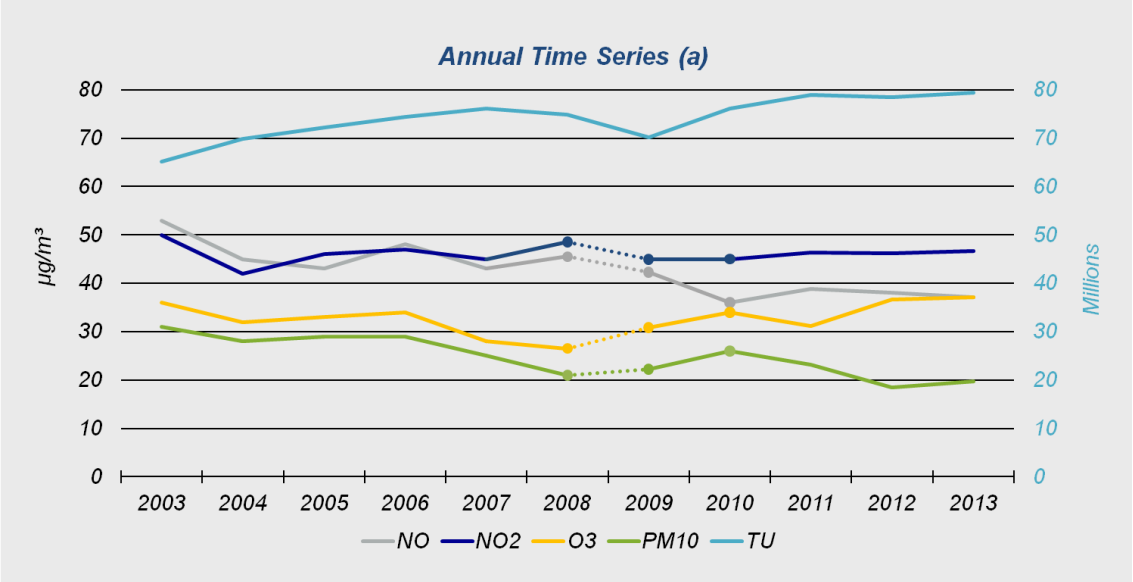
** Reference: Lufthygienischer Monatsbericht Dezember 2013 (floating annual means), HLUG and Lufthygienischer Jahresbericht 2012 (Teil 2: Staub und Staubinhaltsstoffe), HLUG. Part 2 for particles and particle constituents (Teil 2) for 2013 not available by copy deadline of this report.*

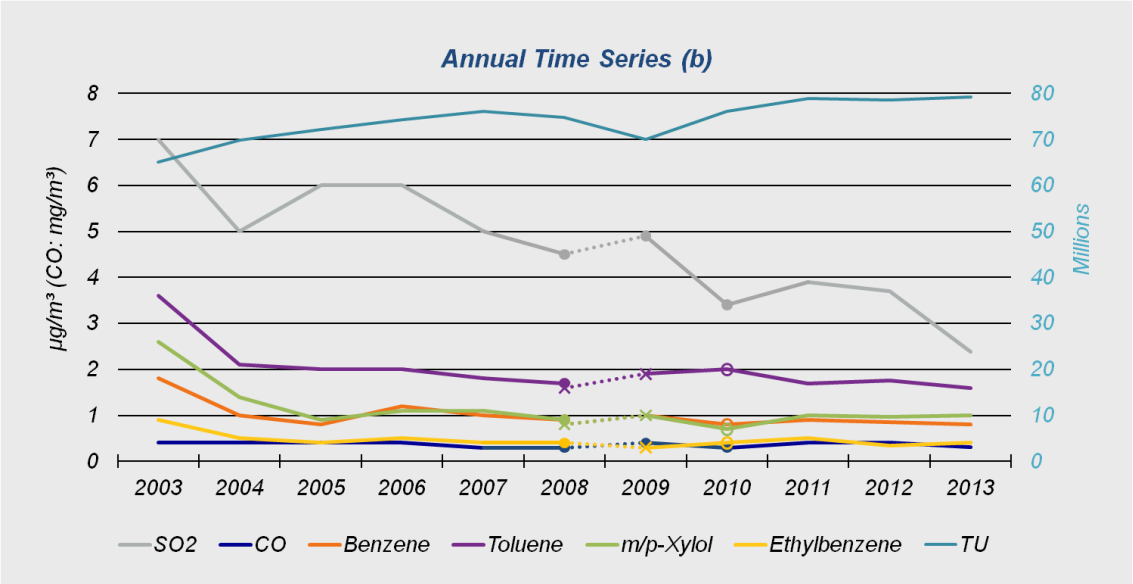
Comparison between Fraport Sites and Near HLUG Sites

As for the previous years, no significant deviations of measurement results at Fraport sites compared to HLUG sites can be identified. Since the 2012 reporting period, nickel concentrations have been determined using material that does no longer cause any elevated blank values. The results are now in the lower range of the comparative values. Thus, the subsequent blank value correction of the past time series described in the previous report is validated. Further on, it should be considered that the comparative HLUG data for arsenic, lead, cadmium and nickel refer to the previous year and may only serve as an indicative measure.

Time Series of Annual Means (Station S1) and Traffic Units (TU)

The declining trend of SO_2 and NO in the past years is still continuing. A corresponding PM10 trend could be obscured by year-to-year variations. NO_2-concentration remains nearly unchanged as well as the already very low concentrations of hydrocarbons. Looking back on the past five years, the increase of ozone concentration seems to be confirmed.



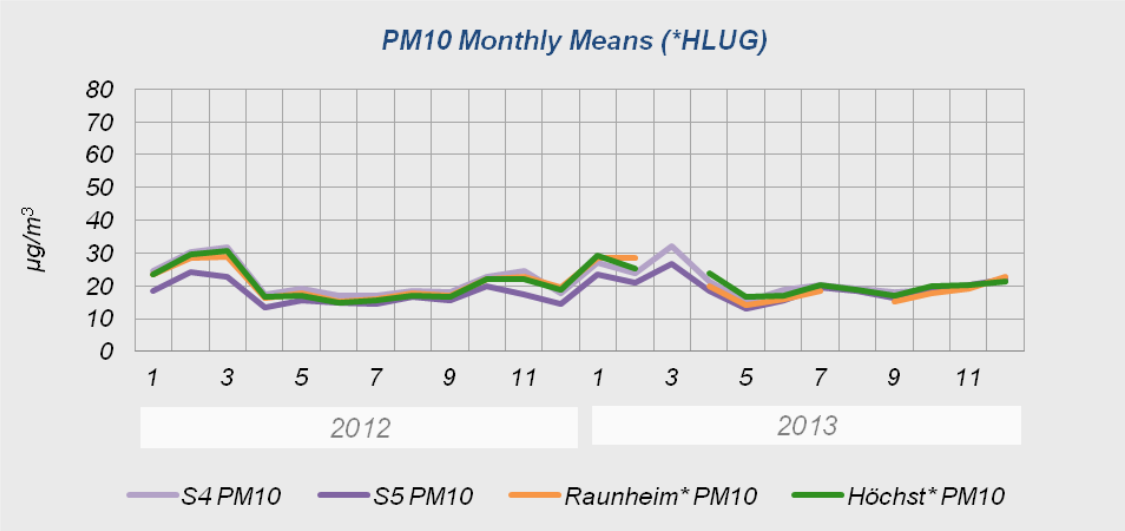


1 TU = 1 passenger including luggage or 100 kg of air freight or airmail respectively
Solid lines: measurement results at site, dotted lines: change of site 2008 / 2009
Large dots: correction for gaps of data at site, crosses: low data volume at site without correction,
Circles: data derived from two sites

PM10 Time Series Close to the New Runway

Regarding the overview of the annual key figures, increased PM10 short-term exceedance frequency has been apparent. Certainly, this is not an airport-specific effect. The course of monthly PM10-means is nearly identical for both Fraport stations close to Runway Northwest, S4 and S5, compared to those of HLUG stations Raunheim and Frankfurt-Höchst.

Only in the winter months, the values of S5 merely are a little lower than those of the other stations. This may be due to less influence of local road traffic and domestic heating at this site outside residential areas. Yet S4, which is also situated away from built-up areas, is exposed to additional influences from fire service activities and probably from the near BAB 3 motorway. During the winter months, when atmospheric mixing is limited, this might compensate for the reduced residential influence there.



The temporally resolved figure does not display any obvious difference between the 2012 and 2013 results. Nonetheless, the short-term threshold exceedance frequency has also increased at the two HLUG reference stations from seven days in 2012 to 14 days at Raunheim and 10 days at Frankfurt-Höchst in 2013. In case of PM10 the short-term threshold is rather low in relation to the long-term value. Thus, even comparably short episodes of only moderately elevated values may cause exceedance of this short-term threshold without contributing considerably to the average concentration level on a monthly or annual scale. Since such episodes usually occur in spatially extended areas, this effect can be observed at many monitoring stations, while local effects are of minor importance. Year-to-year variations of the PM10 short-term threshold exceedance are therefore only meaningful to a certain degree. They cannot simply be interpreted as indicator for an essential temporal trend. In particular, there is no relation to Runway Northwest.

Characteristics of Odor Assessment

While the well-known hazardous air pollution species can be continuously monitored using technical equipment a reliable assessment of real odor perception is much more difficult. The human olfactory sense reacts already to concentrations of some species well below the detection limits even when using advanced analytics. In case of kerosene, a mixture of various hydrogen components, it is not yet known which one of these components causes the perceived odor. However, a correlation between the hydrocarbon concentration and the resulting odor impact was found, which can be utilized for model calculations if the emission of total hydrocarbons is known.

Objective Criteria for Odor Assessment

In Germany, odor assessment is generally based on the ”Guideline on Odour in Ambient Air – GOAA“ (Geruchsimmissionsrichtlinie – GIRL). According to this guideline, severe nuisance is assumed if the frequency of perceived odor related to plants or facilities exceeds the limit value. This limit is given as maximum percentage of hours in the course of a year: 10% for residential areas and 15% for commercial and industrial areas. Every hour is taken into account as an ”odor-hour” if odor can be perceived at least during 10% of the time, i.e. for six minutes. Thus perception of odor has to be tolerated to a certain degree and it does not automatically translate into a health risk.

The guideline also specifies the procedure for monitoring odor frequencies. To this end a field inspection of the assessment area is performed by selected and trained persons in a temporally representative way. Odor occurrence is recorded and evaluated following detailed instructions.

Odor Prediction in the Context of the Approval Procedure

As early as 1999/2000 an odor field inspection was performed in the vicinity of the airport. The resulting information served for calibrating a model calculation on odor dispersion based on the predicted hydrocarbon emissions in 2020. It was part of a series of expert reports within the frame of the approval procedure for the airport expansion. Maximum odor frequency in residential areas was found to be 8% of hours per year at Kelsterbach.

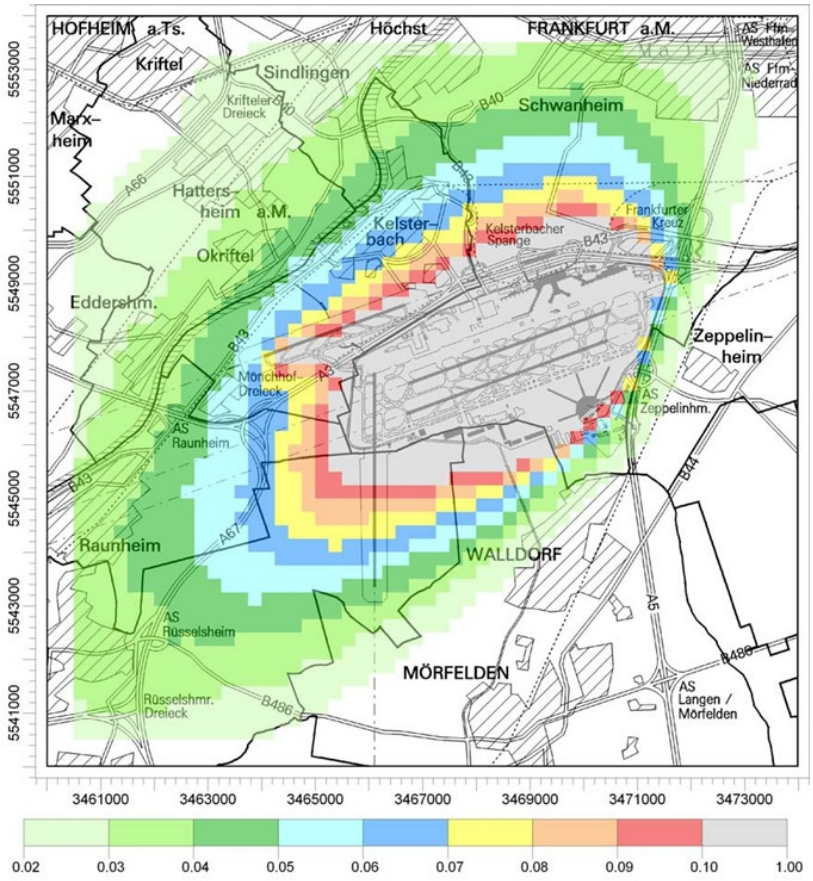


Fig. 11-1 from report G20: Calculated frequency of odor perception due to aircraft engine exhaust and evaporated kerosene for expansion scenario 2020

Assessment values according to GOAA (GIRL)

- *Irrelevance threshold 2%*
- *Permissible odor frequency in residential areas 10%*
- *Permissible odor frequency in commercial and industrial areas 15%*

Referring to the hours of a year, severe nuisance beyond

Explanation of legend:

0.10 = 10% (red)
0.02 = 2% (light green)

What is known in the context of air pollution in general, applies to odor even more: Most of the aircraft-related impact originates from ground-level emissions. Odor causing hydrocarbons are primarily emitted during low power operating conditions, this means in idle mode and while taxiing.

Results of the Latest Odor Field Inspection in the Vicinity of the Airport

The decision for the approval of the expansion planning dating from 2007 included the provision stipulating a one-year odor field inspection in the vicinity of the airport after Runway Northwest would have been brought into service. The monitoring design according to GOOA (GIRL) has been reconciled with the Hessian Agency for the Environment and Geology, particularly regarding the selection of assessment area. In total there were 29 assessment grid squares built up by 88 single monitoring points edging the grids. During the period of monitoring from 2012-09-06 to 2013-09-08 inspections were performed on 104 dates being representative with respect to season, weekday, time of day, meteorological conditions and operating conditions at the airport as well.

Position of grid squares (dark blue) during the 2012/2013 odor field inspection, figures: % of hours of the year with perceptible odor

Kerosene odor was temporarily perceived as a characteristic airport-related smell in the close vicinity. Odor caused by tire wear due to landing aircraft or caused by de-icing agents was not detected. As indicated in the map above kerosene odor was most frequent in the commercial areas of Gateway Gardens (13%) and Kelsterbach Taubengrund (10%), both directly adjacent to the airport. The highest frequency in residential areas was determined for the outskirts of Kelsterbach amounting to 6%. Beyond that, airport-related odor was only detected occasionally: The resulting data were all below the limit values of GOAA (GIRL) and below or close to the 2020 model prediction.

Further Information:

HLUG (Hessisches Landesamt für Umwelt und Geologie)
Hessian State Agency for the Environment and Geology
www.hlug.de

Fraport AG
www.fraport.de

Geruchsimmissionsrichtlinie
www.lanuv.nrw.de/luft/gerueche/bewertung.htm

Guideline on Odour in Ambient Air – GOAA
http://www.lanuv.nrw.de/luft/gerueche/infos.htm

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