RADIOTOXICOLOGICAL ASSESSMENT OF BURNS CONTAMINATED BY NITRIC SOLUTION OF PLUTONIUM

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Skin burn by nitric solutions of plutonium is a possible way of contamination during fuel reprocessing. Two well documented cases have been analyzed. They show that the initial transfer of Pu through the skin is very important. Conversely, there is practically no long-term release of Pu from the burn. Consequently, DTPA therapy can be considered as a medical emergency whereas there is no urgency for an eventual surgical operation.

In fuel reprocessing plants, the Occupational Physician may occasionally come across cases of burns contaminated with plutonium in nitric acid solutions. A long-term follow-up of excretion is necessary in order to assess the systemic burden correctly.

Initial urinary excretion, over about the first ten days following the incident, is essentially attributable to the activity that has passed rapidly into the blood. Measurements performed during this period represent the sum of the excretion relative to systemic burden and of the activity released from the burn, washed away by the circulating DTPA. Excretion over medium and long periods is more difficult to interpret. Measurements performed beyond the first month allow a theoretical determination of the activity transferred very slowly to the blood.

Two examples are presented. The theoretical function of urinary excretion relative to the activity that is rapidly transferred to the systemic target tissues (1, 2) allows us to find the systemic burden by applying a factor of 50 for the action of DTPA. The margin of uncertainty, taking into account the variability of DTPA action (25 at least, 100 at most), is shown by a hatched band. It is obvious that an interpretation with a view to determine a long-term released activity could have been envisaged only if several points had been situated clearly above this band beyond one month. As this is not the case, it can be considered that the long-term release of activity from the burn is virtually non-existent.

In the examples treated, only the rapid transfer component participates in the systemic burden. Internal exposure thus results from the activity which passes in the blood through at the time of the incident or in a few hours thereafter. Emergency medical therapy, i.e. the administration

of DTPA as soon as possible, washes away the plutonium released from the burn.

The local activity which persists for long periods seems above all to be "inert", not at all or very little metabolisable. It is not possible to show a component of slow transfer to the blood. This suggests that, contrary to the medical action which should be very rapid, possible surgical action can be calmly prepared for reducing to a minimum any anatomical and functional risks.

The argument of local dose may be raised, but it should be tempered in view of the very small distance travelled by the radiation and of the very low probability of alpha particles hiting critical target cells. If an excision is performed, it actually removes the irradiated tissues, thereby eliminating the associated risk of a high local dose.

REFERENCES

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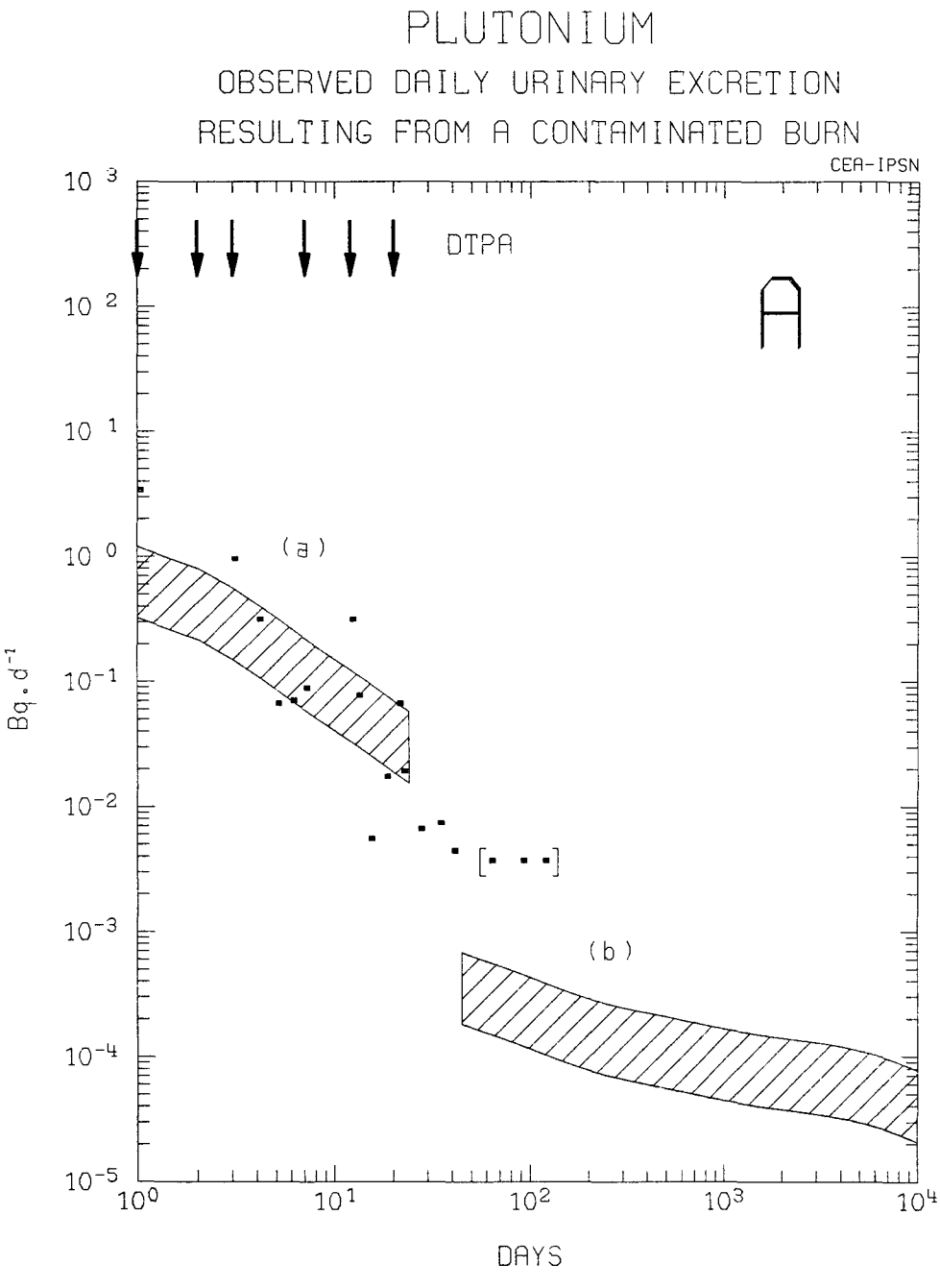
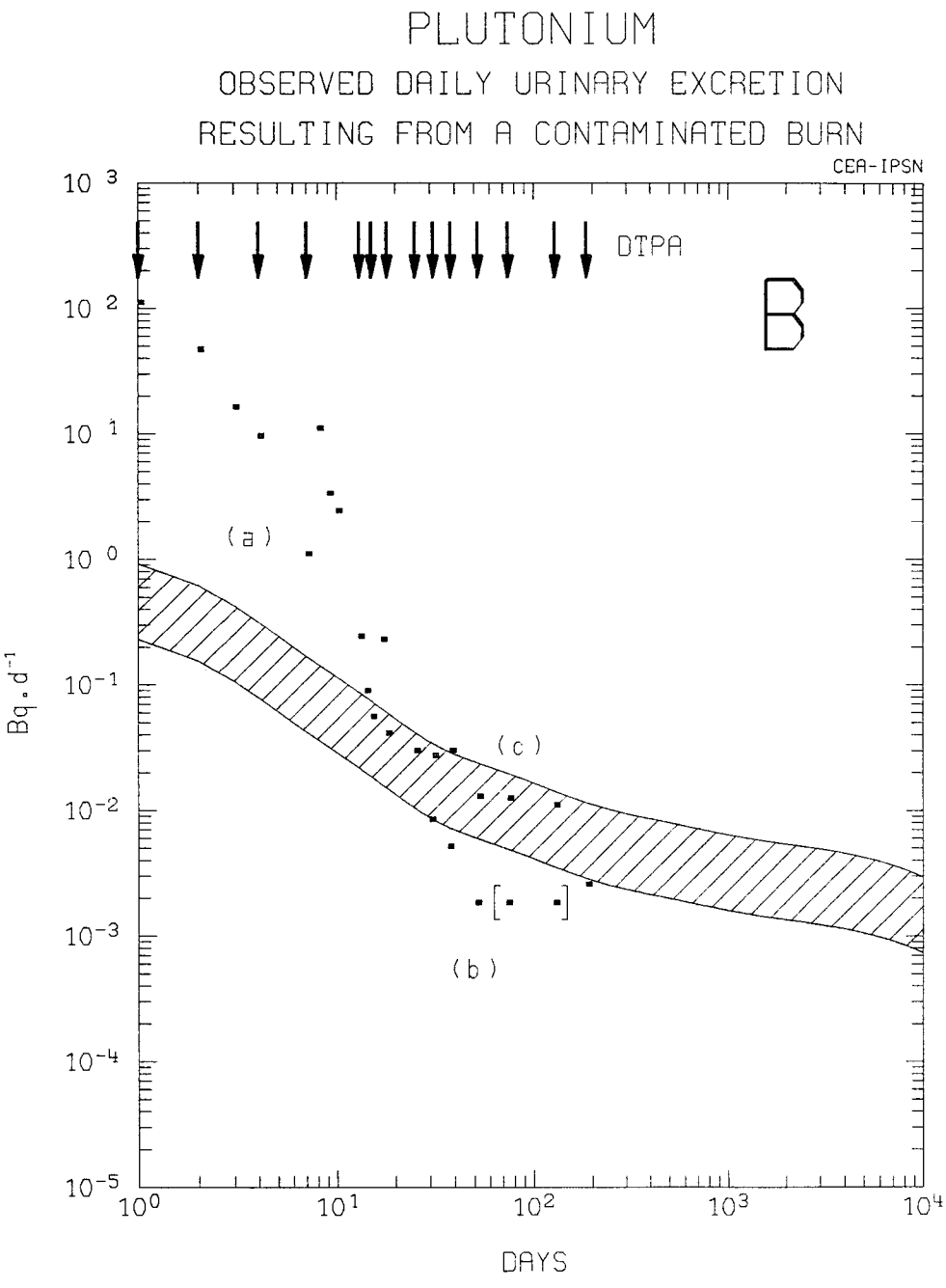
COMMENTARY ON THE FIGURES

Case A : Burn of about 4 cm^2 located on the left forearm, plutonium was in nitric acid solution N 13; initial local activity 600 Bq; excision on day 20; assessment of systemic burden: 2 to 6 Bq.
Case B : Burn of about 48 cm^2 located on the right thigh; plutonium in nitric acid solution N 6 to 8; initial local activity: 50 kBq; no excision; assessment of systemic burden: 1 to 4 Bq.

The hatched bands give an estimate of the activity excreted relative to the systemic burden. The margin of uncertainty takes into account the variability of DTPA action (25 at least, 100 at most).
(a): the initial values above the hatched band represent the activity released from the burn, immediatly trapped by DTPA and eliminated in urine.
(b): the measurement results located in these areas correspond to urinary excretion without DTPA; the points between square brackets represent results below the limit of detection.
(c): no value does appear above the hatched band; it means that there is no long-term release from the burn.


PLUTONIUM
OBSERVED DAILY URINARY EXCRETION
RESULTING FROM A CONTAMINATED BURN
CEA-IPSN
DTPA
A
(a)
(b)
[▪ ▪ ▪]
Bq.d⁻¹
DAYS
10 3
10 2
10 1
10 0
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁰
10¹
10²
10³
10⁴


PLUTONIUM
OBSERVED DAILY URINARY EXCRETION
RESULTING FROM A CONTAMINATED BURN
CEA-IPSN
DTPA
B
(a)
(c)
(b)
Bq.d-1
DAYS
10 3
10 2
10 1
10 0
10-1
10-2
10-3
10-4
10-5
100
101
102
103
104