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User's Guide for the "KILDER" Dispersion Modelling System

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SUMMARY

This report describes the multiple source Gaussian type dispersion models KILDER for long term averaged concentrations from emissions from point and area sources. The KILDER model system is operational on an IBM-compatible personal computer. The programs contains emission calculations from consumption data and traffic work in addition to long term averaged concentrations for different source categories and components. A set of supporting programs for reading, calculating and presenting data fields is described in a separate report (NILU TR 6/92).

The program examples used in this report are based upon data from model calculations for Delhi, India performed by NILU in co-operation with the Central Pollution Control Board in Delhi. The data are only test examples and should not be used in other connections.

The program POI-KILD calculates sector averaged long term averaged concentrations at ground level in a grid of receptor points, with emissions from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer.

The program ARE-KILD calculates sector averaged long term averaged concentrations at ground level in a grid of receptor points, from sources in an emission field given in the same grid system. The program divides each grid area source into 100 point sources and takes into account the impact from the area source within its own square.

USER'S GUIDE FOR THE "KILDER" DISPERSION MODELLING SYSTEM

1 INTRODUCTION

The KILDER dispersion model system has been used at the Norwegian Institute for Air Research (NILU) for about 15 years. The basic units are two programs, POI-KILD and ARE-KILD for calculating long term averaged ground level concentrations in an area from point and area sources, respectively. The models have been continuously revised and updated to include the best of the latest theories for dispersion calculations. The programs POI-KILD and ARE-KILD are PC-versions in English of the NILU programs PUNKT-KILDER and AREAL-KILDER specially prepared for planning use for Central Pollution Control Board (CPCB) in Delhi, India.

In addition to the two dispersion models, the KILDER model system contains about 40 different supporting programmes written in Norwegian (Gram, 1987), of which 8 are transferred into English PC-versions, as described in another report (NILU TR 6/92).

The program system includes programs for calculating emissions from traffic, domestic heating and industrial sources, handling and presentation of data fields and exposure calculations.

2 THE KILDER SYSTEM AND FILE CONFIGURATION

The programs can operate in different modes: interactive or as a batch job. When running interactive, the program asks questions to the terminal, otherwise the program reads the input data from a run-file. It is possible to read some of the data from a separate file, such as fixed informations about the model area and the stack and emission data. All meteorological

data, such as wind speed, inversion height and the meteorological frequency matrix are read from a separate file. The input records are read in free format, unless a format is specified.

The output of the programs is given in data fields with concentration values together with the print-out. It is possible to run the programs separately for different source categories, or even to use different meteorological data for the sources in separate sub-regions of the area. With SUM-FIE we get the total concentration fields. The values are calculated for points located in the centre of each grid. Due to the need of a model which can work for several different areas, the models are using variable dimensioning in the source code, limited to a grid of $KX*KY=2500$ points, but this can easily be changed in the program code if necessary.

2.1 FILE TYPES

When performing model calculations for an area, the number of files are normally increasing rapidly. It has therefore proved to be important to give the files descriptive names and to use file-families.

The program system uses some standard file types:

Run-file	.RUN	} For these files the file type must be given together with the file name
Input data file	.DAT	
METFIL-file	.MET	
Output-file	.PRN	} For these files the file type is given automatically by the program and shall not be specified
Result-file	.FLD	

In the MS/DOS file system 8 characters may be used for a file name, in addition to 3 characters for the file type. If the file names and file-families are declared systematically it will be easier to recall the content of all the files.

For fuel consumption files, use: FUEL-SOURCE.DAT
.PRN
.FLD,

ex: COAL-IND.DAT, OIL-DOM.DAT

For emission files, use: SOURCE-COMPOUND.DAT
.PRN
.FLD,

ex: DOM-COAL.FLD, which may contain three fields with emissions from domestic coal consumption: SO₂, NO_x and SPM, or TRAF-EMI.FLD with emissions from traffic.

For concentration files, use: COMPOUND-SOURCE.PRN
.FLD

ex: DSO2-DOM.FLD with day-time SO₂-concentrations from domestic heating, or NOX-TRAF.FLD with NO_x-concentrations from traffic.

Some of the -KILD and -FIE programs create several different fields which are written to the .FLD file. A .FLD file may thus contain several fields, and the programs have to ask for which field to be read.

CONS-EMI and TRAF-EMI may thus give emission fields for a number of compounds, based upon fields with consumption or traffic work, and emission factors.

2.2 DATA FIELDS

The main data communication between the different programs takes place through files with data fields.

In the data fields the following data are written UNFORMATTED and stored as binary data:

COMPOUND, UNIT, PERIOD, PLACE, KX, KY, ISIZE, X(KX,KY)

- COMPOUND = Name of the compound which is calculated (16 characters). This will normally be 'SO2', 'NOX' or 'CO', but may also be variables such as 'INHABITANT', 'HEIGHT' or 'TRAFFIC'.
- UNIT = Unit of the values which is in the field (16 characters). This will for concentrations be 'UG/M3', for emission fields 'KG/H', but may also be 'PERSONS', 'M' or 'DIESEL-KM'
- PERIOD = Calculation period (16 characters). PERIOD may be used as a period for emission data, a data period for meteorological data, or a period for calculations. This may be 'WINTER 1991/92', '1990'.
- PLACE = Name of the area (16 characters), 'DELHI', 'OSLO'.
- KX,KY = Dimensions for the data-field X, integers $\begin{matrix} \text{KY} \uparrow \\ \text{KX} \end{matrix}$
- ISIZE = Grid size in meters, integer.
- X(KX,KY) = Data-field with values of the real-variable array X in a KX*KY-matrix

In the program system the files with data fields are declared with a file type .FLD, to distinguish them from other files. These files are not readable by the text editor. The formatted output from a program is put on a file with the same file name as the data field, but with file type .PRN, which may be printed out or read by a text editor.

2.3 DATA INPUT FORMAT

The programs will often read values into an array, noted in the program description by < >. WIND<4> means that the program shall read 4 values, according to the FORTRAN notation (WIND(I), I=1,4).

Data are normally read in free format (separated by commas), unless a format is specified. When all data from a data line is read, additional comments may be added, as described in the example above.

In a formatted read each column on a line has its special significance. The variable type and the number of columns this variable occupies must be specified.

Character variables such as name, text etc. are read in A-format. A10 means: read 10 characters. File names will be read with apostrophes (ex: 'SUM-RIB.MET')

Integers are read in I-format, f.eks. I5 which means: read an integer number within a field of 5 places, right-hand adjusted.

Other variables (real) are read in F-format or E-format. The format F6.2 means: read the number within a field of 6 places. If there is a decimal point (.) within the field, this is used. Otherwise, the program puts a decimal point two places from the right-hand side. Extreme high or small numbers may be read in E-format, but this needs more space. As an example: The number -1.234E-6 is read in the format E9.3, which means a mantissa with six locations and an exponent with three locations.

The notation T26 in a format statement means that the reading shall continue from column 26.

2.4 THE METEOROLOGY INPUT FILE

The KILDER programs read all the meteorological data for a period or for a region from a file called METFIL, which has to be specified as .MET. Both KILDER programs reads met.data from the same file, but they do not always use all the data on the file. The program METFREC gives an output file with a joint frequency matrix of wind and stability and some additional data, which has to be adjusted to obtain the correct METFIL-format.

When performing calculations for different seasons or for different parts of an area, only a new .MET-file. has to be obtained.

The following data should be included in the METFIL file:

When reading character variables from this file, they shall not be embedded in apostrophes.

PERIOD	Which data period is used (16 characters)
PLACE	Name of the area/met. station (16 characters)
TMID	Average temperature for the period (°C)
WIND<4>	Average wind speed for each wind speed class (m/s) (from METFREC)
ZZ0	Height of wind measurements (m)
STVEL	Starting velocity for the wind sensor (m/s)

The wind speed U_z at the height Z is calculated in the plume rise calculations in POINT-KILDER:

$$U_z = U_0 \left(\frac{Z}{Z_0}\right)^{RN} \quad (1)$$

where RN is a stability dependent wind profile exponent.

YRN	The program asks if we want standard values RN=0.20,0.28,0.36,0.42: Y/N
-----	--

If the answer is N, then the program reads:

RN<4>	New values for the wind profile exponents for the four stability classes
-------	---

YIN	The program asks for standard values for the mixing height. ZMIX=700.,500.,300.,200.m: Y/N
-----	---

If the answer is N, then the program reads:

ZMIX<4> Stability dependent mixing height. The vertical dispersion parameter σ_z is not allowed to increase more than to ZMIX. The program POI-KILD calculates the partial penetration through a stable layer at height ZMIX. The ground level concentration is reduced according to the calculated penetration factor P.

FREK<4,4,12> Format:(4X,16F4.1)
Joint frequency matrix from METFREC, 4 classes of stability, 4 wind speed classes and 12 wind direction sectors. One line for each sector. Each line may start with a direction, but this is not read.

CALM<4> Format:(4X,4F4.1)
Frequency of "calm" from METFREC, in 4 classes of stability. KILDER adjusts the matrix for "calm" by distributing the frequency of "calm" according to the wind rose for the actual stability class.

The mean wind speed in the lowest wind speed class is adjusted by a mean wind speed for "calm" = $0.7 * STVEL$.

A METFIL file may look as SUM-RIB.MET:

The lines with an * is output from METFREC, the rest must be included by the editor.

```

*DAY WINTER           , Period
DELHI                , Place
  11.0               , Tmid
*   .6, 1.7, 2.7, 5.1, , Wind speed
  10.0               , Height for wind measurements
  0.2                , Start velocity for wind sensor
  Y,                 , Standard wind profile exp
  N,                 , Standard mix. height
  1200.,1000.,400.,150, , New mixing heights
*   30 2.4 .0 .3 .3 .8 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0
*   60 .3 .0 .0 .0 .3 .0 .0 .0 .3 .0 .0 .0 .0 .0 .0 .0
*   90 .8 .0 .3 .0 .3 .0 .3 .0 .3 .0 .0 .0 .3 1.6 .0 .0
*  120 .5 .0 .8 .0 1.1 .0 .5 .0 .5 .0 .3 .0 .3 1.3 .0 .0
*  150 3.0 .0 .0 .0 2.2 .0 .3 .0 2.7 .0 .3 .0 .0 1.6 .0 .0
*  180 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0
*  210 .0 .0 .0 .0 .3 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0
*  240 1.6 .0 .0 .3 .5 .0 .0 .0 .3 .0 .0 .0 .0 .0 .0 .0
*  270 2.2 .0 .5 .3 .8 .0 .0 .0 .5 .0 .0 .0 .0 .5 .0 .0
*  300 3.0 .0 2.7 .5 3.0 .0 .5 .0 2.2 .8 .5 .0 .5 10.5 .0 .0
*  330 2.2 .0 .5 .3 4.0 .0 .8 .0 3.2 1.6 .8 .0 .3 14.8 .0 .0
*  360 .8 .0 .5 .0 .3 .0 .0 .0 .3 .3 .0 .0 .0 .0 1.9 .0 .0
*      7.5 .0 1.9 2.4 , Calm

```

If hourly mixing height data are available, it is recommended to run METFREC with the mixing height as variable no. 5. It could be useful to make two separate METFREC runs for daytime and night-time in order to take into account different dispersion conditions and emission rates for day and night.

The first part of the data are read in free format. The text to the right may be useful, but is not read by the program. The last part is read formatted, as described above.

3 THE GAUSSIAN PLUME EQUATION

The Gaussian plume equation calculates the downwind concentration of an inert gas being continuously emitted from a single source. When applying sector averaging it is assumed that the cross wind concentration distribution is constant within an angular sector corresponding to the resolution in the wind direction data.

Normally a joint frequency distribution of 4 stability classes, 4 wind speed classes and 12 wind directions (30° sectors) is used. The Gaussian dispersion formula for the ground level concentration with sector averaging in n sectors and with emissions from p point sources can then be expressed as follows:

$$C(x,y,0) = n/2\pi \sum_{i=1}^p \sum_{k=1}^{12} \sum_{l=1}^4 \sum_{m=1}^4 f(k,l,m) * Q_i * D(x_i, u) * S(p,k) * (1.0-P), \quad (2)$$

where the dispersion function $D(x_i, u)$ is defined as

$$D(x_i, u) = \sqrt{2/\pi} * (1+\alpha)/2 * \exp(-0.5 * (H/\sigma_z)^2) / (U_s * x_i * \sigma_z), \quad (3)$$

the sector function $S(p,k)$ as

$$S(p,k) = \begin{cases} 1 & \text{if receptor point is within sector } k \text{ downwind} \\ & \text{of source } p \\ 0 & \text{otherwise} \end{cases}$$

P = fraction of the plume that penetrates an elevated stable layer

and

$f(k,l,m)$ = the frequency of occurrence for wind sector k , wind speed class l and stability class m

- $(x, y, 0)$ = location of the receptor point given in Cartesian coordinates with the origin at the source location and x-axis parallel to wind direction
- x_i = distance from the source to the receptor (m)
- Q_i = continuous source emission rate (kg/h or g/s)
- H = effective plume height (m)
- h_s = stack height
- α = ground level reflection coefficient
- n = number of sectors = 12
- σ_z = standard deviation of the vertical concentration distribution
- u_s = mean transport wind speed

Figure 1 shows the geometry of a single point source.

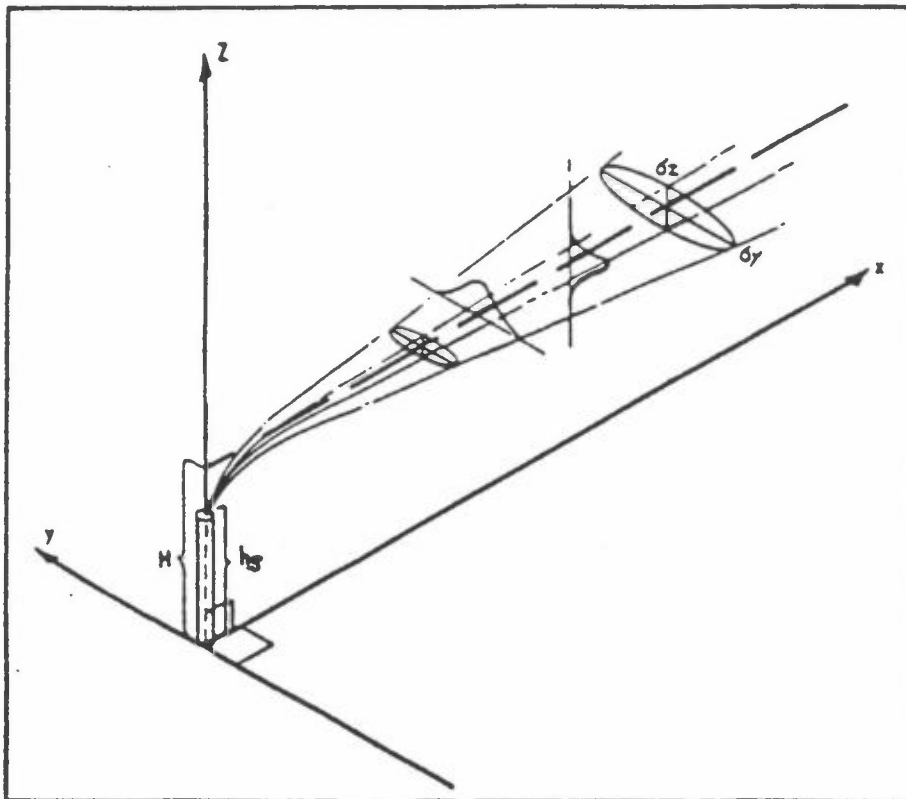


Figure 1: Gaussian point source geometry.

3.1 WIND SPEED

The mean transport wind speed should be representative of the conditions throughout the vertical height interval in which the plume is dispersing. The wind speed in the lower atmosphere varies with height above ground. Since wind measurements are generally performed near ground level (10 m above ground), an adjustment for the expected height range of dispersion has to be made. The variation of wind speed with height depends also upon the atmospheric stability.

The height dependency of the wind speed is described by a power law:

$$\bar{u}(z) = \bar{u}(z_0) \left(\frac{z}{z_0}\right)^m \quad (1)$$

with

z = height above ground,

z_0 = reference height above ground,

\bar{u} = time average wind speed,

m = wind profile exponent (corresponds to RN in the .MET-file).

The mean transport speed representative of an appropriate height range, e.g. from the effective source height (H) to ground level (for dispersion calculations), may then be calculated by integration:

$$\bar{u} = \frac{1}{\Delta z} \int \bar{u}(z) dz = \frac{1}{(z_2 - z_1)} \int_{z_1}^{z_2} \bar{u}(z_0) \cdot \left(\frac{z}{z_0}\right)^m dz, \quad (9)$$

Several empirical values of wind profile exponents (m) for different turbulence conditions have been published. The wind profile exponents are user input parameters, and in the NILU models the following values have been applied as standard values:

Stability class	m
Unstable	0.20
Neutral	0.28
Slightly stable	0.36
Stable	0.42

3.2 ATMOSPHERIC STABILITY

The diffusion of air pollutants in the lower atmosphere is strongly influenced by the local atmospheric stability. The diffusion of effluents is more rapid in the unstable than in the stable atmosphere.

The stability of the atmosphere can be derived from vertical and horizontal turbulence measurements, or from measurements of the vertical temperature profile and wind speed. Estimates of the net radiation or cloud cover, mixing height, and solar elevation have also been used. For practical reasons the turbulence situations of the atmosphere are usually described by a discrete set of stability classes.

Different turbulent classification schemes have been developed and used. Pasquill defined 6 turbulence classes:

- A = extremely unstable
- B = moderately unstable
- C = slightly unstable
- D = neutral
- E = slightly stable
- F = moderately stable

The meteorological data used to determine the turbulence type are usually the surface wind speed, daytime insolation, and nighttime cloudiness.

In the NILU data input for dispersion models, the three unstable classes have been combined into one. The stability classes are usually defined by vertical temperature gradients and by direct measurements of the standard deviation of the horizontal wind direction fluctuations, where such data are available. The stability classes are defined as follows:

Stability class	Temperature gradient dT (deg/100 m)	Corresponds to:	
		Pasquill	Brookhaven
Unstable	$dT < -1$	A+B+C	B_1+B_2
Neutral	$-1 \leq dT < 0$	D	C
Slightly stable	$0 \leq dT < 1$	E	-
Stable	$dT \leq 1$	F	D

3.3 DIFFUSION PARAMETERS

A main assumption for solving the diffusion equation is the existence of a Gaussian normal distribution of the plume concentrations perpendicular to the transport direction. The diffusion parameters σ_y and σ_z are defined as the standard deviations of the concentration distributions in the lateral and vertical, respectively. They are functions of the downwind distance from the emission source and of the stability of the atmosphere. The standard deviations have been determined from tracer experiments carried out during different wind and turbulence conditions.

The most appropriate set of diffusion parameters should be selected for each particular application. The choice will be dependent upon source height, surface roughness and, in some cases, averaging time or transport distance. A set of different parameters has been evaluated at NILU and represents the basis for our selection of stability classes.

When direct turbulence measurements are not available, the following form of diffusion parameters is used:

$$\sigma_y(x) = ax^p, \quad \sigma_z(x) = bx^q.$$

The most commonly used coefficients are listed in the Table 1 below, and apply to averaging times of up to one hour.

Table 1: Commonly used dispersion coefficients applicable for different source types and surface roughness.

Source and surface specifications	Coefficients	Unst.	Neutr.	Sl. stable	Stable
Surface and low sources. Rough surface, urban area. Ref.: Mc Elroy, J.L. Pooler, F., 1968	a	1.7	0.91	1.02	-
	p	0.72	0.73	0.65	-
	b	0.08	0.91	1.93	-
	q	1.2	0.70	0.47	-
High stacks, smooth to medium rough surface. Ref.: Smith, M., 1968 (Brookhaven)	a	0.36	0.32	0.31	0.31
	p	0.86	0.78	0.74	0.71
	b	0.33	0.22	0.16	0.06
	q	0.86	0.78	0.74	0.71
Sea surface. Ref.: Raynor et al. 1977	a	0.012	0.058	0.127	-
	p	1.19	0.877	0.783	-
	b	0.253	0.531	0.167	-
	q	0.637	0.418	0.578	-

3.4 STACK DOWNWASH

An effluent emitted vertically from a stack can rise due to its momentum or can be brought downward by the low pressure in the wake of the stack, which occurrence depends on the ratio of the exit gas velocity, W_s , to the crosswind velocity, U .

The physical stack height is modified according to Briggs (1974):

$$h_s = \begin{cases} h_s + 2 (W_s/U - 1.5)D_s & \text{for } W_s < 1.5 U \\ h_s & \text{for } W_s \geq 1.5 U \end{cases} \quad (5)$$

where h_s is the physical stack height, W_s is the exit gas velocity and D_s is the inside stack-top diameter. The modified stack height h_s is further used to calculate the effective plume height.

3.5 PLUME RISE EQUATIONS

The plume rise due to momentum or buoyancy is estimated using Briggs algorithm (Briggs 1969, 1971 and 1975). The calculated values of ΔH_b in this chapter, and h_s in chapter 3.4 are further used to evaluate the effects of buildings, penetration and topography in the following chapters to end up with the final plume height, H .

3.5.1 Neutral-Unstable Momentum Rise

Regardless of the atmospheric stability, neutral-unstable momentum rise is calculated. The plume rise is calculated as follows:

$$\Delta H_m = 3D_s W_s / U. \quad (6)$$

This equation is most applicable when W_s/U is greater than 4. Since momentum rise occurs quite close to the point of release, the distance to final rise is set equal to zero.

3.5.2 Neutral-Unstable Buoyancy Rise

The value of the buoyancy flux parameter, F (m^4/s^3), is needed for computing the distance to final rise and the plume rise.

$$F = (gW_s D_s^2 \Delta T) / (4T_s), \quad (7)$$

where $\Delta T = T_s - T_a$, T_s is the stack gas temperature (K), and T_a is the ambient air temperature (K).

The distance to final rise x_f (in kilometres) is the distance at which atmospheric turbulence begins to dominate entrainment.

For F less than 55,

$$x_f = 0.049F^{5/8}. \quad (8)$$

For F equal to or greater than 55,

$$x_f = 0.119F^{2/5}. \quad (9)$$

The plume rise, ΔH (in metres), is determined from the equations:

For F less than 55,

$$\Delta H_b = 21.425F^{3/4}/U. \quad (10)$$

For F equal to or greater than 55,

$$\Delta H_b = 38.71F^{3/5}/U. \quad (11)$$

If the neutral-unstable momentum rise (previously calculated from Eq. 6) is higher than the neutral-unstable buoyancy rise calculated here, momentum rise applies and the distance to final rise is set equal to zero.

3.5.3 Stability Parameter

For stable situations, the stability parameter s is calculated from the equation:

$$s = g(\delta\theta/\delta z)T_a. \quad (12)$$

As an approximation $\delta\theta/\delta z$ is taken as 0.02 K/m for the light stable class, and 0.035 K/m for the stable class.

3.5.4 Stable Momentum Rise

When the stack gas temperature is less than the ambient air temperature, it is assumed that the plume rise is dominated by momentum. The plume rise is then calculated by using the equation:

$$\Delta H_m = 1.5[W_s^2 D_s^2 T_a / (4T_s U)]^{1/3} s^{-1/6}. \quad (13)$$

This value of ΔH_m is compared with the value for neutral-unstable momentum rise (Eq. 6) and the lower of the two values is used as the resulting plume height.

3.5.5 Stable Buoyancy Rise

For situations where $T_s \geq T_a$, buoyancy is assumed to dominate. The distance to final rise (in kilometres) is determined by the equation:

$$x_f = 0.0020715Us^{-1/2}. \quad (14)$$

The plume rise is determined by:

$$\Delta H_b = 2.6[F/U \cdot s]^{1/3}. \quad (15)$$

The stable buoyancy rise for calm conditions is also evaluated:

$$\Delta H_b = 4F^{1/4} S^{-3/8} . \quad (16)$$

The lower of the two values obtained from Eqs. 15 and 16 is taken as the plume rise.

If the stable momentum rise is higher than the stable buoyancy rise calculated here, momentum rise applies and the distance to final rise is set equal to zero.

3.6 BUILDING EFFECTS

Briggs (1974) has outlined a useful procedure for estimating the effective height of emission incorporated building-induced disturbances to the flow. The procedure is as follows:

- 1) Calculate the following height h:

$$h = h_s + \Delta H_m$$

where ΔH_m is the momentum plume rise, eqs. (6) or (13).

If stack downwash occurs, $h' = h_s$ from Chapter 3.4.

Let L_B be the smaller of the frontal building dimensions H_B or W_B .

- a) If h' is greater than $H_B + 1.5 L_B$, the plume is above the region of building influence. Continue to the next chapter to check for penetration by using $h_e = h' + \Delta H$ as the effective plume height. ΔH is the plume rise from chapter 3.5.
- b) If h' is less than H_B , set

$$h'' = h' - 1.5 L_B \quad (17)$$

c) If h' is between H_B and $H_B + 1.5 L_B$, set

$$h'' = 2h' - (H + 1.5 L_B) \quad (18)$$

For the cases b) and c) the plume may remain aloft or may be entrained into the wake cavity and become essentially a ground level source.

If h'' is greater than $0.5 L_B$, the plume remains elevated and concentrations can be calculated by using standard formulae with modified stack height equal h'' , and effective plume height $h_e = h'' + \Delta H$. Continue to the next chapter to check for penetration by using h_e as the effective plume height.

If h'' is less than $0.5 L_B$, the plume is trapped in the cavity zone and should be treated as a ground source with initial dimensions equal the projected frontal area of the building, A .

For the cases b) and c), where the plume is influenced by the buildings, an additional dispersion factor is combined with the standard dilution factor as follows (Briggs, 1970).

$$\sigma_y = (\sigma_y^2 + cA/\pi)^{1/2} \quad (19)$$

$$\sigma_z = (\sigma_z^2 + cA/\pi)^{1/2} \quad (20)$$

where $c = 1.0$ and $A = H_B W_B$

In POI-KILD the building effects are taken into account, whereas in ARE-KILD these are included in the box heights as a measure of the initial turbulence. Thus, in the stack file in POI-KILD the height and width of the nearest buildings (within $3 \cdot h_s$ m) should be given in SKOR(8) and SKOR(9).

3.7 PLUME PENETRATION

A buoyant plume rising into a well-mixed layer trapped by stable air may partially or completely penetrate the elevated stable layer. To compute ground level concentrations for this situation, the fraction of the plume that penetrates the stable layer is first estimated and then the emission rate, Q_s , and effective plume height, h_e , for the material remaining within the mixed layer are modified.

The fraction P of the plume that penetrates the elevated stable layer is estimated as follows (Weil and Brower, 1984):

1) No penetration:

$$P = 0 \text{ if } \frac{Z'_i}{\Delta H} \geq 1.5 \quad (21)$$

2) Total penetration:

$$P = 1 \text{ if } \frac{Z'_i}{\Delta H} \leq 0.5 \quad (22)$$

3) Partial penetration:

$$P = 1.5 - \frac{Z'_i}{\Delta h} \text{ if } 0.5 < \frac{Z'_i}{\Delta h} < 1.5 \quad (23)$$

where Δh is the predicted plume rise and $Z'_i = z_i - h_s$, where z_i is the height of the stable layer aloft, and h_s is the stack height.

The plume material remaining within the mixed layer is assumed to contribute to ground level concentrations. The modified source strength, Q is then:

$$Q = Q_s (1-P) \quad (24)$$

where Q_s is the emission rate on top of the stack.

To modify the effective plume height for plumes trapped within the mixed layer, it is assumed that the plume rise due to penetration, ΔH_p , is linearly varying between $0.62 Z'_i$ for no penetration and Z'_i for total penetration.

Thus for partial penetration ($0 < P < 1$):

$$\Delta H_p = (0.62 + 0.38P)Z'_i \quad (25)$$

The modified plume height to be used further, h_m , is the lowest value of the height in the unlimited atmosphere, h_e , from chapter 3.6, and the height due to penetration, such as:

$$h_m = \min (h_e, h_p), \quad h_p = h'_s + \Delta H_p \quad (26)$$

Continue to the next chapter to check for terrain effects by using h_m for the effective plume height.

3.8 TOPOGRAPHY

The effect of elevated terrain on the ground level concentrations is included by reducing the effective plume height, h_m , assuming:

$$H = h_m - \Delta H_t, \quad \Delta H_t = k \cdot h_t \quad (27)$$

where h_t is the height of terrain above stack base level and k is a terrain factor ($0 < k < 1$) dependent upon steepness, distance from source, stability, etc.

Table 2: Terrain factor, k , to evaluate the effect of a hill on a source with stack height h_s .

Distance (x)	k
0 < x ≤ 5 h_s	0.7
5 h_s < x ≤ 10 h_s	0.5
10 h_s < x ≤ 20 h_s	0.3
20 h_s < x ≤ 30 h_s	0.1
30 h_s < x	0.0

4 POI-KILD, DISPERSION CALCULATIONS FOR POINT SOURCES

The program POI-KILD calculates sector averaged long term average concentrations at ground level in a grid of receptor points, with emission from several point sources, taking into account data on dispersion, topography, buildings and penetration through an upper stable layer. The program is dimensioned for 80 sources, but this can be easily increased. Another possibility is to split the sources into different source groups, make separate calculations for each source groups, and add the results by SUM-FIE.

4.1 INPUT DATA FOR POI-KILD

The program POI-KILD gets its input data from different sources; interactive from the terminal or from a RUN-file, from a file with stack data, and from a METFIL-file with meteorological data (as described in chapter 2.4). To run the program for the first time it may be run interactive to perform a .RUN-file with all answers for the next calculations.

4.1.1 Stack file INSTA

All stack data are read from the file INSTA (which should be of type .DAT). At this file all other data which should remain constant are collected, whereas data which are varied from one run to another should be read interactive from a .RUN-file.

The program does not give a dialogue when reading from the file INSTA, as the file is already prepared and the questions answered. Nevertheless, questions will be useful in preparing the file. The file is read until a line that begins with START in columns 1-5. This means that we may put useful comments at the beginning of the file. The data at the file is read in different subroutines.

After the line with START the program reads:

TEXT One line with a heading for the computations (A80).

ISIZE Grid size in meter (integer).

UTMX, UTMY Co-ordinates for south-west corner of the grid array (real).

ANORTH Direction of the Y-axis (in degrees, counter clockwise, normally = 0) (real).

We may perform calculations for standard components. 1=SO₂, 2=NO_x, 3=CO, 4=Particles, 5=HC and 6=Other. The program asks if this is OK T, Y/N.

If YN=N, the program reads new components names

NCOMP, (LCOMP(I), I=1, NCOMP)

The number of components, and their names (in apostrophes). The calculations are carried out for component no. ICOMP, which is read interactive (see chapter 5.1.2).

BACKG Background concentration of component no. ICOMP may be added to the result. For a composite calculation with different source groups the background should be added when making the sum of the data fields in SUM-FIE.

TOP Do you want to correct for topography? Y/N

If TOP=Y, the program asks for

TOPFIL Name of the topography field (which should be a .FLD file)

DGR Standard ground level reflection factor ALPHA = 1.0 OK? Y/N

If DGR=N, the program asks for

ALPHA Ground level reflection factor, which is the relative amount of inert gas reflected from the surface by impaction. Can be used to estimate the effect of deposition on concentrations.

DHL It is possible to use different dispersion parameters for high and low sources (Brookhaven/McElroy-Pooler) if we read IDISP=3 in the routine SIGMA (see below) Standard limit between high and low sources = 50m OK? Y/N

If DHL=N, the program asks for

HL New limit for distinguishing between high and low sources. Sources with effective stack height >HL will use one set of dispersion parameters for high sources, other for low sources.

IDISP Selection of dispersion parameters (cfr. chapter 3.3):

- 1: McElroy-Pooler
- 2: Brookhaven
- 3: McElroy-Pooler for low sources, Brookhaven for high sources with effective stack height > HL
- 4: New values

If IDISP=4, the program asks for

SIGL (CZL(I), I=1,4) (PZL(I), I=1)	}	Name and dispersion parameters for low sources. $\sigma_z(\text{low}) = \text{CZL} \cdot X^{\text{PZL}}$
SIGH (CZH(I), I=1,4) (PZH(I), I=1)	}	Name and dispersion parameters for high sources. $\sigma_z(\text{high}) = \text{CZH} \cdot X^{\text{PZH}}$

JUT, ITT JUT=1: Emissions in g/s
 =2: Emissions in kg/h
 ITT=1: Temperature in degrees C
 =2: Temperature in degrees K

The program reads two dummy lines with heading for the stack data, and then reads the stack data, until the end of the file. In the example file at page 34 these lines are used to show the variable names, and the format.

PIPE, (SKOR(I), I=1, 8), KOD, (UT(I), I=1, ICOMP)

Format: (A10, 8F6.0, I2, 6F6.1)

PIPE Source name A10
 SKOR(1) UTMX (km)
 SKOR(2) UTMX (km)
 SKOR(3) Stack height (m)
 SKOR(4) Stack diameter (m)
 SKOR(5) Gas temperature °C or K, according to ITT
 SKOR(6) Gas velocity (m/s)
 SKOR(7) Building height (default 10 m)
 SKOR(8) Building width (default 30 m)
 KOD Source group code 1-9 (default=1), see
 chapter 5.1.2.
 UT Emission data for max. 6 compounds, unit:
 see JUT. The calculations are performed
 with emission UT(ICOMP).

All data SKOR(3)-SKOR(6) must be present, otherwise the program skips the source and gives a warning message.

For the building dimensions the program uses default height=10m and width=30m. For McElroy-Pooler dispersion parameters no building turbulence is calculated.

4.1.2 Run file or interactive data

\PROGRAM\POI-KILD Starts the program when running it interactive.

\PROGRAM\POI-KILD <run-file.RUN
 Starts the program from the run-file.RUN.
 It may be useful to use the same name for the RUN-file and OUTFI.

The run-file, or the answers to the interactive questions will be:

KX, KY Dimensions of the area, number of grid points easterly and northerly. KY $\begin{array}{l} \longleftarrow \\ \text{KX} \end{array}$

INSTA Name of the INSTA file with stack data etc. (with apostrophes and .DAT). The main part of the input data is read from INSTA, but still some from the terminal.

OUTFI Name of the output files (with apostrophes). The concentration data field is written binary (unformatted) to the file OUTFI.FLD, whereas the output from the program is written to the file OUTFI.PRN.

ICOMP The calculations are carried out for component no. ICOMP, which is called COMPOUND=LCOMP(ICOMP).

Do you want to use all sources (1) or select groups (2). If 2:

NCOD, (IFACT(I), I=1,NCOD)

NCOD = number of source group codes (max. 9).

IFACT = factors 0/1 for these.

It is possible to classify the sources at the file INSTA into source groups by the parameter KOD at the stack file. By this we may include or exclude groups of sources in the calculations without changes in the file INSTA. This is useful especially when the sources are influenced by different dispersion conditions in different parts of the area. It is also possible to include different monthly emission figures at the stack file and choose

the correct set of emission data by the use of IFACT.

[Instead of using the idea of group codes some of the users of this program have preferred to enter the source list in the editor, rearrange it and move the sources which is not to be included to the top of the file, before START.]

It is possible to adjust the emission rates for some stacks without changing the data on the file:

NEMCH Number of emission figures which should be changed

If NEMCH > 0 the program asks for:

IZ,SCALE Scale factor for source no. IZ
YNO Is this source no. correct? Y/N
 If N, try again with a correct
 IZ

Only sources with emission rates different from zero are included in the further calculations. The numbering of a source is thus to some extent depending on what is done to the other sources higher up on the list.

The name of the MET-file is read from terminal/run-file

METFIL Name of the file with meteorological data.
 (with apostrophes and .MET). See the
 separate description of this file in
 chapter 2.4.

YCON Finally the program asks if we want a
 survey of the contribution from each point
 source in selected grid points (max.8):
 Y/N

If YCON=Y, the program reads:

```
NPOINT, (IPO(I), JPO(I), I=1, NPOINT)
```

NPOINT Number of grid points (max.8)

IPO(I), JPO(I) I- and J-indices for each grid point

4.2 TEST EXAMPLE FOR POI-KILD

As a test example is used some calculations for point sources in Oslo, Norway.

The stack file OSLO-POI.DAT will be:

OSLO-POI.DAT

Point sources 1985 from Oslo

The file is read until 'Start' in column 1-5,

Input format: (A10,3X,8F6.0,I2,4(F5.1,I1))

Central heating and big Low-S-consumers 1985

START The file is read until 'START' in column 1-5

WINTER AVERAGE FROM POINT SOURCES IN OSLO 1985

1000, Grid size in meters

587.,633., UTMX,UTMY

0., North is north

Y, Standard compounds

0.0, Background concentration

N, No topography

Y, Std ground reflection coefficient 1.0? Y/N

Y, Std limit between high and low sources 50m? Y/N

3, Code for dispersion coeff. 1)McE 2)Brook 3)McE + Brook 4)own

2,1, Emissions in kg/h, temp in oC

NAME	UTMX	UTMY	H	D	TG	VG	BH	BB	KOD	S02	NOX	CO	SOT
AAAAAAAAAAxxx	FFFF	.Fffff	.fffff	.fffff	.fffff	.fffff	.fffff	.fffff	.fIIFFF	.Fifff	.fiFFF	.Fifff	.fi
HARALDRUD VAR	602.4	645.3	26.	1.0	180.	20.				3.7	1.0	0.0	0.26
KLEMENTSRUD V	603.3	635.0	80.	1.2	150.	25.				2.2	0.6	0.0	0.15
SENTRUM	597.3	643.1	65.	2.7	180.	5				3.0	1.2	0.7	0.07
HARALDRUD SOP	602.2	645.5	80.	1.7	200.	20.				21.6	25.8	7.2	2.1
KLEMETSRUD S	603.3	635.0	80.	1.2	150.	25.				33.6	40.0	11.2	3.2
APOTEKERNE	593.6	644.3	30.	1.0	200.	10.				4.4	1.2	0.06	0.3
HAUGERUD VAR.	604.2	644.0	30.	1.0	200.	10.				4.9	1.3	0.05	0.3
RINGNES TH.M.	598.5	645.2	30.	1.0	200.	16.				10.3	2.7	0.1	0.7
FRYDENLUND B.	597.1	644.1	33.	.95	198.	16.3				10.1	2.7	0.1	0.7
FELLESMEIERIE	604.5	647.1	36.	.65	250.	20.				5.7	1.5	0.06	0.4
FREIA	598.8	644.5	50.	1.8	200.	10.				5.5	1.4	0.06	0.4
TOKERUD SERV.	606.9	647.4	30.	1.0	200.	10.				4.6	1.2	0.05	0.3
SPIKERVERKET	598.7	647.5	35.	1.3	220.	10.				17.2	4.5	0.2	1.2
S.T.K.	601.7	644.9	34.7	.4	190.	20.				2.7	0.7	0.03	0.2
DE-NO-FA	598.1	644.8	41.6	1.1	145.	15.				4.6	1.2	0.05	0.3
NORA	604.6	645.3	30.	1.0	200.	10.				2.7	0.7	0.03	0.2
TVEITA VARME	603.1	643.7	55.	1.4	200.	10.				3.8	1.0	0.04	0.3
KVARNER BRUK	600.1	642.3	30.	1.0	200.	10.				4.1	1.1	0.04	0.3
BOGERUD VARME	603.1	641.9	30.	1.0	200.	10.				2.7	0.7	0.03	0.2

END

The meteorology file OSLO-VAL.MET will be:

WINTER-AVERAGE	Data period
VALLE-HOVIN	Place
-1.5,	Mean temp.
1.0,3.0,5.0,7.0,	Wind speed classes
10.,	Height for wind data
0.5,	Start velocity for wind sensor
J,	Standard windprofileexp.
N,	Not standard inv.height
700.0,500.0,300.0,300.0,	HINV
30 0.3 1.9 0.3 0.1 0.7 3.1 0.1 0.0 0.4 1.9 0.0 0.0 0.1 0.1 0.0 0.0	
60 0.7 6.5 4.7 5.5 3.1 8.4 1.6 0.9 0.8 1.0 0.3 0.1 0.0 0.1 0.0 0.0	
90 0.3 3.6 4.0 4.7 0.5 0.6 0.0 0.0 1.4 0.0 0.0 0.0 0.2 0.0 0.0 0.0	
120 0.2 0.9 0.8 0.9 0.0 0.5 0.0 0.0 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
150 0.1 2.1 0.6 0.6 0.3 0.6 0.2 0.0 0.1 0.1 0.1 0.0 0.0 0.0 0.0 0.0	
180 0.5 2.7 0.5 0.3 0.5 2.0 0.1 0.0 0.8 2.4 0.1 0.0 0.7 1.5 0.0 0.1	
210 0.4 2.4 0.7 0.4 0.3 1.8 0.2 0.0 0.2 0.4 0.2 0.1 0.0 0.1 0.0 0.0	
240 0.2 1.5 1.2 0.1 0.1 0.3 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
270 0.1 0.5 0.8 0.4 0.1 0.2 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	
300 0.1 0.3 0.3 0.2 0.0 0.2 0.0 0.0 0.0 0.1 0.0 0.0 0.0 0.0 0.0 0.0	
330 0.0 0.4 0.1 0.0 0.3 0.8 0.1 0.0 0.2 0.4 0.0 0.0 0.2 0.1 0.0 0.0	
360 0.0 0.1 0.0 0.0 0.1 0.7 0.1 0.0 0.3 1.0 0.0 0.0 0.1 0.1 0.0 0.0	
0.0 0.8 0.9 1.1	

The result will be found at the file OSLO-POI.PRN:

Norwegian institute for air research
 Welcome to the program POI-KILD, for calculating
 long-term mean values from a number of point sources.
 VERSJON : 1992-03-28

WINTER AVERAGE FROM POINT SOURCES IN OSLO 1985
 Stack data are read from file..... oslo-poi.dat
 Computations are made for..... SO2
 Ground level reflection factor ALPHA..... 1.000
 The concentration are ground level values with 30o sector averages
 The SW corner of the area has coordinates (587.00, 633.00)
 The centre of grid (1,1) has the local coordinates (.50, .50)
 Dispersion parameters from McElroy-Pooler for low sources,
 Brookhaven for elevated sources (above 50. meters)

Frequency matrix for WINTER-AVERAGE VALLE-HOVIN
read from OSLO-VAL.MET

	1.0m/s				3.0m/s				5.0m/s				7.0m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	.3	2.0	.3	.1	.7	3.1	.1	.0	.4	1.9	.0	.0	.1	.1	.0	.0
60	.7	6.7	5.0	6.0	3.1	8.4	1.6	.9	.8	1.0	.3	.1	.0	.1	.0	.0
90	.3	3.7	4.3	5.1	.5	.6	.0	.0	1.4	.0	.0	.0	.2	.0	.0	.0
120	.2	.9	.9	1.0	.0	.5	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0
150	.1	2.2	.6	.7	.3	.6	.2	.0	.1	.1	.1	.0	.0	.0	.0	.0
180	.5	2.8	.5	.3	.5	2.0	.1	.0	.8	2.4	.1	.0	.7	1.5	.0	.1
210	.4	2.5	.7	.4	.3	1.8	.2	.0	.2	.4	.2	.1	.0	.1	.0	.0
240	.2	1.6	1.3	.1	.1	.3	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
270	.1	.5	.9	.4	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
300	.1	.3	.3	.2	.0	.2	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0
330	.0	.4	.1	.0	.3	.8	.1	.0	.2	.4	.0	.0	.2	.1	.0	.0
360	.0	.1	.0	.0	.1	.7	.1	.0	.3	1.0	.0	.0	.1	.1	.0	.0

Stability	1	2	3	4
Windprof.exponent	.20	.28	.36	.42
Mixing height	700.	500.	300.	300.

The wind speed in the lowest wind speed group is adjusted for calm from
1.00 m/s to .97 m/s

All point sources are included

Number of sources..... 19
Default building dimensions:.....HEIGHT=10m

Source data:

Name	Relative coordinates		Stack height m	Stack diameter m	Gas temp. oC	Exit velocity m/s	Building		SO2 emission kg/h
	X	Y					height	width	
1 HARALDRUD	15.40	12.30	26.0	1.00	180.	20.0	10.	30.	3.70
2 KLEMENTSRU	16.30	2.00	80.0	1.20	150.	25.0	10.	30.	2.20
3 SENTRUM	10.30	10.10	65.0	2.70	180.	5.0	10.	30.	3.00
4 HARALDRUD	15.20	12.50	80.0	1.70	200.	20.0	10.	30.	21.60
5 KLEMETSrud	16.30	2.00	80.0	1.20	150.	25.0	10.	30.	33.60
6 APOTEKERNE	6.60	11.30	30.0	1.00	200.	10.0	10.	30.	4.40
7 HAUGERUD V	17.20	11.00	30.0	1.00	200.	10.0	10.	30.	4.90
8 RINGNES TH	11.50	12.20	30.0	1.00	200.	16.0	10.	30.	10.30
9 FRYDENLUND	10.10	11.10	33.0	.95	198.	16.3	10.	30.	10.10
10 FELLESEIE	17.50	14.10	36.0	.65	250.	20.0	10.	30.	5.70
11 FREIA	11.80	11.50	50.0	1.80	200.	10.0	10.	30.	5.50
12 TOKERUD SE	19.90	14.40	30.0	1.00	200.	10.0	10.	30.	4.60
13 SPIKERVERK	11.70	14.50	35.0	1.30	220.	10.0	10.	30.	17.20
14 S.T.K.	14.70	11.90	34.7	.40	190.	20.0	10.	30.	2.70
15 DE-NO-FA	11.10	11.80	41.6	1.10	145.	15.0	10.	30.	4.60
16 NORA	17.60	12.30	30.0	1.00	200.	10.0	10.	30.	2.70
17 TVEITA VAR	16.10	10.70	55.0	1.40	200.	10.0	10.	30.	3.80
18 KVARNER BR	13.10	9.30	30.0	1.00	200.	10.0	10.	30.	4.10
19 BOGERUD VA	16.10	8.90	30.0	1.00	200.	10.0	10.	30.	2.70

SUM 147.40

MAP OF SO2 UNIT: UG/M3 PERIOD: WINTER-AVERAGE PLACE: VALLE-HOVIN

MAXIMUM VALUE IS 3.3684E+00, IN (9,11)

SUM= 4.15562E+02 SCALE FACTOR: 1.0E-02

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
J=18	49.	37.	39.	42.	45.	45.	49.	53.	56.	64.	76.	99.	100.	84.	92.	85.	78.	80.	72.	71.	62.	51.
J=17	52.	55.	57.	61.	46.	53.	59.	66.	70.	73.	92.	130.	101.	97.	95.	90.	88.	93.	84.	78.	62.	56.
J=16	65.	65.	70.	73.	72.	82.	89.	100.	77.	91.	98.	180.	116.	99.	108.	109.	90.	108.	84.	69.	70.	54.
J=15	88.	87.	91.	87.	90.	94.	109.	117.	119.	129.	124.	157.	113.	118.	118.	142.	113.	146.	88.	82.	53.	47.
J=14	100.	95.	102.	110.	119.	126.	144.	136.	199.	230.	245.	169.	120.	114.	125.	186.	178.	143.	132.	82.	54.	42.
J=13	117.	119.	118.	125.	159.	162.	199.	216.	220.	235.	169.	196.	130.	152.	169.	166.	133.	121.	76.	52.	47.	42.
J=12	117.	139.	152.	167.	184.	187.	200.	220.	242.	232.	275.	177.	186.	252.	237.	135.	140.	79.	63.	44.	39.	36.
J=11	128.	138.	150.	165.	214.	262.	246.	271.	337.	326.	236.	187.	206.	181.	146.	190.	155.	64.	52.	40.	37.	33.
J=10	137.	158.	175.	200.	258.	258.	284.	286.	272.	238.	197.	187.	170.	154.	152.	128.	84.	52.	43.	34.	31.	29.
J= 9	163.	182.	201.	223.	224.	250.	235.	220.	201.	187.	213.	187.	145.	142.	95.	111.	68.	47.	37.	33.	31.	28.
J= 8	166.	181.	196.	194.	218.	208.	185.	174.	177.	184.	148.	118.	134.	106.	82.	70.	48.	46.	34.	32.	29.	27.
J= 7	167.	179.	177.	195.	183.	160.	148.	150.	165.	141.	92.	102.	82.	71.	50.	55.	48.	47.	34.	32.	29.	21.
J= 6	176.	175.	186.	162.	152.	130.	128.	139.	126.	84.	83.	68.	54.	43.	43.	55.	50.	37.	33.	32.	23.	21.
J= 5	161.	170.	158.	148.	131.	128.	137.	107.	80.	73.	56.	48.	38.	32.	34.	25.	53.	33.	32.	22.	22.	21.
J= 4	156.	143.	130.	118.	116.	122.	110.	93.	95.	73.	65.	35.	33.	28.	27.	19.	56.	29.	17.	20.	21.	20.
J= 3	131.	119.	106.	104.	109.	98.	82.	88.	69.	58.	55.	54.	52.	40.	22.	23.	17.	12.	12.	13.	14.	14.
J= 2	112.	97.	95.	100.	88.	73.	78.	68.	55.	49.	52.	52.	46.	38.	96.	82.	17.	9.	11.	12.	13.	13.
J= 1	89.	87.	91.	81.	65.	69.	60.	54.	44.	47.	50.	94.	96.	98.	92.	44.	18.	16.	9.	10.	10.	9.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Results are printed to file oslo-poi.PRN
Concentrations are put on file oslo-poi.FLD

Plume rise, and index:

- 1: No building turbulence
 2: Building turbulence (He>0.5 Hb)
 3: Trapped by buildings (He=0.5 Hb)
 should this source be included in the area sources?
 -1: No occurrence of the stability/wind speed class

SOURCE	.97 M/S				3.00 M/S				5.00 M/S				7.00 M/S			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
HARALDRUD	197.	184.	96.	83.	81.	77.	74.	65.	59.	57.	67.	59.	50.	48.	0.-1	56.
KLEMENTSRU	275.	245.	152.	137.	143.	133.	130.	119.	118.	112.	122.	113.	107.	103.	0.-1	110.
SENTRUM	288.	257.	142.	127.	135.	124.	114.	103.	104.	97.	104.	95.	90.	86.	0.-1	91.
HARALDRUD	389.	340.	170.	151.	180.	164.	141.	129.	140.	131.	132.	121.	123.	116.	0.-1	116.
KLEMETSrud	275.	245.	152.	137.	143.	133.	130.	119.	118.	112.	122.	113.	107.	103.	0.-1	110.
APOTEKERNE	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.
HAUGERUD V	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.
RINGNES TH	177.	165.	96.	83.	77.	73.	75.	67.	58.	56.	68.	61.	50.	49.	0.-1	57.
FRYDENLUND	168.	156.	96.	84.	76.	73.	76.	68.	59.	57.	69.	63.	52.	50.	0.-1	59.
FELLESMEIE	132.	123.	90.	80.	67.	64.	73.	66.	55.	53.	67.	61.	49.	48.	0.-1	59.
FREIA	275.	248.	128.	113.	123.	114.	104.	93.	93.	87.	94.	85.	79.	75.	0.-1	80.
TOKERUD SE	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.
SPIKERVERK	189.	175.	102.	89.	85.	80.	81.	72.	65.	62.	73.	65.	55.	53.	0.-1	61.
S.T.K.	76.	72.	72.	65.	48.	47.	60.	55.	43.	42.	56.	52.	40.	40.	0.-1	50.
DE-NO-FA	172.	158.	103.	91.	84.	79.	84.	76.	67.	64.	77.	70.	60.	58.	0.-1	67.
NORA	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.
TVEITA VAR	207.	187.	120.	107.	104.	98.	100.	91.	84.	80.	92.	84.	75.	72.	0.-1	80.
KVARNER BR	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.
BOGERUD VA	133.	125.	86.	76.	63.	61.	68.	61.	50.	48.	62.	56.	44.	42.	0.-1	52.

SOURCE CONTRIBUTIONS:

SOURCE	EMISSION	11,11		13,10	
HARALDRUD	3.700	.1525E+00	.1946E+00		
KLEMENTSRU	2.200	.4567E-02	.5672E-02		
SENTRUM	3.000	.6770E-02	.2705E-02		
HARALDRUD	21.600	.3053E+00	.1063E+00		
KLEMETSrud	33.600	.6975E-01	.8662E-01		
APOTEKERNE	4.400	.2900E-01	.8571E-02		
HAUGERUD V	4.900	.1092E+00	.2683E+00		
RINGNES TH	10.300	.2965E+00	.5463E-01		
FRYDENLUND	10.100	.1521E+00	.3250E-01		
FELLESMEIE	5.700	.1808E+00	.2103E+00		
FREIA	5.500	.1883E+00	.2074E-01		
TOKERUD SE	4.600	.1223E+00	.1386E+00		
SPIKERVERK	17.200	.2161E+00	.3349E-01		
S.T.K.	2.700	.1992E+00	.6331E-01		
DE-NO-FA	4.600	.1536E+00	.2520E-01		
NORA	2.700	.5638E-01	.1232E+00		
TVEITA VAR	3.800	.5818E-01	.1599E+00		
KVARNER BR	4.100	.4704E-01	.6033E-01		
BOGERUD VA	2.700	.1604E-01	.1023E+00		

SUM		.2363E+01	.1697E+01		

5 ARE-KILD, DISPERSION CALCULATIONS FOR AREA SOURCES

An area source represents the emission from several small sources within a grid square, mostly from domestic heating, small industries and road traffic. The emission field is often calculated from fields with oil, wood or coal consumption or traffic work.

The program ARE-KILD calculates sector-averaged long term concentrations at ground level in a grid of receptor points from sources in an emission field given in the same grid system.

In the program the pollution contribution from an area source is taken into account by considering 100 point sources evenly distributed over the square-km (Fortak, 1970). Each area source is assigned to a box class, which defines the height of the initial vertical turbulence elements, which again is a function of the average building height. The dispersion from an area source is tabulated as a function of distance, wind speed, stability and box class. Actual concentration values are calculated by linear interpolation between tabulated values and multiplied by the emission.

The vertical standard deviation σ_z is calculated from:

$$\sigma_z^2 = \sigma_{z_0}^2 + H_b^2 \cdot F_a \quad (28)$$

where

$$\sigma_{z_0} = a * x^p$$

$$H_b = \text{box height}$$

$$F_a = \text{wind speed correction factor} = 0.5 * (1.0 + 0.7/\bar{u})^2$$

$$\bar{u} = \text{mean wind speed for the wind speed class.}$$

The result from the program will be two separate data fields, one with the total concentration, and one with the concentration contribution from emissions within a square to to the square itself.

5.1 INPUT DATA FOR ARE-KILD

The program ARE-KILD gets its data from different sources; interactive from the terminal or from a .RUN-file, from a file with constant data, and from a METFIL-file with meteorological data (as described in chapter 2.4). To run the program for the first time it may be run interactive to perform a .RUN-file with all the answers for the next calculations.

5.1.1 Input file INFI

This file includes all information that shall be constant during a set of computations. The program gives no dialogue when reading from this file, as the file is already prepared and the questions answered. Nevertheless, we will use questions in the preparing of the file. The file will be read with a line that begins with START in columns 1-5. This means that we may put useful comments at the beginning of the file. The data at the file is read in different subroutines.

The program asks for:

TEXT	One line with text as a heading for the calculations
ISIZE	Grid size in meter
ANORTH	It is possible to rotate the grid area. ANORTH tells the direction of the y-axis of the grid (in degrees), normally 0.0
BACKG	Background concentration which may be added.

For a composite calculation with different source groups the background should be added when making the sum of the data fields in SUM-FIELD.

IDISP Selection of dispersion parameters:
 1: McElroy-Pooler
 2: Brookhaven
 3: New values

If IDISP=3, the program reads:

SIGM	}	New name and dispersion parameters
(CZA(I), I=1,4)		
(PZA(I), I=1,4)		

INBOX, JFIE Box codes are field no. JFIE on the file INBOX (with apostrophes and .FLD).

INEMIS, IFILE The emission field is field no. IFILE at the file INEMIS (with apostrophes and .FLD).

IKO It is possible to run for selected parts of the emission field.
 IKO=1 uses the whole emission field
 IKO=2 uses "splitted" emission field.

If IKO=2, then:

INCODE, IFIE A field with area codes is read as field no. IFIE at the file INCODE (with apostrophes and .FLD).

NCOD, (IFAK(I), I=1, NCOD)

Factors 0/1 for which area codes that shall be included in the calculations. If we want to use one meteorology file for the northern part of the area and another for the southern, we prepare a data field (by INF.FIE) with 1 and 2 in the different areas. The computations are first made for area 1 using a METFIL1 and IFAK=1 and 0, next for area 2 with a METFIL2 and IFAK=0 and 1.

SCAL,QL

Emissions have to be multiplied by SCAL to have the unit kg/h.

The program is dimensioned for up to 500 area sources. In order to reduce the computer time somewhat area sources with emissions less than QL kg/h may be excluded. If the emissions from these area sources represents more than 5% of the total area emissions, QL is divided by two, until the 5% limit is satisfied.

In the routine CQCALC the program gets information about the boxes:

NBOX Number of box classes, max. 9

(HBOX(I), I=1, NBOX)

Height of each box class. This should be a measure for the height of the initial turbulence elements in each area source box, normally 1.2 * average building height in the square.

(HEMI(I), I=1, NBOX)

Height of emission for each box class. For traffic emissions this will be 1-2 m., for domestic heating the box height.

The OUTFI.FLD-file now contains two data fields. The first field gives the total long term concentration, whereas the second gives the concentration from one grid element to itself. This gives us an opportunity to use other models to calculate the local contribution.

6.1.2 Run file or interactive data

\PROGRAM\ARE-KILD Starts the program.

\PROGRAM\ARE-KILD <runfile.RUN

Starts the program when using a .RUN-file.

It may be useful to use the same name for the RUN-file and OUTFI.

The run-file, or the answers to the interactive questions will be:

KX, KY Dimensions of the area, number of grid points
easterly and northerly KY $\begin{array}{l} \uparrow \\ \text{KX} \end{array}$

INFI Name of the input file (with apostrophes and .DAT).

OUTFI Name of the output files (with apostrophes).
The concentration data fields are written binary (unformatted) to the file OUTFI.FLD, whereas the output from the program is written to the file OUTFI.PRN.

IPR Normally IPR=0, but it may sometimes be useful to look at some of the tables generated in the program (IPR=1).

METFIL Name of the file with meteorological data
 (with apostrophes and .MET). See the separate
 description of this file in chapter 2.3.

5.2 TEST EXAMPLE FOR ARE-KILD

As a test example is used calculations of SO₂ from oil consumption in Oslo, Norway.

The INFI file ARE-TEST.DAT will be:

Data from Oslo winter 1985

START

SO2 from oil consumption in Oslo winter 1985

1000,	,Grid size
0,	,North is north
0,	,Background
1,	,McElroy-Pooler
'EMIS-OIL.FLD',1,	,Emission field
1,	,Uses the whole field
'BOX-CODE.FLD',1,	,Box code file
1.0,0.01,	,Scale,Q1
5,	,NBOX
40,30,25,20,15,	,HBOX
32,24,20,16,12,	,HEMI

The file INBOX.FLD will be:

Field for ZONES is put on file box-code.FLD

MAP OF: ZONES UNIT: NUMBERS PERIOD: WINTER PLACE: OSLO

MAXIMUM VALUE IS 5.0000E+00, IN (11,10)

SUM= 4.01000E+02 SCALE FACTOR: 1.0E+00

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
J=18	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=17	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=16	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=15	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	3.	2.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=14	1.	1.	1.	1.	1.	1.	1.	1.	1.	2.	3.	3.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
J=13	1.	1.	1.	1.	1.	1.	1.	2.	3.	3.	3.	3.	2.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J=12	1.	1.	1.	1.	1.	1.	1.	2.	3.	3.	3.	3.	2.	2.	2.	2.	2.	1.	1.	1.	1.	1.	1.
J=11	1.	1.	1.	1.	1.	1.	1.	3.	4.	5.	5.	3.	3.	3.	3.	2.	1.	1.	1.	1.	1.	1.	1.
J=10	1.	1.	1.	1.	1.	0.	1.	1.	1.	3.	5.	2.	3.	3.	3.	1.	2.	1.	1.	1.	1.	1.	1.
J= 9	1.	1.	1.	1.	1.	0.	1.	1.	0.	0.	0.	1.	1.	1.	3.	1.	3.	1.	1.	1.	1.	1.	1.
J= 8	1.	1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	2.	1.	3.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 7	0.	0.	1.	1.	1.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.
J= 6	1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.
J= 5	1.	1.	0.	0.	0.	1.	1.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 4	0.	0.	0.	0.	0.	1.	1.	1.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
J= 3	0.	0.	0.	0.	0.	1.	1.	1.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.
J= 2	0.	0.	0.	0.	1.	1.	1.	1.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.
J= 1	0.	0.	0.	0.	1.	1.	1.	1.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

The meteorology file will be the same as in 5.2.

The result will be:

Box codes are read from the file BOX-CODE.FLD, field no.

MAP OF SO2 OIL HEATING UNIT: KG/H PERIOD: WINTER 85 PLACE: OSLO

MAXIMUM VALUE IS 1.2500E+01, IN (10,11)

SUM= 2.08100E+02 SCALE FACTOR: 1.0E-01

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
J=18	0.	0.	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.
J=17	0.	0.	0.	1.	0.	3.	0.	0.	0.	3.	1.	3.	3.	3.	2.	0.	0.	2.	4.	3.	3.	0.
J=16	0.	0.	0.	0.	3.	3.	4.	5.	3.	4.	9.	11.	8.	3.	2.	0.	1.	7.	11.	4.	4.	0.
J=15	0.	0.	0.	0.	5.	3.	7.	10.	7.	40.	22.	19.	19.	7.	5.	17.	14.	17.	11.	9.	3.	0.
J=14	0.	0.	0.	0.	4.	10.	8.	10.	18.	26.	37.	27.	25.	24.	21.	15.	12.	23.	13.	5.	6.	0.
J=13	0.	0.	0.	0.	5.	13.	10.	11.	20.	50.	31.	35.	19.	29.	15.	23.	12.	10.	3.	0.	0.	0.
J=12	0.	0.	0.	0.	6.	5.	37.	18.	32.	53.	33.	45.	23.	34.	16.	10.	5.	8.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	7.	5.	3.	19.	32.	125.	107.	35.	16.	18.	14.	10.	9.	1.	0.	0.	0.	0.
J=10	0.	0.	0.	0.	0.	0.	2.	6.	6.	25.	77.	11.	40.	19.	8.	10.	11.	1.	0.	0.	0.	0.
J= 9	0.	0.	0.	0.	0.	0.	3.	3.	0.	0.	0.	3.	5.	8.	10.	7.	19.	0.	0.	0.	0.	0.
J= 8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.	3.	8.	5.	4.	10.	0.	0.	0.	0.	0.
J= 7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	6.	11.	9.	13.	0.	0.	0.	0.	0.
J= 6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	7.	17.	14.	4.	0.	0.	0.	0.	0.
J= 5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.	8.	4.	3.	0.	0.	0.	0.	0.
J= 4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	8.	6.	3.	2.	0.	0.	0.	0.	0.
J= 3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	2.	1.	1.	0.	0.	0.	0.	0.
J= 2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.	1.	1.	0.	0.	0.	0.	0.
J= 1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	0.	0.	0.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Emissions are read from the file emis-oil.fld field no. 1

Emissions less than .010 kg/h are not included

Sum emission 208.1000 kg/h from 164 area sources

Sum emission .0000 kg/h from 0 area sources that are not included

The following box classes are used:

Box	Height	Emis.height
1	40.	32.
2	30.	24.
3	25.	20.
4	20.	16.
5	15.	12.

*** NORWEGIAN INSTITUTE FOR AIR RESEARCH***

PROGRAM AREA-KILDER

for calculating long-term mean values from a field with
area emissions.

Version 1992-03-29

SO2 from oil consumption in Oslo winter 1985

Calculations are made for SO2 OIL HE

Number of area sources generated from the emission field: 164

Concentrations are ground level values and 30 degrees sector averages

Dispersion parameters from McElroy-Pooler

Frequency matrix for JANUAR 90, BLINDERN
read from OSLO-VAL.MET

	.4m/s				2.2m/s				3.8m/s				5.5m/s			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
30	.0	.5	1.3	3.3	.0	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
60	.0	1.2	1.3	2.5	.0	.6	.2	.0	.0	1.0	.0	.0	.0	.0	.0	.0
90	.0	.8	1.6	2.9	.0	1.3	.0	.0	.0	1.1	.0	.0	.0	.6	.0	.0
120	.0	.5	1.0	3.7	.0	.3	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0
150	.0	.6	1.3	3.0	.0	.3	.3	.5	.0	.6	.2	.3	.0	.2	.0	.0
180	.0	.5	1.6	1.9	.0	1.0	.6	.5	.0	2.4	1.6	.5	.0	.6	.0	.2
210	.0	.8	1.3	2.7	.0	2.8	2.6	1.1	.0	2.8	1.3	.2	.0	1.1	.0	.0
240	.2	2.2	4.0	3.5	.2	.6	.8	1.5	.0	.0	.5	.2	.0	.0	.0	.0
270	.0	.6	.2	2.2	.0	.2	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0
300	.0	.8	.5	1.9	.0	.8	.0	.2	.0	.3	.0	.0	.0	.0	.0	.0
330	.0	.6	1.0	3.3	.0	2.6	.0	.0	.0	1.0	.0	.0	.0	.0	.0	.0
360	.0	.3	1.0	2.0	.2	1.9	.0	.0	.2	1.5	.0	.0	.0	.5	.0	.0

Stability	1	2	3	4
Windprof.exponent	.20	.28	.36	.42
Mixing height	800.	500.	300.	200.

The wind speed in the lowest wind speed group is adjusted for calm from
.40 m/s to .39 m/s

MAP OF SO2 OIL HEATING UNIT: UG/M3

PERIOD: JANUAR 90,

PLACE: BLINDERN

MAXIMUM VALUE IS 4.3214E+01, IN (11,11)

SUM= 3.02976E+03

SCALE FACTOR: 1.0E-01

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
J=18	26.	29.	33.	38.	44.	50.	54.	57.	62.	65.	70.	72.	75.	75.	73.	71.	69.	68.	67.	64.	59.	53.
J=17	28.	32.	37.	43.	51.	59.	67.	73.	81.	88.	95.	101.	103.	99.	94.	88.	85.	85.	84.	78.	67.	57.
J=16	29.	34.	40.	48.	60.	71.	83.	96.	111.	125.	142.	146.	142.	129.	118.	112.	111.	108.	102.	87.	70.	55.
J=15	31.	36.	43.	53.	68.	84.	101.	121.	145.	178.	195.	198.	190.	168.	153.	146.	137.	124.	108.	88.	66.	50.
J=14	32.	37.	45.	57.	74.	98.	118.	144.	184.	217.	251.	247.	230.	206.	185.	159.	141.	122.	100.	74.	55.	41.
J=13	32.	38.	46.	59.	79.	107.	134.	170.	221.	277.	295.	281.	255.	223.	188.	154.	128.	100.	77.	56.	42.	34.
J=12	31.	37.	45.	58.	77.	104.	142.	183.	259.	339.	368.	332.	266.	211.	173.	133.	106.	83.	62.	46.	37.	30.
J=11	31.	36.	43.	55.	70.	92.	114.	162.	248.	385.	432.	327.	223.	182.	151.	120.	95.	72.	53.	42.	34.	29.
J=10	29.	34.	40.	49.	59.	74.	95.	127.	179.	237.	297.	230.	181.	155.	124.	107.	91.	71.	49.	39.	32.	27.
J= 9	28.	32.	37.	43.	51.	62.	77.	95.	117.	140.	141.	149.	126.	118.	109.	97.	88.	67.	45.	36.	30.	25.
J= 8	26.	29.	34.	39.	45.	53.	63.	73.	84.	90.	94.	105.	102.	101.	94.	88.	76.	62.	43.	34.	28.	23.
J= 7	24.	27.	31.	35.	40.	46.	53.	59.	65.	67.	71.	79.	85.	88.	90.	86.	72.	55.	38.	30.	25.	21.
J= 6	22.	25.	29.	32.	36.	40.	45.	49.	52.	53.	56.	62.	70.	78.	84.	79.	60.	45.	34.	28.	23.	20.
J= 5	21.	24.	26.	29.	33.	36.	39.	42.	43.	44.	46.	51.	58.	67.	70.	63.	50.	39.	31.	26.	22.	19.
J= 4	20.	22.	24.	27.	29.	32.	34.	36.	36.	37.	39.	42.	49.	56.	56.	50.	42.	35.	28.	24.	21.	18.
J= 3	18.	20.	22.	25.	27.	28.	30.	31.	31.	32.	33.	36.	40.	43.	44.	41.	36.	31.	26.	23.	19.	17.
J= 2	17.	19.	21.	22.	24.	25.	26.	27.	27.	27.	29.	30.	32.	34.	36.	34.	31.	28.	25.	21.	18.	16.
J= 1	15.	17.	19.	20.	21.	23.	23.	23.	23.	24.	25.	26.	27.	29.	29.	28.	26.	25.	23.	20.	17.	15.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

MAP OF SO2 OIL HEATING UNIT: UG/M3 PERIOD: JANUAR 90, PLACE: BLINDERN

MAXIMUM VALUE IS 1.4682E+01, IN (11,11)

SUM= 1.90404E+02 SCALE FACTOR: 1.0E-01

GRID SIZE: 1000 METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
J=18	0.	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.
J=17	0.	0.	0.	1.	0.	2.	0.	0.	0.	2.	1.	2.	2.	2.	1.	0.	0.	1.	3.	2.	2.	0.
J=16	0.	0.	0.	0.	2.	2.	3.	4.	2.	3.	6.	8.	6.	2.	1.	0.	1.	5.	8.	3.	3.	0.
J=15	0.	0.	0.	0.	4.	2.	5.	7.	5.	28.	15.	19.	17.	5.	4.	12.	10.	12.	8.	6.	2.	0.
J=14	0.	0.	0.	0.	3.	7.	6.	7.	13.	18.	33.	27.	25.	21.	19.	13.	11.	16.	9.	4.	4.	0.
J=13	0.	0.	0.	0.	4.	9.	7.	8.	18.	51.	31.	35.	19.	26.	11.	16.	8.	7.	2.	0.	0.	0.
J=12	0.	0.	0.	0.	4.	4.	26.	13.	28.	54.	33.	46.	23.	30.	14.	9.	4.	6.	0.	0.	0.	0.
J=11	0.	0.	0.	0.	5.	4.	2.	13.	32.	146.	147.	48.	16.	18.	14.	10.	8.	1.	0.	0.	0.	0.
J=10	0.	0.	0.	0.	0.	0.	1.	4.	4.	25.	106.	10.	40.	19.	8.	7.	10.	1.	0.	0.	0.	0.
J= 9	0.	0.	0.	0.	0.	0.	2.	2.	0.	0.	0.	2.	4.	6.	10.	5.	19.	0.	0.	0.	0.	0.
J= 8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	2.	8.	4.	3.	7.	0.	0.	0.	0.	0.
J= 7	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	4.	8.	6.	9.	0.	0.	0.	0.	0.
J= 6	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	5.	12.	10.	3.	0.	0.	0.	0.	0.
J= 5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.	6.	3.	2.	0.	0.	0.	0.	0.
J= 4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	6.	4.	2.	1.	0.	0.	0.	0.	0.
J= 3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	0.	0.	0.	0.	0.
J= 2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	1.	1.	0.	0.	0.	0.	0.
J= 1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	0.	0.	0.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Print-out is put on file oslo-are.PRN
 Concentrations are put on file oslo-are.FLD
 Contribution from the squares is field 2

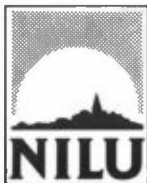
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TITTEL User's Guide for the "KILDER" Dispersion Modelling System. Draft report.		PROSJEKTLEDER T. Bøhler	
		NILU PROSJEKT NR. O-92014	
FORFATTER(E) F. Gram and T. Bøhler		TILGJENGELIGHET * A	
		OPPDRAUGSGIVERS REF.	
OPPDRAUGSGIVER (NAVN OG ADRESSE) NILU			
STIKKORD Programmer Spredningsmodeller Brukerbeskrivelser			
REFERAT NILUs modellsystem "KILDER" for å beregne langtidskonsentrasjoner fra forskjellige kildetyper er beskrevet. Det er laget brukerbeskrivelse av PC-modellene POI-KILD og ARE-KILD som beregner spredning fra punkt- og arealkilder.			

TITLE User's Guide for the "KILDER" Dispersion Modelling System. Draft report.
ABSTRACT The NILU "KILDER" system for calculating long-term concentrations from point and area sources is described, together with a user's guide for the PC-program, s POI-KILD and ARE-KILD.

* Kategorier: Åpen - kan bestilles fra NILU A
 Må bestilles gjennom oppdragsgiver B
 Kan ikke utleveres C