



INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY

c/o INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS 34100 TRIESTE (ITALY) VIA GRIGNANO, 9 (ADRIATICO PALACE) P.O. BOX 586 TELEPHONE 040-224572 TELEFAX 040-224575 TELEX 460449 APH I

SMR/760-55

**"College on Atmospheric Boundary Layer
and Air Pollution Modelling"
16 May - 3 June 1994**

"Exercise in Air Pollution Control"

R. DEININGER
School of Public Health
The University of Michigan
Ann Arbor (MI), USA

Please note: These notes are intended for internal distribution only.

EXERCISE IN AIR POLLUTION CONTROL

Rolf A. Deininger
School of Public Health
The University of Michigan
Ann Arbor, MI 48109
internet: rad@umich.edu

To run this exercise in air pollution control, you need to be at a terminal which has access to Internet. Make sure that you have a way to capture (record, store) the dialog/conversation for later printing, off-line. Also, make sure that you are communicating in upper-case letters only.

To connect to the University of Michigan network, type

TELNET HERMES.MERIT.EDU

You should then see a prompt "WHICH HOST?" type **UM**.

At the # prompt, type **SIGNON LEDE**

and when asked for a password, type **AIR**

You should now be logged onto account LEDE at the UM system.

To start the exercise, type **SOURCE K3K6:AIRPOLLUTION**

and the exercise should start.

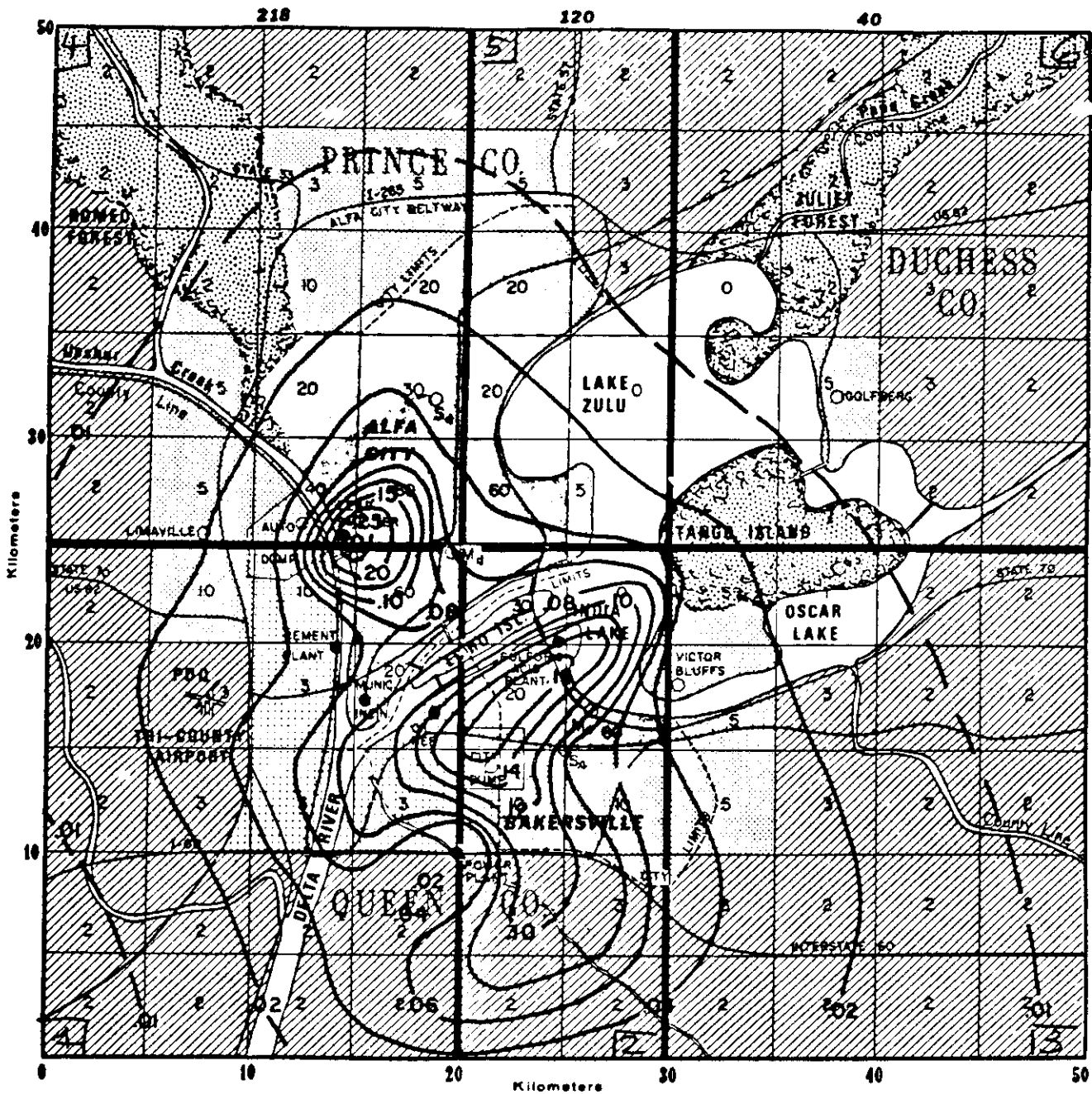
Type **20 10**, then a **1** to get source and fuel and population information. Keep the preselected receptor locations by typing **1** and you will get the ground level concentrations for sulfur and particulates. Both the sulfur and particulate concentrations exceed the standards (.03 ppm and 75 $\mu\text{g}/\text{m}^3$, respectively). You are asked to do 3 things:

1. Find the present receptor sites in the six areas.
2. Find "better" receptor sites which are more representative.
3. Find the lowest cost controls which will bring the area in compliance with the primary air quality standards.

To sign off, type: **SIGNOFF**

GOOD LUCK!

HYPOTHETICAL AIR QUALITY REGION



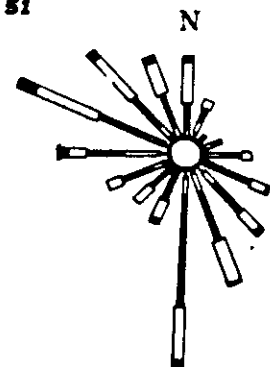
ALL SOURCES
Sulfur Oxides-ppm

LEGEND

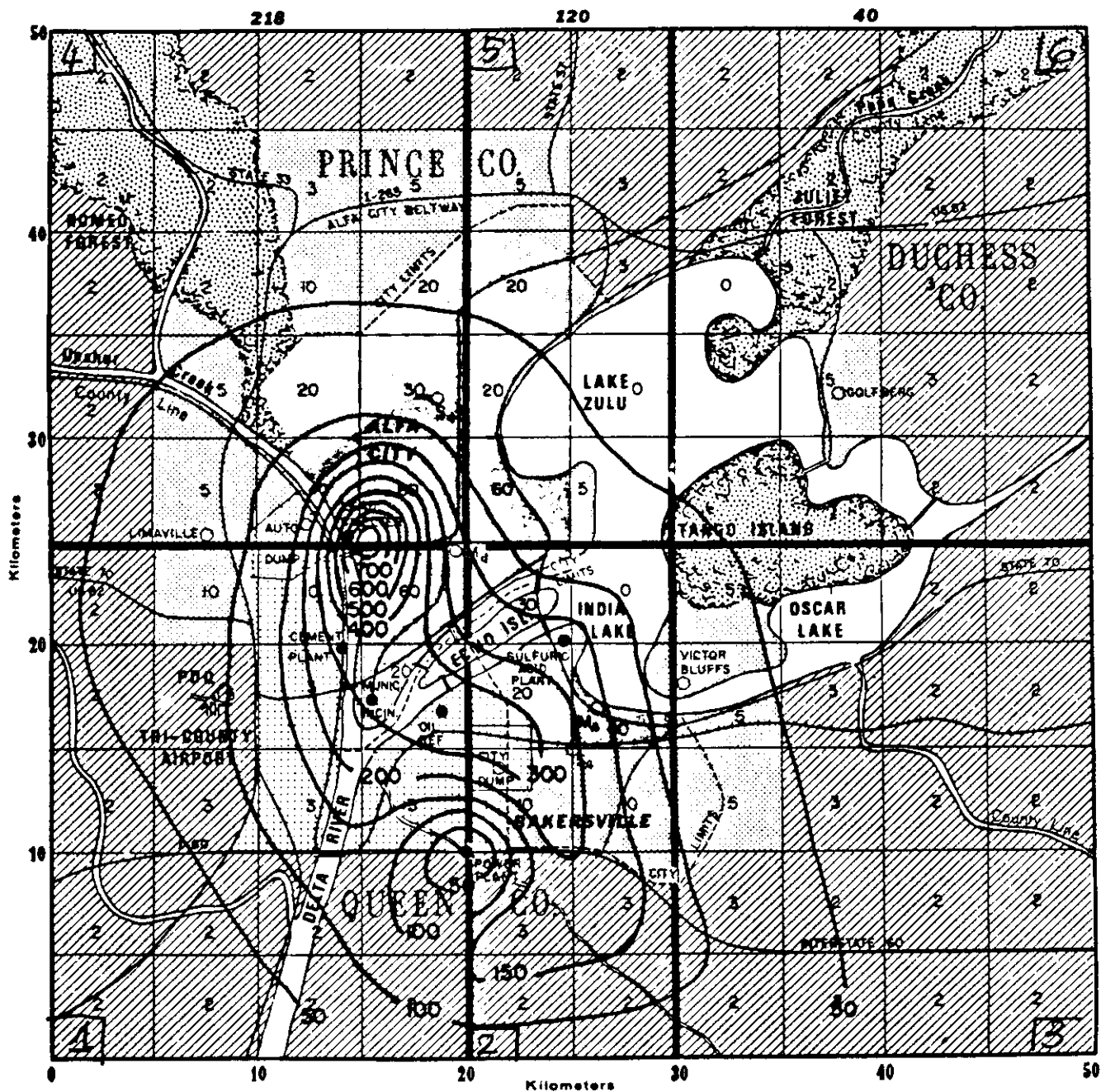
Exurban	
Urban, Low Density	
Urban, Medium Density	
Urban, High Density	
Wooded area	
Water	
Industrial Area	

AREA SOURCE CENTROIDS

Incineration, Alfa City	M ₄
Space Heating, Alfa City	S ₄
Incineration, Bakersville	M ₈
Space Heating, Bakersville	S ₈



HYPOTHETICAL AIR QUALITY REGION



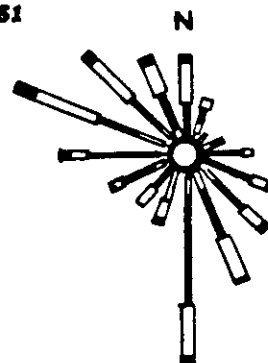
ALL SOURCES
Particulates $\mu\text{g}/\text{m}^3$

LEGEND

- | | |
|-----------------------|---|
| Exurban |  |
| Urban, Low Density |  |
| Urban, Medium Density |  |
| Urban, High Density |  |
| Wooded area |  |
| Water |  |
| Industrial Area |  |

AREA SOURCE CENTROIDS

- | | |
|----------------------------|----------------|
| Incineration, Alfa City | M ₄ |
| Space Heating, Alfa City | S ₄ |
| Incineration, Bakersville | M ₅ |
| Space Heating, Bakersville | S ₅ |



\$Log Output: Rolf Deininger, K2TA, Job#=10808, Host=UM, 20:42:04 Thu Jan 20/94
 #SOURCE K3K6:AIRPOLLUTION
 # \$RUN K3K6:AP+*PL1LIB PAR=SCARDS=*MSOURCE*@F(80) SPRINT=*MSINK* TRW=K3K6:TRW I
 #Execution begins 20:43:08

```
*****
*
*   THE COST EFFECTIVENESS OF AIR
*   POLLUTION CONTROL STRATEGIES MODEL
*
*****
```

ENTER VALUES WHEN REQUESTED AND SIGNAL
 COMPLETION BY PRESSING..RETURN..
 CHECK ENTRIES CAREFULLY AS AN IN-
 CORRECT ENTRY MAY RESULT IN PROGRAM
 TERMINATION. TO CORRECT ERRORS USE
 BACKSPACE KEY. YOU ARE NOW READY TO BEGIN

ENTER 20 10 AND PRESS RETURN
 20 10

IF YOU WISH TO HAVE THE SOURCE,FUEL,AND POPULATION INFORMATION TYPED...TYPE 1
 IF NOT ...TYPE 0
 1

SOURCE	X KM	Y KM	AREA SQ.KM.	STK.HGT. M	SOX TON/DAY	PAR
1 POWER PLANT	20.000	10.000	0.000	100.000	538.649	300.000
2 MUNIC.INC.	15.400	17.200	0.000	25.000	0.420	3.576
3 OIL REFINERY	19.000	16.800	0.000	25.000	0.000	3.720
4 CEMENT PLANT	14.100	19.800	0.000	25.000	0.000	18.240
5 LEAD SMELTER	14.200	25.200	0.000	25.000	44.700	46.200
6 SULFURIC ACID	24.800	20.100	0.000	25.000	32.400	4.044
7 A-CITY INCIN.	19.600	24.500	78.500	25.000	0.084	3.144
8 A-CITY SH-M	18.500	32.000	254.000	0.000	23.880	1.844
9 AUTO. DUMP	12.200	25.400	10.100	0.000	0.000	1.200
10 B-CITY INCIN.	25.900	16.900	10.100	25.000	0.024	0.792
11 B-CITY SH-M	25.100	14.900	78.500	0.000	6.071	4.688
12 B-CITY DUMP	21.500	14.000	9.100	0.000	0.012	1.740
13 A-CITY SH-S	18.500	32.000	254.000	0.000	2.798	0.594
14 B-CITY SH-SC	25.100	14.900	78.500	0.000	8.208	18.000
15 B-CITY SH-SO	25.100	14.900	78.500	0.000	0.361	0.767

CURRENT FUEL UTILIZATION:

SOURCE	FUEL TYPE	% SULFUR
1	COAL	3.00
8	#5 1/2 OIL	1.65
11	#5 1/2 OIL	1.65
13	#2 OIL	0.30
14	COAL	3.00
15	#2 OIL	0.30

POPULATION DENSITY IN THOUSANDS:

45-50	2	2	2	2.	2	2.	2	2	2	
40-45	2	2	3	5.	5	3.	2	2	2	REGIONS
35-40	2	2	10	20.	20	3.	0	2	3	4,5,6
30-35	2	5	20	30.	20	0.	1	5	3	(L TO R)
25-30	2..	5.	40.	60.	60..	5..	1..	1..	2..	2
20-25	2	10	10	60.	30	0.	5	1	2	2
15-20	2	3	3	20.	20	60.	5	3	2	2 REGIONS
10-15	2	3	3	3.	10	10.	5	3	2	2 1,2,3
5-10	2	2	2	2.	3	3.	3	2	2	2 (L TO R)
0- 5	2	2	2	2.	2	2.	2	2	2	2

0 5 10 15 20 25 30 35 40 45 50

IF YOU WISH TO USE THE PRESELECTED RECEPTOR LOCATIONS...TYPE 1
IF NOT, TYPE 0

1

.....GROUND LEVEL CONCENTRATIONS ARE BEING CALCULATED.....

THE ORIGINAL POLLUTANT CONCENTRATIONS ARE:

RECEPTOR	SULFUR (PPM)	PARTICULATE (MCG/M3)
1	0.0717523	142.5553
2	0.0804757	169.1511
3	0.0351803	73.2667
4	0.0337996	109.4619
5	0.0325852	85.2459
6	0.0242328	56.5119

CONTROL OPTION: ENTER

SOURCE NUMBER TO ADD CONTROL MEASURE (EXAMPLE....5..)

MINUS SOURCE NUMBER TO REMOVE CONTROL (EXAMPLE...-5..)

0... TO COMPUTE NEW GLC VALUES

-99..TO RESTART GAME

7777..TO END GAME

1

PRINT LIST OF DEVICES ? (YES-1 NO-2)

1

CHOOSE CONTROL DEVICE FROM THE FOLLOWING

LIST FOR SOURCE NUMBER 1

DEVICE	1	COAL	0.50-3.00%S	
DEVICE	3	OIL (#6)	0.50-2.00%S	
DEVICE	5	OIL (#5)	0.50_1.75%S	
DEVICE	6	OIL (#2)	0.30%S	\$.076/GAL
DEVICE	8	GAS		\$.001/CU.FT.
DEVICE	10	STACK CHANGE		\$3200/M
DEVICE	11	EP (LOW)	0.S	80.0P \$465000
DEVICE	12	EP (MED)	0.S	90.0P \$610000
DEVICE	13	EP (HI)	0.S	95.7P \$790000
DEVICE	18	MC (MED)	0.S	80.0P \$348000
DEVICE	19	MC (HI)	0.S	90.0P \$420000

ENTER DEVICE NUMBER

11

SOURCE 1 IS TO UTILIZE DEVICE 11

ENTER ANOTHER CONTROL DEVICE NUMBER FOR THIS SOURCE OR IF FINISHED TYPE 0

ENTER SOURCE NUMBER OR CONTROL OPTION....

FOR THIS TEST CASE THE FOLLOWING CONTROLS ARE IN EFFECT:

SOURCE	DEVICE	EFF(S)%	EFF(P)%	STK.HGT.(M)	CS(\$/YR)
1	11	0.00	80.00		465000.00

THE POLLUTANT CONCENTRATIONS ARE:

RECEPTOR	SULFUR (PPM)		PARTICULATE (MCG/M3)	
	ORIGINAL	CONTROLLED	ORIGINAL	CONTROLLED
1	0.071752	0.071752	142.5553	42.2942
2	0.080476	0.080476	169.1511	68.3738
3	0.035180	0.035180	73.2667	30.8961
4	0.033800	0.033800	109.4619	71.1310
5	0.032585	0.032585	85.2459	45.8898
6	0.024233	0.024233	56.5119	23.9847

THE FOLLOWING ARE IN MILLIONS OF DOLLARS:

SOILING(BEFORE)	SOILING(AFTER)	BENEFIT	CONTROL
125.270336	21.197424	104.072912	0.465000

THE STRATEGY EFFECTIVENESS RATIO IS:
***** 223.8127 *****

ENTER SOURCE NUMBER OR CONTROL OPTION....

PRINT LIST OF DEVICES ? (YES-1 NO-2)

ENTER DEVICE NUMBER

FUEL SWITCHING TO BE PERFORMED AT SOURCE 1 DEVICE 8

ENTER ANOTHER CONTROL DEVICE NUMBER FOR THIS SOURCE OR IF FINISHED TYPE 0

ENTER SOURCE NUMBER OR CONTROL OPTION....

FOR THIS TEST CASE THE FOLLOWING CONTROLS ARE IN EFFECT:

SOURCE	DEVICE	EFF(S)%	EFF(P)%	STK.HGT.(M)	CS(\$/YR)
1	11	0.00	80.00		465000.00
1	8	100.00	99.89		29999984.00

THE POLLUTANT CONCENTRATIONS ARE:

RECEPTOR	SULFUR (PPM)		PARTICULATE (MCG/M3)	
	ORIGINAL	CONTROLLED	ORIGINAL	CONTROLLED
1	0.071752	0.002857	142.5553	17.2572
2	0.080476	0.013827	169.1511	43.2079
3	0.035180	0.011599	73.2667	20.3154
4	0.033800	0.014352	109.4619	61.5590
5	0.032585	0.012421	85.2459	36.0618
6	0.024233	0.007585	56.5119	15.8621

THE FOLLOWING ARE IN MILLIONS OF DOLLARS:

SOILING(BEFORE)	SOILING(AFTER)	BENEFIT	CONTROL
125.270336	5.735533	119.534800	30.464976

THE STRATEGY EFFECTIVENESS RATIO IS:

***** 3.9237 *****

ENTER SOURCE NUMBER OR CONTROL OPTION....

-99

IF YOU WISH TO HAVE THE SOURCE, FUEL, AND POPULATION INFORMATION TYPED...TYPE 1
IF NOT ...TYPE 0

0

IF YOU WISH TO USE THE PRESELECTED RECEPTOR LOCATIONS...TYPE 1
IF NOT, TYPE 0

0

YOU MAY NOW BEGIN

IF YOU ALREADY KNOW THE RECEPTOR COORDINATE BOUNDARIES

AND WISH TO ENTER THE RECEPTOR COORDINATES QUICKLY, TYPE 0 IF NOT TYPE

ENTER APPROPRIATE COORDINATES ALONG SIDE OF RECEPTOR NUMBER
RECEPTOR X Y

1
0,50

2
30,50

3
50,50

4
0,0

5
30,0

6
50,0

.....GROUND LEVEL CONCENTRATIONS ARE BEING CALCULATED.....

THE ORIGINAL POLLUTANT CONCENTRATIONS ARE:

RECEPTOR	SULFUR (PPM)	PARTICULATE (MCG/M3)
1	0.0040017	20.4227
2	0.0051742	22.5458
3	0.0023380	13.5181
4	0.0073287	25.8015
5	0.0324171	73.3781
6	0.0078707	27.8559

CONTROL OPTION: ENTER

SOURCE NUMBER TO ADD CONTROL MEASURE (EXAMPLE.....5..)

MINUS SOURCE NUMBER TO REMOVE CONTROL(EXAMPLE...-5..)

0... TO COMPUTE NEW GLC VALUES

-99..TO RESTART GAME

7777..TO END GAME

7777

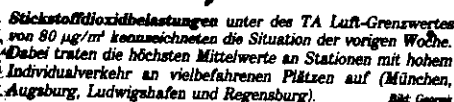
THIS ENDS THE SESSION ON THE COST EFFECTIVENESS MODEL

THANK YOU FOR PLAYING

END

#Execution terminated 20:54:30 T=0.233

All Authors are Qualified

[illegible]

April 25. - May 1, 1994

