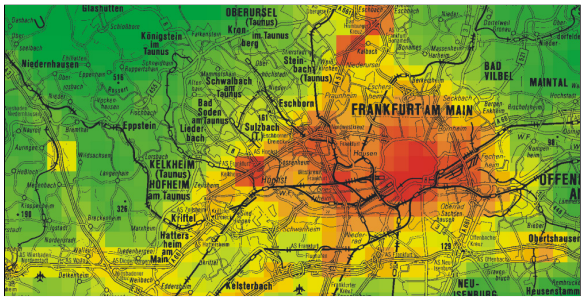
Air Quality Models

IMMIS■■■

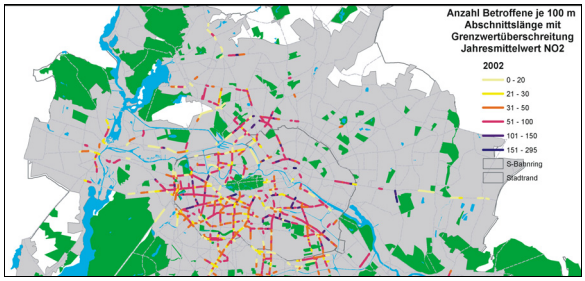
IMMIS■■■ provides a comprehensive program set to evaluate traffic-induced emission and air pollution.
The IMMIS■■■ models are integrated in GIS thus retaining the spatial reference in data used for environmental planning.

Meso scale



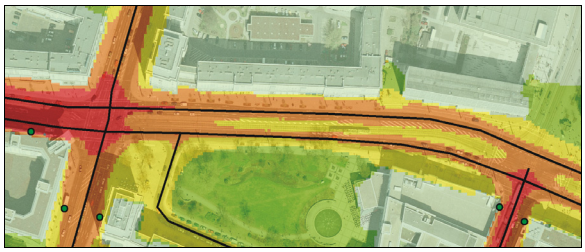
Modeling of regional background concentration using IMMIS^{net}

Screening



State-wide or city-wide air pollution analysis of main roads using IMMIS^{luft} and IMMIS^{cpb}

Micro scale



Analysis of spatial concentrations in the vicinity of a hot spot using LAS^{arc} and IMMIS^{cpb}

IMMIS^{em} – calculation of emissions

- calculation of traffic induced emissions
- based on Handbook emission factors for road transport (HBEFA) and VDI 3782 Blatt 7
- additional individual emission factors applicable
- resuspended dusts and wear emissions
- determination of emission time series

IMMIS^{luft} – citywide screening

- screening model to assess air pollution in city street canyons
- characteristics according to EU Council directives 96/62/EG

IMMIS^{net} – background concentration

- Gaussian multi-source dispersion model
- calculation of regional and urban background

IMMIS^{cpb} – calculations in street canyons

- complex individual case studies based on real street geometries
- calculation of hourly values

IMMIS^{MT} – screening-system for real-time monitoring

- screening system for city-wide calculation of air and noise pollution based on constantly updated traffic data
- Real-time modeling
- scalable and modular
- Oracle database controls application flow

IMMIS^{arc} – GIS integration of IMMIS models

- integration of IMMIS■■■ models in the geographical information system ArcGIS®
- data base free of redundancy
- amendment, editing, correction and customizing of data using the editing tools of ArcGIS®
- results of calculation as GIS data for direct processing
- support of Geodatabase

LAS^{arc} – GIS integration of LASAT

- integration of LASAT in ArcGIS®
- source and configuration files can be directly used as GIS data
- direct conversion of results in GIS data

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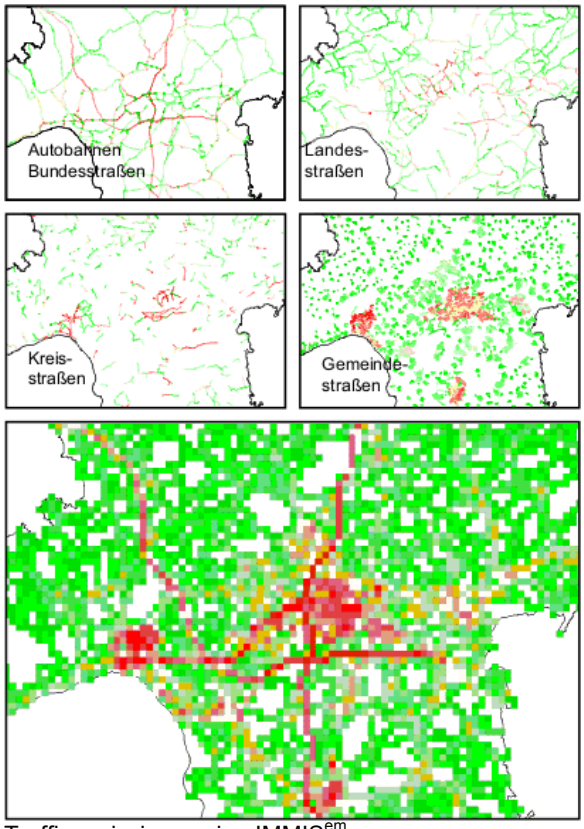
Detailed information to IMMIS■■■ are available at www.immis.de.
Information to IVU Umwelt GmbH are available at www.ivu-umwelt.de.

IVU Umwelt offers expertise, studies and consulting using IMMIS, including data acquisition and preparation, graphical and numerical data representation and documentation, and impact analysis of measures to be taken.

Computation of traffic emissions

IMMIS^{em}

The emission model IMMIS^{em} calculates the traffic emissions of e.g. the air pollutants CO, CO_2, NO_x, SO_2, particulate matter, soot, benzene, xylol, CH_4, NH_3 and fuel based on "Handbook emission factors for road transport" (HBEFA) and VDI 3782 Sheet 7.



Traffic emissions using IMMIS^{em}

Dynamic emission inventories

The creation and regular updating of emission inventories is a standard task in maintaining air quality. For that purpose IVU Umwelt developed a program system for dynamic emission inventories (EKatDyn) supporting the completion of this task in a user-oriented and effcient manner. The makes use of the GIS integrated model IMMIS^{em} to calculate emissions.

Basic data to calculate emissions

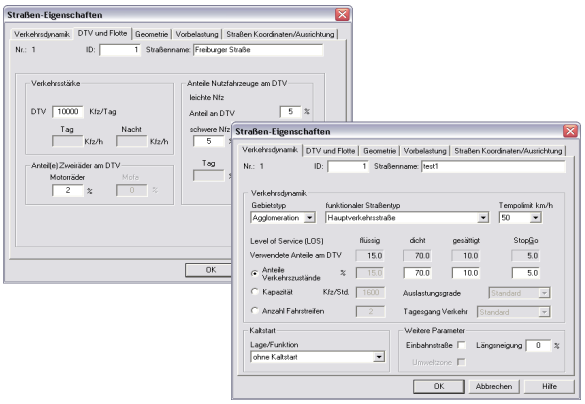
- emission factors for a selection of relevant road types or traffic conditions in the city (HBEFA)
- motor vehicle fleets (HBEFA up to the prognosis year 2030)
- a cold start model for different road properties or road functions, that can be used in any combination with traffic conditions
- a model for the dynamic consideration of Stop&Go traffic

Consideration of different effects

- consideration of tire wear for soot emissions
- consideration of resuspended dust, tire and break wear for emissions of PM_{10} and $PM_{2.5}$
- effect of particle filter
- driving bans for different types of vehicles and concepts (Environmental/Low emission zone)
- effect of air conditioning in cars
- individual emission factors
- calculation of BaP / PAK emissions

Street parameters

- traffic condition and road function
- Stop&Go fraction or of capacity or number of lanes of the road
- road gradient
- average daily traffic (MDT)
- MDT fractions of motorcycles, heavy and light commercial motor vehicles as well as buses



Input dialog of street relevant parameters

Emission time series

The hourly-emission-model IMMIS^{em,h} can be used to establish time series of traffic induced emissions based on detailed traffic data or time series.

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Detailed information to IMMIS^{em} are available at http://www.immis.de/.
The software IMMIS^{em} is available for Windows and as an Extension for ArcGIS®.

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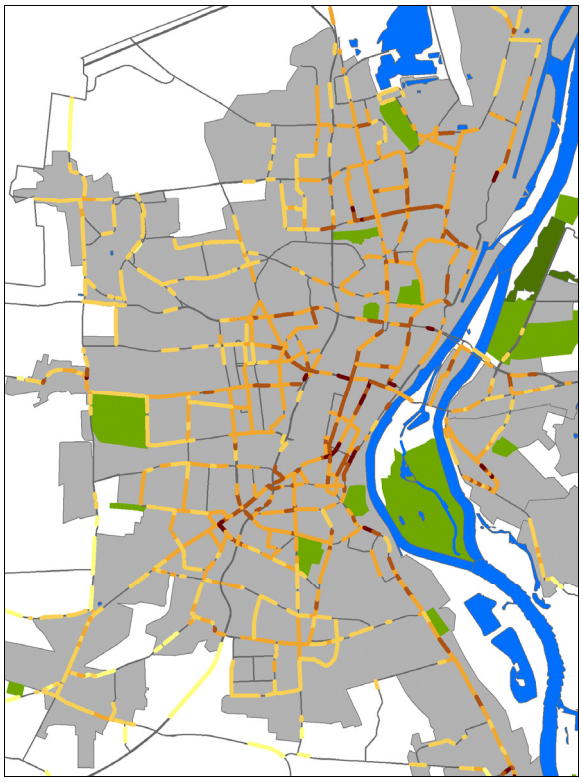
Air Quality Screening

IMMIS^{luft}

is a Screening model for the evaluation of air pollution in city streets.

IMMIS^{luft} models traffic induced emissions and concentrations in city street canyons (additional load). It is based on the CPB model for street canyons and a box model for open building structures



Traffic induced air pollution using IMMIS^{luft}

Validation

- Diegmann, V., Mahlau, A. (1999): Vergleich von Messungen der Luftschadstoffbelastungen im Strassenraum mit Berechnungen des Screeningmodells IMMIS^{luft}. In Immissionsschutz, 3, S. 76–83.
- Diegmann, V., Hartmann, U. (2006): Vergleich von berechneten Luftschadstoffbelastungen mit gemessenen Luftqualitätsdaten im Straßenraum, in Immissionsschutz, 2-2006, S. 73–77.

Pollutants

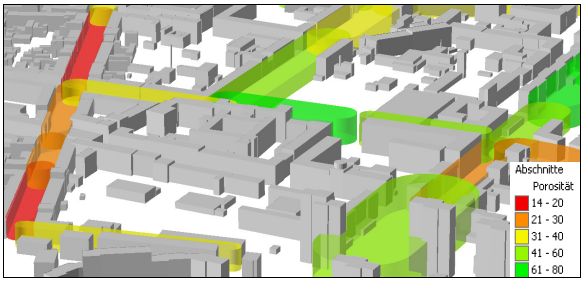
IMMIS^{luft} calculates annual values and 98%-percentiles of CO, CO_2, NO_x, NO, NO_2, SO_2, particulate matter (PM_{10}), soot, HC, benzene, toluol, xylol, CH_4, NH_3, N_2O, Benzo(A)pyren, PAK.

EU directives characteristics

- statistical characteristics of NO_2 derived from NO_x
- exceeding probability of hourly limit value of NO_2
- number of days with a daily PM_{10} mean value above 35 µg/m³
- 90,4%-percentile of PM_{10} daily mean value
- highest sliding 8-hours mean value of CO

Basic data of air pollution modeling

- traffic data
- background concentration e. g. using IMMIS^{net}
- meteorological data
- geometry data of street canyon
- start and end coordinates of street segment



Schematic 3D-Representation of street canyons

Emission modelling

- modeling kernel of IMMIS^{em} based on Handbook emission factors for road transport (HBEfa) and VDI 3782 Sheet 7
- import of emission data
- several methods for calculating resuspended dust and wear emissions

Features

- scaling of wind speed
- customized meteorologies
- several methods for deriving NO_2-characteristics

Interfaces

- input data and results are stored in a Standard Dbase file; easy editing in Microsoft EXCEL
- shape file und MIF export
- LimA, Soundplan (noise)
- VISUM (traffic modelling)

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Detailed information to IMMIS^{luft} are available at http://www.immis.de/.
The software IMMIS^{luft} is available for Windows and as an Extension for ArcGIS®.

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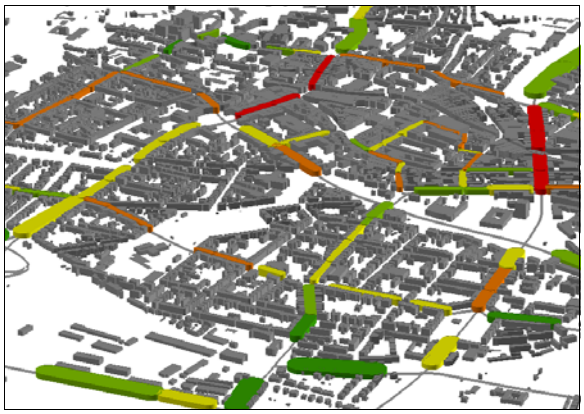
Air Quality Modeling in GIS

IMMIS^{arc}

IMMIS^{arc} integrates the models IMMIS^{em} and IMMIS^{luft} into the geographic information system ArcGIS® (ESRI) and, thus, allows the calculation of traffic emissions and concentration of air pollutants in street canyons for subsequent visualization, analysis, mapping and cartographic publication directly within the GIS.



PM_{10} pollution calculated using IMMIS^{luft}

IMMIS^{em} – calculation of emissions

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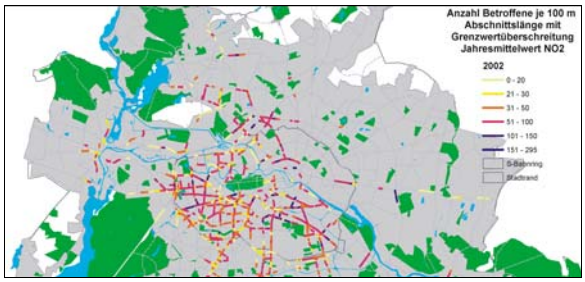
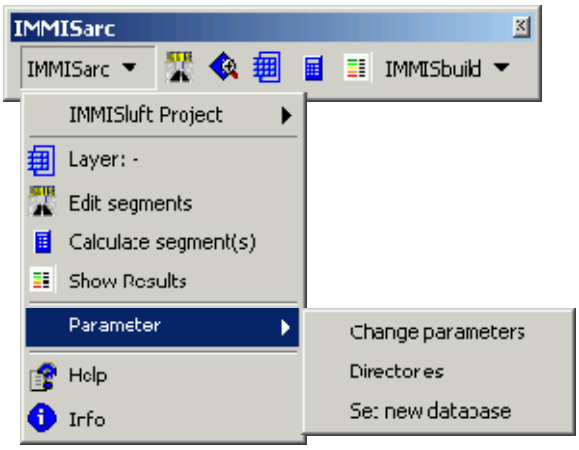


State-wide or city-wide air pollution analysis of main roads using IMMIS^{luft} and IMMIS^{cpb}

Features

- data transfer of IMMIS^{luft} stand-alone projects using automated generation of Geo-objects based on existent coordinates entries and transfer of attribute data
- storage of street segment related data in Shape format or optionally as personal geodatabase
- integration of the well-known input dialogs of IMMIS$^{em/luft}$
- integration of the IMMIS$^{em/luft}$ computing kernels to start calculations within the GIS



IMMIS^{arc} menu

Advantages

- working in an integrated application environment
- free of redundancy data base management
- access to existent geographic information
- use of all GIS functionalities
- consistent and uniform mapping of result for several scenarios

GIS-based generation of input data

- generation of IMMIS^{luft}-compliant segments using IMMIS^{build}
- background concentration using IMMIS^{net} directly in ArcGIS®
- input, editing and consistency check of street-related input data using the complete functional range of the GIS environment

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Detailed information about IMMIS^{arc} is available at www.immis.de/e.
Information about IVU Umwelt GmbH is available at www.ivu-umwelt.de/e.

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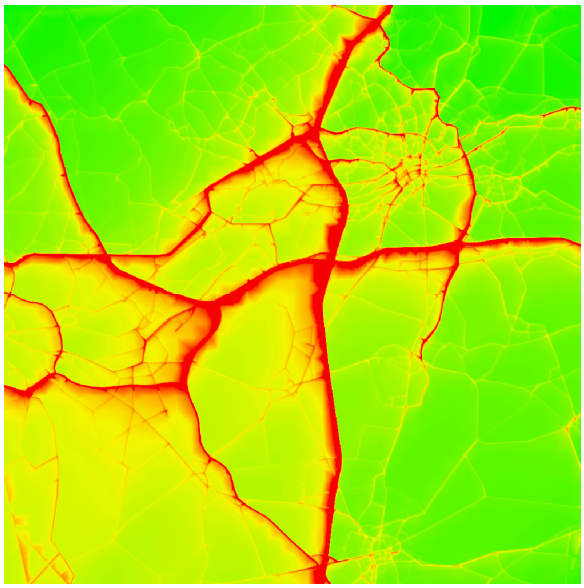
Dispersion modeling in GIS

IMMIS^{net}

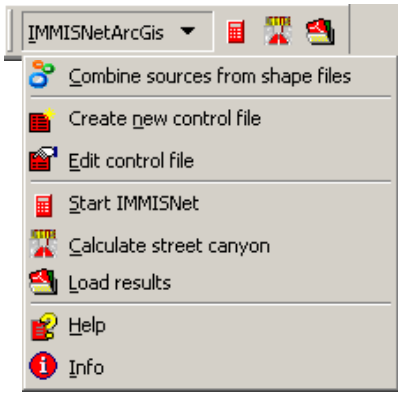
is a Gaussian multi-source dispersion model for calculating the spatial extent of concentration levels of air pollution. Treated as a stationary process, the model describes the dilution and transport of pollutants from point, line or area sources, using a Gaussian normal distribution. Gaussian dispersion models are instruments that have been tried and tested for many years for dealing with problems of air pollution distribution within the framework of plans for maintaining air quality, or planning permit procedures.



Regional background concentration caused by street traffic

GIS Integration

The software is integrated into the user interface of ArcGIS® as an Extension for ArcMap.



IMMIS^{net} menu in ArcGIS®

Area of application

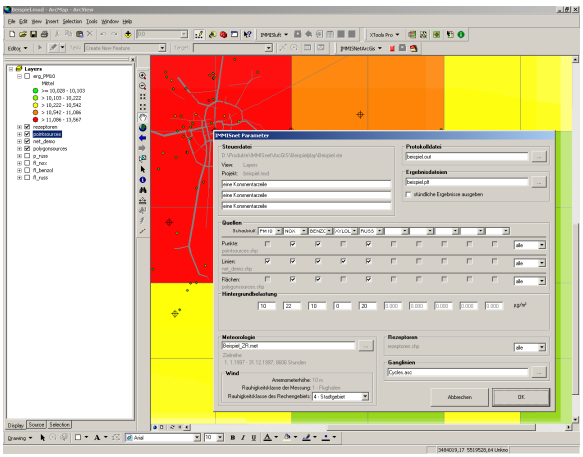
- Calculation of regional and urban background concentration
- Calculation of roof-top concentrations as background for micro-scale modeling of street canyons
- Temporal variation of emission data taken into account through time-variation curves for different polluter groups
- Calculation of hourly concentrations at receptor points
- Calculation of statistical parameters (annual mean values and percentiles)
- Simultaneuos calculation of up to 10 pollutants

Input data

- Meteorological data (wind direction, wind speed, stability): representative frequency distribution or time series
- Emission data: area sources, line sources and point sources
- Receptors: location and height

Functionality

- Data management in GIS Shape-format for emission sources, receptor data, and results
- Tools to merge emission sources from different input Shape-files
- Results directly available in ArcGIS for visualization and analyses
- Direct calculation of background concentrations for IMMIS^{luft}-data bases
- Additional batch operation mode outside of GIS environment



Dialog to set calculation parameters

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Detailed information about IMMIS^{net} is available at http://www.immis.de/.

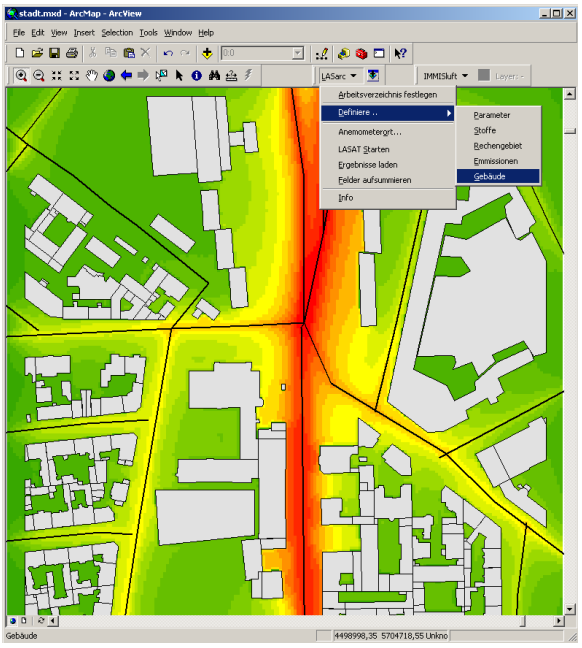
The software IMMIS^{net} is available as an Extension for ArcGIS®.

IVU Umwelt offers expertise, studies and consulting using IMMIS, including data acquisition and preparation, graphical and numerical data representation and documentation, and impact analysis of measures to be taken.

Dispersion modeling using LASAT® in GIS

LAS^arc

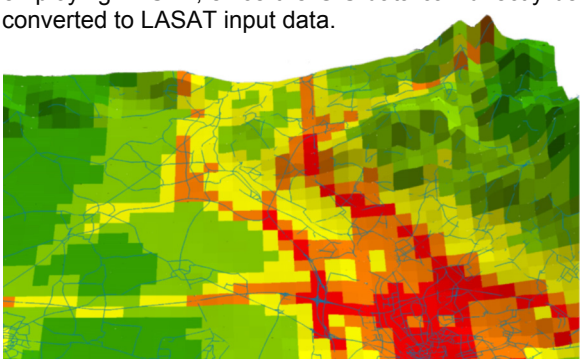
The lagrangian dispersion model LASAT is a complex model for calculating concentrations of air pollutants, taking into account e. g. orography and building structures. LASAT is in accordance with the new German directive on air pollution modeling TA-Luft. With LAS^arc IVU Umwelt has developed an integration of the model in the geographic information systems (GIS) ArcGIS® und ArcView.



Air quality modeling using LAS^arc in ArcGIS

Complex source configurations

The setup of calculations using LASAT and complex source configurations is clearly simplified by employing LAS^arc , since the GIS data can directly be converted to LASAT input data.



Calculation with complex sources and orography

Modeling using LAS^arc in GIS

- handling within the known interface of the GIS
- set calculation parameters in dialog
- set pollutant parameter in dialog
- selection and definition of the gridded domain using shape and grid files
- automatic creation of mandatory intermediate grids in case of grid nesting
- cross-project transformation of coordinates for LASAT input and output files to ensure LASAT-compliant coordinate values (e. g. when using GK-coordinates)
- conversion of shape files in LASAT-source files, controlled by the user's specification of important parameters and unit conversion
- automatic conversion of IMMIS^luft/em-databases into LASAT input files, including the conversion of specific emission data and unit conversion
- direct conversion of GIS data in LASAT building files
- automatic conversion of LASAT results into ESRI-shape files for arbitrary, user defined parts of the investigated domain; conversion of relative and absolute errors is available
- call of LASAT calculations from within ArcGIS® und ArcView
- impressive and informative presentation of result, also in combination with existent geo data
- visualization and mapping using the powerful tools of the GIS

Presentation of results overlaid with aerial views

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More detailed information on LASAT is available on the Ingenieurbüro Janicke home page http://www.janicke.de/. Information on IVU Umwelt GmbH is available at www.ivu-umwelt.de/e.

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