# FAQs

*Here you will find answers to overarching questions, questions regarding the content of the exposure and impact study, the publication of study results, and transparency, as well as questions about scientific quality assurance.*

## General questions

### What work is already being conducted on UFP at the Frankfurt location?

The Hessian Agency for Nature Conservation, Environment and Geology (HLNUG) has been measuring UFP at a number of stations since 2015. Throughout this period, the measurements have been continually expanded and regularly evaluated, and the results have appeared in reports published by the HLNUG. You will find an overview of the locations of the air measuring stations operated collaboratively by the Forum Flughafen und Region (FFR, Airport and Region Forum) and the HLNUG on the website of the Umwelt- und Nachbarschaftshaus (UNH), which acts as the FFR Office: Measuring sites (https://www.umwelthaus.org/umweltmonitoring/ultrafeinstaub/luftmessstationen/)
In addition, the FFR has decided to run research projects to systematically investigate both the UFP exposure in the region surrounding the airport and the associated health impacts.

### Are there any legal regulations governing UFP?

Unlike the situation for particulate matter of the sizes PM10 and PM2.5, there are no limit values at either European or national level specifying the permitted concentration of UFP in the ambient (outdoor) air. Furthermore, until now there have been no legal obligations at all in the EU to measure and document the immission pollution resulting from UFP in the ambient air. However, the European Commission is currently working on a new EU Air Quality Directive that would probably also address UFP (see the question: Are there any recommendations from the WHO or the EU on dealing with UFP?).

### Are there any recommendations from the WHO or the EU on dealing with UFP?

**WHO:** In September 2021 the World Health Organization (WHO) published its Global Air Quality Guidelines containing proposals for new air pollutant limit values that were medically justified. However, WHO concluded that the data available were insufficient for it to recommend limits for UFP. Given that high UFP concentrations are potentially associated with health risks, WHO suggested further measures for researching the risks and approaches for reducing pollution. One particular aspect was to expand the monitoring of air pollutants to include ultrafine particles. Accordingly, UFP should be selected by their size at certain measuring stations and systematically measured in real time in addition to other airborne pollutants and particulate fractions. Moreover, a distinction should be made between low concentrations (daily mean < 1,000 particles/cm³) and high

concentrations (daily mean > 10,000 particles/cm³, or hourly mean > 20,000 particles/cm³), in order to provide a better basis for decisions on measures to limit emissions.
**EU:** In response to WHO's recommendation for measurements of UFP, in October 2022 the European Commission incorporated into its proposals for revising the central European law governing air pollutants (the air quality control and air quality directive) the requirement that in the future, EU Member States must ensure that UFP measurements are carried out. The current proposal for recasting Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe (as of January 2023) specifically envisages the following as a UFP measuring obligation in the European Union:
"Monitoring of UFP shall be introduced at locations where high concentrations of UFP are likely, such as at or close to airports. The sampling points shall be located upwind within the main wind direction at a location where high UFP concentrations are likely to occur. In addition, monitoring supersites shall be established. These monitoring supersites will combine multiple sampling points with the aim of generating long-term data on air pollutants as well as on air pollutants of emerging concern. The introduction of additional sampling (incl. UFP, black carbon) will support scientific understanding of their effects on health and the environment. Each Member State shall establish at least one monitoring supersite per 10 million inhabitants at an urban background location and at least one monitoring supersite per 100,000 km2 at a rural background location."
The recast Ambient Air Quality Directive will be finalised by the European Parliament and the Council in the ordinary legislative procedure.

## What measures exist to reduce UFP emissions, and are they already being implemented at Frankfurt Airport?

According to the latest findings, one key source of UFP at airports is the combustion of various fossil fuels, both in the main engines and in the auxiliary power units (APU) of the aircraft, and in other vehicles and operations on the ground. Therefore all measures leading to a decrease in fossil combustion processes on the ground reduce the formation of UFP in the vicinity of the airport. Particularly in relation to airport operation, this includes the optimisation and/or adaptation of ground operations with the objective of minimising the use of aircraft engines and APU, and thus the emissions from ground transportation services. This can be brought about, for example, by performing single-engine taxi-in and taxi-out, supplying aircraft with ground power and either cooled or warmed fresh air from Pre-Conditioned Air (PCA) systems, or converting the ground vehicles to alternative propulsion systems (battery-electric or fuel cells).
As the airport operator, Fraport has a fundamental interest in reducing emissions. It constantly strives to do so by optimising its ground support to avoid having engines idling during standing times and unnecessary taxiing. The partners Fraport AG, Lufthansa Group and the State of Hesse are aiming to achieve long-term reductions in ground level emissions associated with the entire process of aircraft handling. To this end, individual projects are developing various electromotive technologies and procedures, and testing them in everyday operations with scientific support. The goal is to gradually convert Fraport's fleet at Frankfurt Airport to electric propulsion. Currently 648

vehicles of Fraport's vehicles at the airport already have electric motors. This equates to around 21% (see https://www.fraport.com/de/umwelt/klimaschutz/e-port-on.html). The company plans to procure up to 900 additional electrically powered vehicles by 2030, to replace those that are still running on fossil fuels at present. The latter include vehicles with high levels of ground emissions such as passenger buses and other commercial vehicles. What is more, Lufthansa LEOS, the Lufthansa Group's ground-handling subsidiary, is trialling a switch from purely diesel tugs to fully electric ones. Alongside the two diesel-hybrid tugs, a battery-electric towbarless tractor has also been operating at Frankfurt Airport since early 2022. The battery-powered vehicle can move aircraft with a take-off weight of up to 352 tonnes over short and long distances between parking areas, maintenance hangars, and departure positions (see https://www.lufthansagroup.com/de/newsroom/meldungen/emissionsfreie-flugzeugschlepps-lufthansa-leos-ist-erstkunde-des-vollelektrischen-stangenlosen-flugzeugschleppers-phoenix-e.html). Fraport AG, which supplies the electricity used, is also planning to install a (fast) charging infrastructure to serve the growing number of electric vehicles deployed by the company, its subsidiaries and third parties at Frankfurt Airport, both airside and landside. The State of Hesse supports this project by providing funding.

In addition to gradually switching to vehicles with alternative drivetrains at Frankfurt Airport, all the building positions and the majority of the remote positions are equipped with stationary ground power units to reduce the use of auxiliary power units (APU). At some apron positions far from the terminal, aircraft are supplied via mobile ground power units (GPU), which in the future are to be replaced with battery-electric devices. At present Fraport is already using seven electrically powered GPUs.

Another aspect relating to air traffic is the kerosene used or, to be more accurate, its chemical composition. It is known that the quantities of sulphur and aromatics found in kerosene (Specification Jet A-1) exert a direct influence on the formation of UFP. Mandatory reduction by means of EU limits on these more or less avoidable components of kerosene leads to a decrease in UFP. One concrete approach would therefore be to remove the sulphur from aviation fuels by hydrodesulphurisation (HDS), and to reduce the content of aromatics to the minimum that is technically necessary. In parallel to this, the market ramp-up of advanced biofuels and electricity-based synthetic aviation fuels must be consistently driven forward on all levels – using renewable energy. This is because the higher the blending quota for alternative fuels compared to fossil-based kerosene jet fuel, the smaller the quantities of air pollutants – including UFP – that arise in the first place.

All the same, with all the advantages that alternative fuels have to offer, the most important measure for reducing UFP and other traffic-related air pollutants remains, wherever it is possible and expedient, to switch traffic to more energy-efficient modes of transport on the ground and to operate the remaining flights, that cannot be replaced for a variety of reasons, using the most modern, most fuel-efficient aircraft with the lowest emissions.

## Why will there be separate exposure and impact studies instead of a single study covering both aspects?

The FFR sees conducting separate studies as bringing distinct advantages in terms of the timing and the conceptual design, in comparison with a combined study of exposure and impacts:
The exposure study has to start early if it is to record the most comprehensive data possible about the formation, quantities, sizes, composition and dispersion of UFP from a range of sources. Once this information (from the literature, measurements, databases, etc.) has been broken down into a large number of typical operational processes at the airport or other UFP sources, it will be needed to conduct reliable immission modelling and calculate the dispersion of UFP in the region. A very long preparation period is necessary for drawing up such emission cadastres and devising modelling methods.
Separating the studies can also create transparency in the region about possible exposure from various UFP sources depending on the location, even before the impacts are investigated, providing information for the interested public and for decision-makers.
At this time, it is not possible to make a final decision on the mechanisms of action and methods that could be used in the impact study. To start with, existing impact studies will be examined regarding toxicological, clinical and epidemiological aspects, and suitable health-related endpoints for the location will be identified. If recording of the exposure were to follow, this would considerably delay the realisation of an exposure study, which is not the FFR's objective. It was, therefore, decided to start by launching the exposure study and to begin work on the impact section in parallel.
The exposure study will be closely dovetailed with the development of a design for the impact study by the scientists from each project attending the meetings of the other one and by the simultaneous involvement of impact researchers for scientific quality assurance (SQA) in the exposure study. From the outset, this will ensure that the foundations created for the exposure study that will now be carried out can be applied and expanded for the subsequent impact study.

## What usable outcomes are the exposure and impact studies aiming for?

The main aim of the exposure study is the creation of an "emission cadastre" indicating the UFP sources in the region under investigation. A performance-based emissions model is to be developed on this basis. Furthermore, the emission cadastre and dispersion calculations will be used for mapping out immissions, to create geographical maps showing the number concentrations in various size ranges for different UFP sources (viewed either separately or together). The immission maps generated from the models will be validated by making measurements in the field.
The final outcomes of the subsequent impact study will be defined in more detail when the specifications are drawn up. First, a medical causal model will be developed in a shorter project (sub-project 3, designing a UFP impact study). This causal model will serve as the basis for preparing brief descriptions of possible modules for a UFP impact study. From these, individual modules will be selected for the further collaborative development of a draft design for a UFP impact study.

## What will happen with the results of the exposure and impact studies?

All the results from the studies will be published on the UNH website and will thus be accessible to the general public. In addition, the contractors will be able to use the results for their own scientific publications.

One important goal is that the results and recommendations from the consortia can be used in a targeted manner by organisations tasked with assessing health risks and deriving potential recommendations for limit values and measures to be taken, in particular the WHO and the EU as key bodies that issue recommendations and pass legislation regulating air pollutants. The impact study is intended to add to the studies of UFP, as called for by the WHO.

Furthermore, the responsible bodies within the Forum Flughafen und Region (FFR, Airport Forum and region), i.e. the UFP Working Group, the Coordination Council and the Konvent, will take a close look at the results of the studies and reach their own conclusions. Right now it is not possible to predict what these will be – the results of the studies must be available first.

As well as the main scientific results, the scientists commissioned are also expected to supply recommendations relevant to implementation. It is assumed that the scientists will develop and communicate "technical recommendations and corresponding conclusions for regional and supraregional decision-makers". Alongside information for the regional level, it is therefore especially important that the study also becomes visible internationally, to support the determination of any limit values at the EU level.

## How will the UFP studies be financed?

All the costs of conducting the UFP studies will be covered by funds from the public-benefit Umwelt- und Nachbarschaftshaus GmbH ("Environment and Neighbourhood House", UNH), which is 100% funded by the State of Hesse.

## Are there any overlaps or contacts with other UFP studies in Germany?

The FFR engages in scientific exchange with nationwide research projects on UFP that are conducted at other locations (including the BEAR Study, BayUFP, Ulthras, ULTRAFLEB), in order to identify potential synergies and to learn from their experience in order to benefit the project in Hesse, and particularly the impact study on ultrafine particles in the Rhine-Main area. One factor making this possible is the fact that some of the scientists in the consortium conducting the study also work in the above-mentioned projects.

During the development of the current study design and the invitations to tender, several technical and expert workshops were held which were attended by representatives of other UFP studies from Germany (and beyond).

Most recently, one such exchange took place in the UFP Working Group at the beginning of 2022, to which representatives of several UFP impact studies were specifically invited in order to report on

their experiences to date. This input then fed into the preparation of the specifications, which have now been drawn up. In summer 2022, individuals who presented in the UFP Working Group were again invited to a meeting of the Konvent to present their studies there as well. This type of informal communication is also planned in the future to enable regular exchange about current findings at other places and so that the FFR can take them into account in its own work.

## Questions about the subject matter of the UFP exposure study

### Which sources of UFP are included in the studies?

On this topic the specifications for the exposure study in work package (WP) 1.1) state: "Emission factors must be determined / identified for all sources in the area under investigation. In each case this includes the air traffic, road traffic, shipping and rail traffic, industry and domestic heating. However, all other relevant sources shall also be included."
The specifications can be accessed in full (in German) in the Download (https://www.ultrafeinstaub-studie.de/de/ueber-source-ffr/downloads/) section.

### Will the study investigate only non-volatile particles, or will volatile particles also be examined?

Both volatile and non-volatile UFP will be examined in the projects. The specifications for the exposure study state under work package (WP) 3, for example (but also elsewhere): "The modelling must cover both volatile and non-volatile UFP and map all relevant sources in the area under investigation."
The specifications can be accessed in full (in German) in the Download (https://www.ultrafeinstaub-studie.de/de/ueber-source-ffr/downloads/) section.

### What measurements and results are already available, and what measurements are planned?

The HLNUG has been recording UFP at various air measuring stations since 2015. With support from the UNH, currently nine measuring stations record ultrafine particles at the airport and in the vicinity. https://www.umwelthaus.org/umweltmonitoring/ultrafeinstaub/luftmessstationen/ (https://www.umwelthaus.org/umweltmonitoring/ultrafeinstaub/luftmessstationen/)
Since 2015, these measurements have been continuously expanded and regularly evaluated. The HLNUG has published the results in reports which can be accessed on its website: HLNUG website (https://www.hlnug.de/service/english)
During the exposure study – and also of the following impact study – some of the existing measurements will be continued, while some more measurements will be added from other/additional measuring devices and other locations. The specifications for the exposure study

(available in the Download section (https://www.ultrafeinstaub-studie.de/de/ueber-source-ffr/downloads/) ) contain a number of requirements relating to this aspect:

- In WP 1.2 nearfield measurements at the airport itself are planned for recording the aircraft emissions.
- Regarding the UFP number concentrations and size distributions, WP 2.1 specifies that measurements must be made in residential areas located in the airport plume or which experience exposure from arriving and departing flights, and also that the regional and urban background levels must be recorded. This must include the mapping of areas adversely affected by the airport/flight emissions along with suitable reference areas where no airport-specific UFP exposure is expected.
- In addition, WP 2.6 envisages vertical measurements using drones or existing towers/tall buildings.
- WP 2.7 specifies mobile measurements in the vicinity of existing stationary measuring points in order to determine the spatial and temporal variability of UFP exposure.

### Are the UFP emissions from overflights taken into account in the exposure study, and if so, how?

The influence of overflights on UFP exposure at ground level will be explicitly taken into account. Work package 2.6 of the exposure study put out to tender specifies the objective of "Determining the height up to which the direct contribution of UFP from arrivals/departures is still relevant on the ground. The bidders have to show how vertical measurements can be performed using drones and/or on towers, in order to determine the influence of landings, take-offs and overflights. However, the consortium already pointed out in the conceptual design for the exposure study that owing to factors such as restrictions on the use of drones in the flight path(s) and the limited availability of towers in the area to be investigated, modelling might be the only way to determine the influence of landings, take-offs and overflights. The following requirement for modelling was therefore added to work package 3.3 of the exposure study: "to investigate the descent of the plume due to wake vortices, in order to clarify what influence the arriving and departing aircraft exert on the near-ground UFP concentrations."
It is initially up to the bidders to decide exactly how the vertical measurements and the last-mentioned "microscale simulations" will be fleshed out – within the predefined framework. Ideally it should be possible to select measuring sites for the vertical measurements based on the microscale modelling.

### How will the studies ensure an expedient selection of measuring points that encompass both the most exposed areas and those that are the least exposed by the airport (control areas)?

The selection and identification of the measuring sites necessary for the studies are covered by work package 2.1 of the exposure study. When it comes to choosing the measuring sites, the following types of areas are specified: "First, residential areas situated in the airport plume / affected by arriving and departing flights; second, the regional and urban background levels must be determined. For both types of areas, suitable measuring locations will be identified and proposed. This must include the mapping of areas adversely affected by the airport/flight emissions along with suitable reference areas where no airport-specific UFP exposure is expected."
The final selection will be made during the exposure study. To this end an iterative process will be applied in which dispersion will first be modelled approximately, and this will enable both the final area for investigation and suitable measuring sites to be selected. Only then will the actual modelling be carried out to draw up the final immission maps.

### Any there any plans to replace SMPS at measuring sites with CPC?

There are no plans to systematically exchange SMPS for CPC. There are two reasons for this: Neither of the measuring procedures is regarded as fundamentally preferable over the other. Both of them have advantages and disadvantages, which have to be weighed up against one another in the light of the objective of measuring:

- CPC are able to record integrated (i.e. accumulated) particle number concentrations for diameters of 2-3 nm or more – CPC typically have a lower detection limit of 7 nm. In addition, the measurements have a high temporal resolution (approx. one second).
- SMPS can also detect particles measuring 3 nm or more, and they typically have a lower detection limit of 10 nm, but their temporal resolution is much poorer: unlike CPC, they generally have a temporal resolution of several minutes, because only the number of particles of one particular size can be measured at any one time.
- The key advantage of SMPS is that they can also detect the size of the particles, and can thus deliver a particle number size distribution. CPC, on the other hand, can only count the particle number.

This means that a decision on which device to use depends largely on whether solely the particle number or also the size distribution is to be analysed, and on whether measurements are required

very quickly or with moderate temporal resolution. It should be mentioned that it naturally also depends on the availability of the devices. Depending on how many measurements are to be performed simultaneously, the same device types will not be available for each measuring site. Careful plans should be made concerning where the different devices will be deployed.
The specifications for the exposure study do not include any concrete requirements regarding the types of devices to be used – they only define the objective of the measurements: to record the particle number and the size distribution both of volatile and of non-volatile particles (work package 2.3). The temporal resolution should be less than ten minutes, while the size range covered should be at least 10-500 nm. Work package 2.2 additionally includes requirements pertaining to quality assurance. These activities will be carried out by the consortium commissioned, through the World Calibration Centre for Aerosol Physics (WCCAP) at the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig.
It is also important to mention that the subsequent impact study will include its own extra exposure module. If it transpires that the measurements or modelling from the exposure study are insufficient for certain impact analyses, more can be added in the impact study.

### Will the studies also consider how the UFP exposure develops with an increasing number of aircraft movements?

Work package 3 of the exposure study defines the framework conditions for modelling the immissions. According to WP 3.1, they include the following:

- It must be possible to simulate volatile and non-volatile particles from all relevant sources in the area under investigation, at least for particle sizes in the range of 10 - 800 nm.
- Hourly emissions from all relevant sources will be taken into account.
- It must be possible to simulate longer periods (months and years) with an acceptable amount of calculation (e.g. < 8 weeks of computing time for one year).

Against this background, it is generally possible to make any changes desired to the framework conditions for the simulations – this also applies to the number of aircraft movements. To begin with, the modelling must be performed so that it can be checked and validated with the aid of measured values – that is, based on current numbers of movements. In later simulations based on a validated model, assumptions about the growth in air traffic can also be made. However, so far this has not been an explicit requirement.

### Will particulate immissions (PM2.5 and PM10) also be recorded at the measuring sites and taken into account in the studies?

At present the exposure study does not envisage any recording of PM2.5 or PM10, because it will focus on recording the UFP exposure situation. With regard to quality assurance, WP 2.2 requires "the meteorological parameters of wind speed, wind direction, temperature, humidity, global radiation and the trace gases NO, NO2, CO and SO2 to be recorded". Black carbon is also to be recorded (WP 2.4).
If the levels of exposure due to PM2.5 and PM10 particulates are needed for the subsequent impact study – which may be assumed – they will be covered in the study's own exposure module.
In fact PM2.5 and PM10 are already systematically recorded at many measuring sites used for UFP measurements.

### Will influencing factors such as wind direction and wind speed be recorded separately at all measuring sites?

Work package 2.2 contains specific requirements for quality assurance. The measurements must be performed in compliance with the current standards. It also specifies explicitly, "also to record the meteorological parameters of wind speed, wind direction, temperature, humidity, global radiation and the trace gases NO, NO2, CO and SO2 at all measuring sites" – "as far as technically possible and meteorologically expedient".
It is true that recording wind speed and direction (for instance) in compliance with the standards will not be possible in an expedient manner at all measuring sites. The requirements for quality assurance demand that wind measurements are made at a minimum distance from nearby obstacles (buildings, etc.) – yet this is not possible at all sites. In such cases, therefore, central wind data will be used. All the quality assurance measures must be comprehensibly documented in accordance with the requirements set out in WP 2.2.

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## Questions about the subject matter of the UFP impact study

### What is the decision-making process concerning the final design of the impact study?

Sub-project 3 initially has to elaborate a conceptual design for a UFP impact study and present it to the FFR. Workshops involving external expertise at two points are already planned as part of this project:

- -The first workshop will be held once a causal model has been derived from the existing scientific literature, and brief descriptions of potential study modules have been developed. The aim of the workshop is to prioritise at least two of the modules for further work.

- The modules thus selected will be fleshed out into a design proposal by the contractors. This proposal will then be discussed at a second workshop involving experts from the field.

The final proposal for the design of a UFP impact study at Frankfurt will then be forwarded to the FFR and presented in the UFP Working Group, the Coordination Council and the Konvent. On this basis, the UFP Working Group will have the task of preparing the specifications for the UFP impact study, which will then be approved by the Coordination Council and subsequently put out to public tender.
This means that the preparation of the specifications is based directly on a scientifically sound foundation that has already been discussed multiple times – also with external persons. In addition, the notes and remarks from the meetings of other bodies (e.g. the Konvent) will be taken into consideration. If the specifications include major deviations from the proposal emerging from sub-project 3, they will also be presented to the Konvent in advance together with a rationale.

## How will external comments about conducting a UFP impact study be taken into account?

So far no key decisions have been taken regarding the later UFP impact study. To start with, the development of a conceptual design for an impact study was put out to tender. From the end of 2022, the contractors are expected be working on what such a conceptual design might be like. The specifications envisage that initially a literature search will be conducted, so that the current scientific findings on the impacts of UFP can provide a foundation. Based on this, options for the design of an impact study will then be developed.
As soon as these options are available in the form of brief descriptions, a workshop will be held involving the SQA and external experts. Here it will be decided which of the design options is to be fleshed out in detail. Both the Konvent and the citizens' initiatives have been informed that the stakeholders may also make contributions of their own at this point. Furthermore, the suggestions already submitted will be forwarded to the consortium that will elaborate the concept for the impact study.

## What impacts of UFP on human beings are already known?

Investigating the impact of UFP exposure on human health will be a central task of the UFP impact study (sub-project 4). Part of the design development for a possible UFP impact study (sub-project 3) will include compiling the current findings from the literature and deriving a causal model.
Even though further investigations are necessary and planned, indications already exist of negative health impacts of UFP. It is already known, for instance, that UFP – owing to their small size (< 100 nm in diameter) – can penetrate much deeper into the lungs than larger particulates, and can even cross the air-blood barrier and thus also enter the bloodstream. Once there (or via the olfactory nerve, for example), the particles can be transported throughout the organism. Toxicological and experimental studies indicate (among other things) a connection between UFP exposure and

detrimental effects on the circulation and respiratory systems and the emergence of systemic inflammatory processes. Epidemiological investigations indicate adverse effects caused by UFP, e.g. by affecting the blood pressure (link with increased blood pressure) as a precursor of cardiovascular diseases. (On this see [among others] Hoffmann et al. 2018: "Heath Effects of Ultrafine Particles. Systematic literature search and the potential transferability of the results to the German setting." In: Umwelt & Gesundheit, 5/2018. German Environment Agency. Retrievable online at: https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/uba_ufp_health_effects_haupt (https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/uba_ufp_health_effects_haupt_final.pdf) )

### Will the impact study take toxicological investigations into consideration?

To date, no preliminary decisions have been made concerning the parts of a subsequent UFP impact study. In the project to develop a design for an impact study, which was awarded in January 2023, possible study modules were sketched out and discussed at two specialist workshops that included external experts. At the end of the project a recommendation should be available on which dovetailed study modules can be put out to tender for an impact study. A toxicological investigation will also be discussed at the workshop as a potential study module. The final selection of the modules will depend on the scientific assessment of the necessity of various modules, their feasibility and the objectives of the study, which still have to be defined.

## Publishing the results of the studies and transparency

### How will be the results of the studies be published, and what publishing rights will the contractors have?

The contract for all sub-projects determines that both clients and contractors have rights to use the results. Section 10(1) states that "alongside the client, the contractor is … entitled to use of the services rendered on the basis of this contract." Accordingly, contractors are generally permitted to use the results for their publications.

As all the studies are conducted on behalf of the FFR and financed by the UNH as a public client, it is also determined that the results will initially be published on the client's website (section 10(3)). This is also common practice with other clients and is of special importance in the FFR as a forum for voluntary stakeholder dialogue between various interested parties. As a result, right from the outset the transparency of all the results should be ensured vis-à-vis the general public (and not only experts from the field), and there should also be an opportunity for prior engagement with the results internally at the FFR. This latter activity serves in particular to protect the FFR dialogue forum whose purpose is to discuss the views of various players in internal decision-making bodies in order to define an approach supported by all the stakeholders. This process of dialogue is based among other things on constructive and frank exchange, which needs a confidential framework. This framework will be secured through the chosen procedure, by presenting the results internally first of all – while they can also be discussed with the support of specialist expertise from the SQA – before they are subsequently made available directly to the public in full.

Independent of that, additional publication in the scientific discourse is explicitly desired. Section 10(3) contains the following on this subject: “additional publication of study results in scientific journals or lectures after the conclusion either of individual parts of the study or of the entire study by the contractor is desirable from the client’s viewpoint”. Furthermore, “the contractor shall already have an opportunity to contribute its research work to the scientific discourse while the study is being planned and conducted.” On this subject, the same section provides for a discussion at the beginning of the project, to conclude the relevant consensus-based agreements between the client and the contractors.
The fact that the results will first be published on the client’s website does not prevent other scientific publications – irrespective of whether they undergo a peer-review process (see next question) or not. The data and results can still be used for scientific publications even after they have been published on the website. The German Environment Agency (UBA), for example, initially publishes all the medical environmental impact studies it finances in its own series/on its website, without this being diminishing the later usefulness of the results elsewhere, e.g. for analysis and deriving recommendations by WHO. In any case, standard peer-review procedures for articles in journals are not suited to examining comprehensive general reports on interdisciplinary processes. Scientific articles concentrate primarily on specific individual questions, which can still be addressed after publication of the general report. This is also standard procedure in other research projects and, as already mentioned, it is explicitly desired.
Irrespective of all the contractual regulations, of course the principle of freedom of science applies to all projects. So, if the contract speaks of going through the bodies of the client and of quality assurance, this does not constitute a substantive influence on the research results but represents, firstly, acknowledgement and discussion of the results and, secondly, scientific quality assurance by the independent body (SQA) set up for the purpose, over which the FFR itself has no influence. This is also set forth in the “Structure Paper” that has already been published. Point 2 of the process of reaching results that is described there states: “The FFR does not have the right to issue substantive directives concerning how research results are to be generated, presented and evaluated in the context of the study design commissioned. This is the scientific responsibility of the consortium alone.”

## Is attention paid to ensuring that the publications undergo peer review?

There are no specific requirements placed on the scientists concerning how they design their publications. This also falls under the freedom of science.
As explained above, publications in scientific journals are explicitly desired and when projects are launched there should be a discussion of when publications might be possible during the course of the study. Furthermore, the contract (section 10(3)) specifies the following requirement: “Any such publication must occur in journals with the widest possible accessibility and should ideally be freely accessible in the form of open access articles.” Here, too, the FFR attaches importance to securing the greatest possible accessibility to all results – including the specialist articles – for the general public. This neither prescribes peer-review articles as mandatory, nor does it preclude them.

## How is transparency guaranteed in the planning of the study design?

The FFR also pursues a comprehensive transparency strategy regarding the designs of the exposure and impact studies. In both cases, the process started with public invitations to tender (design of the exposure study from 15 June to 23 September 2022; design of the impact study from 15 June to 12 August 2022), which were publicly accessible via the Hessian tendering database (HAD). One bid was (or, in the case of the impact study, will be) selected from among the applications submitted, according to criteria that were likewise accessible in the invitation to tender. The consortium awarded the commission was (or will be) then responsible for developing the respective study design.

In the case of the exposure study, the final concept from the contractors was presented to the FFR in February 2022. This was published on the website together with an opinion from the SQA and an assessment from the FFR Coordination Council, and presented to the Konvent by the contractors themselves. At a further meeting in July 2022, the invitation to tender for the exposure study derived from the concept was presented to the Konvent.

A similar procedure will be followed regarding the concept for the subsequent impact study. It may be assumed that design development will start at the beginning of 2023.

## How is transparency guaranteed concerning the award of the study?

The criteria for awarding the study are publicly accessible in the invitations to tender and they vary in their details, depending on the project.

As a company 100% owned by the State of Hesse , the UNH is subject to the regulations applicable to public procurements. The award criteria for public invitations to tender are predefined: alongside the principles of competition (discrimination is prohibited, transparency is required), cost-effectiveness is also needed. This does not necessarily mean that the cheapest bid must be accepted. The particular bid is to be accepted which demonstrates the best value for money, even though the price is a major factor in the assessment of the bids. Alongside the price, the "implementation and staffing plan" is also assessed – that is, the personnel and the specific competences of the bidders. To this end a check is made on how far the staff roster in the bid covers the expertise required (as evidenced by relevant references), plus whether and how well the bids satisfy the substantive requirements set forth in the specifications. Points are given for all three aspects (price, implementation plan, staffing roster). The bid with the most points is accepted.

## How is accessibility of the raw data used/generated in the projects guaranteed?

The specifications for the exposure study provide for a separate work package for data management (WP 4). It sets out the following requirement: "All the raw data, associated metadata and evaluation routines shall be kept and documented in a comprehensible manner at the institutions generating the data for at least ten years from the end of the last study (sub-project 4). Upon request from the client, the data shall be made available free of charge."

This will ensure that all the raw data are available in accordance with the legal requirements and restrictions (e.g. relating to data protection). The invitation to tender for the subsequent impact study will also include a requirement of this type.

### How are the views and wishes of various (external) stakeholders taken into consideration?

On the topic of UFP, the Forum Flughafen und Region (Forum Airport and Region, FFR) will include an extended circle of addressees in a constructive dialogue. Initially this will be done via the Konvent as the designated FFR body, and also through the additional involvement of citizens' initiatives in separate meetings. Furthermore, the FFR will make all the documents and information available on a website created especially for the UFP study, so that the general public can also access the information.
In addition the Noise Abatement Commission, as a statutory body for environmental issues at airports, also has participation rights and is therefore invited to all important meetings of the Konvent on the topic of UFP. It thus receives the same information and has the same opportunities of contributing to discussions on the further procedure as the members of the Konvent themselves.

## Scientific quality assurance

### What is "scientific quality assurance" (SQA)?

Independent of any publications in journals, it is important to all stakeholders to guarantee the scientific quality of all publications. To this end, an additional independent body has been established to provide support to all the projects: the external scientific quality assurance (SQA). The SQA has already been inaugurated, in parallel to the first sub-project, and through its early involvement in the preparations for the studies it provides supporting scientific quality assurance across all projects. By doing so and putting the planned methods and their applicability and suitability into a wider scientific context, the SQA also assumes the function of a (classical) peer review and thus guarantees an independent examination of quality before any publication. In fact support from the SQA goes beyond that, as it provides critical support throughout the entire process, including the tendering procedure and realisation. Its comments can therefore be taken into account much earlier than would be possible with those from a peer-review.
To the SQA (https://www.ultrafeinstaub-studie.de/en/scientific-quality-assurance/)

### Do individual members of the SQA have a blocking minority (veto)?

No. The SQA's rules of procedure that it has set itself do not provide for a blocking minority of individual members. Section 3(1) states the following on this subject:
"All members of the SQA decide collectively on the matters before it, including the content of their formal opinions and the assessments therein. Unanimous votes are sought. If this is not possible in individual cases despite extensive discussion, deviating positions of the SQA shall be recorded and reported accordingly. Opinions shall be formed without instruction and guided by independent

scientific conviction."
Accordingly, individual members of the SQA have no possibility of preventing a resolution from being passed overall. However, they may cast votes as a minority and publish them, so the deviating opinion is made known.

## How are conflicts of interest prevented from arising in the work of SQA members, e.g. owing to close contacts with the contractors?

On this subject, too, there is an explicit regulation in the SQA's rules of procedure (section 1(5)): "Members shall disclose conflicts of interest which could influence collaboration in the SQA, without being requested to do so."
In practice the check is carried out using the criteria of the DFG (German Research Foundation) for aspects of bias in scientific appraisals. They include criteria such as first degree relationships / marriage, etc., economic interest, close cooperation, business dependence, etc. Two people have already left the SQA due to conflicts of interest that were disclosed.