International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.70
Amendment 1
(12/2021)

SERIES K: PROTECTION AGAINST INTERFERENCE

Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations

Amendment 1: Appendix I – Software "EMF-estimator" v8.0.32 and v8.64

Recommendation ITU-T K.70 (2020) – Amendment 1

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Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations

Amendment 1

Appendix I – Software "EMF-estimator" v8.0.32 and v8.64

Summary

The EMF-estimator software that is Appendix I of Recommendation ITU-T K.70 uses Microsoft Access databank for the collection of input and output data. As various versions of Microsoft Access exist, different installation procedures need to be used to obtain a software that operates properly on a dedicated PC. Amendment 1 to Recommendation ITU-T K.70 adds clause I.10 to clarify the installation procedure.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.70	2007-06-29	5	11.1002/1000/9140
1.1	ITU-T K.70 (2007) Amd.1	2009-05-29	5	11.1002/1000/10036
1.2	ITU-T K.70 (2007) Amd.2	2011-05-05	5	11.1002/1000/11351
1.3	ITU-T K.70 (2007) Amd.3	2013-02-07	5	11.1002/1000/11906
1.4	ITU-T K.70 (2007) Amd.4	2014-12-19	5	11.1002/1000/12441
1.5	ITU-T K.70 (2007) Amd. 5	2016-04-27	5	11.1002/1000/12978
2.0	ITU-T K.70	2018-01-13	5	11.1002/1000/13448
2.1	ITU-T K.70 (2018) Amd. 1	2018-05-25	5	11.1002/1000/13647
2.2	ITU-T K.70 (2018) Amd. 2	2018-09-21	5	11.1002/1000/13791
3.0	ITU-T K.70	2020-12-14	5	11.1002/1000/14568
3.1	ITU-T K.70 (2020) Amd. 1	2021-12-10	5	11.1002/1000/14880

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Appendix I – Software "EMF-estimator" v8.0.32 and v8.64

(This appendix does not form an integral part of this Recommendation.)

The EMF-estimator software has been developed to support the application of the methods described in this Recommendation. It may help to make an estimation of the cumulative exposure in the vicinity of transmitting stations in the case of many different transmitting systems operating at different frequencies. The EMF-estimator is one of the available programs that may be used for that purpose. This software is not intended to be used, and in fact cannot be used, for any certification procedure of the transmitting equipment.

I.1 Applicability of the EMF-estimator

The EMF-estimator software uses the point source model (described in clause 6.3) and exploits the radiation patterns contained in the attached library or introduced by the user. The radiation pattern may have a full, two-variable 3D form $f(\theta,\phi)$ (a function of azimuth and elevation angles) or may be represented by the horizontal and vertical radiation patterns HRP(ϕ) and VRP(θ). The credibility of the calculation is strongly affected by the model used and depends on the region under investigation and available data concerning a transmitting antenna and operating channels (carriers).

Generally, the results of calculations are adequate in the far-field region and give acceptable results in most of the radiating near-field region. Depending on the direction, one may expect an overestimation or underestimation of the field in the radiating near-field region. The EMF-estimator should not be used for calculations in the reactive near-filed region because the models on which it is based are too simple to describe correctly the real conditions determining the EMFs distribution, so for this region the results are not presented by the software.

The calculations are more credible if a full radiation pattern $f(\theta,\phi)$ is used. Sufficiently good estimations are also achieved if horizontal and vertical radiation patterns HRP(ϕ) and VRP(θ) are applied. The influence of the radiation pattern and, consequently, the importance of the exactness of its knowledge grows with increasing transmitting antenna gain.

As from version v6.0 the cylindrical antenna model has been included, which allows for substantial reduction of the area excluded from calculations, however with a higher level of overestimation.

In the EMF-estimator package, the library is included, containing examples of the radiation pattern for many typical radiocommunication and broadcast services. One should note, however, that if the radiation patterns are used for antennas that are only similar to those in operation, the results of the calculations should be regarded as an estimation only. In many practical cases in which radiation levels are far under the limits, such estimation can be sufficient.

The input data for the EMF-estimator contains the operating frequency and the size of each transmitting antenna. Based on these data, the area around an object is split into regions of the field. For the area very close to the transmitting antennas, appropriate information appears on the screen. In practice, only the area in very close proximity to the transmitting antenna (people do not usually have access to this area) cannot be analyzed with the use of the EMF-estimator.

The EMF-estimator evaluates:

- electric field strength;
- magnetic field strength;
- the equivalent plane-wave power flux-density;
- near- and far-field region distances;
- compliance distances (for general public and occupational exposure);
- cumulative exposure coefficients W_t and W_e;
- charts with reference levels as functions of the distance;
- reference levels related to the ICNIRP limits.

The program uses a library of the radiation patterns for typical antenna systems, but it is possible to introduce user-prepared data concerning the transmitting antenna radiation pattern.

The accuracy of the results of calculations is strongly affected by the accuracy of the input data concerning the transmitting equipment (mainly transmitting antennas). The problem is that in many cases the data, especially concerning the radiation patterns, are not available or are known with limited accuracy.

I.2 Typical situation

Figure I.1 explains some terms used in the EMF-estimator.

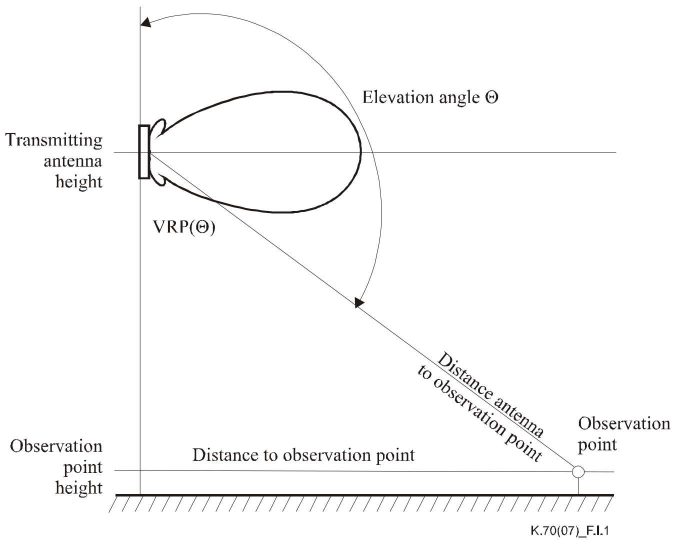

Figure I.1 – Explanation of some terms used in the EMF-estimator

I.3 Software description

Figure I.2 shows the main screen of the EMF-estimator. It consists of three tabs. In the "Radiation sources" tab there are names and input data concerning each operating frequency. On this page, one can choose the antenna system radiation pattern. If the blank field is chosen, then the HRP and VRP for each observation point have to be introduced manually. If no information is available concerning the transmitting radiation pattern, the "isotropic" radiation pattern may be used, but this will lead to an overestimation of the field, growing with the antenna gain. It is also possible to choose the 3D radiation pattern.

The "Source – XXX" tab (Figure I.4) shows results of calculations for the XXX source of radiation (operating frequency). There is also a button on this screen that allows for the visualization of the distribution of the equivalent plane-wave power density, produced at a chosen operating frequency, as a function of the distance along an observation line defined by the user.

The "Antenna orientation and calculations" Tab (Figure I.3) is designed to input the location of each transmitting antenna and the parameters of the user-defined observation points line. The data have to be introduced in the respective blank spaces.

The main toolbar allows users to input options such as: open/save project, import new radiation pattern, add/remove sources, print, chart with the ICNIRP reference limits and cumulative exposure, which makes possible the calculation of the cumulative exposure for all the sources introduced in the project (see the main toolbar).

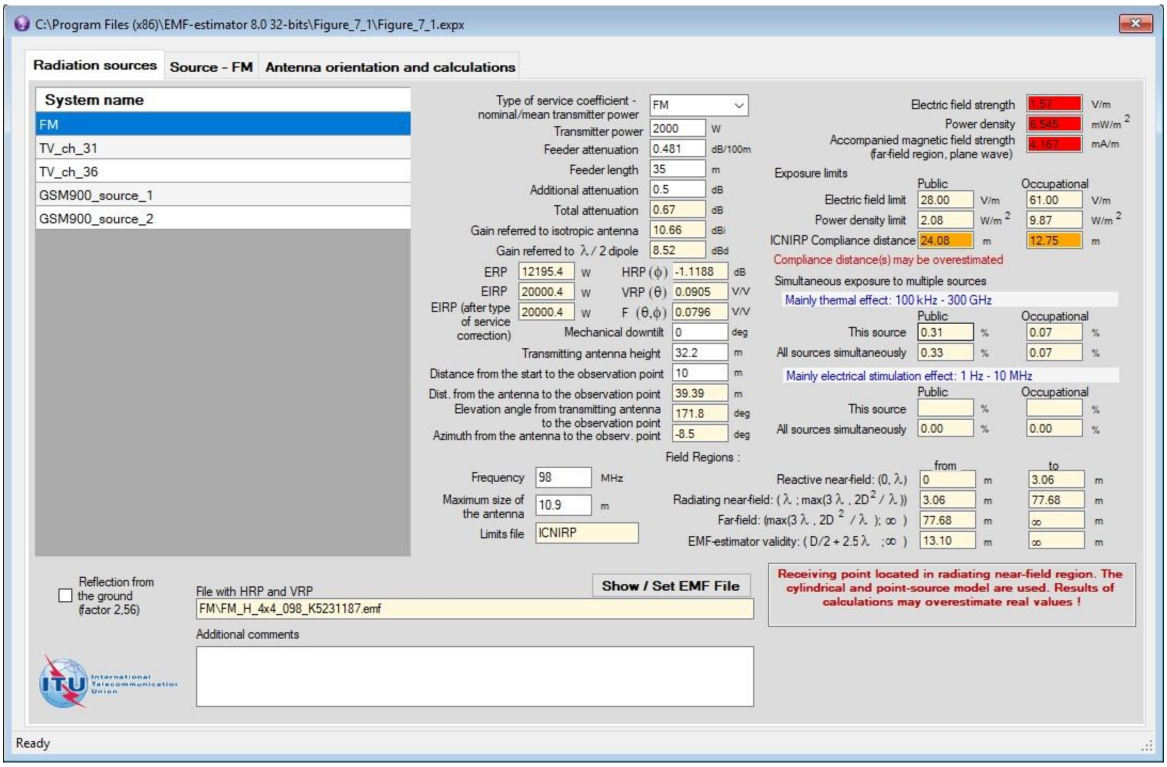

Figure I.2 – Main screen of the EMF-estimator with "Radiating sources" tab opened

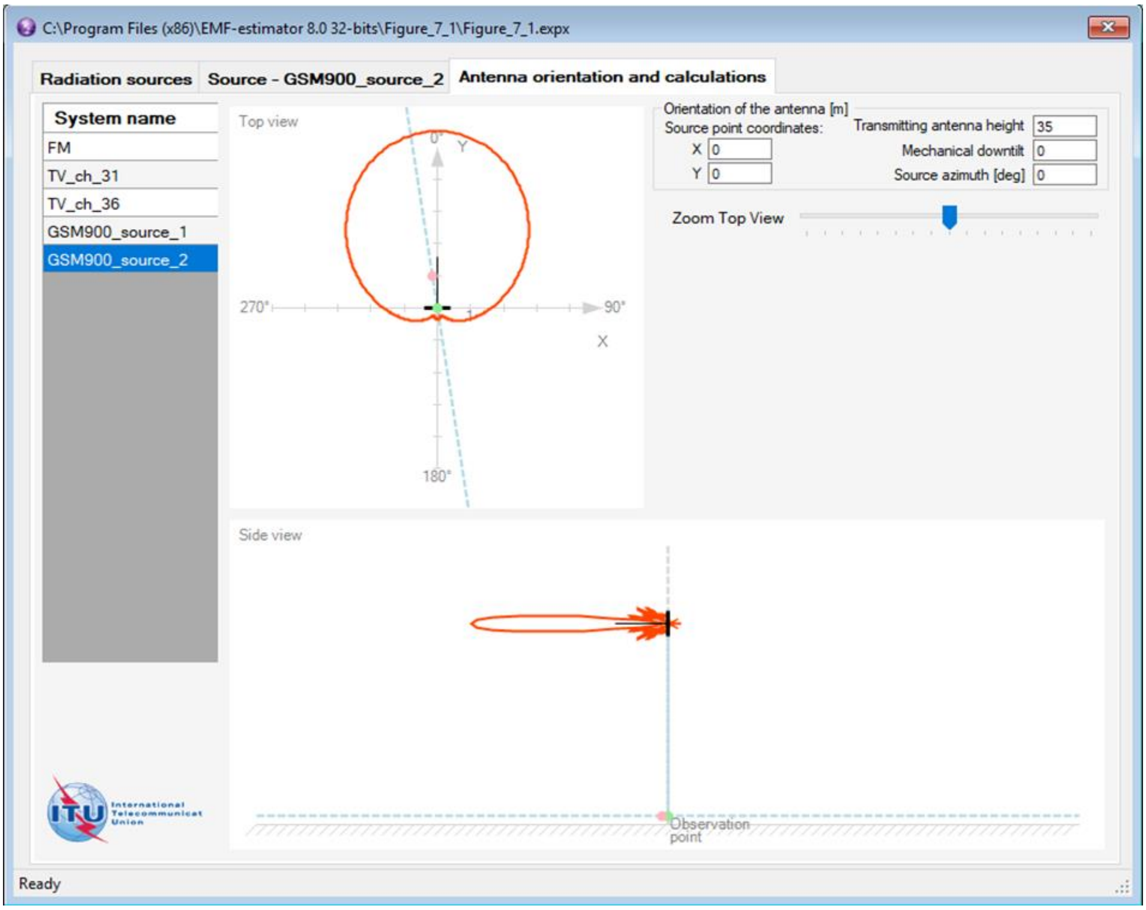

Figure I.3 – Screen of the EMF-estimator with "Antenna orientation and calculations" tab opened

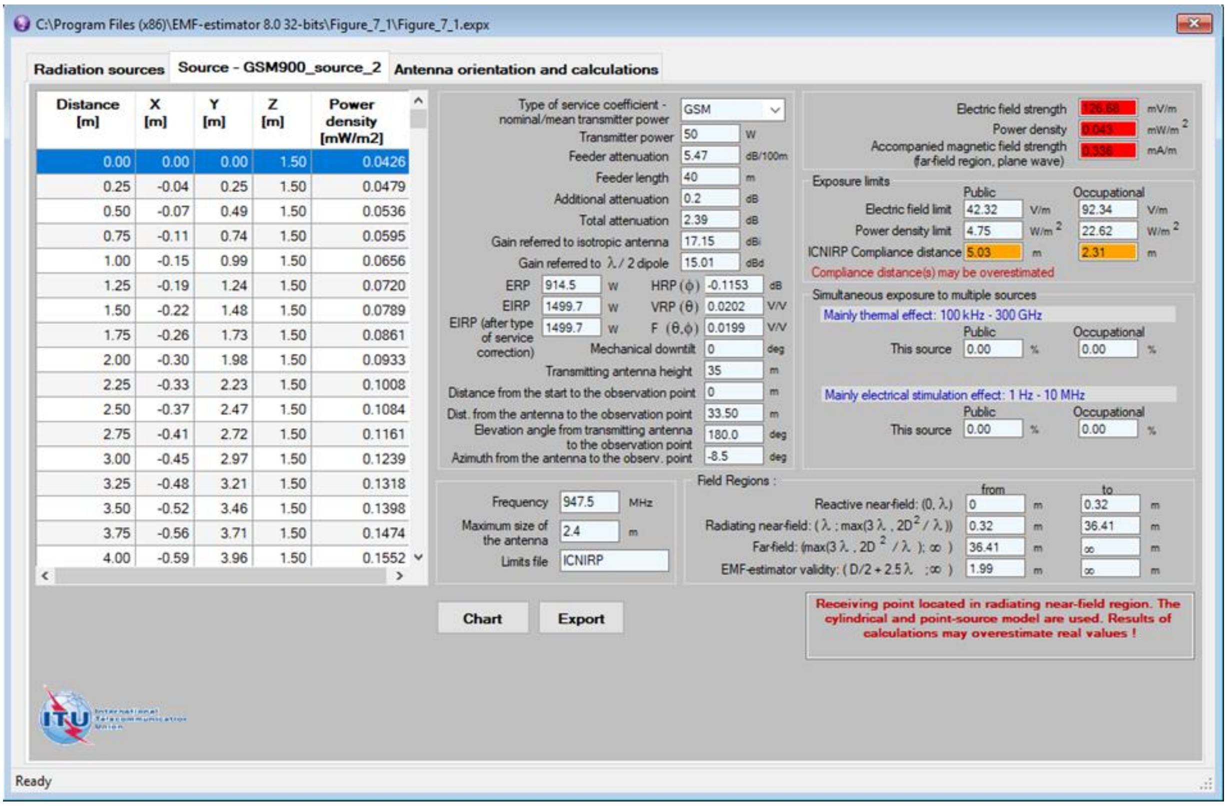

Figure I.4 – Screen of the EMF-estimator with "Source – XXX" tab opened

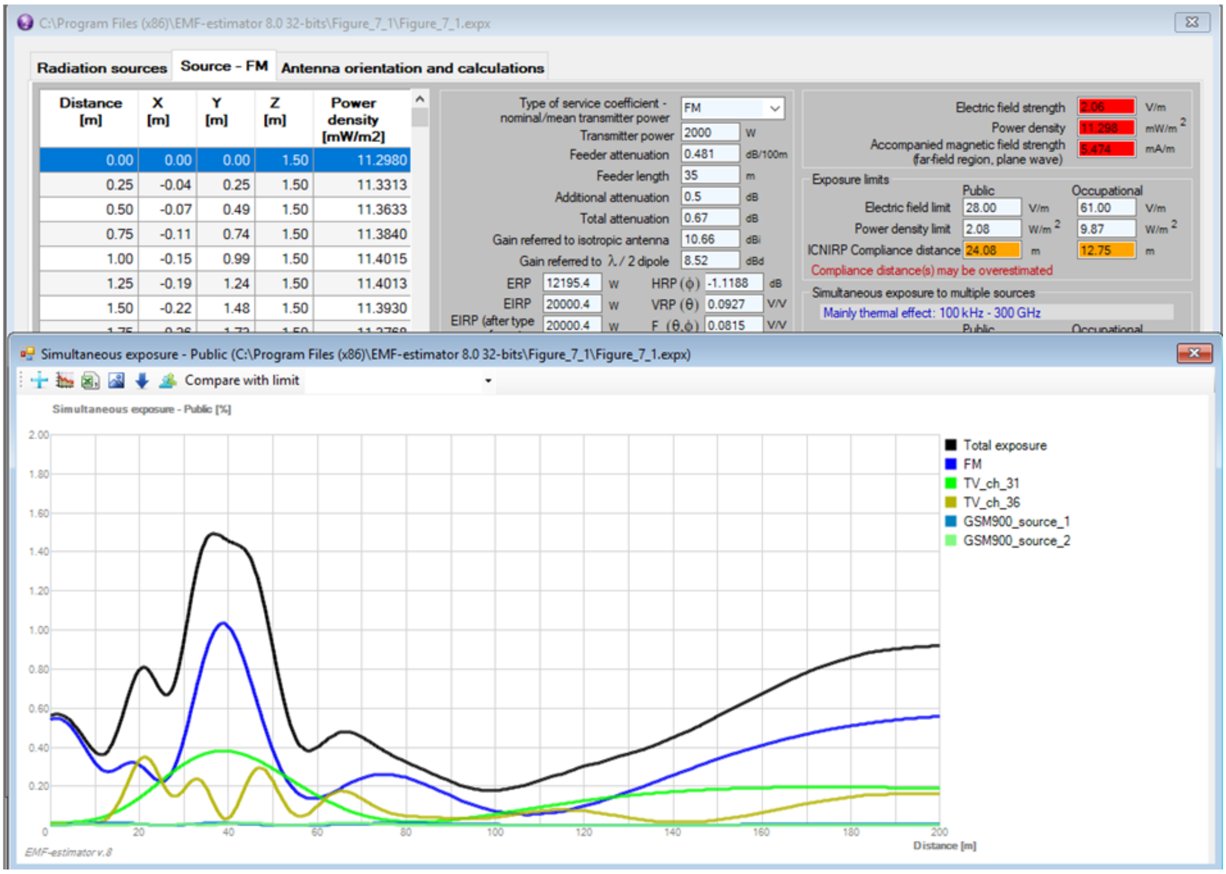

Figure I.5 – Screen of the EMF-estimator – the results of the cumulative exposure calculations

It should be noted that the results of the calculations are strongly affected by the accuracy of the input data and the limitations of the model. Since the radiation patterns are given on the one-degree lattice, the curves may not be smooth for very high gain antennas because, for quickly varying functions, a one-degree step can be too big.

I.4 Compliance distances

The "Source – XXX" tab also presents the results of the calculation of the compliance distances. If the distance is greater than 0.6×D2/λ then the results are shown. If it is smaller, then the overestimating value is shown, i.e., the lower value of the two: at the distances 0.6×D2/λ and at distance at which the radiation limit is achieved under the assumption of isotropic radiation pattern ($f(\theta,\phi) = 1$). It should be noted that, in some cases, such an overestimation may be quite big.

I.5 Coefficient concerning transmitter power

An additional explanation is needed for the parameter "Type of service coefficient – nominal/mean transmitter power". This parameter is required because in many cases the nominal (rated) transmitter power (known for the user) is different from the mean transmitter power (required in the formula for the rms electric field strength calculation). After choosing the type of service, the nominal transmitter power will be automatically multiplied by a suitable coefficient. Table B.1 contains the coefficients for the most commonly used types of radiocommunication services.

I.6 Library – radiation patterns of the antenna systems

In the folder "Library", the files containing radiation patterns for some typical antenna systems used in radiocommunication and broadcasting are collected. There are patterns for FM, TV VHF, TV UHF, GSM 900, GSM 1800, AM and radio relay link antennas. Of course, this library contains only examples of possible configurations of antennas and antenna systems that are in use worldwide. It should be noted that each broadcasting antenna is individually designed and there are no two identical systems. However, the antennas included in the library represent typical solutions realized in many telecommunication systems. There is also a subfolder "User input templates" containing "User_2D_Import_Radiation _Pattern.csv" and "User_3D_Import _Radiation _Pattern.csv" files, in a format that enables importing user data for any additional antenna, by using the import option of the EMF-estimator. Such files may then be added to the library and used in the calculations.

I.7 Examples of calculations

Folder "Examples" stores the projects with the results of calculations presented in this Recommendation. It is possible to open any project and to follow the respective calculations. It is also possible to introduce changes to observe how these influence the results.

I.8 Additional comments

a) The minimum input data required for the electric field strength calculations are the values of EIRP (or ERP), operating frequency, size of the antenna and the distance from the transmitting antenna to the observation point.

b) In many situations there are no data concerning the radiation pattern of the antenna system. In this case it is reasonable to assume $f(\theta,\phi) = 1$. It should be noted, however, that the calculations under such an assumption will give the maximum value of the electric field strength, i.e., valid only in the direction of the main beam of the antenna (the direction of the highest radiation level), and some higher values in all the other directions.

c) If there is an access to the data for feeder attenuation and additional losses in the antenna feeding system, then the results of calculations of the EIRP are more accurate. Otherwise, the typical value of attenuation should be introduced (in most cases about 3 dB).

I.9 System requirements

- MS Windows XP/7/8/10;
- Microsoft Access (32 or 64-bit).

I.10 Installation procedure

Depending on a version of Microsoft Access installed on the considered PC, a proper version of the installation file should be used: "Install v8.32" or "Install v.8.1.64". In case of no Microsoft Access installed, it is advised to use "Install v8.32".

If there is a problem to run EMF-estimator with Access 64 bit – it is caused because **AccessDatabaseEngine** is different for the MS Access 2010, 2013, 2016, and 2019.

Depending on the user version, the file "AccessDatabaseEngine_X64.exe" should be loaded and installed using the following links:

1. MS Access 2019: https://www.microsoft.com/pl-pl/download/confirmation.aspx?id=54920
2. MS Access 2016: https://www.microsoft.com/en-us/download/details.aspx?id=50040
3. MS Access 2013: https://www.microsoft.com/en-us/download/details.aspx?id=39358
4. MS Access 2010: https://www.microsoft.com/en-ca/download/details.aspx?id=10910

It may be done before or after installing EMF-estimator.

In some cases it may be also required to install "MSVCR100.DLL" or "VCRUNTIME140.DLL" available on https://support.microsoft.com/en-us/help/2977003/the-latest-supported-visual-c-downloads.

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Printed in Switzerland
Geneva, 2022