Exposure study

The researchers engaged will conduct a study of exposure caused by ultrafine particles (UFP) in close consultation with the Forum Flughafen und Region (FFR, Airport and Region Forum) and its working bodies. The study will record, calculate and describe the exposure due to ultrafine particles in the Rhine-Main region with sufficient accuracy.
The UFP exposure study began on 1 April 2023.

The study has the following objectives:

1. The planned exposure study requires the UFP emissions from Frankfurt Airport to be recorded at high spatial and temporal resolution. UFP emissions from other sources near the airport in the region under investigation also have to be inventarised.
2. Measurement of the local and regional particle size distributions and particle number concentrations of volatile and non-volatile particles at least in the size range 10 to 800 nm.
3. Preparation of validated immission maps for the area under observation and determination of the proportions of immissions originating from different sources of UFP emissions.

Working packages (WP)

WP 1 Determining emissions of UFP

The emission data collected in work package 1 will form the basis for the following work packages and their modelling of how the particles disperse. To this end, the exposure study will first of all record the UFP emissions from Frankfurt Airport and other sources (e.g. road traffic, industry, domestic heating, etc.) at sufficiently high spatial and temporal resolution. This will be done in four steps: identification of emission factors based on existing data (WP 1.1); validation / determination of emission factors using measurements (WP 1.2); modelling of the emissions on this basis (WP 1.3); an iterative process for generating emission data wherever this is expedient and necessary (WP 1.4). The work package is divided into the following steps:

WP 1.1 UFP emission factors
Objective: identifying emission factors
WP 1.2 UFP emission measurements
Objective: measuring volatile and non-volatile UFP emissions from aircraft
WP 1.3 UFP emission modelling
Objective: creating a performance-based model of relevant UFP emissions
WP 1.4 Iterative process for compiling a valid database
Objective: processing data requirements

WP 2 UFP immission measurements

While the emissions are being determined in WP 1, both the volatile and non-volatile UFP immissions will be recorded in WP 2 to provide a basis for modelling immissions appropriately in WP 3. Alongside recording the particle number concentrations and the particle size distribution, WP 3 will record black carbon and identify chemical marker compounds so that UFP from airport operations can be unequivocally attributed as such.
The work package is divided into the following steps:
WP 2.1 Measuring sites for UFP immission measurements
Objective: specifying the measuring sites for local and regional UFP immissions
WP 2.2 Quality assurance for the UFP immission measurements
Objectives: ensuring and documenting quality assurance of the measurements
WP 2.3 Number concentration and particle size distribution of volatile and non-volatile particles
Objectives: determining the number concentration and number size distribution of the volatile and non-volatile particles
WP 2.4 Measuring black carbon
Objective: determining the mass concentration of black carbon
WP 2.5 Chemical characterisation of UFP
Objective: establishing sources by identifying marker substances
WP 2.6 Vertical UFP measurements
Objectives: determining the vertical distribution of particles in the airport plume, validating the immission modelling, and determining the maximum height at which the UFP coming directly from take-offs and landings are still relevant on the ground
WP 2.7 Mobile UFP measurements in the vicinity of stationary measuring points
Objective: determining the local variability of the UFP particle number concentration and validating the immission modelling

WP 3 UFP immission modelling

All the preparatory work in WP 1 and WP 2 feeds into the creation of a UFP immission modelling system in WP 3, which can prepare separate immission maps for each individual source, and can also present them combined into one overall map. The modelling will include both volatile and non-volatile UFP and will map all the relevant sources in the area under investigation.

The work package is divided into the following steps:

WP 3.1 Selection of the dispersion model

Objective: selecting a method for preparing the immission maps for the dispersion of UFP

WP 3.2 Expanding the area under investigation

Objective: defining and demarcating the area under investigation

WP 3.3 Conducting and validating the dispersion modelling

Objective: The modelling in WP 3.3 is based on the parameters finalised in WP 3.1 and WP 3.2 (selecting the dispersion model and defining the area of dispersion).

WP 3.4 Preparing UFP immission maps

Objective: Preparing maps as products of the work package, which reflect the UFP immissions from relevant sources

WP 3.5 Determining the contributions from a variety of sources

Objective: identifying the specific contribution to UFP immissions made by the airport/air traffic in the region

WP 3.6 Methodological preparation and cooperation on the design of a UFP impact study

Objective: defining the requirements for measuring and modelling exposure to UFP in the design of the UFP impact study

WP 4 Data management

Storing and securing the measurement data collected and the measuring and modelling results, plus the secure exchange of information between all stakeholders.

WP 5 Project management

Given the complexity of the overall project with several sub-projects and the close cooperation with the FFR's bodies, the contractors are expected to establish a professional project management.
The work package is divided into the following steps:

WP 5.1 Collaboration with the UFP Working Group

WP 5.2 Collaboration with the SQA

WP 5.3 Reporting and documentation

WP 5.4 Communication

The UFP exposure study will be carried out in close cooperation with the consortium commissioned to draw up the design / to perform the UFP impact study.