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and

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ENVIRONMENTAL MONITORING FOR THE LEP PROJECT

MEASURING RESULTS OF PREOPERATIONAL BACKGROUND PARAMETERS DURING 1986

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SUMMARY

The present report summarizes the results of measurements performed in 1986 to determine levels of natural radiation, radioactivity and toxic gases in the environment of the future LEP site. The results are compared with those obtained during the previous year.

1. INTRODUCTION

In order to assess the impact of a nuclear installation on the environment, measurement results obtained during operation have to be compared with those specific for the area due to natural or common man-made sources.

A preoperational environmental monitoring programme was set up in 1984 to determine the natural radiation, radioactivity and toxic substances in various environmental media which could be influenced by the operation of LEP later on.

When establishing the LEP preoperational environmental monitoring programme, experience with accelerators already in operation at CERN and their impact on the environment were taken into consideration (Ref. 1). As the LEP accelerator and its experimental facilities are all located deep underground, direct or stray radiation from machine operation are not to be expected on the site in quantities discernible from the natural fluctuations of the background radiation. Detailed calculations and estimates for the production and release of radioactivity and toxic gases (O_3, NO, NO_x) from the LEP tunnels and underground areas have been made (Ref. 2) which show that the impact of LEP on the environment will be insignificant.

2. DESCRIPTION OF THE PROGRAMME

The measurements to be carried out within this preoperational programme are concentrated around future air release points of the LEP ventilation system, with one measuring station in each of the CERN host countries. Figure 1 shows the location of these stations in Switzerland (pit No. 1) and France (pit No. 5).

The stations are equipped with monitors continuously recording neutron and gamma radiation, an aerosol sampler, and instruments for measuring the O_3, NO and NO_x concentrations in air. Sampling points for various environmental media are also shown in Fig. 1. Integrating thermoluminescence dosimeters (TLD) are distributed on Swiss territory together with dosemeters provided by Swiss authorities for intercomparison.

Table 1 summarizes the LEP preoperational environmental monitoring programme. This routine programm will be complemented by special measurements to study particular environmental protection aspects, but during limited periods only.

The instrumentation and measuring methods used are described in Ref. 3.

3. RESULTS OF RADIATION AND RADIOACTIVITY MEASUREMENTS

Detailed measuring results are presented in the form of tables and figures attached. It should be mentioned that measuring results of dose and dose rates as well as total beta activity in environmental samples presented in this report include the impact of the nuclear accident of Chernobyl. Gamma emitting isotopes identified by spectroscopy measurements, which could be attributed to the Chernobyl accident, can be found in a separate report (Ref. 4).

3.1 Natural radiation

The total doses measured with monitor stations PMS 912 and PMS 952 in 1986 were:

	Gamma (μSv)		Neutron (μSv)		Total (μSv)	
	1985	1986	1985	1986	1985	1986
PMS 912	710	750	60	60	770	810
PMS 952	650	700	60	60	710	750

Monthly dose values as measured in 1985 - 1986 by these monitors are shown in Fig. 2. Gamma dose measurements with TLDs gave the

following results:

TLD No.	Location (Fig. 1)	Dose (μSv/y)	
		1985	1986
7	Meyrin	850	870
8	PMS 912	730	820
9	Mategnin	610	910
10	Vireloup	690	820
11	PMS 952	-	860

3.2 Radioactivity in air

The mean air (aerosol) activity concentrations sampled by the fixed-filter stations PMA911 and PMA 951 during 1985 - 1986 were:

	Total beta activity (mBq/m^3)		^7Be (mBq/m^3)	
	1985	1986	1985	1986
PMA 911	6.1 E-1	4.1 E+1	3.4	4.5
PMA 951	3.2 E-1	1.8 E+1	1.9	3.2

Figures 3 and 4 show the seasonal variation of ^7Be - also a typical accelerator produced isotope - and the total long-lived beta activity in air attached to aerosol.

The airborne ^7Be and long-lived beta activity is systematically lower at LEP point 5 (PMA 951) than the activities measured near LEP point 1 (PMA 911) which is also quite close to the present CERN accelerators. However the same difference (about a factor 2) is seen in May 1986 after the Chernobyl accident, suggesting other reasons for these differences. The filters at point 1 sample much more dust (aerosol) than those at point 5. Therefore the more dust loaded air near CERN and the RN84 cause a higher precipitation rate of aerosol and consequently also higher airborne activity concentrations.

3.3 Radioactivity in water

Fur water samples were taken from the Versoix river (near Collex-Bossy, point SWV1) in March, June September and December 1986. The following mean activity concentrations were found:

Total β : 4.5 E-2 Bq/l (1985 : 4.8 E-2 Bq/l)
^{40}K : 1.9 E-2 Bq/l (1985 : 2.4 E-2 Bq/l)
^3H : <9 Bq/l (= detection limit). (1985 : 9/Bq/l)

Results of water sample analyses from the rivers Le Lion and Allondon, also flowing through future LEP areas, are also given in the annex, even though the analysis of these samples is part of the present CERN environmental monitoring programme.

Samples of drinking (underground) water were taken twice in 1986 (March, September) at the fountain of the Versonnex commune (sampling point UWVX). The following mean activity concentrations were measured:

Total β	: 3.3 E-2 Bq/l	(1985 : 1.9 E-2 Bq/l)
^{40}K	: 1.9 E-2 Bq/l	(1985 : 1.7 E-2 Bq/l)
^{3}H	: <9 Bq/l (= detection limit).	(1985 : <9 Bq/l)

3.4 Radioactivity in mud

Together with water samples, mud samples were taken four times during 1986 from the Versoix river (sampling point MUV1), showing the following mean activity concentration:

Total β	: 4.4 E-1 Bq/g dry material	(1985 : 4.2 E-1 Bq/g d.w)
^{40}K	: 3.0 E-1 Bq/g dry material	(1985 : 3.1 E-1 Bq/g d.w)

3.5 Radioactivity in vegetation (grass)

Grass samples were taken twice during 1986 approximately 100 m from the LEP pit No. 5 (sampling points GRC1, GRC2). The sampling points are located next to the air release point approximately in the two main wind directions typical for this area. The following results were obtained:

Mean total β activity	: 1.1 E+3 Bq/kg dry mat.	(1985 : 8.7 E+2 Bq/kg)
Mean ^{40}K activity	: 8.4 E+2 Bq/kg dry mat.	(1985 : 8.0 E+2 Bq/kg)
Mean ^{7}Be activity	: 2.8 E+2 Bq/kg dry mat.	(1985 : 8.7 E+1 Bq/kg)

4. OZONE AND OXIDES OF NITROGEN MEASUREMENTS (Ch. Nuttall)

Ozone

The ozone monitors continued to work well with very little downtime due to the instruments. Results are given for three months of the year at different seasons, January, June and September. The peak reading for all months was in the afternoon with a gradual increase during the morning to the maximum followed by a gradual falling off. This corresponds to the formation of ozone by sunlight and the higher values in June and September reflect greater incident sunlight in these months.

The following table gives the maximum and minimum averaged hourly values together with the one hourly maximum and minimum values.

		Hourly average (ppb)		Hourly (ppb)	
		MAX	MIN	MAX	MIN
JANUARY	Meyrin	24	17	38	3
	Cessy	9	6	26	0
JUNE	Meyrin	48	15	84	2
	Cessy	14	6	37	0
SEPTEMBER	Meyrin	41	8	73	26
	Cessy	44	14	75	40

Figures 5, 6 and 7 attached show the daily evolution of the ozone concentrations at Meyrin and Cessy as average, maximum and minimum hourly values for the three months. Certain values were not recorded due to faults in the data transmission.

Oxides of Nitrogen

The oxides of nitrogen monitors performed somewhat better than in 1985 but continued to give trouble on hot days.

The results obtained do not in all cases cover a full month, the gaps being caused by instrument malfunctions as well as faults in data transmission.

In January, at both sites, there were peaks in the morning and early evening corresponding, probably, to traffic increases at these times together with oil fired central heating coming into use.

In June the peaks are much less evident, possibly because the element due to central heating is absent.

In September only the results for Meyrin are presented because of malfunction of the monitor at Cessy.

The maximum and minimum averaged hourly values together with the one hourly maximum and minimum are shown in the following table :

		Hourly average (ppb)		Hourly (ppb)	
		MAX	MIN	MAX	MIN
JANUARY	Meyrin	30	9	200	1
	Cessy	51	22	100	0
JUNE	Meyrin	27	20	62	6
	Cessy	66	41	150	2
SEPTEMBER	Meyrin	28	5	97	0
	Cessy	--	--	--	--

Figures 8,9 and 10 attached show the daily evolution of the oxides of nitrogen concentrations at Meyrin and Cessy as average, maximum and minimum hourly values.

REFERENCES

1. G. Rau and D. Schwenke, Environmental radiation measurements around the 300 GeV accelerator area, SPS/RA/NOTE/76-6 (1976).

A. Bonifas and G. Rau, Environmental monitoring on the CERN sites during 1986, TIS-RP/IR/87-06 (1987). A. Bonifas and G. Rau, environmental monitoring for the LEP project 1985, TIS-RP/IR/86-11 (1986).

2. K. Goebel (editor), The radiological impact of the LEP project on the environment, CERN 81-08 (1981).

3. B. Moy, G. Rau and D. Schwenke, The instrumentation for monitoring the environment around CERN, HS-RP/050 (1980).

4. A. Bonifas and G. Rau, Chernobyl, a summary of measurements at CERN TIS-RP/181/CF (1986).

5. A. Bonifas, Ch. Nuttall and G. Rau, Environmental Monitoring for the LEP Project 1985, CERN TIS-RP IR/86 - 11 and LEP note 558, 1986.

TABLE 1

Programme for the determination of preoperational environmental background parameters around the future LEP area

I. Radiation monitoring:

Monitored subject	Radiation/ radio-activity	Measuring instruments	Location/ sampl.point (Fig. 1)	No. of points	Frequency
1. Ambient radiation	γ n	Argon-filled ionization chamber, moderated BF_3 counter	PMS 912 (CH) PMS 952 (F)	1 1	Continuous
	γ	TLD	PMS 912 PMS 952 Swiss territory	1 1 3	4x per year
2. Aerosol	Total β	Large-area prop.counter	PMA 911 (CH) PMA 951 (F)	1 1	Continuous sampling; Filter change 2x per month
	γ	Ge(Li) or Ge diode			
3. Surface water	Total β	Large-area prop.counter	SWV1 SWA1	1 1	4x per year
	γ	Ge(Li) or Ge diode	SWL4	1	
	^{40}K	Flame photometer			
	^{3}H	Liquid scintillation counter			
4. Tap- and underground water	Total β	Large-area prop.counter	UWVX	1	2x per year
	γ	Ge(Li) or Ge diode			
	^{40}K	Flame photometer			
	^{3}H	Liquid scintillation counter			

(continued)

Table 1 (continued)

Monitored subject	Radiation/ radio-activity	Measuring instruments	Location/ sampl.point	No. of points	Frequency
5. Mud	Total β	Large-area prop.counter	MUV1	1	4x per year
			MUA1	1	
	^{40}K γ	Ge(Li) or Ge diode	MUL3	1	
6. Grass and vegetation *)	Total β	Large-area prop.counter	Near pit 5 GRC1	2	2x per year
	^{40}K γ	Ge(Li) or Ge diode	GRC2 (F)		

*) Ashed substance for all measurements.

II. Monitoring of toxic substances:

Monitored substance	Type	Measuring method	Location	No. of points	Frequency
7. Air	O_3	UV absorp-tion,	PMU 912	1	Continuous
	NO, NO_x	Chemolumi-nescence	PMN 952	1	

TABLE 2

Radioactivity in grass samples
(in Bq/kg dry material)

te 86)	Sampling point	Weight of dry mat. (in g)	Total β	^{40}K	^{7}Be	^{103}Ru	^{134}Cs	^{137}Cs	^{140}La
June	100 m east of pit 5 (GRC 1)	190	1.4 E+3	1.4 E+3	1.7 E+2	4.0 E+1	3.3 E+1	6.3 E+1	-
Oct.	- " -	301	6.9 E+2	4.9 E+2	2.6 E+2	-	-	1.7 E+1	-
June	100 m west of pit 5 (GRC 2)	210	1.7 E+3	8.5 E+2	2.1 E+2	2.5 E+2	2.2 E+2	4.5 E+2	1.5 E+1
Oct.	- " -	247	7.3 E+2	6.4 E+2	4.7 E+2	-	1.5 E+1	3.2 E+1	-

DL (Bq/kg)= Detection limit; ^{7}Be: 3.0 E+1.

TABLE 3

Radioactivity in water samples
(in Bq/l)

Surface water (rivers):

Date (1986)	Sampling point	Total β	^{40}K	^{3}H
11 March	SWA1	8.2 E-2	6.5 E-2	<DL *)
	SWL4	7.1 E-2	3.2 E-2	<DL
	SWV1	5.2 E-2	2.1 E-2	<DL
26 June	SWA1	1.4 E-1	1.2 E-1	<DL
	SWL4	2.5 E-1	4.7 E-2	<DL
	SWV1	3.5 E-2	1.6 E-2	<DL
22 Sept.	SWA1	3.0 E-1	1.8 E-2	<DL
	SWL4	6.2 E-2	4.3 E-2	<DL
	SWV1	7.4 E-2	2.2 E-2	<DL
3 Dec.	SWA1	1.2 E-1	1.1 E-1	<DL
	SWL4	1.2 E-1	6.5 E-2	<DL
	SWV1	1.8 E-2	1.5 E-2	<DL

*) DL = 9 Bq/l (detection limit).

Drinking water (fountain Versonnex):

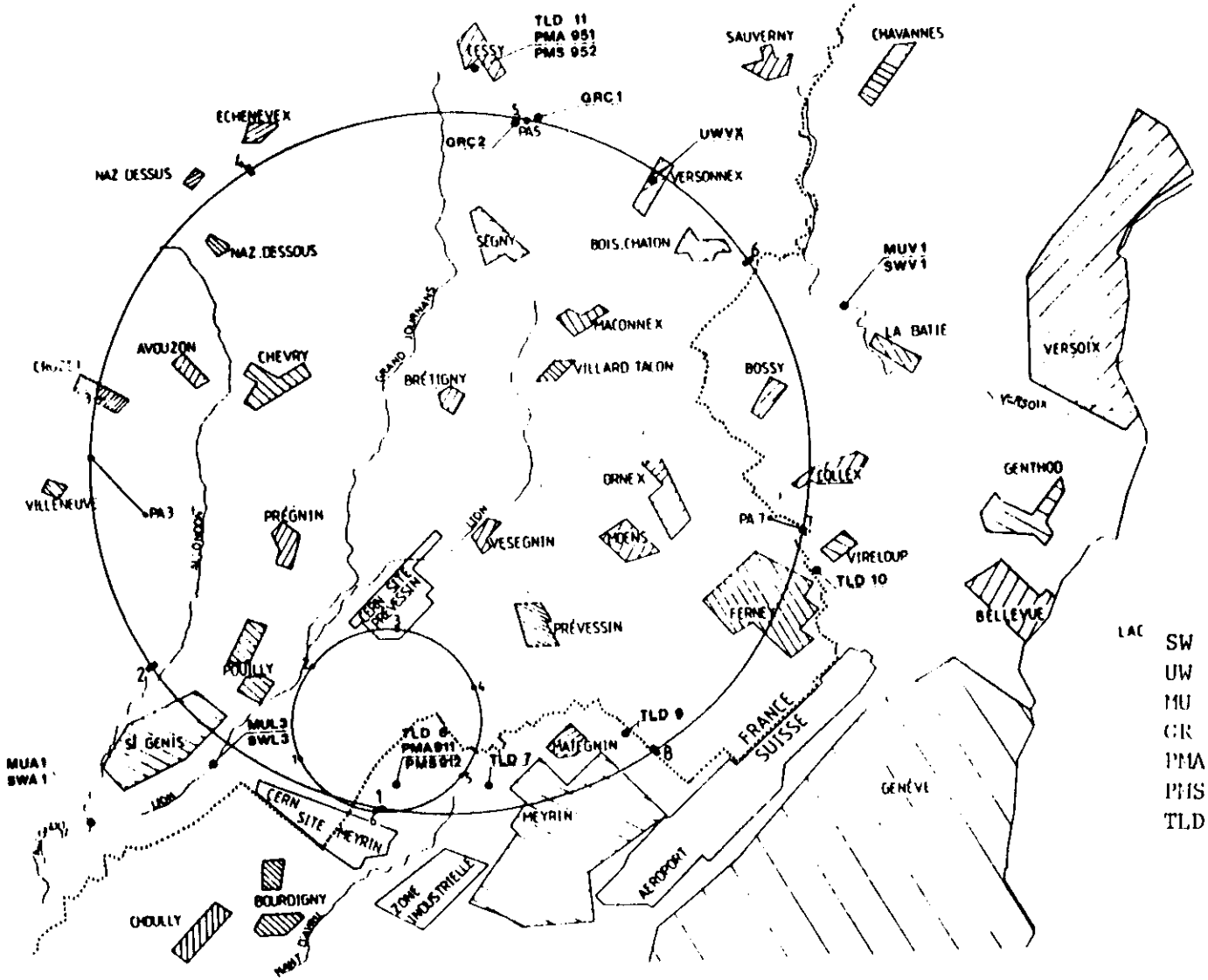
Date (1986)	Sampling point	Total β	^{40}K
11 March	UWVX	2.9 E-2	1.9 E-2
1 Oct.	UWVX	3.7 E-2	1.9 E-2

TABLE 4

Radioactivity in sediment of rivers
(in Bq/g dry material)

Date	Sampling point	Total β	^{40}K	^{103}Ru	^{134}Cs	^{137}Cs	^{106}Ru ^{106}Rh	^{7}Be
11 March	MUA1	4.2 E-1	2.9 E-1	-	-		-	-
	MUL3	3.8 E-1	2.5 E-1	-	-		-	-
	MUV1	4.0 E-1	3.0 E-1	-	-		-	-
26 June	MUA1	7.3 E-1	3.8 E-1	5.2 E-2	5.6 E-2	1.2 E-1	-	-
	MUL3	1.5	2.9 E-1	3.3 E-1	3.4 E-1	6.8 E-1	-	-
	MUV1	5.0 E-1	3.3 E-1	5.0 E-1	2.7 E-2	6.3 E-2	-	-
22 Sept.	MUA1	7.4 E-1	3.4 E-1	-	4.8 E-2	9.9 E-2	-	-
	MUL3	9.2 E-1	2.9 E-1	2.0 E-2	9.4 E-2	2.0 E-1	-	-
	MUV1	4.5 E-1	3.1 E-1	-	6.7 E-3	1.4 E-2	-	-
2 Dec.	MUA1	5.7 E-1	2.9 E-1	-	4.5 E-2	1.1 E-1	-	-
	MUL3	1.3	3.0 E-1	1.6 E-2	3.5 E-1	8.2 E-1	1.8 E-1	2.5 E-1
	MUV1	4.2 E-1	2.6 E-1	-	-	2.3 E-2	-	-

Detection limit : ^{7}Be : 6.0 E-2.



SW = surface water
UW = underground water
MU = mud
GR = grass
PMA = aerosol sampler
PMS = site radiation monitor
TLD = thermoluminescence dosimeter

Fig. 1

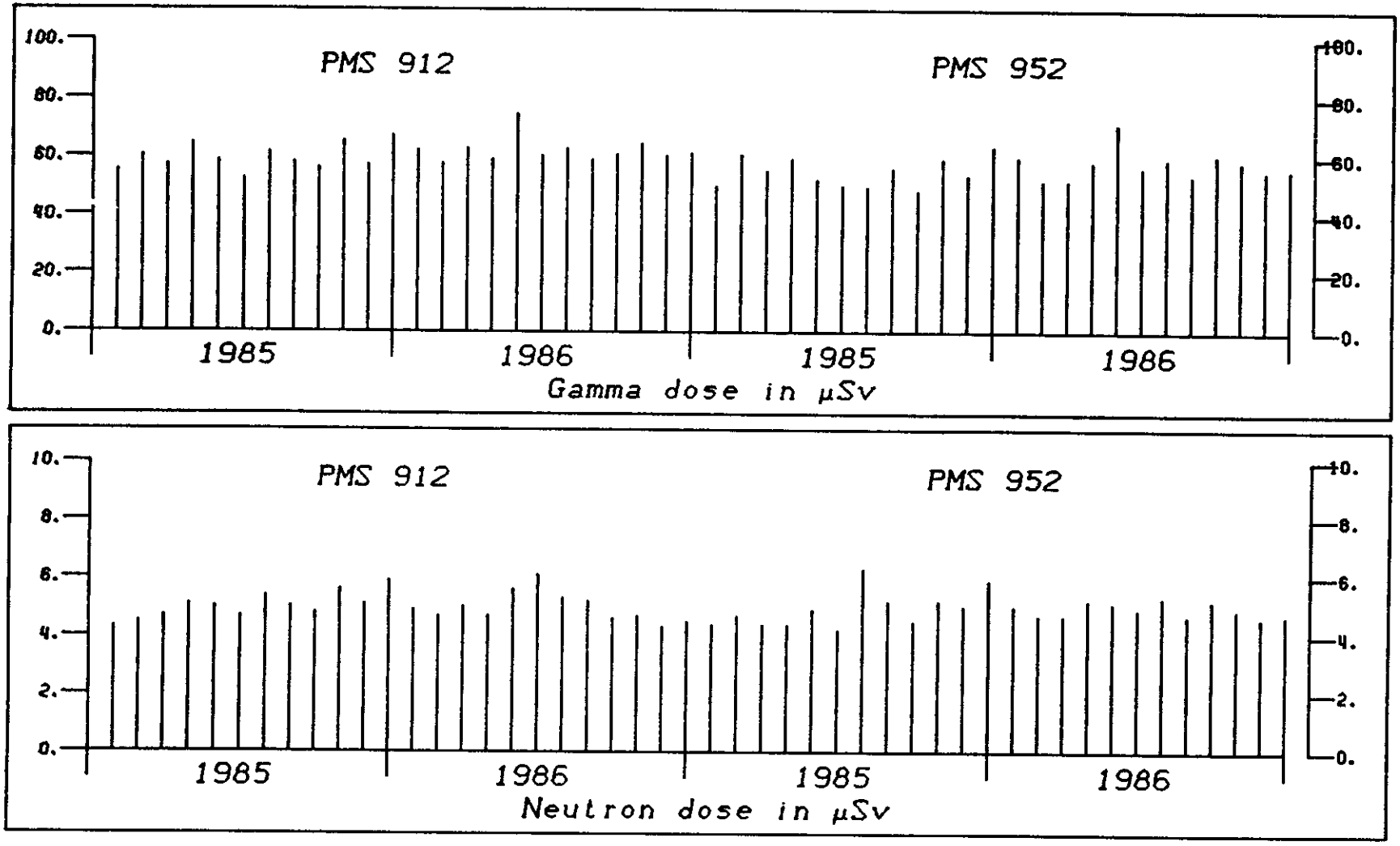


Fig. 2 Monthly doses 1985 - 1986

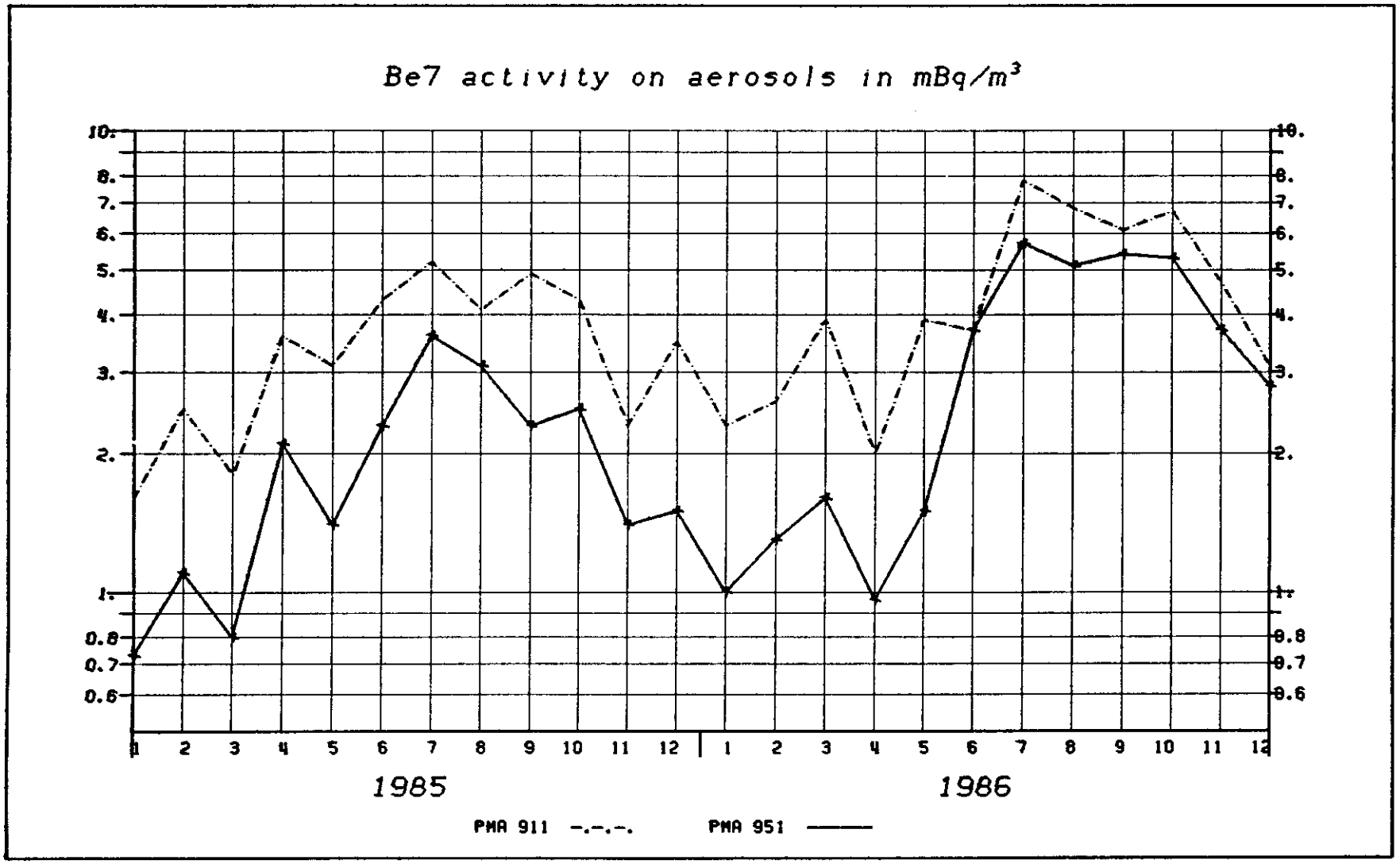


Fig. 3 Seasonal variation of ^{7}Be in air (aerosol) 1985 - 1986

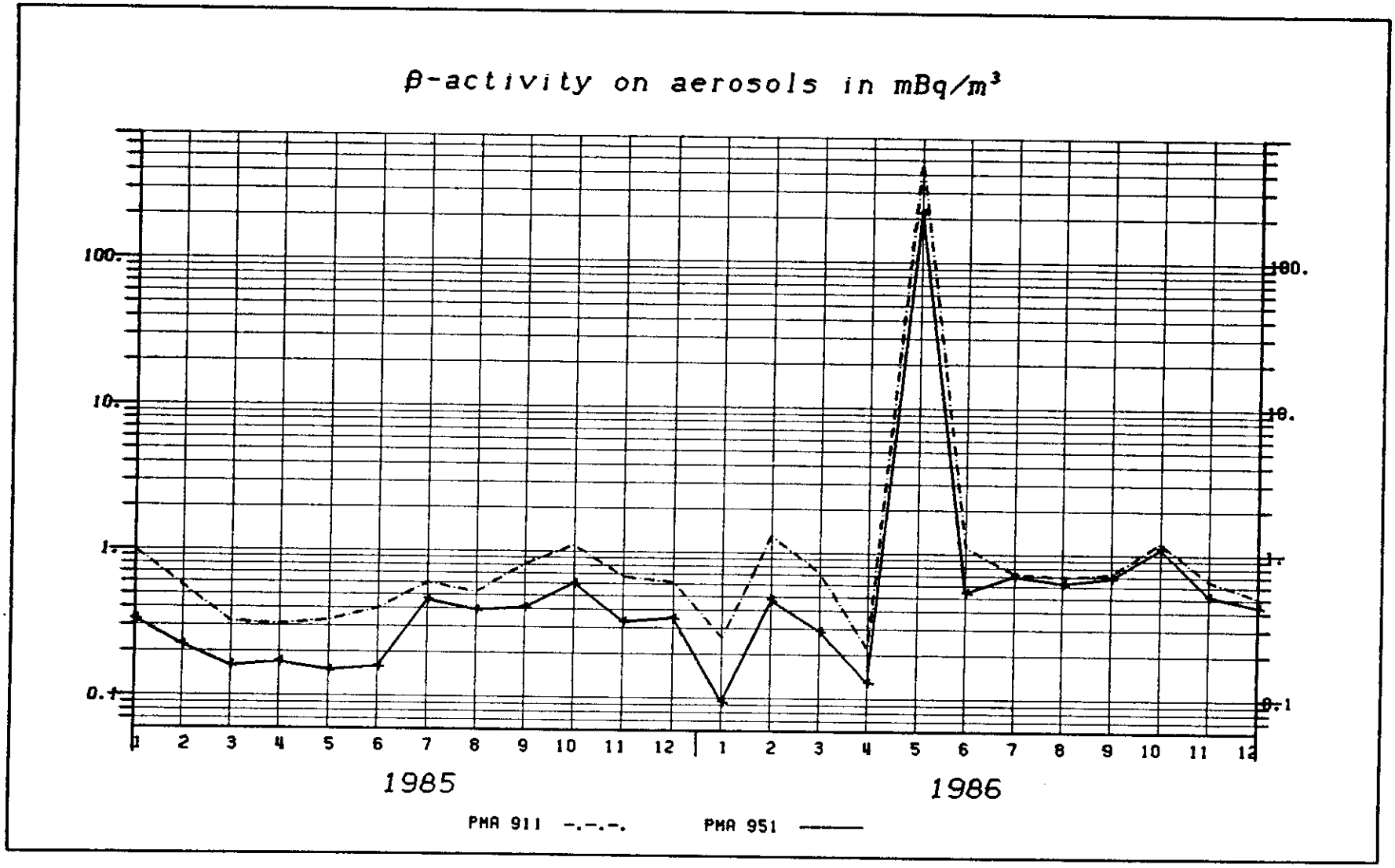
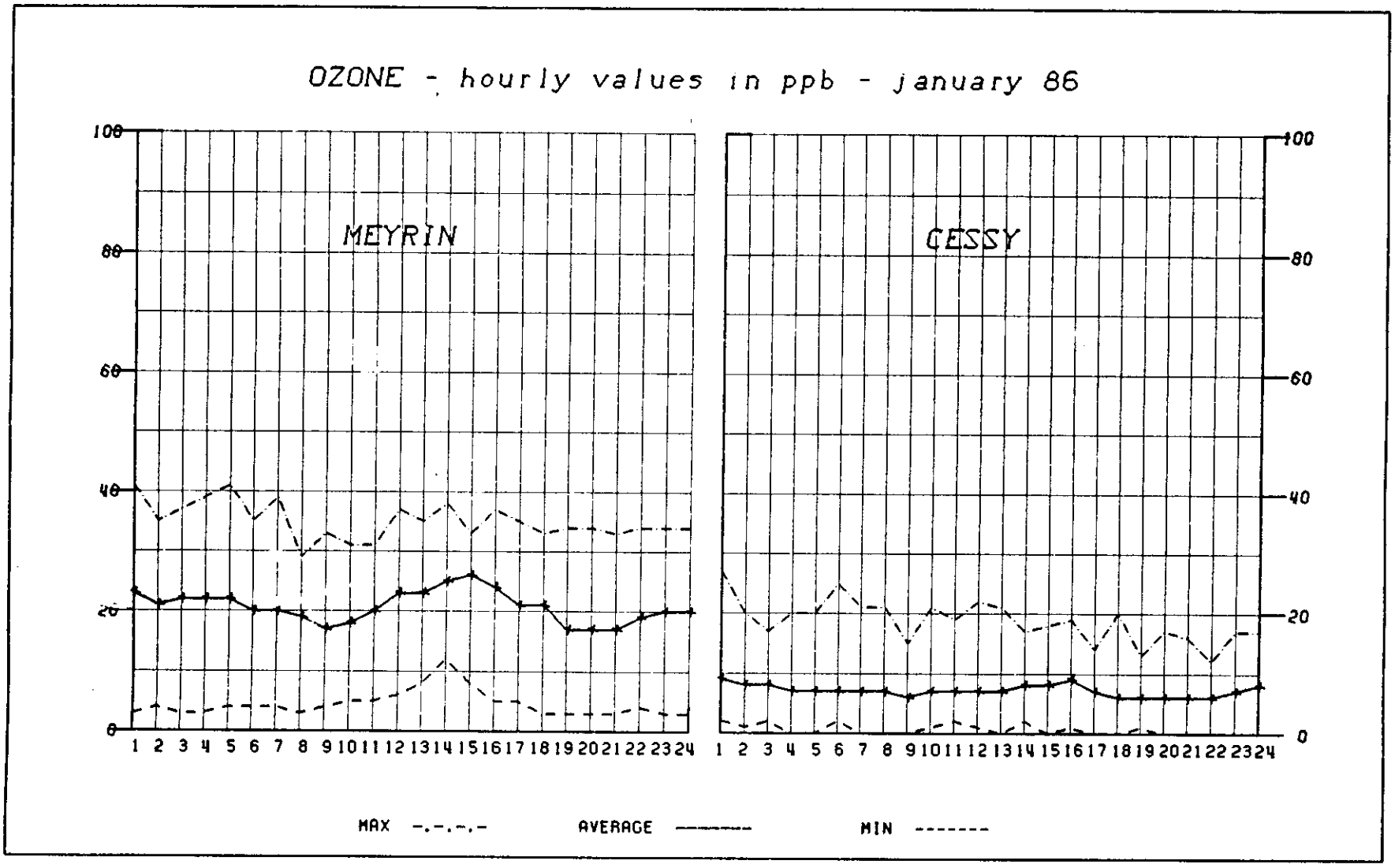


Fig. 4 Long-lived beta activity in air (aerosol) 1985 - 1986


OZONE - hourly values in ppb - january 86
MEYRIN
CESSY
100
80
60
40
20
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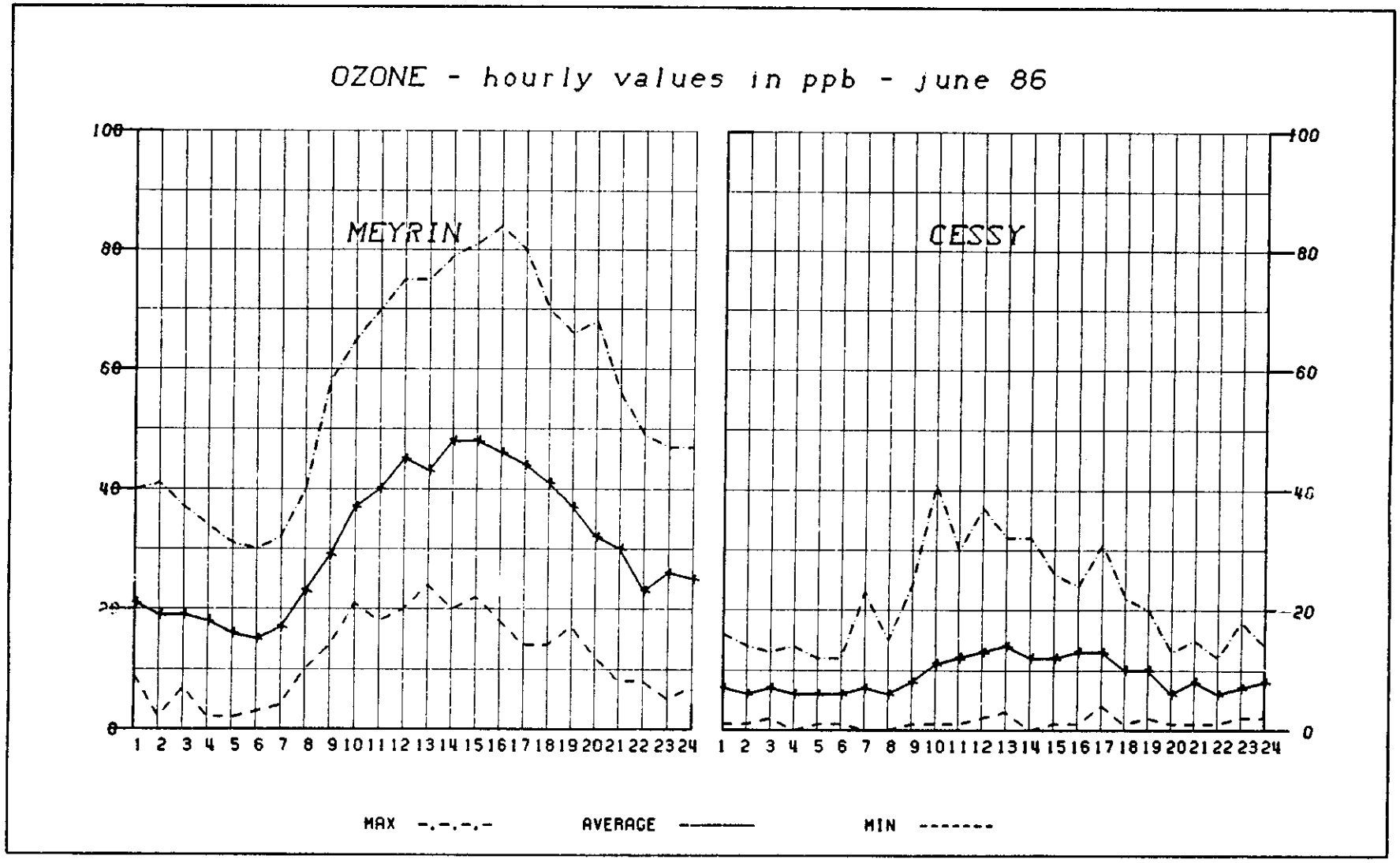
MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 5


OZONE - hourly values in ppb - june 86
MEYRIN
CESSY
100
80
60
40
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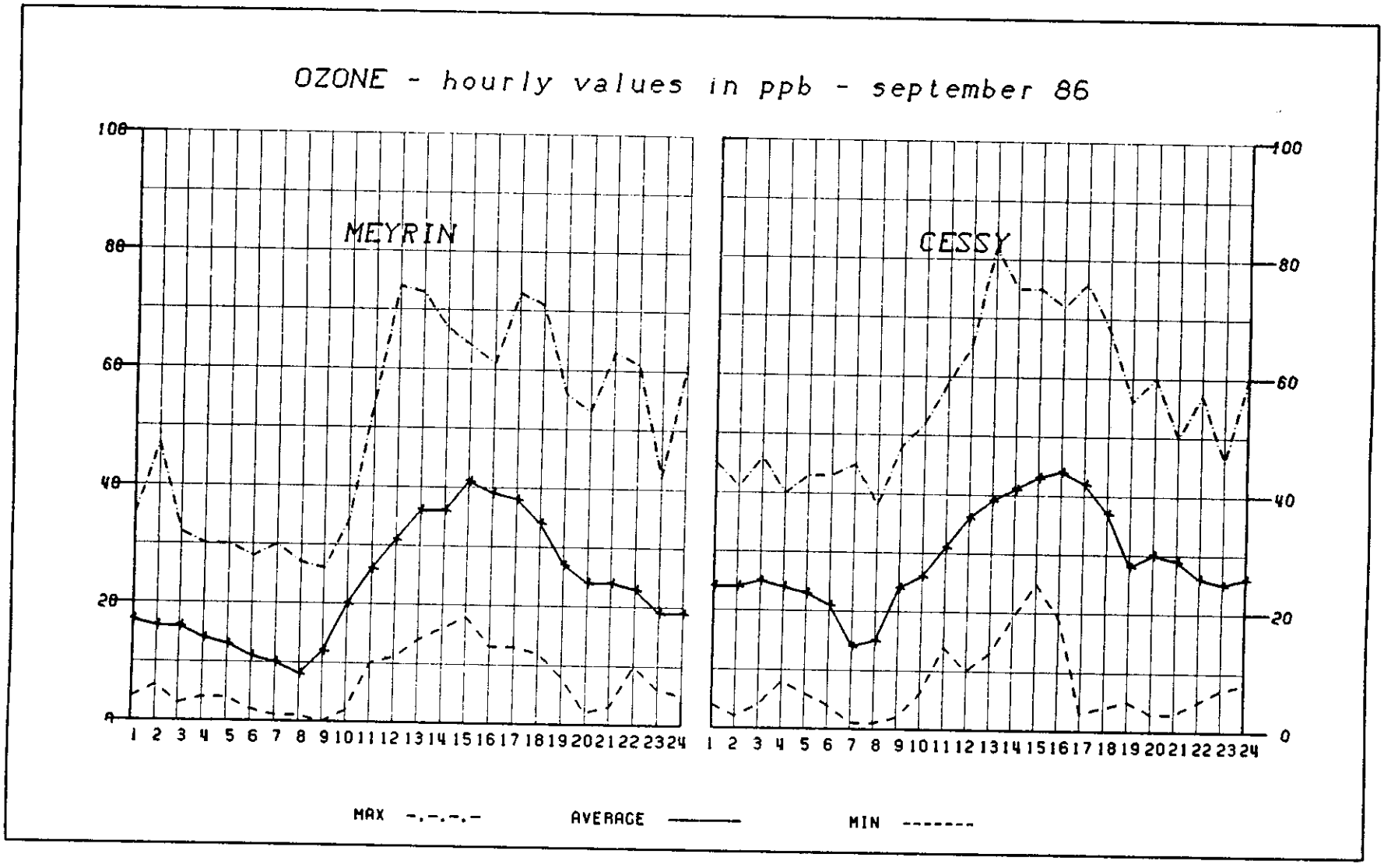
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 6


OZONE - hourly values in ppb - september 86
MEYRIN
CESSY
100
80
60
40
20
0
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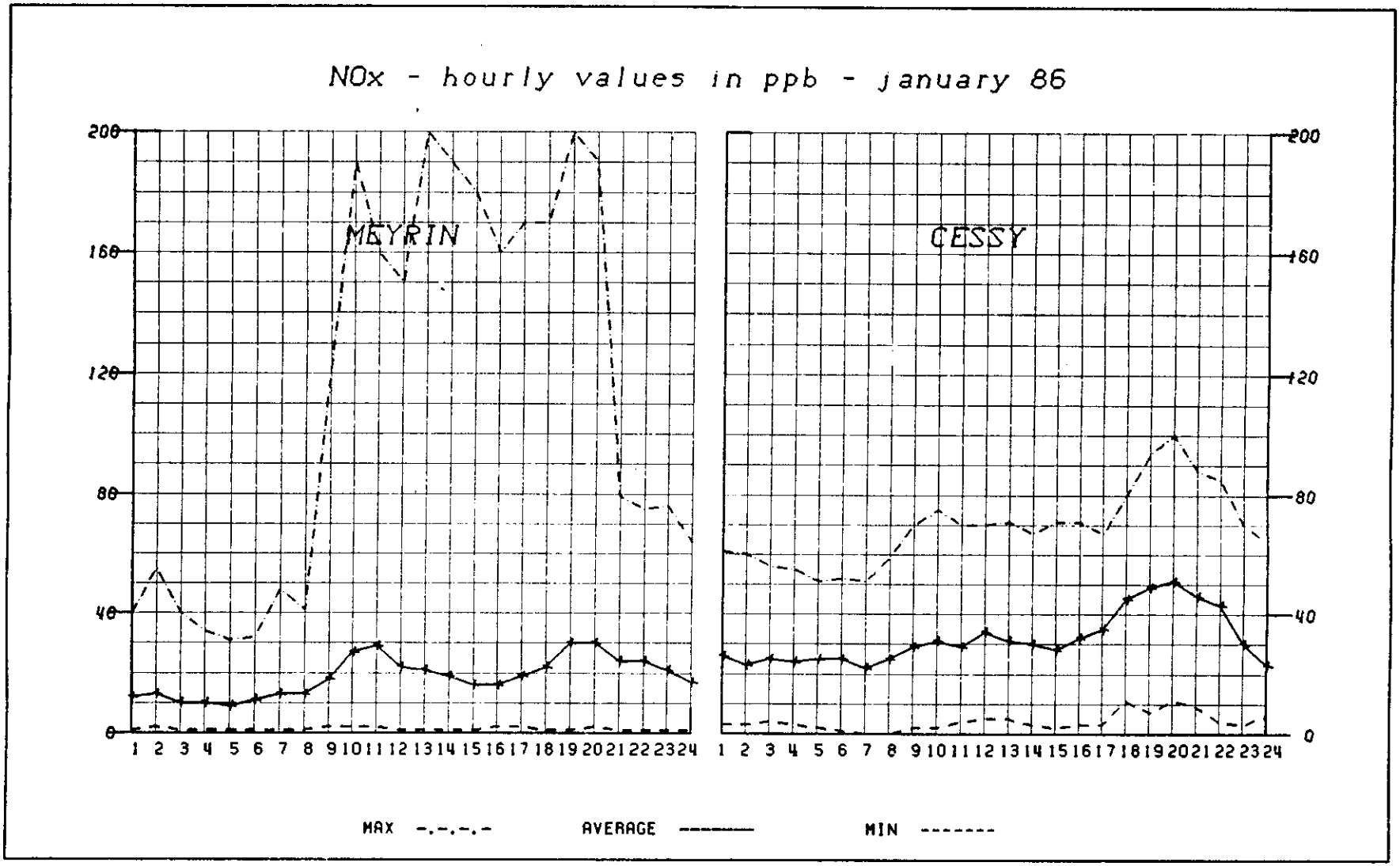
MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 7


NOx - hourly values in ppb - january 86
MEYRIN
CESSY
200
160
120
80
40
0
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MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 8

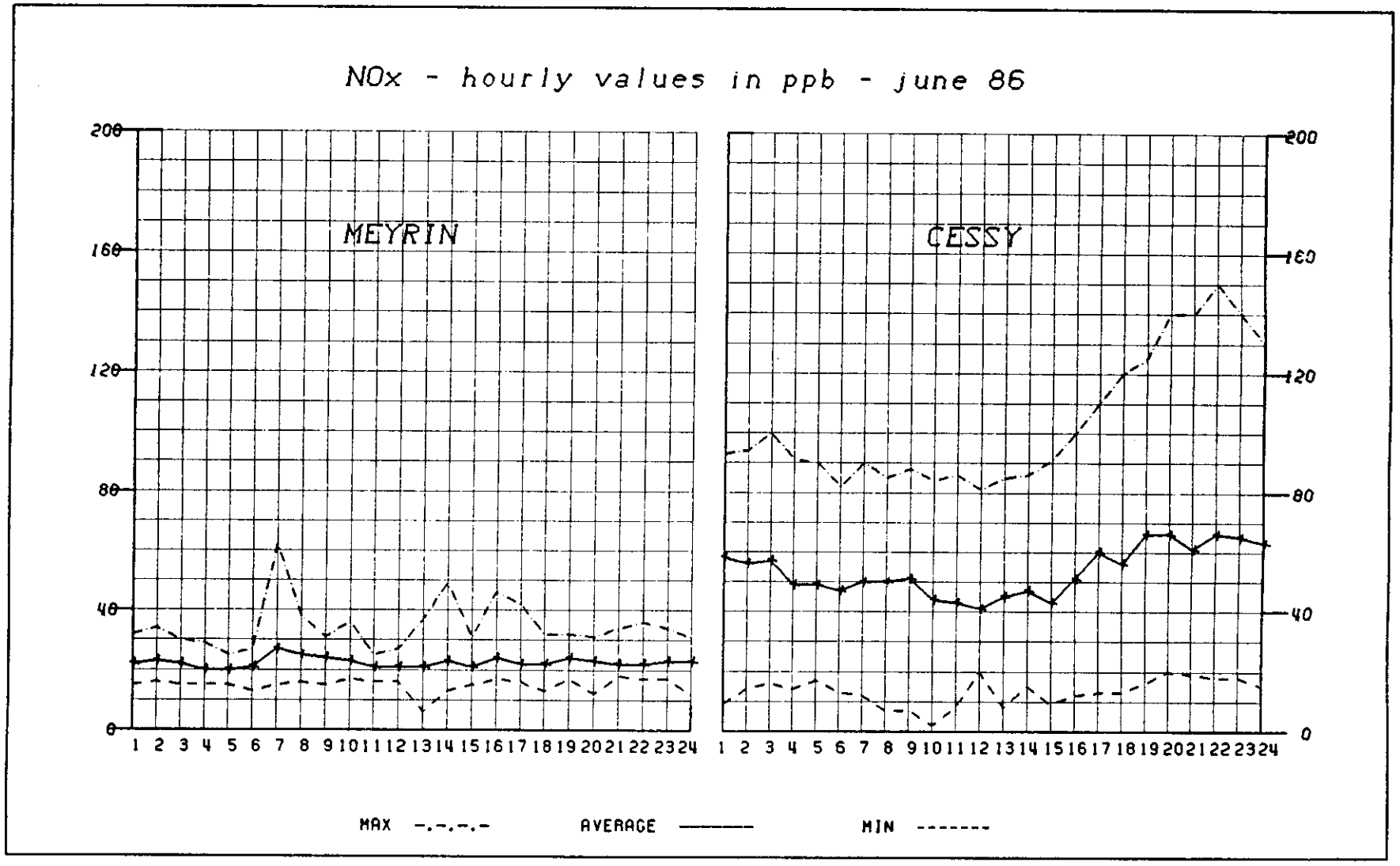
NOx - hourly values in ppb - june 86
MEYRIN
CESSY
200
160
120
80
40
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 9

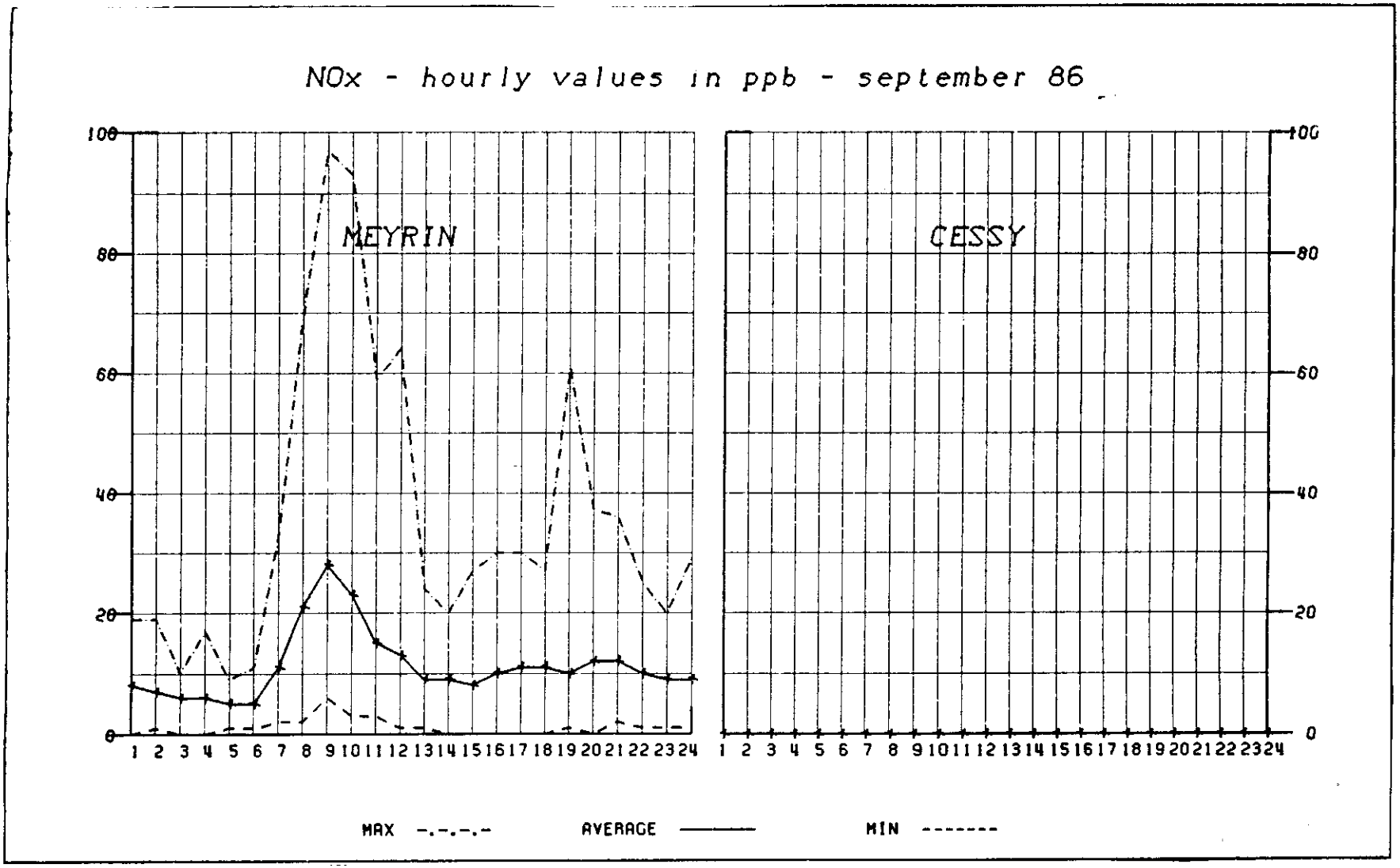
NOx - hourly values in ppb - september 86
MEYRIN
CESSY
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
MAX -.-.-.-
AVERAGE ———
MIN -------

Fig. 10