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Abstract

Airborne radon concentration has been measured at the rehabilitated Nabarlek mine for the best part of three years, during 1997, 1998 and 1999. A pronounced annual pattern can be observed with higher radon concentrations during the dry season and lower concentrations during the wet, mainly due to the lower radon exhalation rates from wet soils. Average wet season airborne radon concentration amounts to 43 Bq per m^3; average dry season concentration is 110 Bq per m^3. In 1997 (82 Bq per m^3) radon concentration was significantly higher at Nabarlek as compared to 1998 (71 Bq per m^3) and 1999 (66 Bq per m^3), most likely due to the relatively long lasting dry season of 1997.

The observed diurnal pattern in radon concentration is due to a temperature inversion at Nabarlek in the early morning hours. Radon is effectively trapped and builds up during the night, resulting in a radon concentration maximum in the early morning. The maximum radon concentration however depends on local meteorological conditions, in particular wind speed. Dry season early morning radon concentration maxima with calm conditions were typically between 300–400 Bq per m^3 in 1998 and 1999 and 300–600 Bq per m^3 in 1997. However, when the wind does not effectively drop to zero at night, maxima are between 10–100 Bq per m^3 only. On average, the differences between minima during the day and maxima in the early mornings are 1–2 orders of magnitude.

Halfhourly radon concentrations can vary by up to three orders of magnitude (range of measured values 0.926–915 Bq per m^3) whereas average daily radon concentrations vary by two orders of magnitude (range 3.8–352 Bq per m^3). Monthly averaged radon concentrations ranged from a minimum of 10 Bq per m^3 during the wet to a maximum of 160 Bq per m^3 during the dry season.

The most likely scenario of occupation at Nabarlek would be that local Traditional Owners use the site occasionally for hunting and camping. This would occur during the dry season, as the site is difficult to access during the wet. A conservative estimate for occupation of the site would be 50 days per year, and the dose received from the inhalation of radon progeny would then amount to 0.44 mSv; most likely, much less than 20% of this dose would be due to mining activities in the 1980s and 90s.

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1 Introduction

This report describes the results of continuous measurements of airborne radon concentration at the rehabilitated Nabarlek uranium mine in the Alligator Rivers Region, obtained over a period of three years. It is part of a project (the *Radon-network*) being undertaken by researchers of eriss' Environmental Radioactivity Section over the last few years (Martin et al in press). It also forms part of the Environmental Radioactivity's program to assess the radiological status of the Nabarlek uranium mine (see for example Martin et al 2002; Bollhöfer et al 2003; Hancock et al submitted; Martin et al in prep). The equipment for the radon measurements, its setup, calibration and operation are described in detail in reports by Whittlestone et al. (1994) and Tims (2001).

Radon is a natural radioactive noble gas and has three major isotopes, ^{219}Rn ('*Actinon*'), ^{220}Rn ('*Thoron*') and ^{222}Rn with halflives of 3.96 seconds, 55.6 seconds and 3.82 days, respectively. ^{222}Rn is a decay product of ^{238}U (figure 1) and, being a noble gas, it is inert and diffuses through and emanates from U rich soils and rocks without undergoing chemical reactions. The radon exhalation flux however depends on the type of soil (sandy, silty etc.), the soil porosity and soil moisture, uranium and radium content, and the depth of the watertable, which impedes the flow of soil gas (eg Markkanen & Arvela 1992; Holkko & Liukkonen 1992; Porstendoerfer 1994).

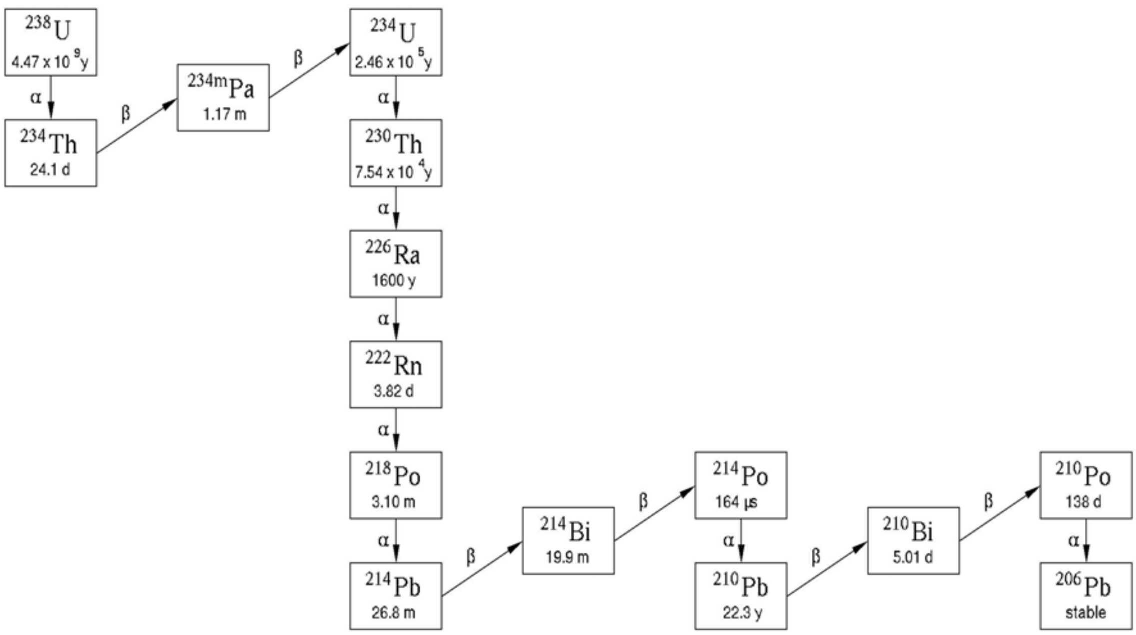


Figure 1 The ^{238}U decay chain

Uranium mines are sources of elevated radon exhalation due to the high uranium and radium contents of stockpile, waste rock dump or tailings material, and their relative porosity as compared to the undisturbed areas nearby. A recent study at Nabarlek (Bollhoefer et al 2003) has shown that radon exhalation rates, despite attempts to rehabilitate the former mine site, are still relatively high (in some areas up to 200 times above environmental background).

Geographical and temporal airborne radon concentration data are useful in assessing the impact of mining on the airborne radon concentration levels within the Alligator River Region, in particular near Ranger mine. For instance, Akber et al (1994) determined that approximately ¼ of airborne radon gas measured in Jabiru East, 2 km northwest of the mine, is mine related, although the magnitude of total radon output of the source term, ie Ranger uranium mine, has not yet been determined. A study on the temporal and geographical variation of radon exhalation on the Ranger lease is currently on its way. It will also provide valuable data for various radon transport models currently in use (Petersen et al 1992, Martin 2000), their aim being to predict radon concentration at various locations as a function of time.

Although radon itself does not impose a major health risk due to its inhalation, its short lived radioactive progeny, ^{214}Pb, ^{214}Bi and ^{214}Po (^{212}Pb, ^{212}Bi and ^{212}Po for thoron) can be deposited in the lungs and deliver a significant dose to the respiratory system (Tubiana et al 1990). The most important parameters for dose estimation due to inhalation of radon progeny are the radon progeny potential alpha energy concentration (PAEC), the equilibrium factor (E), and the unattached fraction of radon progeny (f_p). Akber et al (1994) estimated an average equilibrium factor (which gives a measure of the ratio of the PAEC of radon progeny present in ambient air and the PAEC of radon progeny in equilibrium with radon) in the Alligator River Region of 0.2–0.5. Akber and Pfitzner (1994) estimated an annual average of about 14% for the unattached fraction of radon progeny in Jabiru and Jabiru East. Using those factors radon concentration measurements can be used to estimate the geographical and annual variation of the average potential alpha energy concentration and give upper and lower limits of the dose received due to the inhalation of radon progeny in the Alligator River Region.

Following the ICRP guidelines (1991) the non-natural radiation exposure of the public should be less than 1 mSv per year from a practice such as uranium mining. Therefore, it is essential, though difficult, to estimate the above natural component of radiation exposure. In addition, it is indispensable to have reliable pre-mining data available in order to assess the impact of a practice. It has proven to be almost impossible to estimate the mining related component of radon exhalation at the Nabarlek site; however, it is unlikely that radon exhalation increased significantly (Bollhöfer et al 2003).

The majority of radon related research focuses on indoor environments because indoor exposure to radon, although it varies widely, can reach over 20 mSv per year in some cases (Tubiana et al 1999). This is 20 times higher than the annual dose limit from a practice recommended by the International Commission for Radiological Protection (ICRP60 1991). Main sources of radon in indoor environments are building materials (such as materials based on granite or clay) and the type of soil a house is built on. In addition, it is largely influenced by the ventilation of inside air. In warm and subtropical regions such as the Alligator Rivers Region, homes are usually well ventilated and radon exhalation from building materials does not contribute significantly to radon exposure. This is reflected in the average radiation exposure from radon, which is 1.3 mSv worldwide, but only approximately 0.2 mSv in Australia.

The study described here is part of a larger program to investigate the radiological conditions of the rehabilitated Nabarlek site. One of the aims of this program of work is to provide a detailed radiometric description of the rehabilitated Nabarlek mine site, so that future users of the area will have sufficient information to judge radiological risk and any future study of the site will have a baseline dataset available. In addition, it aims to provide information which may help in the rehabilitation of other mine sites, particularly the Ranger and Jabiluka mine sites which are located in Kakadu National Park and are subject to similar climatic conditions, with contrasting wet (approximately November to April) and dry (approximately May to October) seasons.

2 Methods

2.1 Radon monitors

The sampling equipment used is described in detail in Tims (2001) and Whittlestone et al (1994), a schematic diagram is shown in figure 2.

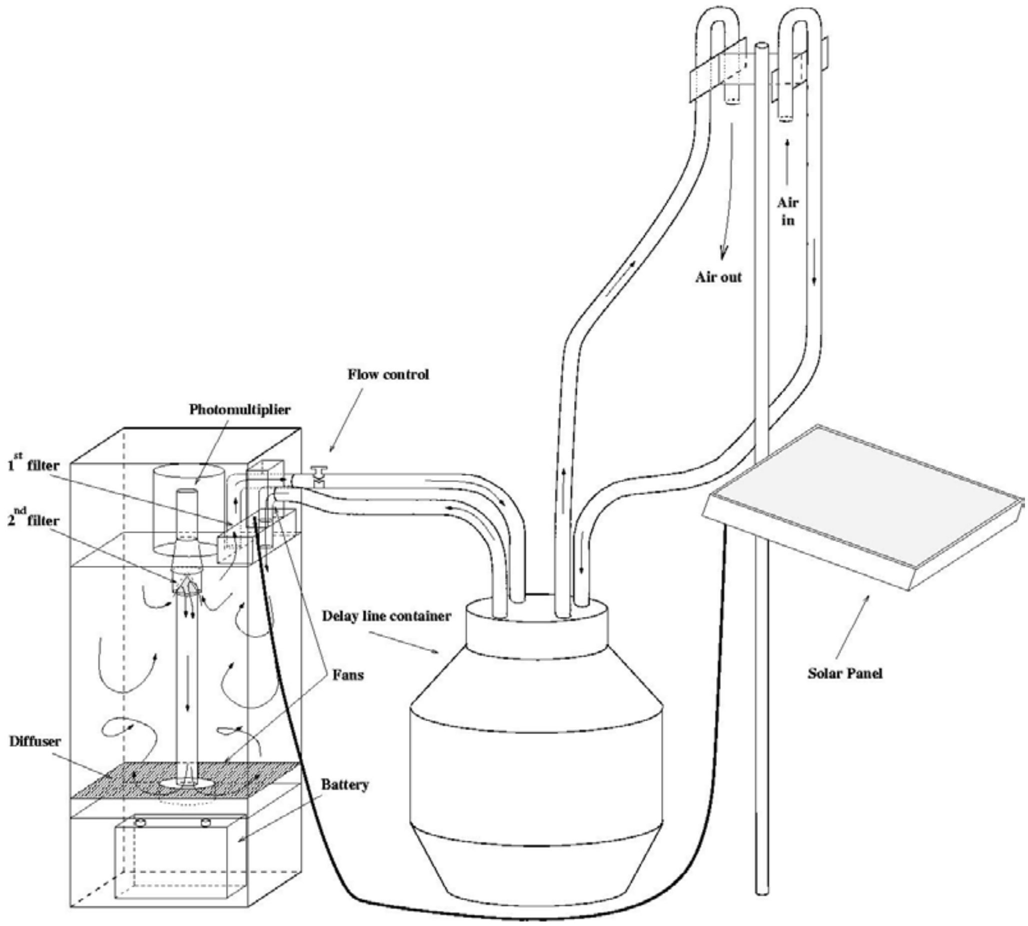


Figure 2 Principal layout of the Rn-monitors

Air is drawn through a delay line of ~15 litres to remove thoron at a flow rate of approximately 4-6 litres per minute. The air then passes through a class P2 particulate filter to remove radon and thoron decay products before it enters the tank with a volume of 100 l. The radon (and any residual thoron) decays in the tank and with the aid of an internal blower the radon progeny is circulated through and collected on a second filter (2^{nd} screen). This screen is mounted approximately 7 mm from a ZnS coated light guide, attached to a photomultiplier (PM) tube. The PM tube detects the light pulses generated in the scintillating ZnS coating by the α-particles emitted by the radon progeny on the screen. Pulses are fed into a discriminator to remove low energy noise and then directly into a data logger. Data are read into the long-term memory of a data logger every 30 minutes. The logger also records the internal tank pressure, the flow rate, the internal and external blower fan currents, the PM tube voltage, the internal battery voltages and the temperature.

Power consumption of the radon monitors is usually less than 3 watts (Whittlestone et al 1994). Power is supplied by a solar panel charging a 12V, 38Ah battery. Starlogger data are downloaded monthly to bi-monthly and checked for variations and/or faults in battery voltages, PM-tube voltage, blower fan currents (internal and external), tank pressure and flow rate. The variations in temperature are used to check the continuity of the data and detect timing errors that may occur. After all the checks have been conducted, data which are considered as 'good data' are used for the final evaluation of the airborne radon concentration.

2.2 Calibration

2.2.1 2001 Calibration

To estimate the detection efficiency or calibration constant (Bq/m^3 per counts/30min) of each radon monitor, a Pylon radon source is attached to the inlet of the monitors and air is pumped through at a known flow rate.

Assuming a constant radon output from the Pylon source, the concentration of radon drawn into the detector volume in Bq per m^3 is:

$$[Rn] = E_{Rn}/F \qquad (1)$$

where:

E_{Rn}: Radon emanation from Pylon source

F: flow rate in m^3 per minute.

As per original design, the calibration constant for monitor 1 was given by the Australian Nuclear Science and Technology Organisation (ANSTO) to be 0.0167 Bq/m^3 per counts/30min and assumed to be identical for the remaining three monitors. However, deterioration of the monitors, changes and differences in detection efficiency due to changes of detector geometry (possible displacement of 2nd filter) or replacement of the PM tube require all monitors to be calibrated separately.

The manufacturers of the Pylon source quote radon emanation rates for their different sources given in table 1. From this, we estimated the radon emanation from our source to 2.63 Bq per minute as its nominal ^{226}Ra activity is given as 20.9 kBq.

Table 1 Radon emanation from various Pylon sources

Model	^{226}Ra activity [kBq]	^{222}Rn output [Bq/min]
2000A-20	20	2.52
2000A-100	100	12.6
2000A-500	500	62.9

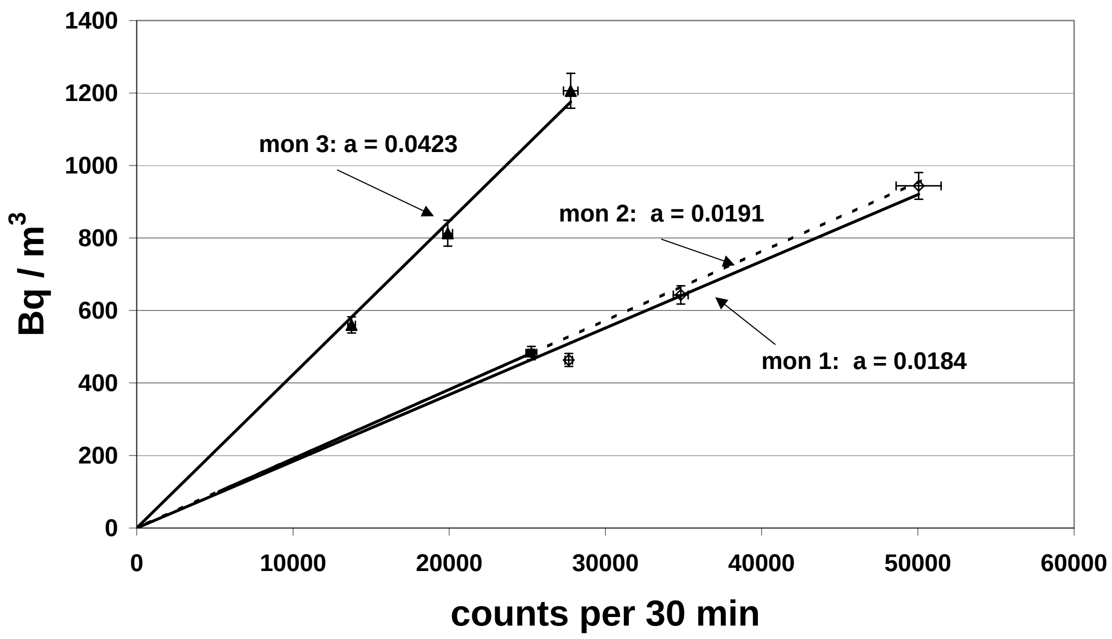


Figure 3 Determination of the calibration constant. Note that monitor 2 has been calibrated using one measurement only.

For calibration, an Ametek pump connected to the Pylon source and a Mini Buck flow meter was used and air was pumped through the radon monitor volume, usually at three different flow rates. After a response time of 1–2 hours the count rate per 30 minutes was recorded over a period of time. The counts for the particular time of day originating from the ambient radon concentration in the ***eriss*** workshop and the internal background of each monitor were subtracted and the resulting net counts per 30 minutes were plotted versus the calculated radon concentration. The slope of the best fit to the data represent the detection efficiency in Bq/m^3 per counts/30min. Figure 3 shows the results of the calibration of detectors 1, 2 and 3. Monitor 4 was calibrated by comparing data measured simultaneously at one sampling location and adjusting the calibration constant.

2.2.2 2003 Calibration

A different, field applicable method was used for the calibration of the radon monitors in 2003. The Pylon source was connected to the delay line of the radon monitors, approximately 1 m in from the inlet. A measuring cylinder, open to both sides and of the same diameter as the Kreepy-Krauly hose, was connected to the inlet. Flow rate and internal pressure of the system were not changed. The measuring cylinder was then dipped into a soap solution and the time was measured for the bubble to travel through a certain volume (0.2–0.3 l). Using equation 1 and the flow rates estimated in the field, the detection efficiency was calculated, after having subtracted the counts due to the ambient radon concentration for the particular time of day, averaged over the 5–10 days prior to the day of calibration.

Table 2 compares the 2001 and 2003 calibration results. It is obvious that monitor 3 has deteriorated quite substantially since it was delivered. At this stage, the monitor is being sent to ANSTO for repair. From our data set it is difficult to decide whether the deterioration occurred suddenly, while relocating the monitor from one station to another, or gradually putting great uncertainty on the validity of data from monitor 3.

Table 2 Calibration constants estimated in 2001 and 2003

	Calibration constant [Bq/m3 per counts/30min]		difference
	2001	2003	
Monitor 1	0.0184 ± 0.0023	0.018 ± 0.001	-2.3 %
Monitor 2	0.0191 ± 0.0004	0.020 ± 0.002	4.7 %
Monitor 3	0.0423 ± 0.0040	0.145 ± 0.008	243 %
Monitor 4	N/A	0.0186 ± 0.0011	N/A

2.3 Calibration check of radon monitor 1 in the radon calibration chamber of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Melbourne

In April 2002 radon monitor 1 was calibrated in the radon calibration chamber of the Australian Radiation Protection and Nuclear Safety Agency, Melbourne, which is used to calibrate radon and radon progeny detectors.

The calibration constant was determined previously, using the Pylon source from ***eriss***. The calibration indicated that the efficiency deteriorated slightly and changed from 0.0167 Bq/m^3 per counts/30min, as per original design, to 0.0184 Bq/m^3 per counts/30min. However, the Pylon source used for the calibration itself is not calibrated. Therefore, an additional absolute calibration was required.

Figure 4 ARPANSA's radon chamber

ARPANSA runs a radon chamber that can be used to perform an absolute radon calibration. It consists of a room approximately 2 x 2 x 3 m^3 in volume, which can be held at a constant radon level (figures 4 & 5). Comparing the count rates of radon monitor 1 with the radon gas concentration in the chamber allows calculating a calibration constant.

Figure 5 ***eriss***'s radon monitor 1 in ARPANSA's radon chamber

The radon chamber was held at a low radon level of approximately 400 Bq per m^3 at the first day of calibration, Tuesday, April 30, 2002. It was decided to acquire the first set of calibration data at that low level, closer to environmental levels, and increase the radon levels gradually in the course of the following two days to acquire further data. The radon monitor was put in the chamber at 11:00 am and the first cycle was started. Taking into account the background, which was approximately 220 counts per 30 min in April 2002, the calibration constant calculated amounted to 0.0181 Bq/m^3 per counts/30min, in good agreement with the earlier calibration performed at ***eriss*** (see table 2).

The radon level in the radon calibration chamber was increased at 10:00 am the next day by decreasing the fan speed in the radon calibration chamber. This fan regulates the pressure difference between radon chamber and a source chamber, in which a piece of solid U ore is constantly emitting radon (in addition to a radon source that is sitting in the radon chamber itself). Hence the fan is regulating the radon concentration in the chamber.

It was aimed for a concentration of 1500 Bq per m^3, however, at approximately 14:00 hours radon levels in the radon chamber were still as low as 700 Bq per m^3. Fan speed was further reduced until a level of approximately 900 Bq per m^3 was established. However, radon monitor 1 still had not reached a stable count rate. It was then decided to open the restricting valve of monitor 1 to increase the flow rate (see figure 6), and hence the response time, of the monitor slightly. The calibration could not be started before 17:00 and therefore it was decided to run it overnight. Radon concentration data in the radon chamber given by the ARPANSA and radon concentrations measured by monitor 1, using a calibration constant of 0.0184 Bq/m^3 per counts/30min, over the whole period of the calibration check are shown in figure 8. Additionally the flow rate of monitor 1 is plotted as well, indicating the times when the restricting valve was opened.

Figure 6 shows a good agreement between reported and measured radon concentrations during the first day indicating that the calibration performed at ***eriss*** is valid. In addition, it is obvious that opening the restricting valve, and hence increasing the flow rate of monitor 1, has had a negative effect on the agreement between given and measured radon concentrations. The reason for this is most likely an increase in the thoron (^{220}Rn) contribution to total detected alpha decays in the active volume of the radon monitor. With an increase in flow rate the delay line becomes less effective, leading to apparently higher ^{222}Rn levels detected by the radon monitor. It was assumed that the calibration of the first day is valid and a calibration constant of 0.0184 Bq/m^3 per counts/30min was used for the evaluation of the Nabarlek data.

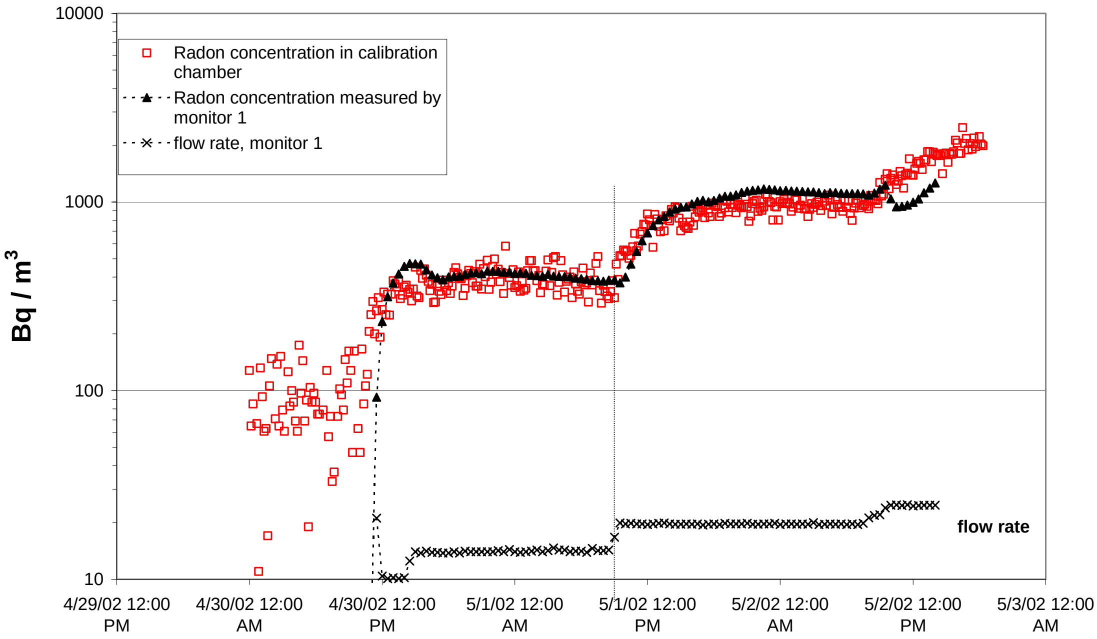


Figure 6 Radon concentration measurements in the ARPANSA radon chamber. Monitor 1 data were calculated using a calibration constant of 0.0184 Bq/m^3 per counts/30min.

2.4 Evaluation of the radon monitors' internal background

The majority of the internal background of the radon monitors originates from the radon decay product ^{210}Pb. ^{210}Pb continually builds up on the 2nd screen and decays via two β-decays into ^{210}Po (see figure 1). The subsequent α-decay of ^{210}Po to stable ^{206}Pb is detected on the ZnS screen and gives rise to an intrinsic background. Another possible source, present before sampling started, may be β-emitting contaminants in the ZnS coating of the light guide or the dynodes of the PM tube.

Background count rates are periodically determined for all the detectors. External and internal fans are turned off, the in- and outlets are plugged off and the count rate is estimated for a period of a few days up to a couple of weeks. Background count rates determined experimentally are interpolated and the background is calculated for each 30 minutes period individually.

The program used to calculate the background count rates takes into account the collection of ^{210}Pb on the screen and its subsequent decay to ^{210}Po, and the decay of ^{210}Po present on the screen. The background count rate will depend on the total amount of radon collected over a period of time (ie it will depend on the total amount of radon progeny collected on the 2nd screen). A factor *b* is fitted to the background data, which gives an estimate of the increase in background per registered count. The following formulae are used to calculate the background counts n_{i+1} due to the decay of ^{210}Po sampled on the screen for each subsequent step (i+1):

$$m_{i+1} = m_i \cdot \exp(-\lambda_{Pb} \cdot t) + b \cdot (C - n_i) \quad (2)$$

$$n_{i+1} = (C - n_i) \cdot \exp(-\lambda_{Po} \cdot t) + m_i \cdot (1 - \exp(-\lambda_{Pb} \cdot t)) \quad (3)$$

With:

m_i: background from ^{210}Po producing ^{210}Pb present on the screen

n_i: background from ^{210}Po

b: empirical factor describing the increase of the ^{210}Pb per registered net count

C: total counts per 30 minutes

λ_{Pb}: decay constant ^{210}Pb.

λ_{Po}: decay constant ^{210}Po.

t: 30 min.

Table 3 Background sampling periods, average counts m per half hour and empirical factor b fitted to the data

	Sampling period	m	b ($\cdot 10^{-6}$)
Monitor 1	11/02/99 13:30 – 17/02/99 11:30	126	1.0
	03/07/99 16:00 – 08/08/00 10:00	192	0.9
	06/09/00 18:30 – 03/10/00 14:00	191	0.9
	15/07/01 22:00 – 28/07/01 13:00	205	0.9
Monitor 2	04/10/00 18:30 – 09/10/00 09:30	43	1.4
	24/05/01 22:30 – 29/05/01 14:30	49	1.4
	25/06/01 16:30 – 26/06/01 08:30	73	1.4
	28/06/01 16:00 – 29/06/01 09:00	58	1.4
	16/07/01 22:00 – 28/07/01 13:00	59	1.4
	21/01/02 23:30 – 25/01/02 14:30	71	0.1
Monitor 3	19/01/00 19:00 – 24/01/00 14:30	12	0.8
	02/10/01 17:30 – 19/10/01 11:00	13	0.8
Monitor 4	04/02/00 19:30 – 08/02/00 09:00	24	0.88
	22/02/02 14:30 – 28/02/02 11:30	42	

3 Location and climate

The Nabarlek mine site is located in Arnhem Land in the Northern Territory, 1 km south-east of the Gadjerigamundah Creek and 1 km north-west of the western arm of Cooper Creek, the latter being a tributary of the East Alligator River (figure 4). The Nabarlek ore body 1 extended from the surface to a depth of 72 metres, with a length of 230 m and a variable thickness of about 10 m. It was a relatively compact, high-grade ore body and Queensland Mines Ltd (QML) mined it out during 4 months of the dry season of 1979. Approximately 600 000 t of average 2% grade ore were stockpiled, and subsequently milled and sold over an eight year period that ended in 1988 (UIC 1997).

Figure 7 Location of the Nabarlek mine site

Rehabilitation of the Nabarlek site is described in detail in Waggitt and Woods (1998) and Adams and Hose (1999). 680 000 t of mill tailings, together with scraped sludge from the bottom surfaces of runoff and evaporation ponds, were placed in the pit. The tailings were covered by geotextile followed by a graded rock and leached sand layer of 1 to 3 meters. The design relied on the fact that tailings would be below ground water and approximately 13 meters below the final ground surface to keep radon exhalation rates at the surface low (Waggitt & Woods 1998). Vertical 'wicks' to a maximum depth of 33 m were installed to drain the mass and aid consolidation. With final decommissioning of the mine in 1995, remaining contaminated material and unsaleable plant equipment were placed in the pit and covered with another layer of waste rock. In addition to the pit area, other sites to be rehabilitated were the plant area, the evaporation ponds, the plant runoff pond, stockpile runoff pond, waste rock pad runoff pond, ore stockpile area, waste rock stockpile area and the topsoil stockpile area. Most of these areas were left covered with run-of-mine waste rock. This waste rock cover was then prepared for revegetation.

Nabarlek is located in the wet-dry tropics of northern Australia. The dry season extends from May to September while the wet season extends from November to March. April and October are transition months.

No long-term climatic records are available for Nabarlek itself, however, more than 60 years of weather data from Gunbalanya (Oenpelli), a small town 15 km west of Nabarlek uranium mine, exist. On average the temperatures at Gunbalanya range from a minimum in July of 17.8 °C to a maximum in November of 37.1 °C. Mean annual rainfall is reported 1389 mm per year, with 60% of it falling in December, January and February (Waggitt & Riley 1992). The contrasting wet and dry seasons result in highly variable radon exhalation rates at Nabarlek over the year (Martin et al 2002) primarily due to the influence of soil moisture on radon exhalation. It is therefore expected that ambient radon concentration will vary considerably as well. From a dose assessment point of view, the dry season months are more relevant as access to the site during the wet is restricted and mainly occurs during the dry season. Figure 8 shows the location of radon monitor and weather stations on site.

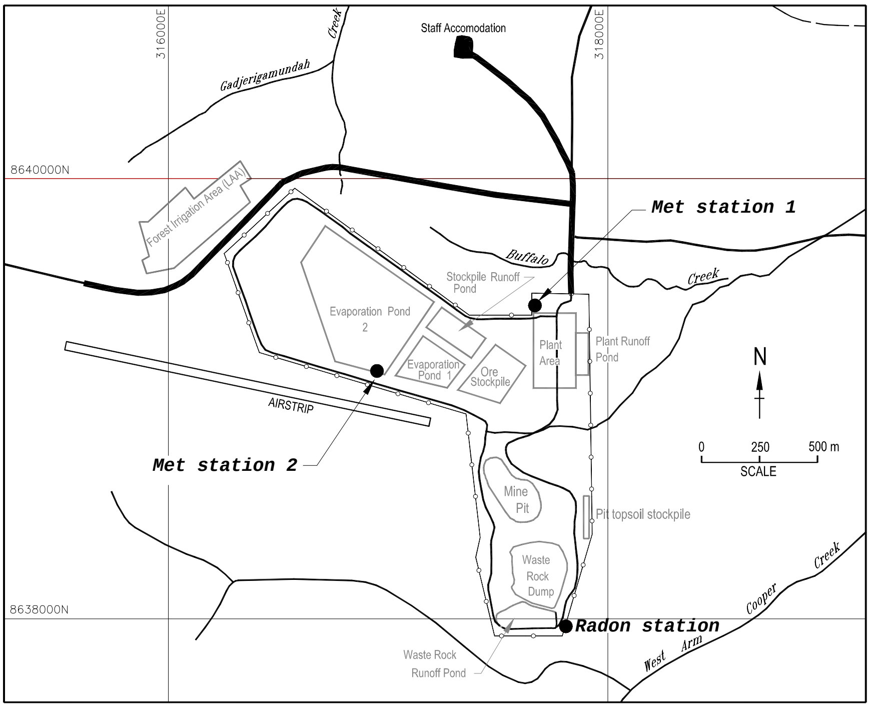


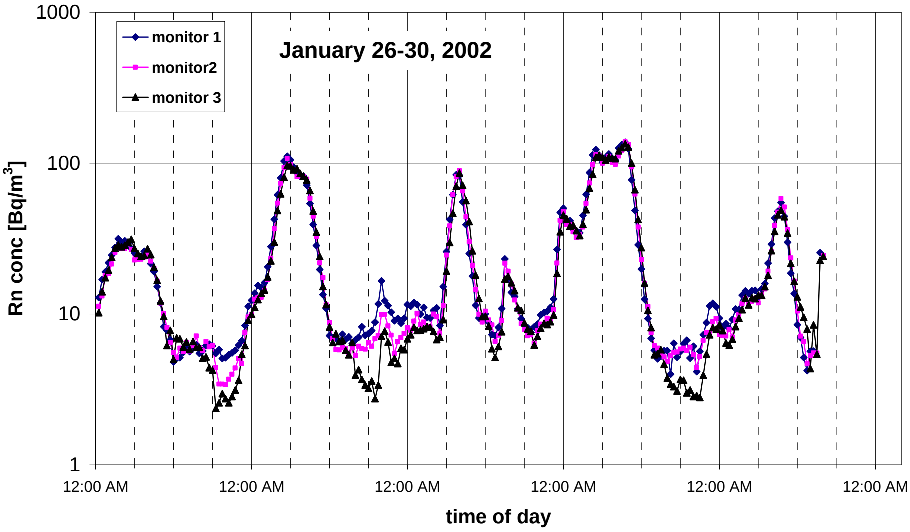
Figure 8 The rehabilitated Nabarlek mine site and the location of radon monitor and weather station

4 Results

4.1 Intercomparison of the radon monitors

Figure 9 shows the results of an intercomparison exercise performed in early December 2001 (Martin et al in press).

Data were acquired simultaneously by radon monitors 1, 2 and 3 in Jabiru East between December 1, 2001, 0:00, and December 4, 0:00, and concentrations calculated using the calibration constants shown in figure 3 after subtracting the internal background. The intercomparison shows a good agreement between radon monitors 1, 2 and 3. An additional intercomparison was performed at the end of January 2002 and is shown as well.



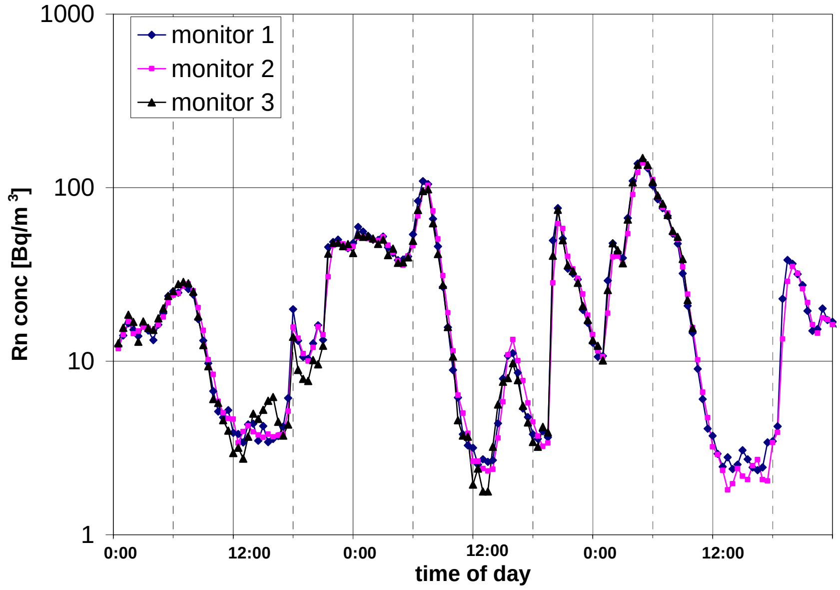


Figure 9 Intercomparison of monitors 1,2 and 3, December 2001 and January 2002. The averages for these periods amount to 23.3, 22.7 and 22.4 Bq per m³ (December 2001) and 25.5, 24.5 and 24.1 Bq per m³ (January 2002), respectively.

Average daily radon concentrations agree well within uncertainties but indicate a systematic difference between monitors 1, 2 and 3 of 2.5 to 5%. Assuming that the calibrations are correct, this may be caused by differences in flow rates and hence response times. Monitor 3 has deteriorated through the years and may have further deteriorated between the two intercomparison dates.

4.2 Halfhourly radon concentration data

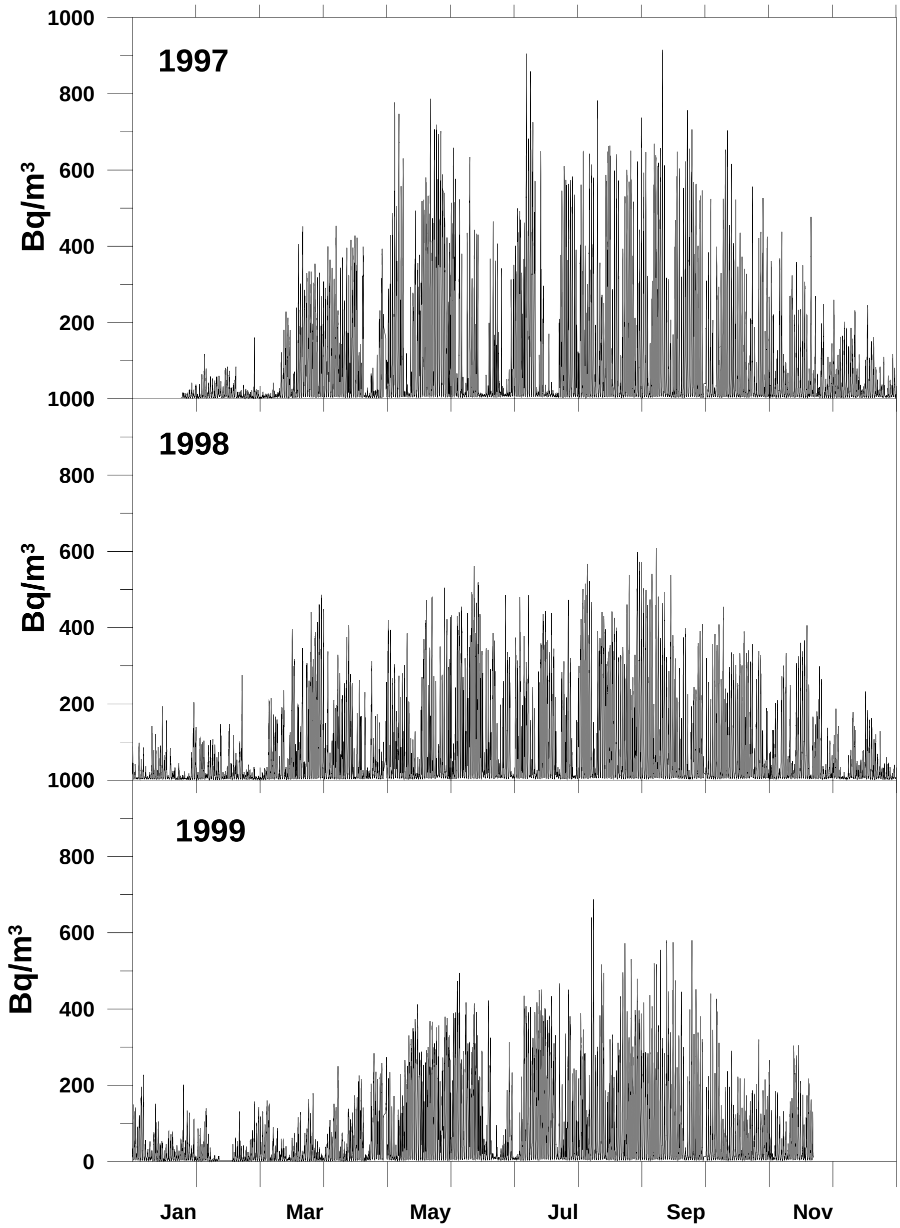


Figure 10 Half hourly radon concentration data acquired at Nabarlek, 1997–1999. Figure 10 a, b and c shows the radon concentrations measured at Nabarlek in 1997, 1998 and 1999, respectively, using radon monitor 1. Radon concentrations have been calculated using the calibration constant given in table 2 after subtracting the internal background calculated using equation 3. Minimum airborne radon concentration amounted to 0.926 Bq per m^3, measured on February 9, 1999 at 1:00 pm, maximum radon concentration was measured on September 11, 1997, at 5:00 am and amounted to 915 Bq per m^3; a variation of three orders of magnitude.

The airborne radon concentration is dependent on a variety of parameters, such as the soil uranium and radium content, soil porosity and soil moisture (and consequently the amount of rain) and other local meteorological conditions such as wind velocity, wind direction or atmospheric temperature gradient (Porstendoerfer, 1994).

In our study, a meteorological station was located next to the radon monitor. Meteorological data will be published in a separate report (Ryan, in prep.). However, daily rainfall data for Oenpelli were available from the Bureau of Meteorology and are included in the discussion of the daily and monthly averaged radon concentration results below.

4.3 Daily radon concentration data

Figure 7 shows the average daily radon concentration data plotted versus the date. In addition, the vertical bars indicate the daily rainfall, measured at Oenpelli from 1997–99.

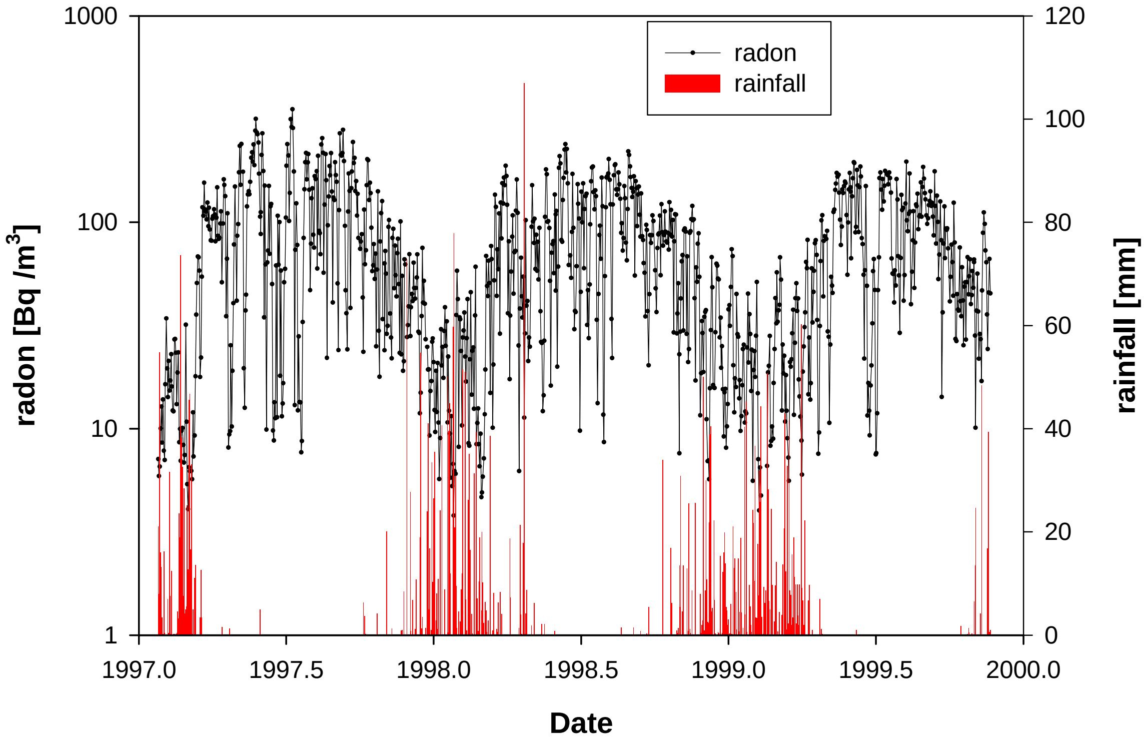


Figure 11 Daily averaged radon concentration at Nabarlek plotted on a logarithmic scale and rainfall data for Oenpelli

The maximum average daily radon concentration amounts 352.2 Bq/m^3, detected on July 10, 1997, minimum radon concentration was 3.8 Bq/m^3 on January 26, 1998. The complete daily dataset is given in Appendix A. It is obvious that, with the onset of the first major rainfalls, airborne radon concentration drops significantly.

4.4 Monthly radon concentration variations

Figure 12 shows average radon concentration at Nabarlek averaged over the month of the year. The maximum radon concentration was measured in May 1997, and amounted to 159.5 Bq/m^3. The minimum concentration amounted to 9.4 Bq/m^3 and was measured in January

1997. In addition to the radon concentration data, monthly rainfall data for Oenpelli, acquired from the Bureau of Meteorology, are indicated in figure 12 with the grey bars.

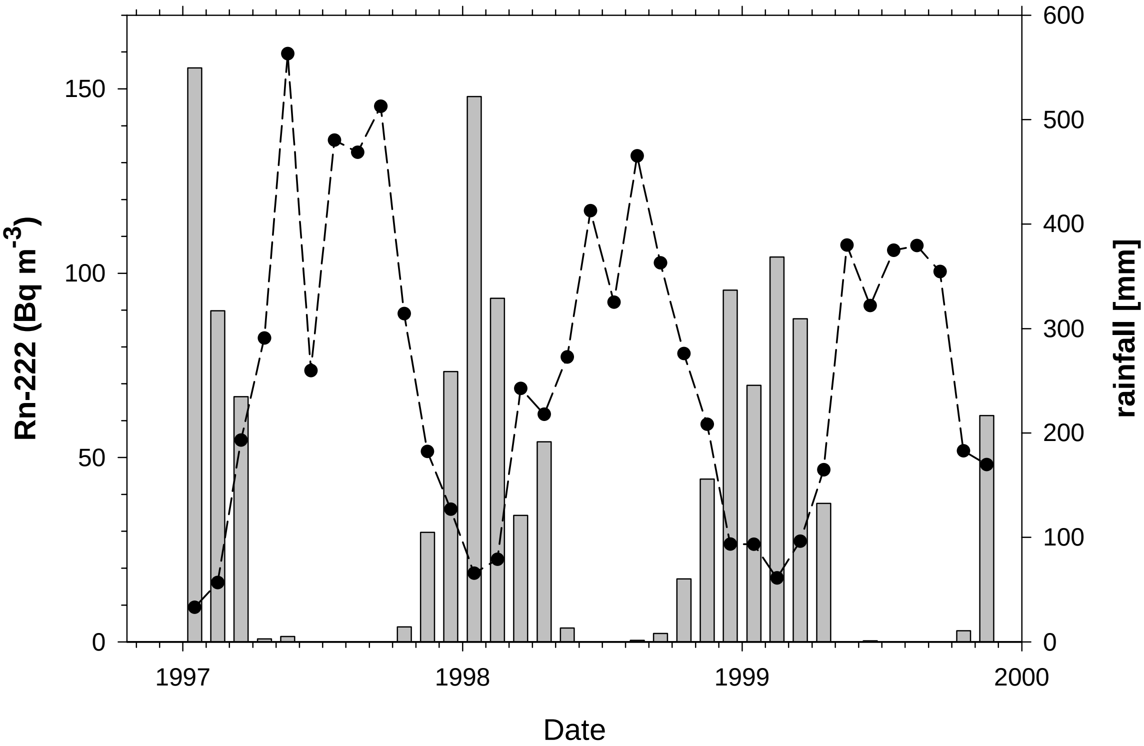


Figure 12 Monthly averaged radon concentration data at Nabarlek and rainfall data for Oenpelli

Again, figure 12 shows that with the onset of the wet season average airborne radon concentrations decrease. This decrease may be due to various reasons, including a reduction in radon exhalation due to a higher soil moisture, and a change in meteorological conditions such as wind direction or atmospheric turbulences associated with storms, which lead to a more effective mixing of radon within the atmosphere.

Higher annually averaged radon concentration data in 1997 are most likely due to the lower rainfall and earlier onset of the dry season during that year. Rainfall data for Oenpelli are given in table 4. The complete monthly radon dataset is given in Appendix B.

Table 4 Rainfall statistics for Oenpelli for 1997–1999

	1997	1998	1999
total rain [mm]	1397.3	1595.5	1684.2
days of rain	100	128	119
Max [mm]	83.8	77.9	51.6

4.5 Radon concentration variations averaged over time of day

Figures 13–15 shows data composites of average radon concentration changes with time of the day averaged over one month each, for 1997, 1998, and 1999. It is obvious that there is a pronounced diurnal pattern of airborne radon concentration.

Maxima in radon concentration develop in the early morning hours, between 6:30 and 8:00 and then exhibit a sharp decrease to a minimum at about 12:00 am. The low radon concentration lasts throughout the afternoon until about 18:00–19:00 hrs. The radon concentration then starts to increase. The difference between maxima and minima are approximately two orders of magnitude during the dry season months and one order of magnitude during the wet season months, respectively. Differences in wet and dry season maxima are approximately one order of magnitude.

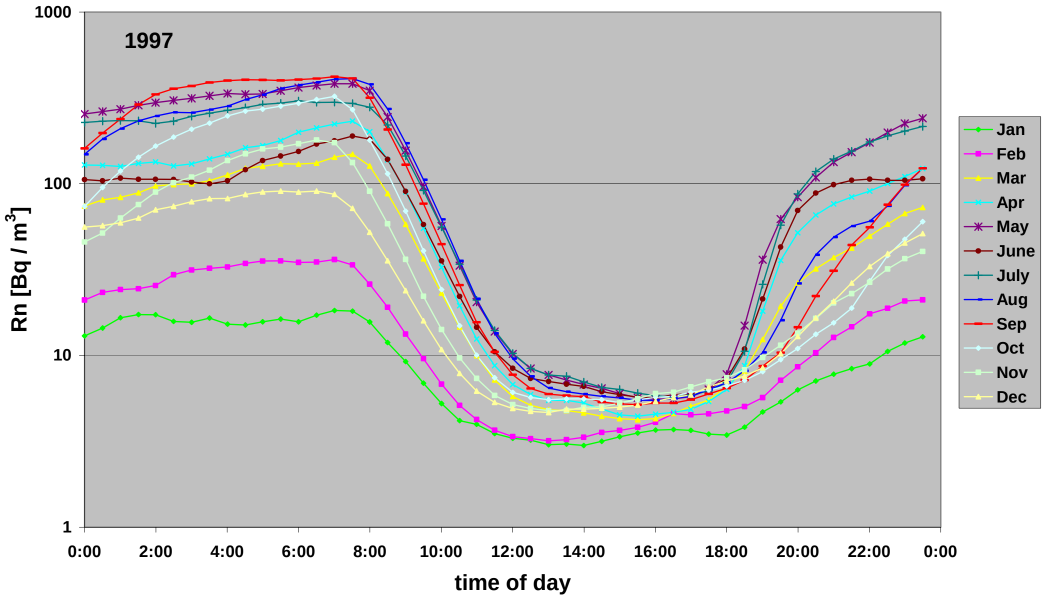


Figure 13 1997 radon concentration composite data plotted on a logarithmic scale versus time of day averaged over one month. Maxima were measured in September, minima in January.

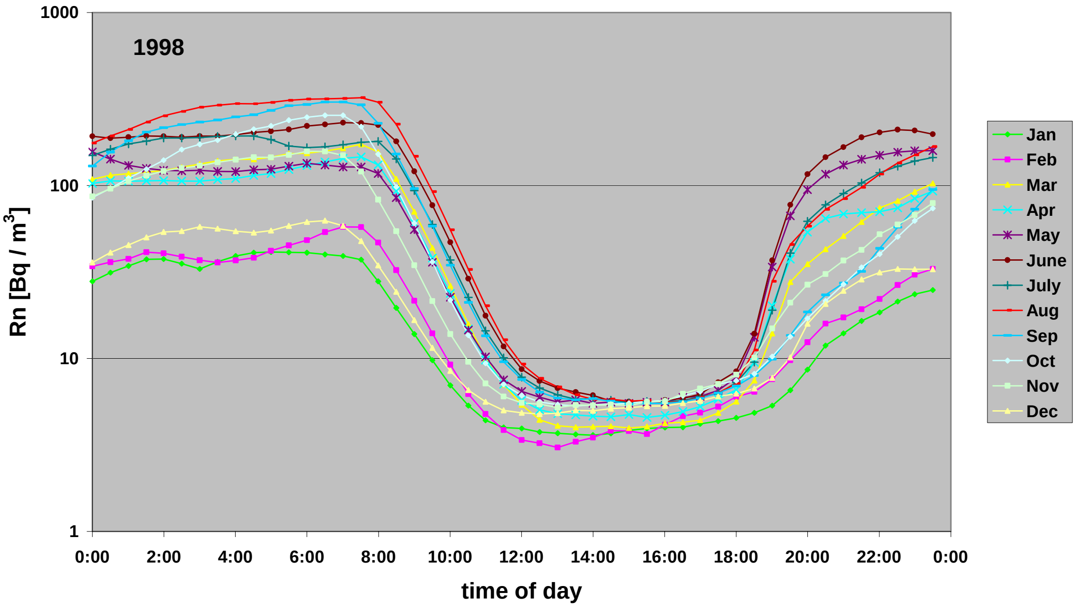


Figure 14 1998 radon concentration composite data plotted on a logarithmic scale versus time of day averaged over one month. Maxima were measured in August, minima in February.

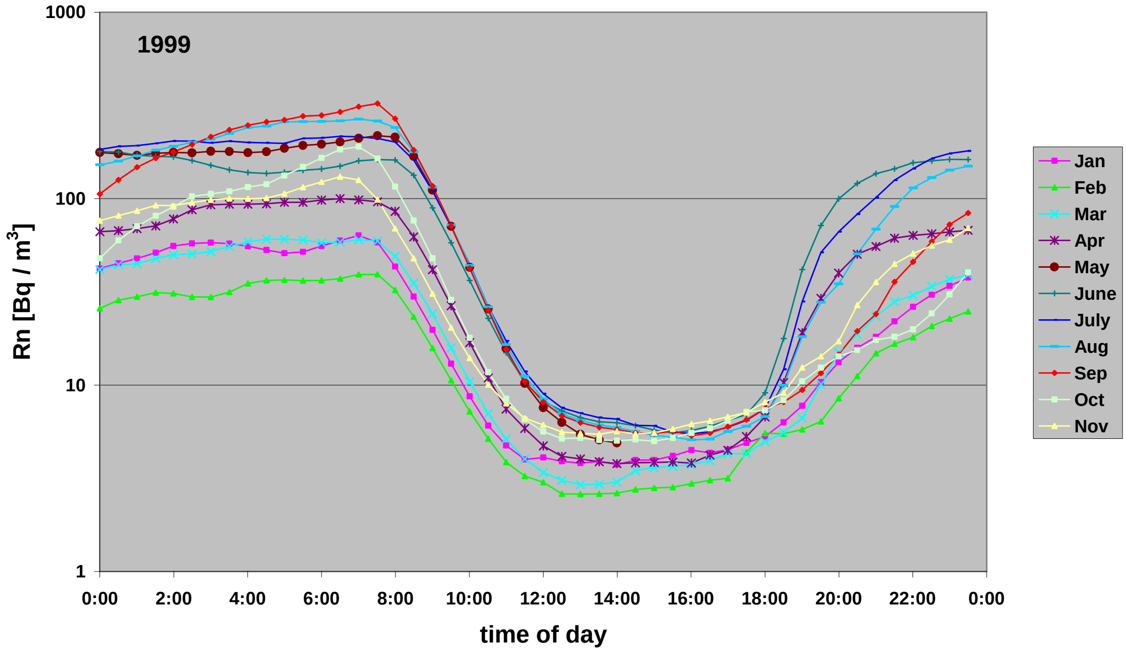


Figure 15 1999 radon concentration composite data plotted on a logarithmic scale versus time of day averaged over one month. Maxima were measured in September, minima in February.

The pronounced diurnal cycle at Nabarlek is due to the occurrence of a temperature inversion overnight (Martin et al in press). This inversion layer effectively traps radon exhaling from the surface of the Nabarlek mine and leads to a build up of airborne radon concentration. Dames and Moore (1980) have shown in a study that in three of four mornings in September, an inversion formed at Nabarlek at about 40 m height. The reason for the relative magnitude of the variation is due to a relatively high radon exhalation rate from the Nabarlek surface as compared to other areas in the Alligator Rivers Region (Bollhöfer et al 2003).

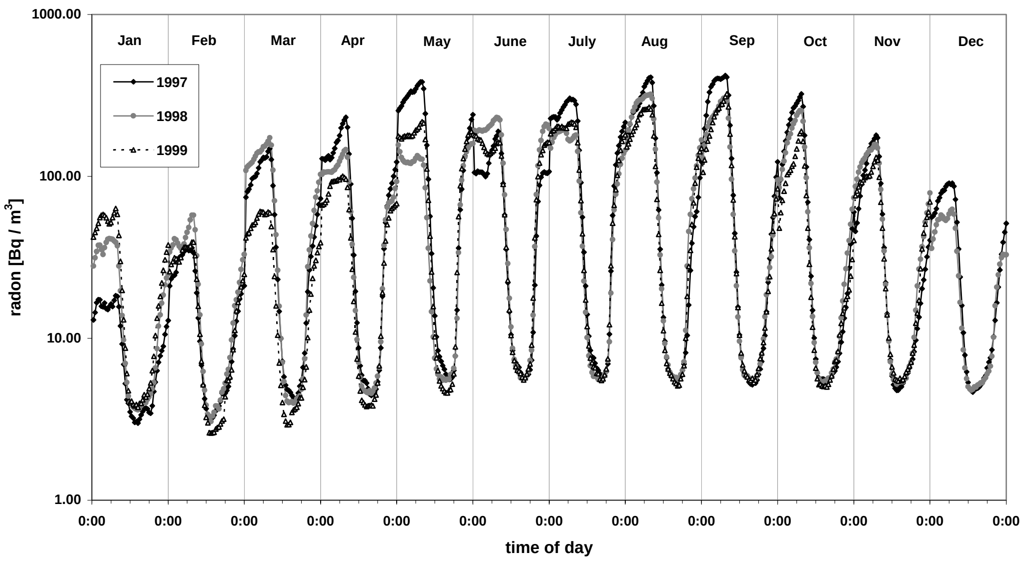


Figure 16 Comparison of averaged radon concentration versus time of day for 1997 – 1999

Figure 16 shows a comparison of 1997, 1998 and 1999 data, averaged over the time of day. During the dry season months, the radon concentration in 1997 was on average higher than in 1998 and 1999, respectively.

5 Radon concentration and wind speed

Differences in daily concentration can be up to three orders of magnitude, due to local meteorological conditions, such as wind speed and wind direction. During times when the wind does not effectively drop to zero, a build up of airborne radon is hindered and the early morning maximum of the radon concentration is much less pronounced. Figure 17 shows the radon concentration measured in July 1997 plotted versus the day, figure 18 shows the wind speed measured at Nabarlek during the same period.

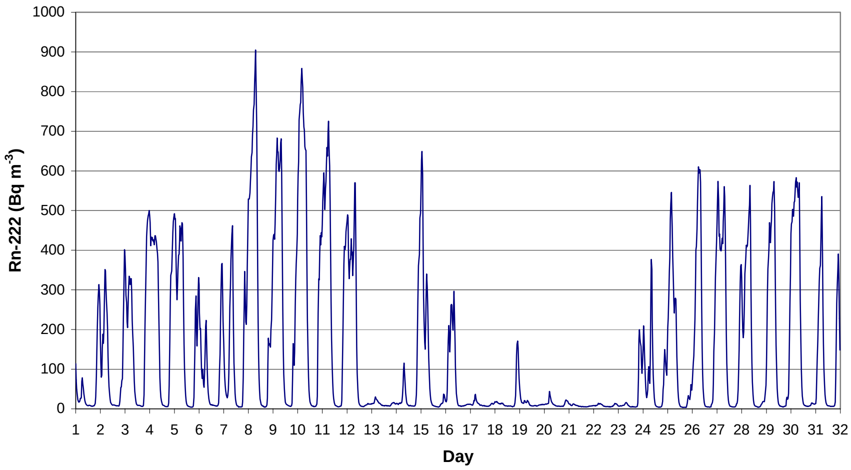


Figure 17 Radon concentration measured in July 1997

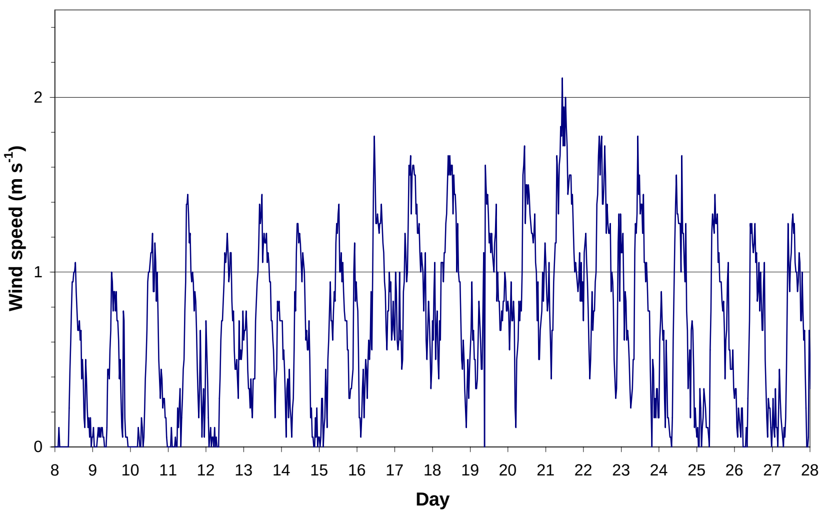


Figure 18 Wind speed measured in July 1997

The wind speed does not drop to zero during July 13-14 for example and radon maxima are only 30 and 115 Bq per m^3, whereas the adjacent maxima are at 570 (July 12) and 650 Bq per m^3 (July 15), respectively. Detailed analyses of the meteorological data at Nabarlek are currently undertaken and will be published in a separate report (Ryan, in prep.).

6 Statistical distribution of airborne radon concentration

Figure 19 shows the distribution of halfhourly radon concentration data and the distribution of the natural logarithms of halfhourly radon data, respectively, for 1997, 1998 and 1999.

The distributions of the radon concentration data are right skewed. This is no surprise, as radon exhaled from soil is undergoing a series of independent dilutions in the atmosphere, and therefore airborne radon concentration is expected to show a lognormal distribution (Ott, 1995). However, the frequency distributions of the logarithm of the radon concentration exhibit two maxima at 1.65–1.85 and 5.65–6, respectively. These are representing typical radon concentrations during the day, between 5.2 and 6.4 Bq/m^3, and in the early morning hours at about 280–400 Bq/m^3. Table 5 gives a statistical description of the 1997, 1998 and 1999 half hourly data sets.

The 1997 radon data set shows much larger variations as compared to the 1998 and 1999 data sets, mainly due to the comparatively higher radon concentrations measured during the dry season in 1997, which are most likely due to the relatively long lasting dry season (see table 4). Comparing the local meteorological data for the respective years may provide further clues as to what caused this magnitude in the variation.

Table 5 Statistical description of the halfhourly radon concentration data

	1997	1998	1999
Mean	87.71	71.58	68.29
Standard Error	1.13	0.82	0.80
Median	14.84	15.37	17.19
Mode	5.99	5.34	3.85
Standard Deviation	145.13	108.26	98.96
Sample Variance	21062	11721	9793
Kurtosis	4.40	2.91	3.20
Skewness	2.19	1.91	1.90
Range	913.91	606.62	686.57
Minimum	1.19	1.36	0.93
Maximum	915	608	687
Count	16390	17519	15325
Conf. Level (95.0%)	2.22	1.60	1.57

The 1998 and 1999 datasets are very similar. Although neither normally distributed nor single peaked (and therefore not strictly suitable for a student's t-test (Ott 1995)) a t-test with the logarithms of the radon data for the respective years indicates that 1997 and 1998 data are significantly different, whereas the 1998 and 1999 data are not.

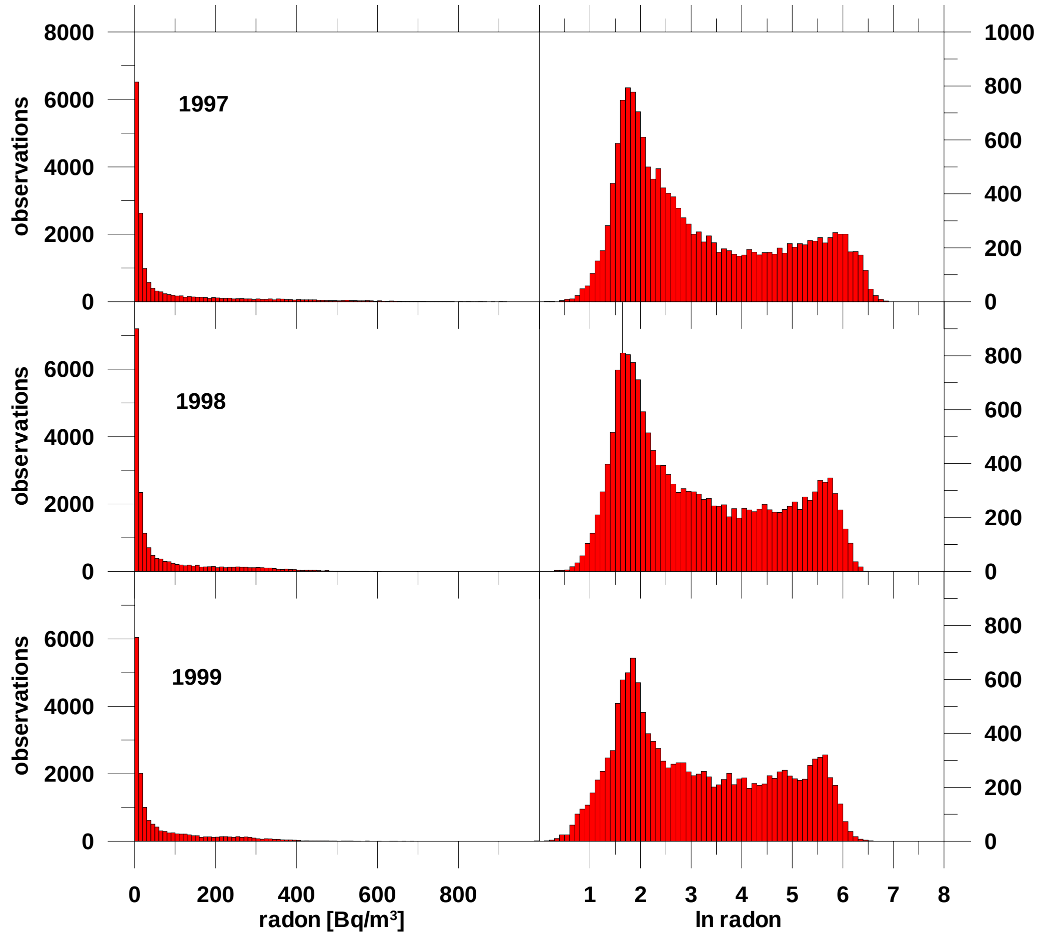


Figure 19 Histograms of halfhourly radon concentration and natural logarithm of the radon concentration data, respectively, for 1997, 1998 and 1999

Looking at the frequency plots for the daily maxima during dry season days only (June 1 – 30 September), excluding the days after a day of rain, shows that the datasets exhibit two (possibly three for the 1997 dataset) maxima (figure 20).

The first relatively smaller maximum of the distribution corresponds to the radon concentration maximum that most likely occurs during those nights when the wind speed does not effectively drop down to zero and a build up of radon is inhibited (se figure 17). This results in relatively lower radon concentrations of 10–100 Bq per m^3. A second maximum forms at approximately 300–400 Bq per m^3, most likely related to the wind speed effectively dropping to zero and radon exhaling from the soil building up during the night on site. In 1997, this maximum appears to be quite small (but still noticeable) in favour of a third maximum at higher radon concentrations of about 600 Bq per m^3. Figure 20 shows the relative frequencies of the dry season maxima plotted versus the respective radon concentration.

A Gaussian fit to the data, neglecting the first two bins (0–100 Bq per m^3) exhibits overnight dry season maxima at 350 and 615 (1997), 370 (1998) and 360 (1999) Bq per m^3.

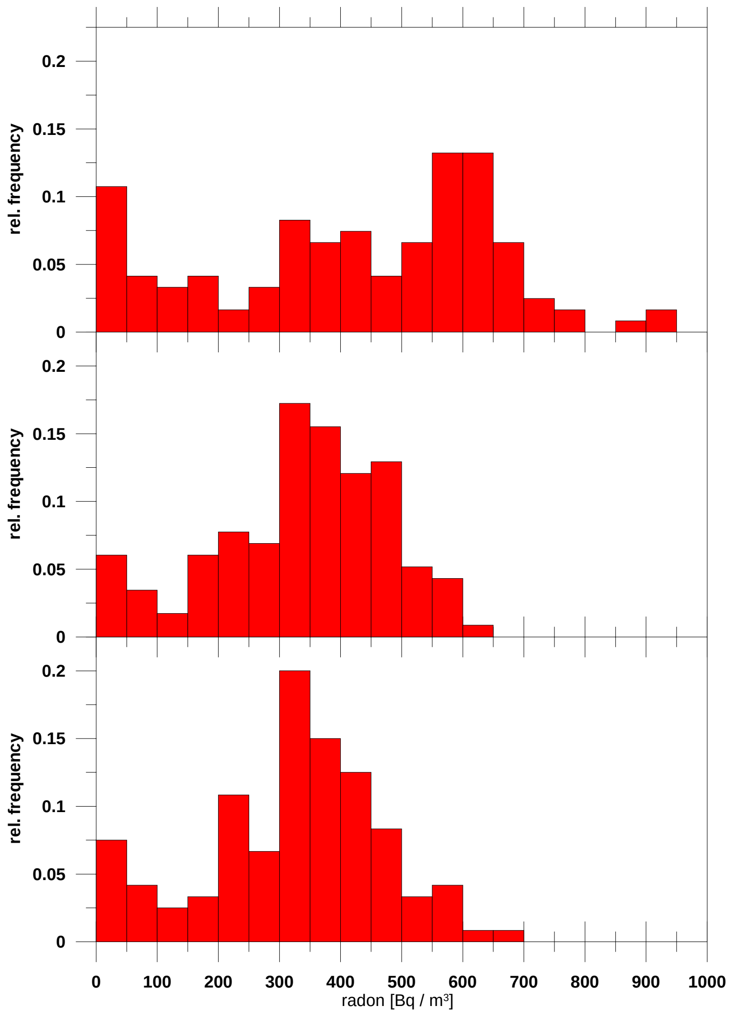


Figure 20 Relative frequencies of maximum dry season radon concentrations

7 Annual radon concentrations and public radiation doses due to inhalation of radon progeny at Nabarlek uranium mine

Table 6 shows the annual average radon concentrations for Nabarlek and the average radon concentration for wet and dry season months for the complete data set. In addition, doses to the public are calculated.

Although a radioactive noble gas, radon itself does not impose a major health risk to the public, as it is exhaled again after inhalation. However, radon progeny, ^{214}Pb, ^{214}Bi and ^{214}Po, can be deposited in the lungs and deliver a significant dose to the respiratory system (Tubiana et al 1990). The radon decay product (RDP) concentration and its potential alpha energy concentration (PAEC) may be estimated from radon activity concentrations using the equation:

$$C_{RDP} = f_{\alpha} \cdot E_{\alpha} \cdot C_{Rn} \quad (4)$$

With:

E_{α} :PAEC per Bq of ^{222}Rn in equilibrium with short lived progeny, 5.6 nJ/Bq

f_α : equilibrium factor

C_{Rn}: radon activity concentration [Bq per m^3].

Equilibrium factors vary, with higher values during the dry season as compared to the wet. Consequently, different average equilibrium factors have been used for the dry season and wet season dose calculations, respectively. Akber et al. (1994) reported values for the Alligator Rivers Region of between 0.2 and 0.5. For our data set an average equilibrium factor of 0.39 for the wet season and 0.55 for the dry season was used. An annual average of 0.45 was used for the annual dose calculations.

To convert radon progeny PAEC to an effective dose resulting from the exposure to radon progeny, the following calculation was performed:

$$E_{RDP} = h_{RDP} \cdot C_{RDP} \cdot t \qquad (5)$$

With:

E_{RDP}: effective dose due to the inhalation of Rn decay products [µSv]

h_{RDP}: dose conversion factor, 1.1 µSv/(µJh/m^3) (ICRP65, 1994)

C_{RDP}: Rn progeny PAEC [µJ/m^3]

t: inhalation time [h].

Table 6 Average airborne radon concentrations and public doses at Nabarlek

	1997	1998	1999	dry	wet
Radon [Bq/m^3]	82	71	66	110	43
equ. factor	0.45	0.45	0.45	0.55	0.39
Dose rate [µSv/h]	0.23	0.20	0.19	0.37	0.10
Eff. Dose [mSv]	2	1.8	1.7	1.6	0.4

A more realistic, but still conservative, estimate for the time spent on site by local traditional owners for hunting would be 50 days during the dry season (Martin 2000). This would result in an average effective dose of 0.44 mSv. As demonstrated in a previous report it is not possible to reliably estimate the mining related fraction of radon, however it is unlikely that a significant fraction of the dose from inhalation of radon progeny would be due to the mining activities in the 80s and 90s (Bollhöfer et al 2003).

It is possible however, to estimate an upper limit for the maximum mining related radon exposure at Nabarlek during the dry, using the minimum pre mining radon exhalation rate per unit area and the post mining radon exhalation rate per unit area, determined at Nabarlek in the dry seasons 1999, 2001 and 2002 (Bollhöfer et al 2003). The minimum total pre mining flux from the site amounted to 1.7 kBq·s^{-1}·ha^{-1} whereas the post mining radon exhalation has been estimated to 2.2 kBq·s^{-1}·ha^{-1}. Hence, a maximum of 20 per cent of the radon exhalation rate can possibly be attributed to mining activities. Consequently, local Aboriginal people who spend 50 days during the dry season on site for hunting would receive a maximum effective dose 0.1 mSv from mining activities. This maximum effective dose represents 10 per cent of the limit for members of the public of 1 mSv per year received from a practice such as uranium mining, recommended by the International Commission for Radiological Protection (ICRP 60).

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Appendices

Appendix A Daily averaged airborne radon concentration at Nabarlek and rainfall at Oenpelli, December 1996 – November 1999

Table A1 Average daily radon concentration at Nabarlek

Date	radon [Bq/m^3]	decdate	min	max	rainfall
96 12 05	14.06	1996.926	4.09	35.24	9.3
96 12 06	25.88	1996.929	4.64	74.89	0.8
96 12 07	13.37	1996.932	4.84	40.76	2
96 12 08	28.96	1996.934	4.25	97.64	0
96 12 09	12.96	1996.937	3.52	37.82	11.4
96 12 10	7.44	1996.94	4.34	11.67	47.8
96 12 11	15.45	1996.943	3.57	42.23	15.6
97 01 25	7.12	1997.066	2.37	15.17	21
97 01 26	5.89	1997.068	1.7	14.51	8
97 01 27	6.55	1997.071	1.3	22.68	54.8
97 01 28	10.01	1997.074	2.11	24.52	16
97 01 29	12.8	1997.077	2.25	42.42	13.2
97 01 30	8.56	1997.079	3.08	22.46	3.4
97 01 31	13.85	1997.082	3.56	37.75	0.2
97 02 01	7.81	1997.085	2.34	38.44	16.2
97 02 02	7.05	1997.088	2.51	26.24	0.4
97 02 03	16.4	1997.09	3.3	64.63	0
97 02 04	34.21	1997.093	3.81	117.38	0
97 02 05	19.56	1997.096	2.47	79.23	0
97 02 06	14.2	1997.099	2.91	42.6	7
97 02 07	21.27	1997.101	3.15	58.68	0.4
97 02 08	15.27	1997.104	2.82	53.45	31.6
97 02 09	17.1	1997.107	2.1	54.54	7.6
97 02 10	22.96	1997.11	2.74	58.38	0.2
97 02 11	16	1997.112	5.02	60.43	12.4
97 02 12	12.22	1997.115	2.39	46.11	0
97 02 13	12.14	1997.118	2.54	32.79	0.2
97 02 14	27.04	1997.121	4.4	80.78	0.2
97 02 15	27.18	1997.123	2.91	84.2	0.2
97 02 16	23.33	1997.126	2.17	73.03	0.2
97 02 17	13.13	1997.129	2.7	29.82	0.4
97 02 18	18.7	1997.131	3.33	49.55	4.6
97 02 19	23.41	1997.134	2.83	84.69	3.2
97 02 20	8.59	1997.137	2.35	18.45	23.6
97 02 21	9.96	1997.14	3.9	22.86	18.9
97 02 22	6.98	1997.142	2.94	36.44	73.6
97 02 23	9.77	1997.145	2.05	34.16	38.3
97 02 24	10.07	1997.148	2.5	25.81	32.6
97 02 25	8.34	1997.151	1.19	22.05	7.6
97 02 26	6.85	1997.153	2.05	22.4	28.4
97 02 27	7.45	1997.156	1.63	30.55	4.2
97 02 28	31.83	1997.159	1.65	160.95	5
97 03 01	10.8	1997.162	2.23	24.96	5.5
97 03 02	5.38	1997.164	2.27	13.81	25.1
97 03 03	4.07	1997.167	2.38	9.11	12.7

97 03 04	6.5	1997.17	2.47	17.8	45.6
97 03 05	6.21	1997.173	2.93	10.07	46.8
97 03 06	6.22	1997.175	2.82	13.6	16.6
97 03 07	6.24	1997.178	2.67	14.6	33.1
97 03 08	5.69	1997.181	2.34	21.35	0.2
97 03 09	11.99	1997.184	3.04	42.29	5
97 03 10	7.33	1997.186	4.36	12.05	0
97 03 11	9.26	1997.189	4.03	16.87	11.1
97 03 12	17.93	1997.192	3.77	97.15	13.6
97 03 13	35.65	1997.195	3.02	121.94	0
97 03 14	50.76	1997.197	2.94	180.6	0
97 03 15	68.18	1997.2	2.87	228.8	0
97 03 16	67.56	1997.203	3.27	212.89	0
97 03 17	58.29	1997.205	4.82	180.23	0
97 03 18	17.78	1997.208	3.97	65.78	3.4
97 03 19	22.1	1997.211	3.49	71.2	12.6
97 03 20	54.47	1997.214	4.45	239.34	3.4
97 03 21	118.05	1997.216	2.98	405.4	0
97 03 22	107.36	1997.219	3.62	302.4	0
97 03 23	155.31	1997.222	5.86	452.34	0
97 03 24	115.41	1997.225	5.16	285.18	0
97 03 25	112.41	1997.227	5.55	329.77	0
97 03 26	103.23	1997.23	4.65	334.37	0
97 03 27	124.52	1997.233	4.61	333.77	0
97 03 28	95.57	1997.236	4.75	304.29	0
97 03 29	117.64	1997.238	3.34	354.17	0
97 03 30	92.18	1997.241	4.28	318.73	0
97 03 31	81.67	1997.244	4.62	331	0
97 04 01	81.34	1997.247	4.51	268.61	0
97 04 02	103.87	1997.249	4.18	308.09	0
97 04 03	106.9	1997.252	4.23	290.83	0
97 04 04	115.49	1997.255	4.88	399.8	0
97 04 05	108.96	1997.258	4.16	364.73	0
97 04 06	80.83	1997.26	4.12	343.12	0
97 04 07	105.4	1997.263	5.04	314.8	0
97 04 08	147.71	1997.266	4.93	453.25	0
97 04 09	85.89	1997.268	4.5	231.6	0
97 04 10	82.95	1997.271	5.26	343.52	0
97 04 11	84.13	1997.274	4.37	370.7	0
97 04 12	98.39	1997.277	3.64	257.63	0
97 04 13	112.74	1997.279	4.3	396.12	0
97 04 14	51.18	1997.282	3.56	324.66	1.6
97 04 15	98.54	1997.285	3.87	416.42	0
97 04 16	161.35	1997.288	4.2	396.75	0
97 04 17	151.26	1997.29	4.11	427.95	0
97 04 18	133.82	1997.293	4.81	422.74	0
97 04 19	35.02	1997.296	4.05	122.07	0
97 04 20	66.45	1997.299	4.09	322.59	0
97 04 21	110.5	1997.301	4.93	399.39	0
97 04 22	8.09	1997.304	4.01	16.27	0
97 04 23	9.36	1997.307	4.27	29.7	1.3
97 04 24	9.73	1997.31	3.66	66.68	0
97 04 25	25.35	1997.312	3.36	81.76	0
97 04 26	10.23	1997.315	3.95	21.63	0

97 04 27	19.05	1997.318	3.75	115.6	0
97 04 28	40.53	1997.321	3.12	209.44	0
97 04 29	77.94	1997.323	3.69	281.58	0
97 04 30	148.79	1997.326	4.38	393.91	0
97 05 01	41.66	1997.332	3.87	158.32	0
97 05 02	85.91	1997.334	4.27	289.14	0
97 05 03	97.85	1997.337	3.68	428.98	0
97 05 04	174.47	1997.34	4.36	486.79	0
97 05 05	234.14	1997.342	4.75	777.35	0
97 05 06	151.71	1997.345	3.49	505.19	0
97 05 07	239.29	1997.348	4.38	747.04	0
97 05 09	175.64	1997.353	5.73	630.8	0
97 05 10	19.59	1997.356	6.41	119.43	0.1
97 05 11	12.62	1997.359	5.36	37.07	0
97 05 12	37.35	1997.362	5.01	293.08	0
97 05 13	44.51	1997.364	5.19	278.07	0
97 05 14	119.23	1997.367	7.05	367.45	0
97 05 15	136.49	1997.37	5.25	493.55	0
97 05 16	141.37	1997.373	4.03	355.6	0
97 05 17	136.76	1997.375	4.49	377.38	0
97 05 18	157.02	1997.378	6.36	518.29	0
97 05 19	205.03	1997.381	5.72	522.34	0
97 05 20	218.09	1997.384	5.84	580.68	0
97 05 21	196.59	1997.386	5.97	532.36	0
97 05 22	237.84	1997.389	5.73	786.68	0
97 05 23	189.04	1997.392	4.94	473.33	0
97 05 24	277.64	1997.395	5.29	706.9	0
97 05 25	317.02	1997.397	5.08	718.89	0
97 05 26	271.99	1997.4	6.63	694.34	0
97 05 27	266.58	1997.403	4.76	701.61	0
97 05 28	242.96	1997.406	5.35	588.72	0
97 05 29	171.8	1997.408	4.02	539.56	0
97 05 30	106.25	1997.411	4.78	423.19	5
97 05 31	111.65	1997.414	5.99	384.88	0
97 06 01	87.58	1997.414	4.57	408.43	0
97 06 02	211.89	1997.416	4.9	513.73	0
97 06 03	269.53	1997.419	5.82	657.95	0
97 06 04	177.05	1997.422	7.36	576.75	0
97 06 05	34.59	1997.425	4.36	215.75	0
97 06 06	150.65	1997.427	3.88	523.14	0
97 06 07	62.42	1997.43	3.45	380.23	0
97 06 08	9.9	1997.433	5.88	16.35	0
97 06 09	63.8	1997.436	5.19	434.91	0
97 06 10	72.74	1997.438	4.29	432.13	0
97 06 11	149.85	1997.441	5.06	633.53	0
97 06 12	70.21	1997.444	4.73	315.78	0
97 06 13	119.46	1997.447	4.56	443.09	0
97 06 14	122.59	1997.449	4.63	433.42	0
97 06 15	50.17	1997.452	5.71	430.77	0
97 06 16	9.79	1997.455	5.67	13.84	0
97 06 17	8.75	1997.458	6.41	11.93	0
97 06 18	13.42	1997.46	5.63	62.65	0
97 06 19	11.24	1997.463	4.62	35.05	0

97 06 20	61.65	1997.466	5.06	367.65	0
97 06 21	11.35	1997.469	4.59	31.57	0
97 06 22	107.32	1997.471	4.13	464.85	0
97 06 23	62.24	1997.474	3.91	362.18	0
97 06 24	99.95	1997.477	4.79	407.25	0
97 06 25	18.02	1997.479	5.67	58.7	0
97 06 26	58.21	1997.482	6.24	342.3	0
97 06 27	11.48	1997.485	7.1	28.7	0
97 06 28	13.23	1997.488	6.53	51.31	0
97 06 29	16.6	1997.49	6.47	76.92	0
97 06 30	51.16	1997.493	6.23	312.88	0
97 07 01	59.44	1997.496	6.5	313.69	0
97 07 02	105.28	1997.499	7.18	401.2	0
97 07 03	187.89	1997.501	6.04	499.8	0
97 07 04	239.01	1997.504	5.57	488.04	0
97 07 05	210.55	1997.507	4.26	492.14	0
97 07 06	101.5	1997.51	6.75	366.39	0
97 07 07	138.63	1997.512	4.59	462.05	0
97 07 08	315.79	1997.515	4.26	904.94	0
97 07 09	289.5	1997.518	6	682.76	0
97 07 10	352.15	1997.521	5.52	858.62	0
97 07 11	285.95	1997.523	5.28	725.18	0
97 07 12	176.04	1997.526	5.79	570.29	0
97 07 13	13	1997.529	6.75	30.15	0
97 07 14	73.56	1997.531	6.85	493.13	0
97 07 15	123.23	1997.534	4.61	649.12	0
97 07 16	77.61	1997.537	6.02	296.24	0
97 07 17	12.25	1997.54	6.28	36.64	0
97 07 18	27.97	1997.542	5.13	170.99	0
97 07 19	13.44	1997.545	6.82	51	0
97 07 20	13.4	1997.548	6.16	43.9	0
97 07 21	7.68	1997.551	4.79	12.6	0
97 07 22	8.71	1997.553	4.77	14.08	0
97 07 23	32.88	1997.556	4.25	199.83	0
97 07 24	84	1997.559	4.1	377.05	0
97 07 25	144.52	1997.562	3.73	545.82	0
97 07 26	195.12	1997.564	4.32	610.14	0
97 07 27	216.39	1997.567	4.65	573.76	0
97 07 28	161.2	1997.57	4.17	563.21	0
97 07 29	194.85	1997.573	4.75	573.48	0
97 07 30	213.76	1997.575	6.18	582.88	0
97 07 31	143.58	1997.578	5.89	535.27	0
97 08 01	46.91	1997.581	6.43	194.28	0
97 08 02	78.68	1997.584	4.44	372.96	0
97 08 03	130.66	1997.586	4.75	561.56	0
97 08 04	145.89	1997.589	4.83	648.53	0
97 08 05	87.03	1997.592	3.59	401.25	0
97 08 06	75.26	1997.594	4.43	300.53	0
97 08 07	167.12	1997.597	4.23	642.8	0
97 08 08	161.91	1997.6	4.81	614.7	0
97 08 09	176.63	1997.603	4.66	580.05	0
97 08 10	59.68	1997.605	4.75	223.12	0
97 08 11	209.84	1997.608	5.3	782.33	0
97 08 12	90.73	1997.611	4.84	356.77	0

97	08	13	88.59	1997.614	4.36	272.7	0
97	08	14	69.93	1997.616	4.63	250.84	0
97	08	15	237.8	1997.619	4.63	586.53	0
97	08	16	255.69	1997.622	5.21	663.05	0
97	08	17	216.94	1997.625	5.67	663.91	0
97	08	18	56.88	1997.627	5.06	287.17	0
97	08	19	121.56	1997.63	4.68	598.55	0
97	08	20	213.85	1997.633	5.12	641.01	0
97	08	21	159.67	1997.636	4.86	572.63	0
97	08	22	22.02	1997.638	4.23	114.08	0
97	08	23	96.48	1997.641	4.19	393.32	0
97	08	24	133.11	1997.644	5.92	530.54	0
97	08	25	186.86	1997.647	6.23	600.44	0
97	08	26	168.91	1997.649	5.84	569.54	0
97	08	27	215.91	1997.652	6.35	650.5	0
97	08	28	140.86	1997.655	5.41	517.21	0
97	08	29	40.81	1997.658	5.35	211.93	0
97	08	30	131.55	1997.66	5.49	622.3	0
97	08	31	128.09	1997.663	4.29	443.56	0
97	09	01	195.41	1997.666	4.16	737.57	0
97	09	02	169	1997.668	4.71	592.89	0
97	09	03	156.85	1997.671	4.36	646.74	0
97	09	04	50.5	1997.674	4.32	321.88	0
97	09	05	24.02	1997.677	4.35	146.24	0
97	09	06	114.34	1997.679	4.61	412.29	0
97	09	07	269.53	1997.682	4.93	668.57	0
97	09	08	211.91	1997.685	4.54	638.2	0
97	09	09	210.29	1997.688	5.63	618.31	0
97	09	10	216.13	1997.69	6.54	657.42	0
97	09	11	280.46	1997.693	6.35	915.09	0
97	09	12	197.77	1997.696	5.89	612.67	0
97	09	13	96.02	1997.699	4.91	317.22	0
97	09	14	46.75	1997.701	4.58	313.59	0
97	09	15	36.23	1997.704	4.13	207.32	0
97	09	16	24.22	1997.707	4.5	168.75	0
97	09	17	112.61	1997.71	4.12	468.5	0
97	09	18	171.98	1997.712	4.45	648.08	0
97	09	19	141.9	1997.715	4.81	604.01	0
97	09	20	38.43	1997.718	3.47	320.45	0
97	09	21	146	1997.721	3.92	552.67	0
97	09	22	175.8	1997.723	4.69	622.47	0
97	09	23	244.47	1997.726	5.65	756.53	0
97	09	24	193.29	1997.729	5.7	656.05	0
97	09	25	204.64	1997.732	5.42	706.46	0
97	09	26	141.59	1997.734	4.84	568.31	0
97	09	27	158.05	1997.737	4.29	563.28	0
97	09	28	107.58	1997.74	4.47	401.39	0
97	09	29	137.09	1997.742	4.08	532.97	0
97	09	30	83.98	1997.745	4.05	546.71	0
97	10	01	74.21	1997.751	4.57	310.06	0
97	10	02	80.74	1997.753	4.51	384.43	0
97	10	03	87.46	1997.756	4.5	523.86	0
97	10	04	43.11	1997.759	4.68	206.27	0
97	10	05	23.53	1997.762	5.34	149.63	6.3

97 10 06	115.01	1997.764	4.25	399.28	0
97 10 07	62.48	1997.767	3.95	293.57	3.7
97 10 08	73.16	1997.77	3.93	329.5	0.2
97 10 09	151.11	1997.773	4.41	524.41	0
97 10 10	201.97	1997.775	5.63	653.83	0
97 10 11	199.7	1997.778	5.5	704.1	0
97 10 12	128.01	1997.781	4.17	455.73	0
97 10 13	155.32	1997.784	4.96	615.58	0
97 10 14	138.36	1997.786	5.73	407.64	0
97 10 15	94.12	1997.789	5.28	522.75	0
97 10 16	57.86	1997.792	4.84	346.84	0
97 10 17	61.83	1997.795	4.82	435.43	0
97 10 18	78.36	1997.797	4.7	372.81	0
97 10 19	53.06	1997.8	4.27	340.26	0
97 10 20	70.44	1997.803	4.6	327.5	0
97 10 21	25.02	1997.805	3.95	93.98	0
97 10 22	58.97	1997.808	6.52	210.82	4.2
97 10 23	140.89	1997.811	6.26	556.57	0
97 10 24	29.8	1997.814	5.41	187.52	0
97 10 25	17.81	1997.816	4.38	96.12	0
97 10 26	80.65	1997.819	5.72	421.36	0
97 10 27	110.55	1997.822	6.04	437.18	0
97 10 28	126.53	1997.825	4.88	526.38	0
97 10 29	33.9	1997.827	4.73	177.47	0
97 10 31	63.19	1997.833	3.82	267.82	0
97 11 01	23.95	1997.833	3.38	76.48	0
97 11 02	72.56	1997.836	5.67	360.76	0
97 11 03	56.29	1997.838	5.89	221.28	0
97 11 04	28.82	1997.841	4.28	105.52	20.1
97 11 05	31.48	1997.844	4.43	127.39	0
97 11 06	94.86	1997.847	4.28	368.03	0
97 11 07	102.46	1997.849	4.77	437.96	0
97 11 08	36.12	1997.852	3.97	117.39	0
97 11 09	27.64	1997.855	3.91	96.45	0
97 11 10	21.88	1997.858	4.67	86.91	1.3
97 11 11	83.87	1997.86	4.29	270.01	0
97 11 12	92.88	1997.863	4.9	323.6	0
97 11 13	47.88	1997.866	3.84	220.85	0.1
97 11 14	77	1997.869	4.43	358.56	0
97 11 15	55.37	1997.871	3.96	233.04	0
97 11 16	43.64	1997.874	4	234.64	0.1
97 11 17	70.79	1997.877	4.45	350.01	0
97 11 18	83.15	1997.879	3.53	307.46	0
97 11 19	50.12	1997.882	3.58	219.91	0
97 11 20	23.27	1997.885	5.01	79.79	0
97 11 21	100.73	1997.888	6.04	476.84	0
97 11 22	22.9	1997.89	5.21	74.91	0.9
97 11 23	54.9	1997.893	4.85	268.84	1
97 11 24	19.07	1997.896	4.83	65.63	0
97 11 25	21.2	1997.899	3.78	74.08	8.5
97 11 26	66.12	1997.901	2.84	197.6	0
97 11 27	62.38	1997.904	4.16	248.16	0.1

97 11 29	27.78	1997.91	3.12	109.62	72.8
97 11 30	31.72	1997.912	3.48	96.99	0
97 12 01	39.1	1997.915	2.96	145.31	0
97 12 02	69.92	1997.918	3.64	259.53	0
97 12 03	28.05	1997.921	3.27	78.93	27.8
97 12 04	38.73	1997.923	3.91	115.01	0.8
97 12 05	44.86	1997.926	3.56	162.41	0
97 12 06	41.48	1997.929	3.52	165.36	6.8
97 12 07	63.63	1997.932	3.29	202.18	0
97 12 08	47.99	1997.934	3.55	184.18	0
97 12 09	42.62	1997.937	3.56	138.41	1.2
97 12 10	48.03	1997.94	4.72	185.74	10.8
97 12 11	53.9	1997.943	4.23	163.19	0
97 12 12	69.84	1997.945	3.55	231.77	0
97 12 13	29.48	1997.948	4.98	79.32	0
97 12 14	29.01	1997.951	3.54	116.39	0
97 12 15	11.87	1997.953	2.44	24.29	18.9
97 12 16	14.92	1997.956	3.98	39.1	54.7
97 12 17	35.08	1997.959	4.03	110.82	1.3
97 12 18	75.13	1997.962	3.91	245.18	3.5
97 12 19	40.73	1997.964	3.29	131.46	0
97 12 20	51.99	1997.967	3.1	150.81	0
97 12 21	40.27	1997.97	3.3	161.17	0
97 12 22	27.1	1997.973	5.46	82.64	1.4
97 12 24	24.88	1997.978	4.79	84.41	23.9
97 12 25	19.32	1997.981	2.97	97.4	41
97 12 26	19.37	1997.984	4.86	109.65	5
97 12 27	9.26	1997.986	4.09	28.06	16.8
97 12 28	15.22	1997.989	3.92	60.87	0
97 12 29	17	1997.992	5.29	49.67	1
97 12 30	26.34	1997.995	4.81	117.46	33.5
97 12 31	27.34	1997.997	4.4	81.26	10.3
98 01 01	20.98	1998	3.04	88.23	26.5
98 01 02	12.3	1998.003	3.4	42.87	35.5
98 01 03	9.63	1998.005	2.98	45.5	16.2
98 01 04	19.05	1998.008	2.4	98.23	2.8
98 01 05	12.04	1998.011	2.67	55.47	8.1
98 01 06	20.78	1998.014	3.39	85.82	1.2
98 01 07	10.7	1998.016	3.11	36.23	10.9
98 01 08	5.7	1998.019	3.05	14.44	0
98 01 09	9	1998.022	3.01	20.88	24.2
98 01 10	30.3	1998.025	3.12	142.31	0
98 01 11	20.21	1998.027	2.87	79.22	40.6
98 01 12	24.87	1998.03	2.63	121.2	0
98 01 13	17.61	1998.033	2.59	86.85	0
98 01 14	29.73	1998.036	3.07	90.67	0
98 01 15	38.71	1998.038	3.36	193.76	8.9
98 01 16	25.18	1998.041	3.76	73.55	0
98 01 17	33.06	1998.044	3.96	156.61	0
98 01 18	10.71	1998.047	2.58	84.88	50.1
98 01 19	22.33	1998.049	3.58	77.87	0.5
98 01 20	12.19	1998.052	4.28	24.08	39.6
98 01 21	9.45	1998.055	1.85	33.2	44.9

98 01 22	5.77	1998.057	1.94	28.87	11.9
98 01 23	11.49	1998.06	2.1	44.77	0
98 01 24	5.26	1998.063	2.15	14.13	0
98 01 25	6.73	1998.066	2.89	22.88	59.7
98 01 26	3.79	1998.068	1.46	5.83	77.9
98 01 27	6.23	1998.071	2.34	17.41	20.9
98 01 28	6.04	1998.074	1.84	17	30.8
98 01 29	35.5	1998.077	1.95	124.2	9.5
98 01 30	58.12	1998.079	2.59	204.2	1.4
98 01 31	42.38	1998.082	2.39	140	0
98 02 01	8.15	1998.085	1.96	21.76	4.6
98 02 02	34.61	1998.088	2.31	110.22	0
98 02 03	33.82	1998.09	3.08	99.18	2.7
98 02 04	23.78	1998.093	2.06	103.71	8.9
98 02 05	10.35	1998.096	5.11	31.31	11.9
98 02 06	27.61	1998.099	1.49	91.76	51.5
98 02 07	29.87	1998.101	2.46	105.2	0
98 02 08	36.49	1998.104	2	107.48	0
98 02 09	22.32	1998.107	2.21	93.24	51
98 02 10	16.9	1998.11	2.06	60.41	6.9
98 02 11	27.42	1998.112	1.36	135.16	0.9
98 02 12	42.4	1998.115	2.46	147.16	0.1
98 02 13	8.51	1998.118	2.53	21.25	26.2
98 02 14	8.26	1998.121	2.75	24.65	35.1
98 02 15	21.65	1998.123	2.95	81.81	16.5
98 02 16	45.82	1998.126	3.13	147.52	0.1
98 02 17	14.6	1998.129	2.45	42.12	4.1
98 02 18	23.8	1998.131	3.53	118.84	0.3
98 02 19	24.75	1998.134	3.71	71.41	0
98 02 20	12.46	1998.137	3.38	51.38	31.4
98 02 21	35.37	1998.14	2.55	101.23	0.1
98 02 22	60.88	1998.142	3.79	275.25	0
98 02 23	8.4	1998.145	2.23	21.33	39.4
98 02 24	10.65	1998.148	1.97	27.97	7.1
98 02 25	12.51	1998.151	1.56	40.83	0.8
98 02 26	8.41	1998.153	2.68	27.13	10.4
98 02 27	6.57	1998.156	2.47	20.45	18.9
98 02 28	9.44	1998.159	1.61	35	0
98 03 01	4.66	1998.162	2.23	8.27	4.8
98 03 02	4.9	1998.164	1.68	11.43	20
98 03 03	5.85	1998.167	2.46	20.68	10.2
98 03 04	7.18	1998.17	2.46	18.23	2.4
98 03 05	11.74	1998.173	1.56	30.98	0
98 03 06	19.32	1998.175	2.53	109.5	6.4
98 03 07	68.68	1998.178	2.82	207.83	4.8
98 03 08	49.06	1998.181	4.16	215.06	0.6
98 03 09	43.88	1998.184	3.02	172.02	0
98 03 10	65.05	1998.186	5.11	166.59	2.8
98 03 11	50.78	1998.189	2.81	152.07	0
98 03 12	14.9	1998.192	2.71	63.31	38.6
98 03 13	76.61	1998.195	3.52	191.29	0
98 03 14	66.16	1998.197	3.11	235.69	0
98 03 15	10.09	1998.2	2.06	34.82	0.9
98 03 16	20.42	1998.203	2.56	57.22	8.2

98	03	17	52.28	1998.205	2.57	175.75	0.8
98	03	18	135.79	1998.208	3.08	396.26	0
98	03	19	118.46	1998.211	3.29	317.7	0
98	03	20	43.9	1998.214	3.67	192.86	1.2
98	03	21	73.81	1998.216	3.02	197.09	0.6
98	03	22	59.15	1998.219	3.26	180.93	6.3
98	03	23	110.12	1998.222	4.34	347.1	0
98	03	24	28.87	1998.225	3.84	169.96	8.4
98	03	25	124.49	1998.227	4.39	306.19	0
98	03	26	83.39	1998.23	3.54	261.2	4.1
98	03	27	154.46	1998.233	4.26	441.37	0
98	03	28	122.97	1998.236	4.29	318.47	0
98	03	29	164.35	1998.238	4.25	388.74	0
98	03	30	151.16	1998.241	5.24	415.1	0
98	03	31	187.58	1998.244	5.29	461.01	0
98	04	01	167.32	1998.247	5.73	486.82	0
98	04	02	121.32	1998.249	3.5	449.3	0
98	04	03	36.17	1998.252	4.44	150.21	0
98	04	04	80.84	1998.255	3.59	337.77	0.1
98	04	05	17.37	1998.258	3.62	72.44	18.7
98	04	06	35.25	1998.26	4.67	123.94	7.3
98	04	07	57.72	1998.263	4.06	210.36	0
98	04	08	85.16	1998.266	3.85	239.06	0
98	04	09	107.81	1998.268	3.67	329.4	0
98	04	10	45.05	1998.271	3.65	275.49	0
98	04	11	71.58	1998.274	3.24	222.51	0
98	04	12	72.65	1998.277	3.53	254.03	0
98	04	13	113.76	1998.279	3.79	375.74	0
98	04	14	160.9	1998.282	3.76	406.72	0
98	04	15	111.12	1998.285	3.52	278.11	0
98	04	16	25.27	1998.288	4.2	143.25	0
98	04	17	6.23	1998.29	3.26	10.65	1.4
98	04	18	38.16	1998.293	4.8	175.9	21.3
98	04	19	67.24	1998.296	3.45	263.06	4
98	04	20	43.73	1998.299	3.98	168.74	0.2
98	04	21	34.54	1998.301	3.21	207.61	0
98	04	22	54.49	1998.304	4.33	230.32	17.8
98	04	23	11.3	1998.307	3.3	33.22	17.6
98	04	24	28.92	1998.31	4.1	178.42	0.2
98	04	25	102.29	1998.312	4.91	312.06	4.2
98	04	26	39.38	1998.315	5.83	155.23	8.8
98	04	27	41.47	1998.318	5.62	173.13	0
98	04	28	21.25	1998.321	3.63	80.95	0
98	04	29	27.62	1998.323	3.3	151.2	0
98	04	30	24.92	1998.326	4.31	101.02	0
98	05	01	95.05	1998.332	4.87	337.64	1.9
98	05	02	151.17	1998.334	5.85	420.49	0
98	05	03	100.75	1998.337	4.26	394.78	0
98	05	04	79.44	1998.34	4.26	267.71	0
98	05	05	103.95	1998.342	6.3	303.77	6.2
98	05	06	59.25	1998.345	5.03	181.45	0
98	05	07	86.88	1998.348	4.64	274.11	0
98	05	08	58.11	1998.351	4.96	280.04	0
98	05	09	80.34	1998.353	3.62	302.43	0

98 05 10	52.75	1998.356	4.04	241.27	0
98 05 11	93.94	1998.359	3.41	384.92	0
98 05 12	37.01	1998.362	3.83	177.69	0
98 05 13	26.29	1998.364	3.88	106.57	0.2
98 05 14	25.96	1998.367	4.34	127.82	2.1
98 05 15	12.16	1998.37	4.15	60.11	0
98 05 16	14.5	1998.373	3.69	60.77	0
98 05 17	26.66	1998.375	3.12	184.72	2.1
98 05 18	106.07	1998.378	3.96	318.38	0
98 05 19	180.3	1998.381	5.45	387.17	0
98 05 20	170.84	1998.384	5.21	472.49	0
98 05 21	100.47	1998.386	4.76	347.48	0
98 05 22	101.31	1998.389	4.54	363.72	0
98 05 23	93.79	1998.392	5.93	479.37	0
98 05 24	51.9	1998.395	4.13	260.27	0
98 05 25	16.15	1998.397	7.11	58.15	0
98 05 26	71.04	1998.4	7.99	350.28	0
98 05 27	78.38	1998.403	6.16	322.97	0
98 05 28	80.91	1998.406	5.66	457.51	0
98 05 29	56.7	1998.408	5.07	505.16	0
98 05 30	136.2	1998.411	4.42	421.51	0.8
98 05 31	46.6	1998.414	3.21	296.5	0
98 06 01	109.21	1998.414	4.21	428.81	0
98 06 02	113.43	1998.416	3.55	432.07	0
98 06 03	19.93	1998.419	3.95	96.48	0
98 06 04	61.01	1998.422	3.87	243	0
98 06 05	183.21	1998.425	5.03	430.81	0
98 06 06	208.79	1998.427	6.02	440.17	0
98 06 07	192.76	1998.43	6.72	454.89	0
98 06 08	81.96	1998.433	5.87	319.68	0
98 06 09	80.31	1998.436	5.2	347.22	0
98 06 10	128.14	1998.438	4.21	437.78	0
98 06 11	163.81	1998.441	4.15	399.05	0
98 06 12	224.67	1998.444	5.76	493.2	0
98 06 13	238.69	1998.447	4.67	560.85	0
98 06 14	174.18	1998.449	4.19	465.57	0
98 06 15	226.68	1998.452	4.58	518.75	0
98 06 16	153.97	1998.455	3.89	436.37	0
98 06 17	62.03	1998.458	8.03	281.55	0
98 06 19	69.01	1998.463	6.2	342.22	0
98 06 20	53.7	1998.466	4.52	249.68	0
98 06 21	89.71	1998.469	4.83	317.63	0
98 06 22	171.57	1998.471	4	386.8	0
98 06 23	93.99	1998.474	7.73	365.95	0
98 06 24	30.28	1998.477	6.02	149.01	0
98 06 25	37.13	1998.479	6.18	197.98	0
98 06 26	36.74	1998.482	6.23	214.45	0
98 06 27	61.24	1998.485	4.32	260.48	0
98 06 28	152.79	1998.488	4.28	485.38	0
98 06 29	122.73	1998.49	4.62	336.5	0
98 06 30	104.16	1998.493	8.34	323.62	0
98 07 01	9.76	1998.496	5.76	16.48	0
98 07 02	45.99	1998.499	5.13	276.08	0

98 07 03	140.39	1998.501	6.06	374.12	0
98 07 04	99.74	1998.504	5.19	313.64	0
98 07 05	154.09	1998.507	5.61	481.05	0
98 07 06	59.86	1998.51	5	256.62	0
98 07 07	115.74	1998.512	4.12	378.54	0
98 07 08	133.71	1998.515	4.48	310.02	0
98 07 09	137.39	1998.518	7.97	484.98	0
98 07 10	31.78	1998.521	6.5	157.34	0
98 07 11	46.9	1998.523	6.05	244	0
98 07 12	27.4	1998.526	4.71	188.65	0
98 07 13	49.89	1998.529	4.19	284.97	0
98 07 14	97.67	1998.531	3.41	310.44	0
98 07 15	157.68	1998.534	5.4	358.7	0
98 07 16	183.94	1998.537	6.48	435.7	0
98 07 17	185.73	1998.54	4.75	444.1	0
98 07 18	139.81	1998.542	4.01	366.38	0
98 07 19	115.61	1998.545	5.48	336.36	0
98 07 20	142.74	1998.548	3.94	437.8	0
98 07 21	133.82	1998.551	4.49	344.88	0
98 07 22	33.67	1998.553	7.93	158.22	0
98 07 23	13.29	1998.556	5.32	33.78	0
98 07 24	44.92	1998.559	3.82	266.68	0
98 07 25	86.57	1998.562	4.28	283.24	0
98 07 26	96.08	1998.564	4.18	311.26	0
98 07 27	66.46	1998.567	3.83	217.03	0
98 07 28	164.61	1998.57	4.56	472.38	0
98 07 29	119.52	1998.573	3.75	320.67	0
98 07 30	11.69	1998.575	6.47	34.27	0
98 07 31	8.6	1998.578	4.79	14.15	0
98 08 01	54.83	1998.581	4.42	267.56	0
98 08 02	118.01	1998.584	5.7	300.27	0
98 08 03	164.72	1998.586	4.95	423.11	0
98 08 04	166.82	1998.589	4.33	500.53	0
98 08 05	172.27	1998.592	4.85	515.25	0
98 08 06	202.54	1998.594	4.42	567.83	0
98 08 07	160.42	1998.597	4.86	521.9	0
98 08 08	122.2	1998.6	7.23	467.69	0
98 08 09	34	1998.603	6.08	152.29	0
98 08 10	21.98	1998.605	6.17	123.8	0
98 08 11	121.89	1998.608	5.89	390.77	0
98 08 12	168.74	1998.611	6.24	373.28	0
98 08 13	188.93	1998.614	5.61	441.78	0
98 08 14	190.9	1998.616	5.02	429.54	0
98 08 15	144.04	1998.619	4.88	351.1	0
98 08 16	135.56	1998.622	6.04	336.87	0
98 08 17	144.31	1998.625	4.62	354.7	0
98 08 18	174.31	1998.627	4.82	441.84	0
98 08 19	152.58	1998.63	5.9	426.01	0
98 08 20	129.7	1998.633	4.22	399.86	0
98 08 21	88.88	1998.636	5.29	323.72	1.5
98 08 22	98.8	1998.638	4.64	328.09	0
98 08 23	72.81	1998.641	3.53	349.78	0
98 08 24	83.74	1998.644	4.46	304.46	0
98 08 25	149.63	1998.647	4.96	460.54	0

98	08	26	130.51	1998.649	5.34	538.48	0
98	08	27	79.56	1998.652	5.12	239.75	0
98	08	28	65.34	1998.655	5.37	269.67	0
98	08	29	115.84	1998.658	5.83	348.75	0
98	08	30	220.3	1998.66	4.53	598.32	0
98	08	31	211.88	1998.663	5.14	573.15	0
98	09	01	186.15	1998.666	4.86	571.47	0
98	09	02	165.32	1998.668	4.76	502.56	0
98	09	03	146.29	1998.671	4.76	498.98	0
98	09	04	132.35	1998.674	4	458.5	0
98	09	05	140.35	1998.677	4.97	474.15	1.5
98	09	06	166.84	1998.679	4.3	541.29	0
98	09	07	55.09	1998.682	6.25	222.63	0
98	09	08	158.18	1998.685	6.49	607.98	0
98	09	09	146.16	1998.688	5.58	481.72	0
98	09	10	95.8	1998.69	5.15	372.51	0
98	09	11	135.97	1998.693	4.49	464.01	0
98	09	12	148.67	1998.696	5.13	493.45	0
98	09	13	108.58	1998.699	4.61	322.47	0
98	09	14	85.05	1998.701	3.65	286.05	0.8
98	09	15	137.67	1998.704	5.15	537.65	0
98	09	16	85.66	1998.707	6.2	379.96	0
98	09	17	81.93	1998.71	7.06	319	0
98	09	18	63.36	1998.712	5.8	216.71	0
98	09	19	56.94	1998.715	5.17	294.11	0
98	09	20	34.93	1998.718	4.82	162.68	0
98	09	21	97.12	1998.721	4.28	374.2	0
98	09	22	91.76	1998.723	4.02	398.81	0.3
98	09	23	37.08	1998.726	3.87	225.46	0
98	09	24	20.27	1998.729	3.41	126.69	5.4
98	09	25	44.78	1998.732	4.78	193.73	0
98	09	26	86.65	1998.734	4.94	244.48	0
98	09	27	79.4	1998.737	4.96	237.83	0
98	09	28	86.51	1998.74	5.82	359.32	0
98	09	29	107.77	1998.742	5.23	391.26	0
98	09	30	101.33	1998.745	5.81	409.25	0
98	10	01	58.52	1998.751	4.74	320.38	0
98	10	02	47.84	1998.753	4.05	257.52	0
98	10	03	36.74	1998.756	3.96	212.25	0
98	10	04	75.04	1998.759	3.85	356.94	0
98	10	05	87.33	1998.762	4.39	382.9	0
98	10	06	88.21	1998.764	3.21	354.12	0
98	10	07	107.65	1998.767	4.16	408.36	0
98	10	08	55.29	1998.77	4.77	264.6	0
98	10	09	122.34	1998.773	4.93	454.85	0
98	10	10	89.34	1998.775	4.87	239.86	0
98	10	11	76.95	1998.778	5.73	229.77	34
98	10	12	86.65	1998.781	4.75	296.17	0
98	10	13	112.73	1998.784	4.69	334.96	0
98	10	14	89.92	1998.786	4.69	330.7	0
98	10	15	80.63	1998.789	5.38	302.8	0
98	10	16	79.5	1998.792	5.12	254.65	0
98	10	17	88.89	1998.795	5.62	332.68	0
98	10	18	73.65	1998.797	4.05	301.15	0

98 10 19	125.13	1998.8	4.72	390.02	0
98 10 20	86.93	1998.803	4.7	334.14	0
98 10 21	114.68	1998.805	5.62	341.29	16.9
98 10 22	85.21	1998.808	8.08	310.93	6.2
98 10 23	102.41	1998.811	6.4	356.32	0
98 10 24	29.27	1998.814	4.25	146.97	0.1
98 10 25	80.76	1998.816	4.44	264.93	0
98 10 26	109.37	1998.819	4.27	338.4	0
98 10 27	108.81	1998.822	3.85	327.19	0
98 10 28	28.92	1998.825	4.91	131.72	0.9
98 10 29	36.11	1998.827	3.93	189.2	0.4
98 10 30	50.65	1998.83	4.88	180.66	1.4
98 10 31	7.6	1998.833	4.35	15.96	0.4
98 11 01	22.89	1998.833	6.72	74.81	13.5
98 11 02	29.49	1998.836	3.93	131.72	5.4
98 11 03	42.69	1998.838	4.39	130.95	30.8
98 11 04	64.69	1998.841	3.82	202.67	0
98 11 05	69.35	1998.844	4.82	209.31	4.6
98 11 06	29.87	1998.847	5.46	208.84	13.5
98 11 07	91.32	1998.849	4.67	271.88	0
98 11 08	93.12	1998.852	4.55	300.58	0
98 11 09	90.17	1998.855	4.28	333.53	0
98 11 10	28.77	1998.858	5.98	93.79	0
98 11 11	68.38	1998.86	3.4	249.3	12.9
98 11 12	21	1998.863	5.39	49.97	0.8
98 11 13	24.31	1998.866	3.63	82.37	25.5
98 11 14	88.87	1998.869	4.59	306.4	1.2
98 11 15	90.49	1998.871	5.3	324.76	0.4
98 11 16	103.53	1998.874	4.69	360.79	0
98 11 17	120.01	1998.877	4.83	337.19	8.6
98 11 18	102.14	1998.879	4.57	366.78	0
98 11 19	103.32	1998.882	4.42	406.04	0
98 11 20	42.81	1998.885	3.31	250.72	0
98 11 21	17.09	1998.888	4.28	88.87	25.6
98 11 22	60.35	1998.89	4.08	166.74	0
98 11 23	51.41	1998.893	4.5	146.11	0
98 11 24	78.64	1998.896	3.5	204.92	0
98 11 25	88.36	1998.899	4.32	298.67	0
98 11 26	54.36	1998.901	2.74	264.83	0
98 11 27	11.59	1998.904	3.47	28.57	8
98 11 28	18.55	1998.907	3.65	78.85	0.4
98 11 29	33.16	1998.91	4.55	136.94	2
98 11 30	29	1998.912	5.89	103.69	2.8
98 12 01	18.8	1998.915	5.81	65	50
98 12 02	34.81	1998.918	5.04	119.02	0.9
98 12 03	36.77	1998.921	4.29	187.82	8.6
98 12 04	37.53	1998.923	4.27	142.09	30
98 12 05	11.09	1998.926	4.12	34.81	10.8
98 12 06	6.95	1998.929	4.28	12.03	2.6
98 12 07	7.01	1998.932	2.92	21.95	2.4
98 12 08	5.69	1998.934	2.99	19.27	21.8
98 12 09	15.69	1998.937	4.9	65.71	38.9
98 12 10	30.03	1998.94	6.18	79.66	40.4
98 12 11	67.65	1998.943	3.57	178.22	4.6

98 12 12	48.4	1998.945	4.63	142.15	5.3
98 12 13	16.23	1998.948	2.09	50.59	0.1
98 12 14	15.8	1998.951	2.62	50.97	22.2
98 12 15	15.75	1998.953	3.68	53.71	6.8
98 12 16	29.3	1998.956	4.84	78.51	0.3
98 12 17	62.9	1998.959	2.99	232.7	0
98 12 18	61.52	1998.962	4.08	183.5	0
98 12 19	53.3	1998.964	2.95	158.69	0.6
98 12 20	52.78	1998.967	2.74	162.72	0.4
98 12 21	27.66	1998.97	1.8	107.03	0
98 12 22	34.48	1998.973	2.65	119.97	15.3
98 12 23	19.72	1998.975	5.7	69.47	0.1
98 12 24	25.1	1998.978	3.87	128.53	0.4
98 12 25	15.52	1998.981	2.51	31.95	12.2
98 12 26	9.17	1998.984	2.6	43.68	16
98 12 27	14.97	1998.986	2.65	60.59	19.9
98 12 28	15.58	1998.989	1.94	45.92	13.9
98 12 29	8.07	1998.992	2.03	29.34	5.4
98 12 30	10.26	1998.995	4.16	30.4	4.8
98 12 31	13.15	1998.997	4.49	39.99	2
99 01 01	37.81	1999	3.92	150.11	3
99 01 02	39.67	1999.003	3.82	141.88	0.2
99 01 03	31.47	1999.005	3.56	90.32	0.3
99 01 04	48.59	1999.008	3.67	121.21	6
99 01 05	74.01	1999.011	3.35	195.95	0.2
99 01 06	68.46	1999.014	2.32	227.54	0.1
99 01 07	20.25	1999.016	3	56.56	21.1
99 01 08	11.98	1999.019	2.11	32.71	13
99 01 09	17.5	1999.022	3.4	52.95	14.9
99 01 10	15.89	1999.025	2.1	63.28	8.4
99 01 11	44.92	1999.027	3.06	151.76	1.1
99 01 12	28.69	1999.03	1.45	107.55	0
99 01 13	27.83	1999.033	1.3	105.39	14.9
99 01 14	14.02	1999.036	1.43	47.76	0.7
99 01 15	17.17	1999.038	1.87	54.16	4.5
99 01 16	9.75	1999.041	1.96	35.17	18.8
99 01 17	11.51	1999.044	2.52	45.73	4.4
99 01 18	16.2	1999.047	2.33	79.56	0
99 01 19	24.29	1999.049	2.9	72.05	1.4
99 01 20	25.49	1999.052	2.13	77.29	0
99 01 21	10.7	1999.055	2.23	25.57	40.3
99 01 22	12.11	1999.057	2.6	42.99	4
99 01 23	11.84	1999.06	2.71	28.3	45.3
99 01 24	24.72	1999.063	3.84	58.13	0.6
99 01 25	45.09	1999.066	4.47	201.18	0.1
99 01 26	20.9	1999.068	2.42	83.23	0
99 01 27	35.88	1999.071	3.14	133.47	9.7
99 01 28	28.73	1999.074	3.13	128.11	5.6
99 01 29	15.22	1999.077	2.56	42.64	2
99 01 30	24.12	1999.079	2.85	110.6	0.6
99 01 31	5.58	1999.082	2.41	13.17	24.3
99 02 01	19.22	1999.085	2	86.23	21.7
99 02 02	23.72	1999.088	2.16	87.85	10.5
99 02 03	17.8	1999.09	1.55	52.79	36.7

99 02 04	28.15	1999.093	3.04	104.88	3.4
99 02 05	51.29	1999.096	2.08	139.82	3.3
99 02 06	14.83	1999.099	1.49	72.57	17.7
99 02 07	7.11	1999.101	1.41	36.69	7.7
99 02 08	4.02	1999.104	1.76	9.74	31.9
99 02 09	6.47	1999.107	0.93	16.36	25.8
99 02 10	4.74	1999.11	2.91	12.15	44.3
99 02 11		1999.113			3.5
99 02 12		1999.115			0
99 02 13		1999.118			0.2
99 02 14		1999.12			9.3
99 02 15		1999.123			6.2
99 02 16		1999.125			0.7
99 02 17		1999.128			8.6
99 02 18	6.59	1999.131	1.16	25.32	50.7
99 02 19	18.72	1999.134	1.71	62.59	28.2
99 02 20	20.16	1999.137	1.63	103.22	6.6
99 02 21	28.12	1999.14	1.81	131.22	5
99 02 22	8.26	1999.142	1.83	33.44	0
99 02 23	8.7	1999.145	2.08	42.38	24.5
99 02 24	10.24	1999.148	1.93	39.51	9.7
99 02 25	8.93	1999.151	1.42	25.46	0
99 02 26	16.62	1999.153	1.76	57.88	0
99 02 27	24.3	1999.156	3.05	82.26	2.7
99 02 28	42.88	1999.159	2.79	157.37	9.6
99 03 01	32.34	1999.162	2.31	100.73	14.2
99 03 02	57.16	1999.164	2.76	142.86	0
99 03 03	32.95	1999.167	2.82	117.98	0.7
99 03 04	37.43	1999.17	2.12	131.85	0
99 03 05	39.81	1999.173	2.89	97.3	4.5
99 03 06	67.52	1999.175	2.5	160.35	0
99 03 07	52.65	1999.178	2.38	149.44	0
99 03 08	12.23	1999.181	1.86	53.9	3.9
99 03 09	25.55	1999.184	2.25	90.48	13.7
99 03 10	18.5	1999.186	1.86	60.65	13.6
99 03 11	22.54	1999.189	2.98	87.79	20.7
99 03 12	10.81	1999.192	2.35	27.61	43
99 03 13	18.14	1999.195	2	59.74	12.3
99 03 14	12.21	1999.197	2.14	35.38	1.1
99 03 15	8.98	1999.2	2.73	40.49	32.8
99 03 16	7.23	1999.203	3.93	17.56	2.2
99 03 17	5.59	1999.205	1.84	12.97	41.6
99 03 18	20.98	1999.208	2.12	62.01	8.7
99 03 19	19.96	1999.211	1.69	75.14	7.8
99 03 20	21.69	1999.214	1.43	83.62	2
99 03 21	28.96	1999.216	1.52	116.47	15.6
99 03 22	37.63	1999.219	1.88	130.04	3.4
99 03 23	11.67	1999.222	2.23	31.14	18.9
99 03 24	26.02	1999.225	2.82	75.24	11.3
99 03 25	42.79	1999.227	1.55	110.92	9.8
99 03 26	50.61	1999.23	2.43	164.02	2.2
99 03 27	37.17	1999.233	2.35	127.07	9.8
99 03 28	42.69	1999.236	2.66	179.17	3.8
99 03 29	17.32	1999.238	1.61	59.29	2

99	03	30	14.33	1999.241	3.12	53.4	9.8
99	03	31	11.43	1999.244	2.76	37.36	0
99	04	01	8.74	1999.247	1.6	18.57	60.2
99	04	02	5.99	1999.249	2.26	13.25	9.1
99	04	03	18.89	1999.252	2.3	45.61	6.7
99	04	04	24.97	1999.255	1.83	72.36	2
99	04	05	31.06	1999.258	2.38	109.23	22.2
99	04	06	36.59	1999.26	2.51	104.89	6.6
99	04	07	64.18	1999.263	3.1	151.59	0
99	04	08	59.88	1999.266	3.41	148.75	0
99	04	09	82.06	1999.268	2.61	250.02	0
99	04	10	14.66	1999.271	1.89	52.53	6.7
99	04	11	27.6	1999.274	1.45	75.82	9.7
99	04	12	13.83	1999.277	1.85	52.4	0
99	04	13	16.6	1999.279	2.15	72.49	0
99	04	14	59.73	1999.282	2.36	138.63	0
99	04	15	32.69	1999.285	2.29	110.59	1
99	04	16	45.97	1999.288	2.95	129.06	0
99	04	17	58.15	1999.29	3.13	173.79	0
99	04	18	79.17	1999.293	4.27	210.31	0
99	04	19	81.76	1999.296	4.04	225.71	0
99	04	20	69.38	1999.299	2.66	216.64	0
99	04	21	33.56	1999.301	2.33	141.36	0
99	04	22	7.56	1999.304	2.9	18.52	0
99	04	23	9.57	1999.307	4.53	28.08	0
99	04	24	31.41	1999.31	4.71	180.89	7
99	04	25	64.75	1999.312	5.21	204.08	0
99	04	26	102.11	1999.315	3.62	283.86	1.2
99	04	27	108.01	1999.318	7.17	235.24	0.2
99	04	28	43.69	1999.321	5.05	146.75	0
99	04	29	81.22	1999.323	5.51	230.97	0
99	04	30	85.55	1999.326	4.18	258.77	0
99	05	01	82.97	1999.332	5.49	273.93	0
99	05	02	90.76	1999.334	4.7	234.71	0
99	05	03	29.53	1999.337	4.95	144.51	0
99	05	04	27.86	1999.34	4.67	172.15	0
99	05	05	10.67	1999.342	3.35	44.38	0
99	05	06	25.54	1999.345	2.85	135.88	0
99	05	07	54.32	1999.348	3.12	229.53	0
99	05	08	49.27	1999.351	3.38	173.57	0
99	05	09	45.43	1999.353	4.02	146.14	0
99	05	10	111.95	1999.356	4.99	266.79	0
99	05	11	114.98	1999.359	5.67	306.18	0
99	05	12	143.23	1999.362	4.54	330.56	0
99	05	13	153.9	1999.364	5.11	345.27	0
99	05	14	173.15	1999.367	4.24	350.07	0
99	05	15	166.04	1999.37	3.95	373.83	0
99	05	16	169.67	1999.373	3.26	411.93	0
99	05	17	139.1	1999.375	4.5	285.91	0
99	05	18	102.84	1999.378	3.85	287.89	0
99	05	19	77.5	1999.381	3.31	259.79	0
99	05	20	95.27	1999.384	4.1	291.99	0
99	05	21	143.98	1999.386	4.21	300.54	0
99	05	22	138.41	1999.389	4.19	368.21	0

99 05 23	149.66	1999.392	4.15	366.24	0
99 05 24	157.07	1999.395	4.61	309.94	0
99 05 25	154.36	1999.397	3.63	351.94	0
99 05 26	108.35	1999.4	4.01	357.22	0
99 05 27	55.69	1999.403	4.07	238.09	0
99 05 28	99.65	1999.406	3.2	273.11	0
99 05 29	144.01	1999.408	4.48	379.88	0
99 05 30	173.2	1999.411	4.06	376.58	0
99 05 31	147.5	1999.414	4	331.24	0
99 06 01	140.54	1999.414	4.97	326.4	0
99 06 02	66.9	1999.416	5.65	213.02	0
99 06 03	133.37	1999.419	5.46	389.09	0
99 06 04	163.23	1999.422	3.99	390.9	0
99 06 05	195.24	1999.425	3.99	473.72	0
99 06 06	193.2	1999.427	4.96	494.68	0
99 06 07	89.17	1999.43	4.66	267.56	0
99 06 08	94.87	1999.433	6.35	289.53	1
99 06 09	179.07	1999.436	5.56	417.2	0
99 06 10	150.94	1999.438	4.63	312.36	0
99 06 11	89.63	1999.441	6.66	311.79	0
99 06 12	147.94	1999.444	4.61	311.01	0
99 06 13	185.83	1999.447	4.81	414.56	0
99 06 14	166.45	1999.449	6.13	392.83	0
99 06 15	83.74	1999.452	5.65	222.99	0
99 06 16	78.29	1999.455	3.75	290.55	0
99 06 17	55.64	1999.458	4.54	285.64	0
99 06 18	21.85	1999.46	3.62	52.21	0
99 06 19	58.44	1999.463	5.29	360.45	0
99 06 20	149.76	1999.466	4.53	422.47	0
99 06 21	49.19	1999.469	5.8	325.15	0
99 06 22	11.56	1999.471	6.48	21.7	0
99 06 23	16.64	1999.474	7.06	95.75	0
99 06 24	12.2	1999.477	4.5	38.36	0
99 06 25	9.27	1999.479	4.06	18.25	0
99 06 26	16.18	1999.482	4.35	42.82	0
99 06 27	20.24	1999.485	5.07	69.32	0
99 06 28	32.32	1999.488	5.65	187.72	0
99 06 29	57.93	1999.49	4.2	313.48	0
99 06 30	66.17	1999.493	4.32	285.11	0
99 07 01	46.94	1999.496	5.4	233.29	0
99 07 02	7.49	1999.499	5.03	10.42	0
99 07 03	7.61	1999.501	4.5	12.91	0
99 07 04	11.88	1999.504	5.84	28.41	0
99 07 05	46.85	1999.507	3.77	222.22	0
99 07 06	67.54	1999.51	3.61	269.26	0
99 07 07	163.4	1999.512	3.73	434.79	0
99 07 08	174.18	1999.515	4.23	407.54	0
99 07 09	143.76	1999.518	3.58	391.73	0
99 07 10	114.87	1999.521	4.39	405.12	0
99 07 11	161.87	1999.523	5.27	324.6	0
99 07 12	126.08	1999.526	5.01	392.71	0
99 07 13	150.11	1999.529	5.32	417.72	0
99 07 14	177.36	1999.531	5.26	449.84	0

99 07 16	171.44	1999.537	6.58	383.06	0
99 07 17	169.14	1999.54	5.91	401.95	0
99 07 18	152.67	1999.542	5.41	371.22	0
99 07 19	174.08	1999.545	5.92	382.43	0
99 07 20	163.41	1999.548	6.64	434.16	0
99 07 21	139.06	1999.551	5.99	309.89	0
99 07 22	66.72	1999.553	5.99	331.62	0
99 07 23	56.39	1999.556	5.1	467	0
99 07 24	56.16	1999.559	6.85	293.37	0
99 07 25	40.83	1999.562	5.58	202.62	0
99 07 26	58.4	1999.564	5.09	335.46	0
99 07 27	49.37	1999.567	4.37	243.28	0
99 07 28	161.92	1999.57	3.89	451.05	0
99 07 29	128.75	1999.573	4.7	380.85	0
99 07 30	68.47	1999.575	4.6	241.35	0
99 07 31	55.22	1999.578	3.72	243.97	0
99 08 01	29.09	1999.581	5.54	107.42	0
99 08 02	67.2	1999.584	4.87	257.94	0
99 08 03	135.59	1999.586	5.2	388.95	0
99 08 04	114.44	1999.589	4.97	346.43	0
99 08 05	117.4	1999.592	4.6	284.43	0
99 08 06	41.66	1999.594	4.73	134.82	0
99 08 07	55.45	1999.597	4.29	227.02	0
99 08 08	123.17	1999.6	4.61	639.84	0
99 08 09	196.28	1999.603	5.14	687.49	0
99 08 10	101.97	1999.605	4.81	279.56	0
99 08 11	90.47	1999.608	5.08	300.85	0
99 08 12	109.69	1999.611	4.64	383.24	0
99 08 13	172.26	1999.614	5.65	517.15	0
99 08 14	112.69	1999.616	7.5	494.81	0
99 08 15	40.03	1999.619	4.33	187.14	0
99 08 16	57.57	1999.622	3.54	205.98	0
99 08 17	81.69	1999.625	4.71	320.64	0
99 08 18	113.08	1999.627	5.04	332.58	0
99 08 19	47.98	1999.63	3.31	222.07	0
99 08 20	79.71	1999.633	3.1	311.69	0
99 08 21	121.9	1999.636	3.69	293.45	0
99 08 22	119.69	1999.638	3.74	432.96	0
99 08 23	137.51	1999.641	3.81	496.11	0
99 08 24	92.36	1999.644	4.62	572.37	0
99 08 25	106.7	1999.647	5.7	394.33	0
99 08 26	107.98	1999.649	3.93	325.81	0
99 08 27	155.98	1999.652	6.03	530.96	0
99 08 28	106.24	1999.655	7	301.27	0
99 08 29	148.18	1999.658	4.79	397.3	0
99 08 30	185.12	1999.66	5.19	479.36	0
99 08 31	162.59	1999.663	4.43	396.3	0
99 09 01	138.3	1999.666	5.72	388.02	0
99 09 02	129.16	1999.668	5.33	417.49	0
99 09 03	107.88	1999.671	4.92	287.21	0
99 09 04	98.05	1999.674	4.73	283.84	0
99 09 05	104.45	1999.677	3.55	436.56	0
99 09 06	120.91	1999.679	4.78	407.25	0
99 09 07	126.88	1999.682	5.86	520.14	0

99	09	08	141.06	1999.685	6.25	516.96	0
99	09	09	120.03	1999.688	5.07	356.54	0
99	09	10	124.33	1999.69	5.17	555.3	0
99	09	11	106.28	1999.693	4.71	323.9	0
99	09	12	86.34	1999.696	5.94	284.39	0
99	09	13	176.12	1999.699	5.4	579.76	0
99	09	14	119.86	1999.701	6.19	446.19	0
99	09	15	78.81	1999.704	5.58	338.97	0
99	09	16	134.62	1999.707	4.9	575.11	0
99	09	17	100.3	1999.71	4.63	474.87	0
99	09	18	52.97	1999.712	4.08	247.4	0
99	09	19	69.72	1999.715	6.03	330.48	0
99	09	20	125.93	1999.718	5.67	445.27	0
99	09	21	81.82	1999.721	5.52	300.37	0
99	09	22	14.24	1999.723	4.3	36.43	0
99	09	23	36.55	1999.726	5.22	223.34	0
99	09	24	78.83	1999.729	4.85	398.83	0
99	09	25	119.21	1999.732	4.46	579.94	0
99	09	26	66.95	1999.734	3.78	334.74	0
99	09	27	92.97	1999.737	4.11	451.67	0
99	09	28	91.81	1999.74	4.43	338.49	0
99	09	29	93.28	1999.742	4.39	381.45	0
99	09	30	74.7	1999.745	3.29	321.11	0
99	10	01	41.28	1999.751	3.04	195.53	0
99	10	02	54.37	1999.753	3.32	224.01	0
99	10	03	77.79	1999.756	3.79	440.39	0
99	10	04	64.01	1999.759	4.86	345.38	0
99	10	05	44.03	1999.762	5.38	231.98	0
99	10	06	124.38	1999.764	6.01	427.02	0
99	10	07	79.7	1999.767	5.38	311.28	0
99	10	08	27.17	1999.77	4.07	147.68	0
99	10	09	26.58	1999.773	4.05	112.41	0
99	10	10	44.76	1999.775	3.58	195.39	0
99	10	11	37.75	1999.778	3.25	236.88	0
99	10	12	37.32	1999.781	4.26	195.95	0
99	10	13	75.37	1999.784	3.91	290.49	0
99	10	14	41.43	1999.786	3.55	148.8	0
99	10	15	35.02	1999.789	4.23	124.16	1.8
99	10	16	60.44	1999.792	4.59	222.49	0
99	10	17	41.71	1999.795	4.28	218.2	0
99	10	18	25.32	1999.797	4.28	140.97	0
99	10	19	48.75	1999.8	4.49	217.81	0
99	10	20	51.12	1999.803	4.67	173.53	0
99	10	21	26.99	1999.805	4.67	95.88	0
99	10	22	51.22	1999.808	3.79	158.49	0
99	10	23	67.73	1999.811	4.54	187.03	0.2
99	10	24	44.68	1999.814	3.93	176.19	1.4
99	10	25	54.7	1999.816	5.47	203.44	0.5
99	10	26	66.07	1999.819	5.87	319.66	0
99	10	27	40.14	1999.822	4.43	125.65	0
99	10	28	44.36	1999.825	4.5	186.79	0.3
99	10	29	58.06	1999.827	3.52	215.34	0
99	10	30	48.07	1999.83	4.92	171.6	0
99	10	31	65.91	1999.833	4.22	266.32	6.5

99 11 01	64.07	1999.833	4.66	235.13	0
99 11 02	28.21	1999.836	4.67	134.63	13.5
99 11 03	10.09	1999.838	5.18	36.26	24.6
99 11 04	37.27	1999.841	4.98	184.75	0.1
99 11 05	56.29	1999.844	3.85	180.94	0
99 11 06	36.94	1999.847	3.83	118.65	0
99 11 07	21.81	1999.849	2.43	107.27	0
99 11 08	28.72	1999.852	3.49	132.81	0
99 11 09	27.12	1999.855	4.17	104.88	4.2
99 11 10	17	1999.858	5.24	47.19	48.4
99 11 11	46.7	1999.86	5.71	157.93	0.1
99 11 12	88.92	1999.863	4.2	304.01	0
99 11 13	111.55	1999.866	4.47	295.62	0
99 11 14	98.11	1999.869	5.06	278.32	0
99 11 15	72.97	1999.871	4.83	305.45	0
99 11 16	63.93	1999.874	5.36	210.93	0
99 11 17	35.68	1999.877	4.85	175.03	0
99 11 18	24.28	1999.879	4	114.82	16.8
99 11 19	45.58	1999.882	4.67	173.75	39.4
99 11 20	66.39	1999.885	4.95	217.47	0.6
99 11 21	45.28	1999.888	4.25	162.3	1

Appendix B Monthly averaged radon concentration

Table B1 Monthly averaged radon concentration at Nabarlek, 1997–1999

Year	Month	radon [Bq/m^3]	decdate
97	1	9.37	1997.042
97	2	16.03	1997.125
97	3	54.7	1997.208
97	4	82.39	1997.292
97	5	159.51	1997.375
97	6	73.56	1997.458
97	7	136.09	1997.542
97	8	132.77	1997.625
97	9	145.23	1997.708
97	10	89	1997.792
97	11	51.6	1997.875
97	12	35.98	1997.958
98	1	18.58	1998.042
98	2	22.35	1998.125
98	3	68.71	1998.208
98	4	61.69	1998.292
98	5	77.25	1998.375
98	6	116.93	1998.458
98	7	92.1	1998.542
98	8	131.81	1998.625
98	9	102.8	1998.708
98	10	78.16	1998.792
98	11	58.99	1998.875
98	12	26.51	1998.958
99	1	26.46	1999.042
99	2	17.33	1999.125
99	3	27.25	1999.208
99	4	46.64	1999.292
99	5	107.61	1999.375
99	6	91.19	1999.458
99	7	106.18	1999.542
99	8	107.47	1999.625
99	9	100.41	1999.708
99	10	51.81	1999.792
99	11	48.05	1999.875

Appendix C Radon concentration at time of the day averaged over one month

Table C1 Radon concentration at time of the day averaged over one month each at Nabarlek, December 1996 – November 1999

time of day	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97
0:00	19.92	13.00	21.04	74.20	128.56	254.80
0:30	20.69	14.44	23.26	80.56	127.99	263.59
1:00	21.61	16.59	24.20	83.24	126.00	271.58
1:30	25.73	17.32	24.48	88.58	131.13	286.36
2:00	27.49	17.29	25.56	96.89	134.06	297.06
2:30	27.71	15.78	29.53	98.89	126.93	305.65
3:00	25.62	15.61	31.45	99.77	130.36	314.34
3:30	27.49	16.52	32.17	104.20	139.41	325.39
4:00	31.96	15.23	32.76	112.67	148.78	335.82
4:30	35.1	15.04	34.33	122.97	161.91	331.80
5:00	39.28	15.70	35.46	126.39	166.81	333.41
5:30	39.22	16.28	35.52	130.74	178.67	347.52
6:00	38.44	15.71	34.83	129.95	199.24	363.54
6:30	41.38	17.16	34.94	131.88	211.36	373.05
7:00	42.66	18.29	36.14	142.63	222.89	382.66
7:30	36.87	18.12	33.63	148.68	231.72	382.76
8:00	27.59	15.66	26.02	127.02	200.93	348.26
8:30	21.44	11.90	19.08	87.68	137.71	244.27
9:00	16.08	9.22	13.33	57.99	89.52	155.94
9:30	12.09	6.89	9.57	36.53	55.08	96.07
10:00	9.97	5.25	6.81	23.08	32.61	56.69
10:30	8.41	4.17	5.12	14.63	19.49	33.32
11:00	7.37	3.97	4.23	9.96	12.47	20.47
11:30	6.54	3.51	3.67	7.20	8.72	13.77
12:00	6.24	3.29	3.37	5.77	6.77	10.20
12:30	5.9	3.21	3.28	5.13	5.91	8.39
13:00	5.55	3.02	3.18	4.82	5.48	7.70
13:30	5.47	3.05	3.23	4.77	5.48	7.20
14:00	5.72	2.99	3.34	4.63	5.28	6.78
14:30	5.84	3.16	3.56	4.43	4.88	6.43
15:00	5.97	3.36	3.66	4.29	4.51	6.00
15:30	5.91	3.53	3.81	4.22	4.43	5.67
16:00	6.74	3.68	4.08	4.29	4.55	5.57
16:30	7.22	3.70	4.58	4.59	4.66	5.59
17:00	7	3.66	4.51	5.06	4.85	5.75
17:30	7.18	3.48	4.57	5.51	5.39	6.33
18:00	7.44	3.44	4.75	6.60	6.34	7.77
18:30	7.55	3.82	5.04	8.10	8.73	14.91
19:00	8.08	4.69	5.68	12.40	18.12	36.12
19:30	9.11	5.36	7.16	19.38	35.78	62.20
20:00	9.78	6.30	8.58	26.41	51.86	83.43
20:30	12.08	7.10	10.37	31.97	65.68	108.76
21:00	13.48	7.78	12.73	37.15	76.36	133.62
21:30	15.64	8.37	14.69	42.15	83.69	152.61
22:00	16.41	8.92	17.46	49.56	90.56	173.89
22:30	15.93	10.56	18.84	58.13	100.33	198.56
23:00	17.47	11.80	20.74	67.13	110.09	224.52
23:30	19.27	12.85	21.08	72.83	122.72	240.41

time of day	Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97
0:00	105.58	227.55	148.44	160.69	73.71	45.72
0:30	104.09	231.70	182.04	197.32	95.29	51.54
1:00	107.71	232.95	208.95	237.67	118.68	63.15
1:30	106.07	232.51	232.55	289.19	142.60	75.55
2:00	106.08	224.14	247.86	330.99	165.57	89.44
2:30	105.87	231.41	260.17	357.63	186.88	101.42
3:00	102.37	246.64	259.39	370.51	207.67	109.34
3:30	99.81	257.23	270.04	388.80	225.57	119.87
4:00	103.88	267.84	283.33	398.45	248.38	136.48
4:30	120.71	277.28	309.37	403.31	264.51	149.19
5:00	136.34	289.51	329.18	402.00	271.71	159.29
5:30	145.13	294.83	358.22	399.21	283.30	163.49
6:00	154.15	303.60	374.39	403.79	293.94	171.16
6:30	170.26	297.73	389.47	409.75	309.45	179.62
7:00	177.76	298.30	405.79	419.75	323.01	173.32
7:30	189.51	293.59	409.27	410.06	270.10	132.66
8:00	181.95	278.74	379.08	316.61	179.16	90.42
8:30	138.64	219.88	272.59	206.86	114.31	58.41
9:00	90.23	144.92	172.09	129.03	69.23	36.24
9:30	57.76	91.44	105.48	76.48	40.68	22.09
10:00	35.52	55.96	61.98	44.42	24.18	14.17
10:30	22.06	33.99	35.51	25.63	14.88	9.67
11:00	14.57	21.02	21.36	15.60	10.04	7.35
11:30	10.51	14.01	13.44	10.48	7.42	5.85
12:00	8.41	10.29	9.57	7.73	6.09	5.17
12:30	7.34	8.41	7.55	6.42	5.69	4.91
13:00	7.06	7.69	6.46	5.96	5.52	4.77
13:30	6.81	7.56	6.15	5.84	5.59	4.78
14:00	6.60	7.01	5.95	5.76	5.59	4.99
14:30	6.15	6.52	5.78	5.35	5.52	5.01
15:00	5.91	6.34	5.65	5.22	5.31	5.28
15:30	5.71	6.03	5.49	5.16	5.51	5.60
16:00	5.67	5.83	5.48	5.28	5.70	6.00
16:30	5.90	5.71	5.62	5.28	5.78	6.10
17:00	5.99	5.89	5.80	5.52	6.11	6.56
17:30	6.38	6.20	6.34	5.97	6.28	7.03
18:00	7.33	6.94	6.93	6.45	6.64	7.42
18:30	10.88	10.58	8.14	7.18	7.16	8.26
19:00	21.29	25.96	10.41	8.66	8.07	9.72
19:30	42.73	57.32	16.03	10.38	9.47	11.47
20:00	69.90	87.23	26.22	14.59	10.97	13.51
20:30	88.12	117.71	38.58	22.16	13.29	16.43
21:00	98.80	139.21	48.84	31.11	15.50	20.22
21:30	104.81	154.67	56.55	43.90	18.87	22.93
22:00	106.34	174.78	60.53	55.74	27.12	26.65
22:30	104.79	189.82	74.32	75.36	38.18	31.84
23:00	104.60	202.76	97.75	98.79	47.49	36.57
23:30	106.85	215.23	122.81	122.95	60.20	40.28

time of day	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98
0:00	55.95	27.91	34.10	108.71	102.88	156.26
0:30	56.95	31.38	36.05	114.77	106.42	141.99
1:00	59.29	34.28	37.71	117.07	106.00	130.71
1:30	63.15	37.46	41.17	119.73	106.54	125.64
2:00	70.45	37.60	40.57	121.95	106.69	122.50
2:30	73.91	35.30	38.72	127.34	106.33	121.55
3:00	78.63	32.94	37.01	133.07	106.02	122.46
3:30	81.90	36.23	35.93	138.77	108.18	120.63
4:00	82.03	39.10	36.88	141.73	109.81	120.37
4:30	86.61	40.91	38.21	141.70	114.41	123.21
5:00	89.62	41.24	41.89	145.72	117.34	124.07
5:30	90.65	41.09	45.09	152.64	123.82	129.41
6:00	89.42	40.91	48.29	153.74	130.33	134.43
6:30	90.66	39.94	53.80	157.97	136.71	131.17
7:00	86.88	39.14	57.65	164.43	143.81	127.89
7:30	72.01	37.25	57.58	173.01	146.32	127.84
8:00	52.13	27.92	46.73	155.68	131.45	117.40
8:30	35.57	19.63	32.42	109.17	92.89	84.92
9:00	23.87	13.84	21.57	70.55	60.47	55.58
9:30	15.91	9.77	13.96	43.66	38.04	35.96
10:00	10.82	7.00	9.22	26.32	23.77	22.61
10:30	7.87	5.34	6.23	15.79	14.83	14.62
11:00	6.20	4.39	4.78	9.98	9.80	10.20
11:30	5.33	3.99	3.86	7.08	7.10	7.53
12:00	4.91	3.94	3.38	5.40	5.72	6.46
12:30	4.73	3.76	3.24	4.42	5.05	5.98
13:00	4.65	3.70	3.06	4.09	4.79	5.60
13:30	4.87	3.64	3.30	4.00	4.72	5.76
14:00	4.87	3.61	3.49	4.03	4.64	5.50
14:30	4.92	3.69	3.82	4.06	4.60	5.59
15:00	5.00	3.84	3.81	3.97	4.74	5.50
15:30	5.14	3.94	3.66	4.04	4.56	5.58
16:00	5.40	3.99	4.15	4.22	4.70	5.60
16:30	5.68	4.00	4.64	4.28	4.93	5.97
17:00	5.89	4.19	4.87	4.40	5.28	6.04
17:30	6.56	4.34	5.27	4.84	5.83	6.53
18:00	7.11	4.54	6.01	5.63	6.60	7.76
18:30	7.58	4.86	6.42	7.46	9.50	13.28
19:00	8.47	5.34	7.59	13.94	20.19	33.82
19:30	10.24	6.55	9.77	27.68	37.53	66.69
20:00	12.89	8.61	12.40	35.17	53.80	94.57
20:30	16.55	11.88	15.90	42.79	64.41	116.43
21:00	20.70	13.96	17.27	51.15	68.53	131.37
21:30	26.43	16.48	19.27	61.56	69.52	141.60
22:00	32.98	18.46	22.10	74.19	70.54	149.49
22:30	39.14	21.35	26.58	81.44	74.29	155.87
23:00	45.16	23.52	30.47	91.93	84.17	158.93
23:30	51.27	24.87	32.91	102.92	92.76	159.30

time of day	Jun-98	Jul-98	Aug-98	Sep-98	Oct-98	Nov-98
0:00	192.43	149.20	175.83	129.53	85.24	86.63
0:30	187.68	162.22	193.63	155.99	96.25	95.90
1:00	190.49	173.79	211.05	181.31	110.22	106.07
1:30	193.47	180.77	232.28	203.48	124.21	114.23
2:00	192.48	188.35	252.81	215.91	140.01	121.36
2:30	190.27	188.07	268.10	225.20	161.27	126.07
3:00	192.86	189.64	283.06	232.47	172.93	129.91
3:30	193.09	192.27	291.30	239.01	183.01	136.36
4:00	196.45	193.56	297.05	249.02	198.54	140.91
4:30	202.44	193.54	296.92	255.98	211.23	145.55
5:00	205.84	184.31	302.30	271.43	220.99	145.41
5:30	211.02	169.06	310.46	289.42	238.33	150.18
6:00	220.65	165.68	315.84	293.91	247.82	157.52
6:30	225.60	167.47	316.86	303.61	254.66	157.14
7:00	230.78	172.11	318.84	303.29	254.49	149.62
7:30	229.80	177.72	321.57	292.37	219.01	120.53
8:00	223.52	179.81	303.15	228.54	151.94	82.94
8:30	180.19	142.49	225.88	151.89	98.08	54.37
9:00	120.65	93.47	147.27	95.89	60.47	34.61
9:30	76.98	59.57	92.10	58.13	36.13	21.48
10:00	47.00	37.04	55.46	34.62	21.78	13.83
10:30	28.93	22.55	32.74	21.07	13.62	9.57
11:00	17.65	14.47	20.18	13.52	9.39	7.17
11:30	11.75	10.10	12.81	9.57	7.09	6.02
12:00	8.67	7.80	9.28	7.57	6.13	5.54
12:30	7.41	6.76	7.67	6.39	5.61	5.44
13:00	6.73	6.15	6.84	5.90	5.42	5.21
13:30	6.40	5.82	6.17	5.77	5.31	5.39
14:00	6.12	5.86	5.81	5.86	5.40	5.36
14:30	5.69	5.74	5.82	5.66	5.44	5.40
15:00	5.63	5.56	5.67	5.45	5.52	5.37
15:30	5.57	5.64	5.73	5.50	5.66	5.60
16:00	5.75	5.63	5.57	5.51	5.71	5.66
16:30	5.88	5.71	5.65	5.63	6.10	6.25
17:00	6.23	6.02	5.95	5.89	6.45	6.71
17:30	7.29	6.26	6.33	6.31	7.11	7.12
18:00	8.43	7.27	7.15	6.92	7.44	8.08
18:30	13.90	9.52	11.18	7.98	8.15	10.12
19:00	36.88	19.03	27.93	9.91	10.26	14.90
19:30	77.25	40.69	45.63	13.58	13.37	21.04
20:00	116.28	62.09	58.16	18.56	17.01	26.71
20:30	145.58	77.28	72.69	23.28	21.55	30.79
21:00	166.74	89.78	83.75	27.29	26.86	36.78
21:30	189.82	103.58	97.52	31.86	33.61	42.46
22:00	202.75	118.45	116.17	43.30	40.11	52.26
22:30	210.11	129.15	134.81	57.36	50.56	59.45
23:00	207.75	138.50	150.08	72.84	62.57	67.50
23:30	197.82	145.17	167.76	94.82	73.78	79.12

time of day	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99
0:00	35.91	42.13	25.82	41.65	66.46	177.19
0:30	40.95	45.06	28.59	44.19	67.32	174.20
1:00	45.28	47.80	29.80	44.73	69.00	170.78
1:30	50.18	51.32	31.36	47.79	71.49	175.21
2:00	53.91	55.76	31.01	50.15	77.96	177.27
2:30	54.48	57.57	29.68	50.50	87.08	176.42
3:00	57.77	58.09	29.67	52.01	92.58	179.73
3:30	56.34	57.41	31.52	55.35	93.39	179.24
4:00	54.37	55.61	35.06	58.62	93.41	176.57
4:30	53.41	53.00	36.49	60.67	93.99	178.81
5:00	54.93	51.02	36.63	60.49	95.59	186.25
5:30	58.48	51.89	36.38	60.15	95.63	192.92
6:00	61.48	55.76	36.48	58.09	98.35	196.23
6:30	62.63	59.56	37.23	58.57	100.14	201.57
7:00	58.47	63.44	39.22	60.26	98.53	211.15
7:30	47.75	58.26	39.27	59.37	96.29	217.67
8:00	34.48	43.21	32.42	49.07	85.48	214.11
8:30	24.29	29.83	23.22	35.30	62.29	168.92
9:00	16.66	19.75	15.78	24.11	41.62	111.02
9:30	11.52	13.03	10.60	15.83	26.64	71.08
10:00	8.47	8.70	7.22	10.43	16.90	42.81
10:30	6.56	6.06	5.16	7.03	10.92	25.65
11:00	5.62	4.74	3.86	5.12	7.44	15.70
11:30	5.02	4.00	3.25	4.01	5.85	10.23
12:00	4.86	4.09	3.01	3.39	4.72	7.57
12:30	4.78	3.90	2.61	3.08	4.14	6.31
13:00	4.83	3.82	2.60	2.92	4.01	5.45
13:30	5.01	3.90	2.61	2.93	3.88	5.08
14:00	4.99	3.75	2.63	3.02	3.79	4.89
14:30	5.13	3.96	2.75	3.48	3.83	4.71
15:00	5.19	3.96	2.81	3.61	3.84	4.61
15:30	5.30	4.17	2.83	3.66	3.87	4.60
16:00	5.31	4.48	2.96	3.75	3.82	4.79
16:30	5.53	4.33	3.09	3.94	4.21	4.82
17:00	5.70	4.51	3.16	4.29	4.47	5.21
17:30	6.02	4.89	4.35	4.29	5.30	6.03
18:00	6.27	5.30	5.52	4.97	6.74	8.84
18:30	6.71	6.31	5.48	5.56	10.31	25.50
19:00	7.73	7.74	5.78	6.65	19.10	56.49
19:30	10.15	10.38	6.39	10.10	29.15	87.55
20:00	15.87	13.29	8.50	14.93	39.89	111.62
20:30	20.69	15.85	11.18	18.73	50.39	128.94
21:00	24.62	18.13	14.80	23.42	55.43	147.43
21:30	28.67	21.96	16.65	27.97	61.38	164.38
22:00	31.47	26.26	18.05	30.32	63.44	180.48
22:30	32.95	30.53	20.76	33.86	64.83	187.95
23:00	32.81	34.07	22.70	36.84	66.29	189.32
23:30	32.77	37.71	24.83	39.00	67.75	181.88

time of	Jun-99	Jul-99	Aug-99	Sep-99	Oct-99	Nov-99
0:00	179.23	183.53	152.09	106.01	47.85	76.09
0:30	177.96	190.72	158.93	126.18	59.68	81.09
1:00	171.13	192.64	169.79	147.66	71.14	86.22
1:30	168.82	198.11	181.85	165.07	80.97	92.31
2:00	167.73	203.88	190.83	177.88	90.63	91.83
2:30	160.29	203.34	200.60	195.40	102.75	95.39
3:00	151.19	199.29	208.63	215.06	105.99	98.43
3:30	142.97	203.32	223.93	233.99	109.35	100.23
4:00	138.20	200.22	240.90	247.51	115.50	99.91
4:30	136.68	199.20	245.38	258.24	119.51	100.72
5:00	138.92	197.86	258.60	264.30	133.09	106.47
5:30	142.06	210.43	258.90	277.56	147.90	115.20
6:00	144.30	211.90	259.82	279.85	165.47	123.21
6:30	149.57	216.01	261.49	292.06	183.85	131.11
7:00	159.61	215.13	267.63	311.21	190.10	125.91
7:30	162.15	210.62	260.44	324.17	164.42	98.87
8:00	161.46	201.09	240.68	268.56	116.15	69.21
8:30	133.74	161.53	178.17	182.45	76.27	47.88
9:00	89.41	109.53	115.11	116.90	47.92	30.98
9:30	58.04	70.75	72.19	71.44	28.67	20.30
10:00	36.44	44.29	43.82	42.36	17.91	13.97
10:30	22.83	26.27	26.30	25.14	11.72	10.06
11:00	14.91	17.23	16.48	15.52	8.44	7.97
11:30	10.42	11.82	11.15	10.45	6.54	6.65
12:00	8.20	8.97	8.42	8.11	5.63	6.12
12:30	7.29	7.55	7.00	6.85	5.17	5.60
13:00	6.69	7.07	6.47	6.29	5.20	5.51
13:30	6.35	6.69	6.10	5.94	5.07	5.44
14:00	6.28	6.58	5.92	5.78	5.03	5.66
14:30	6.06	6.09	5.63	5.55	5.10	5.48
15:00	5.74	6.04	5.37	5.49	5.00	5.55
15:30	5.53	5.59	5.26	5.67	5.20	5.81
16:00	5.71	5.49	5.09	5.34	5.53	6.18
16:30	6.02	5.61	5.13	5.53	5.86	6.43
17:00	6.47	5.94	5.63	5.97	6.44	6.75
17:30	6.94	6.47	6.00	6.52	7.19	7.12
18:00	9.09	7.47	6.77	7.49	7.33	8.10
18:30	17.75	12.14	9.99	8.11	8.29	9.08
19:00	41.65	28.05	18.18	9.42	10.48	12.42
19:30	71.86	51.52	27.78	11.58	12.39	14.28
20:00	99.83	66.41	34.89	14.58	14.25	17.18
20:30	121.00	82.70	50.58	19.47	15.43	26.89
21:00	136.37	101.39	68.56	24.04	17.46	35.68
21:30	144.52	125.62	90.82	35.77	18.17	44.66
22:00	156.04	145.14	114.06	45.85	19.90	50.76
22:30	159.54	164.26	129.71	58.93	24.26	56.02
23:00	162.31	174.79	142.35	72.66	30.63	60.33
23:30	162.01	180.36	149.29	83.87	40.19	69.55