

# REGULATION OF RADIATION DOSES RECEIVED DURING HIGH ALTITUDE MOUNTAINEERING EXPEDITIONS

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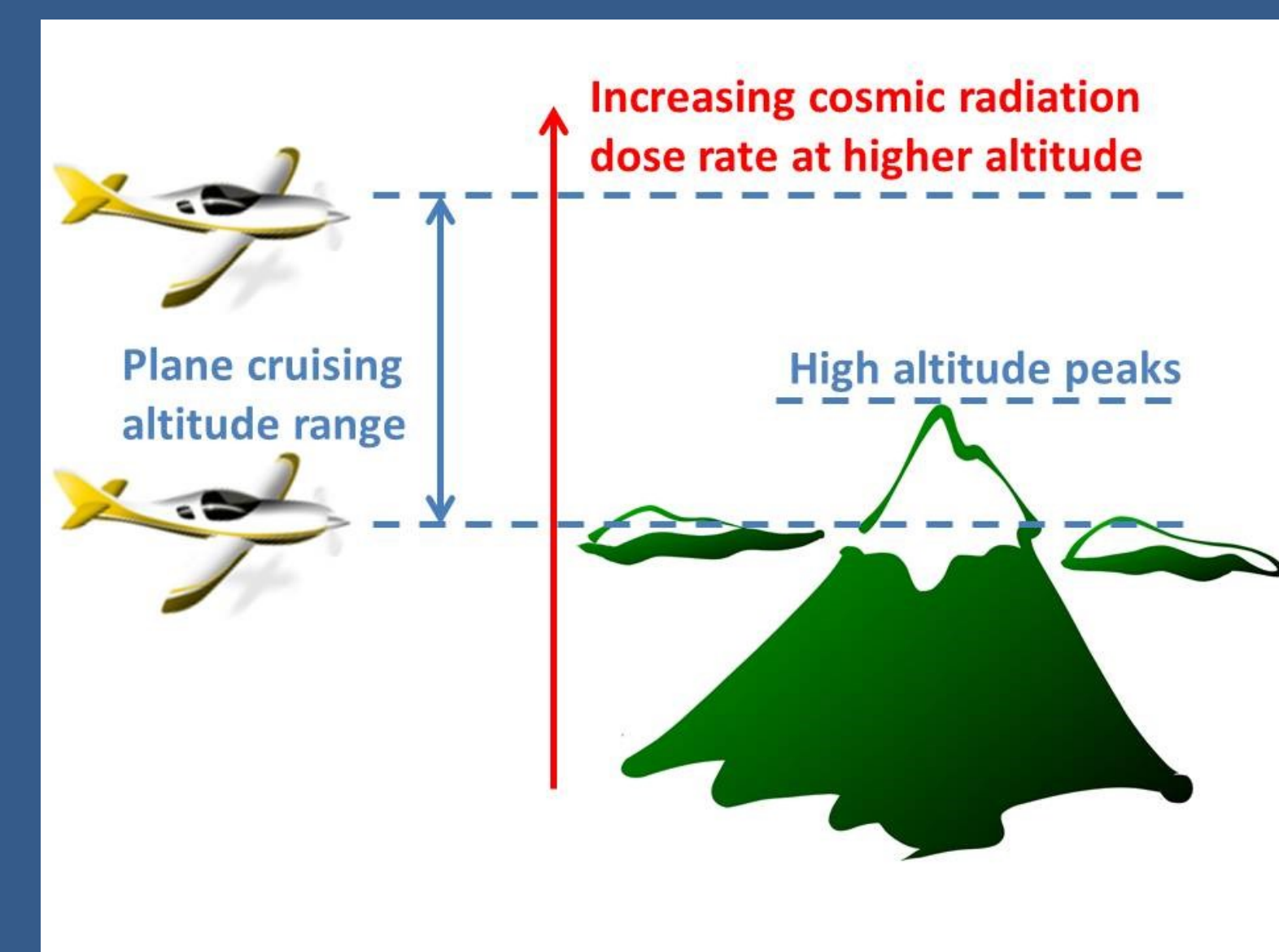
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## 1. Introduction

Radiation dose rates from cosmic radiation increase with altitude. High altitude mountaineering involves being present for prolonged periods of time in elevated cosmic radiation fields. The European Basic Safety Standard (BSS) [1], does not apply to cosmic radiation doses received at ground level.

Various companies sell high altitude expeditions that are supported by a number of high altitude workers performing different roles. These high altitude workers are occupationally exposed to cosmic radiation dose rates that are greater than those at their home location. These doses have not previously been measured or estimated.

Cosmic radiation measurements were made on Mount Everest during the pre-monsoon season of 2013. The potential cosmic radiation doses received by high altitude workers whilst participating in high altitude expeditions are discussed and recommendations made.

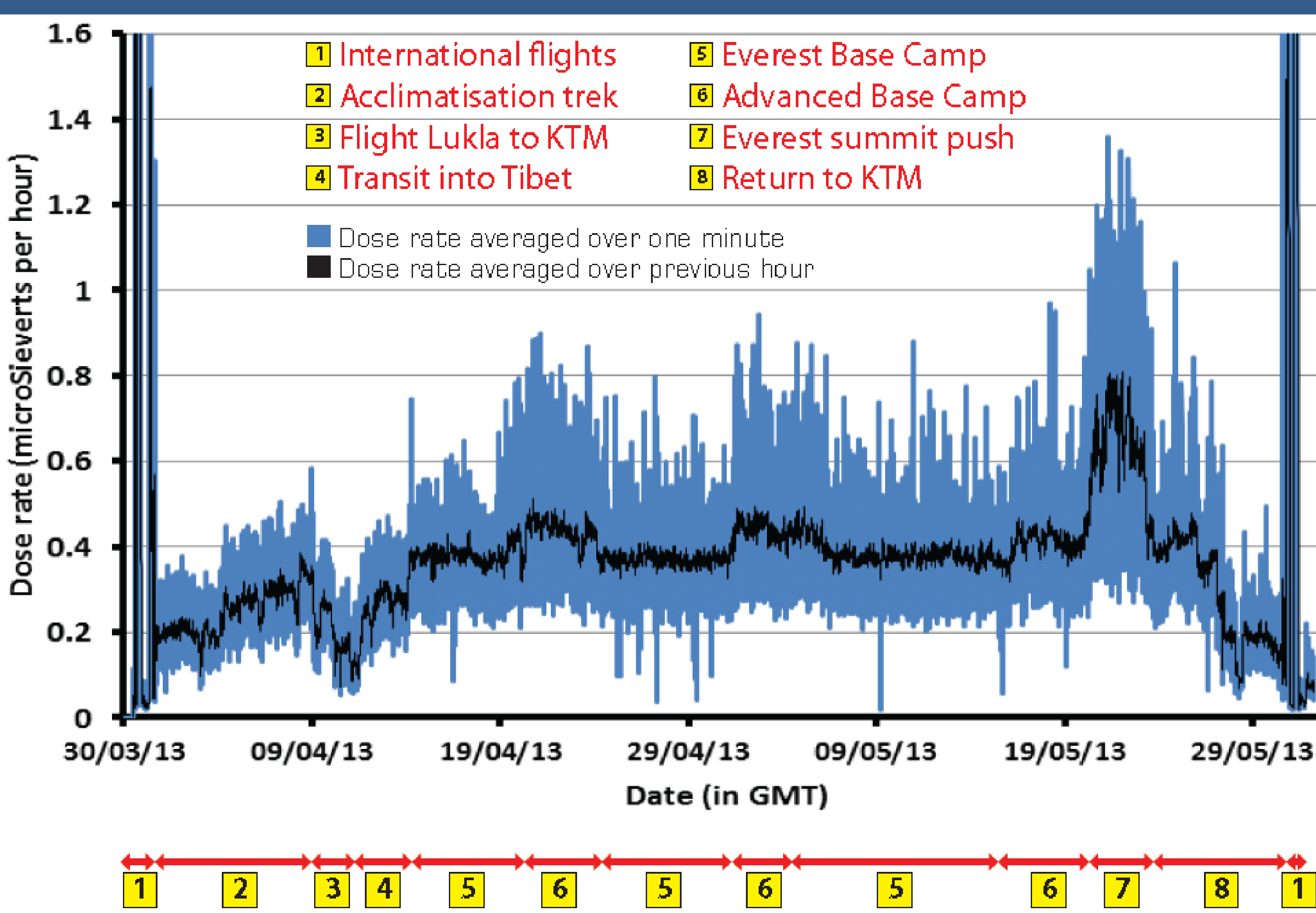


## 2. Measurement of doses at ground level on Everest

Mount Everest (8,848m) is one of the most extreme environments on the planet.

Measurement of cosmic radiation at ground level in this extreme environment has never previously been performed.

Western mountain guides climbing Everest, in general, follow a similar itinerary to their clients and as such undertake acclimatisation at increasing altitudes during their typical two month long expeditions. As a result at different stages of their expedition they are exposed to varying cosmic radiation dose rates. The figure below shows the variation in dose rate, as measured on a Tracerco T404 Personal Electronic Dosimeter (PED), during the 2013 Everest expedition.



## 3. Doses to high altitude workers during high altitude expeditions

Western mountain guides are exposed to cosmic radiation and to natural radiation when not on expedition. Therefore the amount of radiation dose received by these high altitude workers on a high altitude expedition is equal to the radiation dose received during travel to/from the expedition plus the radiation dose received whilst at ground level on expedition minus the radiation dose that would have been received if they had remained at home for the duration.

The additional dose detected for a UK based mountain guide was of the order of 400

## 4. Conclusions

The high altitude workers that receive the greatest additional occupational cosmic radiation dose on expeditions to Mount Everest are Western mountain guides. This group of workers, and their clients, receive about 1 millisievert of additional dose from cosmic radiation per Everest expedition.

It is possible for high altitude workers to participate in multiple expeditions per annum and receive significant additional cosmic radiation doses.

Most high altitude workers are unaware of being exposed to cosmic radiations. Expedition companies are not breaching current legislation in relation to the cosmic radiation doses being received by their employees, support staff and clients.

Consideration should be given in future recommendations from the International Commission on Radiological Protection (ICRP) to aligning the recommendations for exposure to cosmic radiation at high altitude ground level with the requirements that currently exist on employers of personnel working in the aviation industry.

## References

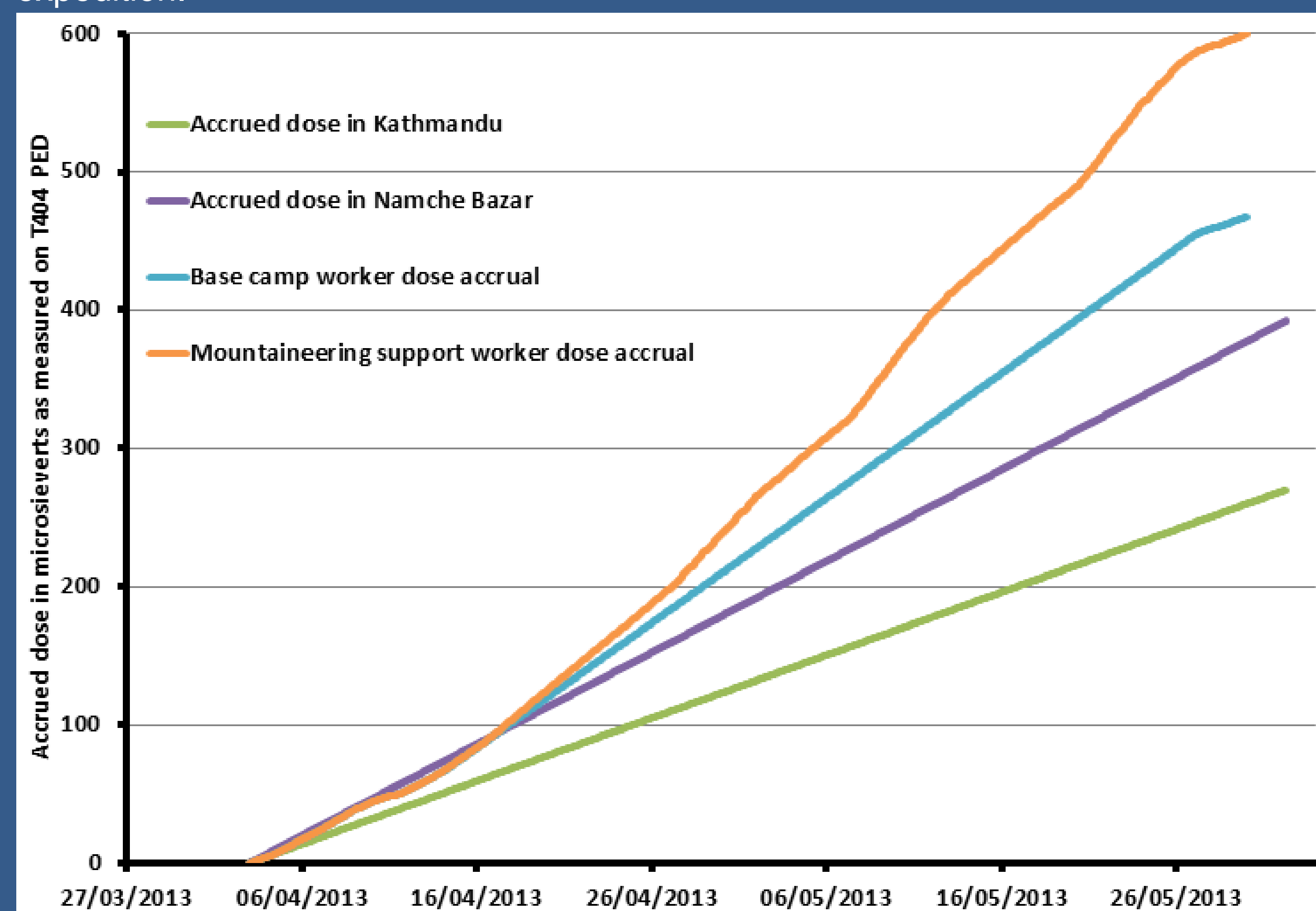
[1] Council Directive 96/29/EURATOM of 13 May 1996 Laying Down the Basic Safety Standards for Protection of the Health of Workers and the General Public Against the Dangers Arising from Ionising Radiation. Official Journal of the European Communities 39, L159.

[2] Journal of the ICRU, Volume 10, No 2, 2010. ICRU Report 84: Reference Data for the Validation of Doses from Cosmic-Radiation Exposure of Aircraft Crew. ISSN 1473-6691.

microsieverts for the two month long expedition. Only about 4/9ths of the true accrued dose was detected [2].

Therefore the total additional radiation dose received by a western mountain guide climbing Mount Everest is of the order of 1 millisievert per expedition. The exact dose received will vary depending on the incident cosmic radiation intensity and the individual's time spent at different altitudes.

Based on the Tracerco T404 PED data and records of movements of mountaineering support staff and base camp staff during the 2013 Everest expedition, a cumulative dose estimate was performed for these workers and the results are presented in the figure below. This figure also shows the cumulative dose that would be detected on the Tracerco T404 PED if these workers had remained at their home locations of Namche Bazaar or Kathmandu. Depending on the altitude that these workers normally live at, they will have a varying additional dose accrual from an Everest expedition.



Taking into account the components of dose that were not assessed using the Tracerco T404 PED, it is estimated that the mountaineering support staff would accrue a total additional radiation dose received per Mount Everest expedition of the order of 0.5 to 0.8 millisieverts depending on whether they were based in Namche Bazaar or Kathmandu respectively.

Taking into account the components of dose that were not assessed using the Tracerco T404 PED, it is estimated that the base camp staff would accrue a total additional radiation dose received per Mount Everest expedition of the order of 0.2 to 0.5 millisieverts depending on whether they were based in Namche Bazaar or Kathmandu respectively.