The Goiania Accident
- Environmental Survey -

J M.Godoy, M.C.F.Moreira and E.S.da Fonseca

Institute of Radiation Protection and Dosimetry, IRD/CNEN

Introduction [1,2]

Not more than one day after the accident alarm the four main foci, as well as several secondary foci were identified (Fig. 1) During this phase, simple hand monitors were used, and one can say, more as a way to confirm verbal information about possible contamined places.

A.	IGR clinic	G.	Physicist W F 's house
B	Source first exposed	H	Olympic stadium
C	Junkyard I	J	General Hospital
D.	Junkyard II	K, L	Other contamination points
E	Junkyard III	M.	Initial CNEN command post
F.	Vigilância Sanitária	N:	Present CNEN office

Figure 1: Plan of Goiânia showing the principal sites of contamination

After the first days of activities in Goiânia, other survey methods were introduced in order to produce a detailed figure about the main foci and to verify the presence or not of additional contaminated areas

The objectives of the present work is to show when, where, why and how the different survey methods

have been applied during the Goiânia Accident.

Aerial Survey[2,3]

During the course of the initial phase of the response, it was necessary to confirm that all the major sources of contamination had indeed been traced To do this, an aerial survey of Goiânia was carried out.

A portable battery powered gamma spectrometer SCINTREX having NaI(Tl) detectors with a total volume of 830 cm^3 was used Most of the survey was flown at an altitude of 40 m and a ground speed between 50 and 70 km/h. A cycle of 80 m radius was effectively monitored and the sensitivity (two times the background) was 0.5 mSv/h at 1 meter

Over two days, all the urban area of Goiania was monitored (about 67 km^2) This confirmed that no sites of major contamination had been missed, and one discrete spot was found that gave rise to a dose rate of 21 mSv/h at 1 meter The Figure 2 shows a typical analogue record obtained over contaminated areas.

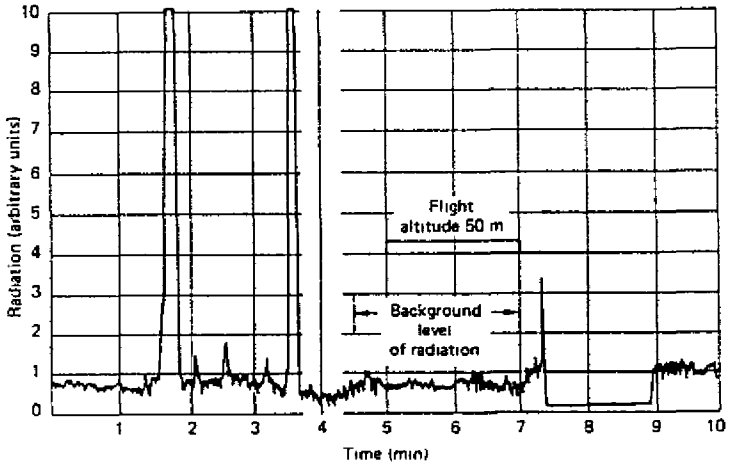

Figure 2: A recorder trace from an aerial radiation survey. The background reading was taken at 50 m altitude over open land away from the contaminated area of Goiânia The peaks represent radiometric anomalies over contaminated areas

Survey by Car[2,4]

It is still possible that sites of lesser contamination had been missed by the aerial survey, specially in the heavily contaminated sites which gave rise to high background readings A complementary system of monitoring that likewise could survey large areas, and was not as labor intensive as surveying with hand held instruments, was therefore necessary.

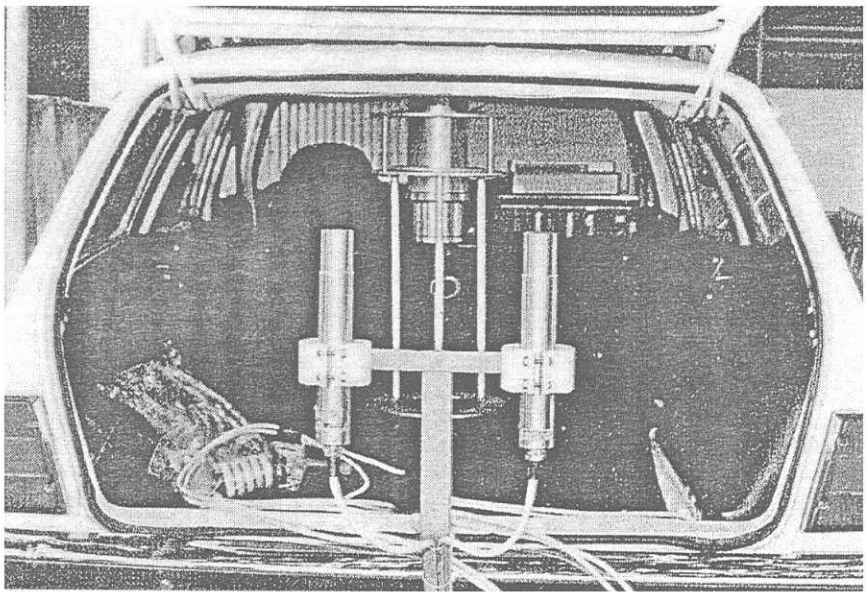

Figure 3: Mobile radiation monitoring: NaI and G-M detectors mounted on a car

Two Geiger-Müller detectors were placed outside of a station wagon, 1m above the ground, covering an exposure rate range from 10^{-4} to 10^{2} mSv/h. To assure a rapid response to naturally occurring exposure rates, an additional 10^{2} x 10^{2} mm NaI(Tl) detector was placed inside the vehicle 1 m above ground (Fig 3).

All streets of Goiania were traveled at a velocity of 20 km/h. At this condition, a 333 kBq source placed at the ground gave rise to a NaI(Tl) count rate twice the normal background. Information concerning the locations with exposure rates greater than 10^{-3} mSv/h was entered into a data base.

The mobile survey was performed until March 1988 and covered a distance of 2000 km across Goiânia's streets, representing 80% of the city's urban area. Based on the effectiveness of the mobile survey, this station wagon was integrated into the IRD/CNEN's emergency unit in early 1988.

Hand Held Survey[2]

In order to plane the intervention actions in the principal foci, an extensive measurement program was started aiming to obtain a more detailed picture of the contamination pattern in each place.

Depending on the contamination level different monitors and detectors were used, ranging from scintillometers to teledectors. An example of the obtained pictures is shown in Fig 4.

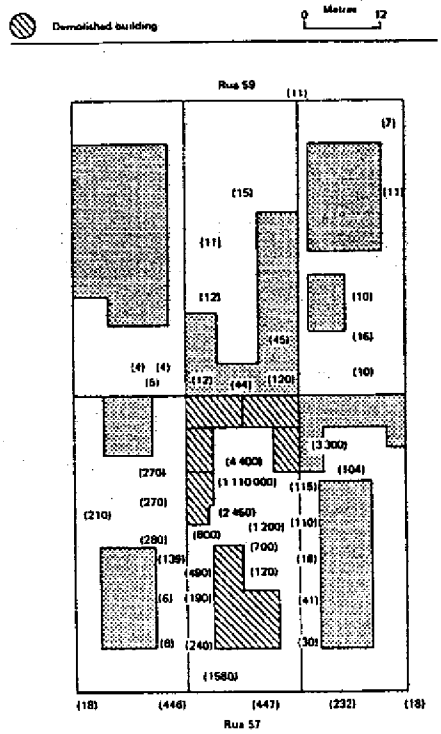

Figure 4: Dose rates (in μSv/h) around the house where the cesium source was broken in Rua 57 (57th Street).

Environmental Monitoring[2,5]

To quantify the environmental dispersion of cesium, more than 1300 measurements were performed in soil, vegetation, water and air samples. Emphasis was put on investigating areas near the main foci.

Initially, a multichannel analyzer with a 5 cm x 5 cm NaI(Tl) crystal was used at a special laboratory set up in Goiania. However, it was found that a single channel analyzer with a 7.5 cm x 7.5 cm crystal was sensitive enough for short (10 min) counting times, since only ^{137}Cs was present. For soil samples with ^{137}Cs concentrations higher than 100 Bq/kg, a good correlation between the Goiania measurements with NaI(Tl) and those performed in Rio using germanium detectors was found. For lower values the ^{137}Cs concentration was over-estimated due to the interference of the 609 keV gama ray of ^{214}Bi.

Based on the Goiania measurements, among others, it was possible to show that:

- The surface soil contamination follows the wind pattern (Fig. 5), showing the effect of resuspension and further dispersion.
- Leaf radioactivity closely paralleled of the soil in levels and distribution, owing to deposition of dust, a mechanism confirmed by the fact that washing reduced the contamination by 50%.

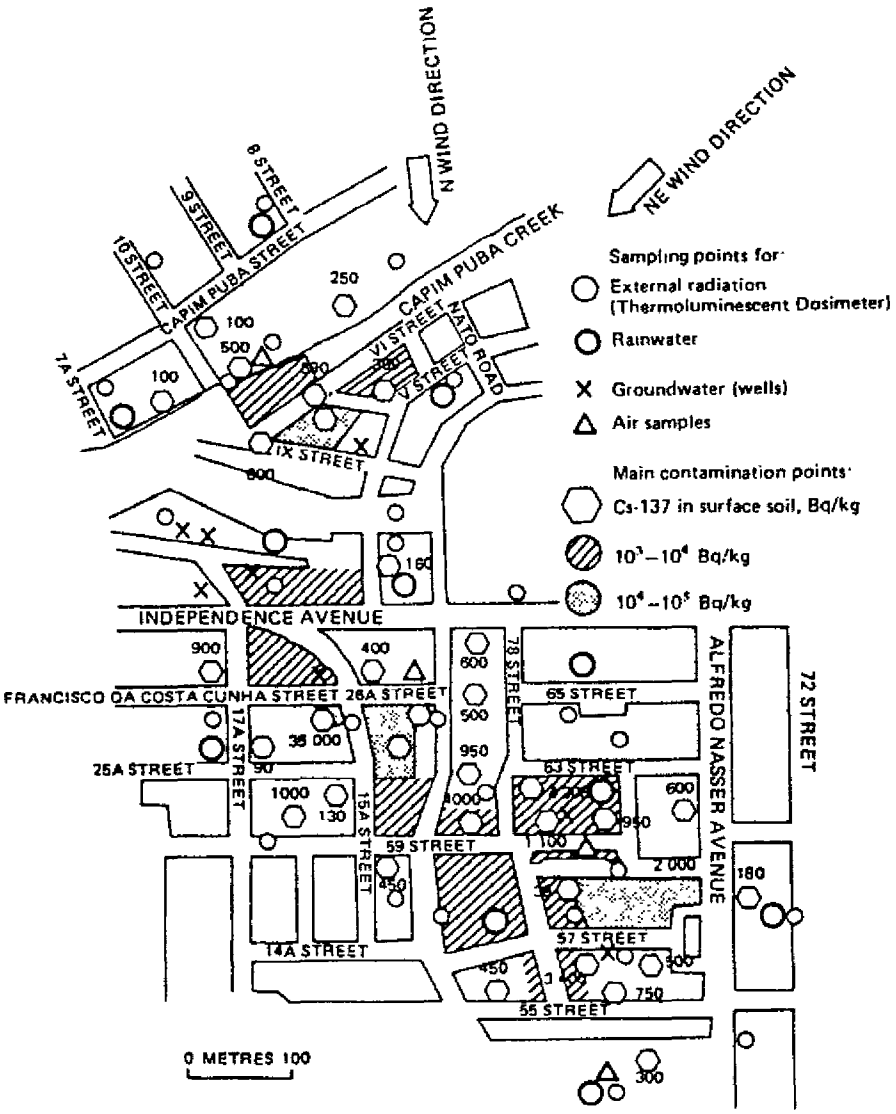

Figure 5: Plan of Aeroporto sector of Goiânia city showing the locations of the principal sites of contamination and the environmental survey sampling points.

Conclusion

The survey methods applied during the Goiania Accident could be considered complementary one to the other, and were able to give a clear picture about the contamination in the city to guide the further decontamination works.

References

1 J.J Rosenthal C E. de Almeida and A H. Mendonça - The Radiological Accident in Goiânia: The Initial Remedial Actions - Health Phys. 60, 7-15, 1991.

2 International Atomic Energy Agency - The Radiological Accident in Goiânia - IAEA, Vienna, 1988.

3. P.M.C. Barreto and E.S. da Fonseca - Levantamento Aeroradiométrico da Cidade de Goiânia após o Acidente com Cs-137 - Proceedings of the Segundo Congreso Geral de Energia Nuclear Vol. 3 pag. 47-57, Rio de Janeiro, April 1988

4 M C F Moreira - Radiological Survey of Goiânia by a Mobile Monitoring Unit - Health Phys. 60, 81-85, 1991

5 J M Godoy, J R D Guimarães, J C.A Pereira and M.A Pires do Rio - Cs-137 in the Goiânia Waterways During and After the Radiological Accident - Health Phys 60, 99-103, 1991.