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managed by Brookhaven Science Associates
for the U.S. Department of Energy

date: September 18, 2003

to: C. Schaefer

from: R. Casey

subject: **Revised Proposal to Change Dosimetry Requirements at the NSLS**

Attached is the revised technical basis for eliminating the current dosimetry requirement for access to the Controlled Areas within the NSLS Facility (Building 725). This revision is based on comments made at the NSLS ESH Committee meeting on 9/11/03 and on written comments provided to me by Henry Kahnhauser. It was concluded at that meeting that there is no regulatory basis in Part 835 or the BNL Radiological Protection Plan for the current TLD requirements. As such we request that the current posting of the NSLS Experimental Area be revised to no longer require TLDs for access effective 10/1/03. All other access requirements remain the same.

This change in practice will be incorporated into the existing approved NSLS SADs as an Unreviewed Safety Issue, and will be included into the revised SAD currently under development. It was concluded at the meeting of 9/11/03 that this change in dosimetry practice does not constitute a significant change in the safety basis for the facility and that no change in the ASE is required.

Attachment

cc. H. Kahnhauser
S. Musolino

Unreviewed Safety Issue No. 1

NSLS Safety Assessment Document

Change in Dosimetry Policy for Access to the Controlled Areas of Bldg. 725 (NSLS Experimental Floor) – Elimination of Regulatory Requirement to Wear TLD When in the Controlled Area.

Date: September 16, 2003

Note: Signature of this cover sheet indicates approval for the change in the dosimetry policy described in the attached proposal. This change in policy has been evaluated as an Unreviewed Safety Issue (USI). This USI will be appended to the approved NSLS Safety Authorization Documents and included in the next revision to the SAD. It has been determined that this change in policy does not substantially alter the safety basis of NSLS operations and does not require a modification of the NSLS Accelerator Safety Envelope.

Signature of NSLS Associate Chair for ESH/Q

Date

Signature of RCD Facility Support Representative

Date

Signature of Radiological Control Division Manager

Date

Signature of RCD Technical Support Manager

Date

Signature of NSLS ESH Committee Chair

Date

Signature of NSLS Department Chair

Date

Technical Basis to Change the Personnel Dosimetry Requirements at the NSLS

By

S. Musolino & W.R. Casey



September 16, 2003

Introduction

The National Synchrotron Light Source issues approximately 7,000 personnel dosimeters per year distributed about evenly between persons on permanent badge service and short-term episodic users who are issued temporary badges. Users who wear temporary dosimeters typically return them within a one-week period. The permanent badge wearers are NSLS employees, resident scientists and other technical members of Participating Research Teams (PRTs) operating an NSLS beam line. The short-term users are primarily visitors from universities and other research institutions who are at the NSLS for a brief period to work on a specific experiment.

All personnel who enter the experimental floor are currently required to wear dosimetry except for short-term (< 8 hours) escorted visitors and members of tour groups. This requirement has been in place from the beginning of operations and was based on the radiation levels associated with the injection systems and VUV ring operation in the early years of operation. The purpose of this analysis is to demonstrate that there is no regulatory basis for requiring a TLD to enter the posted Controlled Areas of the NSLS facility within Building 725.

Facility Background

The NSLS operates two electron storage rings producing very small, high intensity synchrotron radiation beams. While these beams are very intense, they are easily shielded and confined because of low photon energies. In addition, the total power of the electron beam stored in the ring is low. Therefore, there is much less potential for exposure from lost or scattered electrons and activation of beamline components compared to high energy proton machines such as the AGS or high power electron machines such as the SLAC linear accelerator. The highest levels observed from induced activity are typically in the few tens of micro-R/hr at contact.

As a result of these factors, actual radiation exposures to personnel working at synchrotron light sources typically are very low, and DOE synchrotron sources in general do not require their user communities to wear radiation dosimeters. The NSLS is a current exception to that practice, primarily because injection systems and VUV Ring used to be thinly shielded.

In the past 10 years, a number of shielding upgrades were completed within the facility, particularly to the Linac/Booster and the VUV Ring. Despite the earlier concerns and thinner shielding, operation of the NSLS Complex has consistently resulted in very small individual and collective Total Effective Dose Equivalent (TEDE). The annual Administrative Control Level of 100 mrem to an individual has never been exceeded. Although the entire floor is posted as a Controlled Area, there are very limited areas posted as a Radiation Area and there are no accessible High or Very High Radiation Areas.

The user community within the DOE synchrotron sources is quite transient and many NSLS users work at one or more of the other major facilities during the year. In order to eliminate the confusion created by radically different dosimetry practices at very similar facilities and to reduce the administrative burden of managing a large dosimetry program, NSLS

management decided to seek relief from its current unnecessarily conservative dosimetry requirement.

Regulatory Requirements for Personnel Monitoring

The regulatory requirements for wearing personnel dosimetry are contained in 10 CFR Part 835.402 and read as follows:

For the purpose of monitoring individual exposures to external radiation, personnel dosimeters shall be provided to and used by:

1. *Radiological workers who, under typical conditions, are likely to receive one or more of the following:*
 - a. *An effective dose equivalent to the whole body of 0.1 rem or more in a year;*
 - b. *A shallow dose equivalent to the skin or to any extremity of 5 rems or more in a year;*
 - c. *A lens of the eye dose equivalent of 1.5 rem or more in a year;*
2. *Declared pregnant workers who are likely to receive from external sources a dose equivalent to the embryo/fetus in excess of the limit at Part 835.206(a) (note added by writers; the current limit is 0.5 rem);*
3. *Occupationally exposed minors likely to receive a dose in excess of 50 percent of the applicable limits at Part 835.207 in a year from external sources (note added by writers; the current limit is 0.1 rem);*
4. *Members of the public entering a controlled area likely to receive a dose in excess of 50 percent of the limit at Part 835.208 in a year from external sources (note added by writers; the current limit is 0.1 rem); and*
5. *Individuals entering a high or very high radiation area*

The rationale for the proposed change in the NSLS personnel dosimetry requirements is based primarily on the TEDE measured for personnel in the period 1999 – 2002¹. Future operation and practices of the accelerators in Building 725 will be consistent with the practices during this period as no significant changes to the accelerator or beam loss scenarios are anticipated.

Figure 7 shows the distribution of individual TEDE by year from 1999 through the first six months of 2003. Figure 8 shows the distribution of individual TEDE for all data during that period. The data includes all personnel wearing permanent or temporary TLDs during that period. No individual received a TEDE greater than 40 mrem. Over the four and half year period, only two persons out of a cohort of 10186 received a TEDE in the 31- 40 mrem range. In

¹ Prior to 1999, some of the personnel dosimeter badge boards were in locations that received some exposure due to small elevations in background during to injection system operation. The SC board was moved from the wall outside the U1 beam line (first floor, inside stairwell) up to the second floor adjacent to Room 2-152 in May 1996. The SB board was moved from the wall outside the electron gun/LINAC to the front lobby entrance door in March 1997. In 1998 the User Administration supply of temporary badges was compromised due to storage of unused badges at a location affected by VUV injection losses. Subsequent to 1998 the storage location was changed. Therefore both permanent and temporary badge data used in this proposal are assumed to be unaffected by prompt radiation that is unrelated to the badge wearers actual use.

the 4 ½ year period, only 81 people out of this large cohort received any recordable whole body dose. The results clearly indicate that during the operating conditions over that 4 1/2 year period, no worker, pregnant women, minor or member of the public was likely to receive a total effective dose equivalent exceeding the regulatory limits established in Part 835.402. Therefore, based on the actual personnel monitoring data, there is clearly no regulatory basis in Part 835 for requiring any occupant on the experimental floor to wear a dosimeter.

Area Monitoring Program

Although there may be no regulatory requirement for individual monitoring, Part 835.401 requires that facility monitoring be provided to demonstrate compliance with the regulation, to document radiological conditions, to detect changes in the radiological conditions and to verify effectiveness of radiological controls. At the NSLS, area monitoring for photon and neutron radiation is provided through an extensive network (~ 80 units) of detectors located around the X-ray and VUV experimental floor. These monitors use thermoluminescent dosimeters (TLDs) placed on a 5-inch diameter polyethylene cylinder. The locations of the area monitors for the X-Ray and VUV Rings are shown in Figures 1 and 2 respectively. These monitors are exchanged quarterly and utilize the same dosimeters provided to personnel. The monitors provide an excellent method for tracking changes in radiation exposure potential that may occur on the floor and provide an empirical characterization of the upper limit of potential radiation exposures at many locations throughout the building. Most of the area monitors identified in Figures 3 – 6 are located in typical work areas for researchers and staff working on the floor.

A number of the area monitors are located closer to loss points within the ring or transfer lines and represent areas that have much lower occupancy than those monitors located in typical work areas. Examples of these locations include the units designated in Figures 3 – 6 as U-7, U-11, U-15ext, VUV injection straight, VUV transfer line, and X-4C hutch. These devices provide a useful tool for tracking changes in radiological patterns on the experimental floor near the machine, but do not represent actual exposure to personnel because of the low occupancy in these areas.

Exposures to personnel as measured through personnel dosimeters are considerably lower than the doses recorded by the area monitors even when adjustments are made to reflect the increased presence on the floor of the area monitors compared to the occupancy times of personnel². As such, these area monitors provide a conservative tool for tracking radiological conditions and estimating radiation exposure to personnel working in the building.

The last four years of area monitoring data are shown in the Figures 3, 4, 5 and 6. In general, the annual integrated dose equivalent measured on the area monitors in the X-ray region is small. Even uncorrected for occupancy, most of the locations in the X-Ray Ring are less than 100 mrem/yr. Some areas of the X-Ray Ring and a number of areas around the VUV Ring indicate the potential for exposures above 100 mrem/year. As mentioned above, all areas with

² Area monitors are measuring low-level radiation fields at a fixed point 24 hours per day 7 days per week while users and staff are present intermittently on the floor. A correction factor 0.23 (assumes 50 weeks per year occupancy at 40 hours per week.) is applied to the annual data to better approximate potential occupancy on the experimental floor.

values greater than 100 mrem/year based on occupancy of 2000 hours per year are located in non-typical work areas which have much lower occupancy factors. In addition, other administrative control practices discussed below have been implemented to assure low occupancy in these locations during operating conditions with potential for increased radiation levels.

Administrative Practices to Control Radiation Exposure

The highest potential for radiation exposure is associated with beam losses that occur during injection. To reduce the potential for exposure during injection, both rings are normally filled during low occupancy periods. The X-Ray Ring fills are typically scheduled to occur at 0700 and 1900 hours. Injection of the VUV ring is more frequent, typically seven times per day, but is scheduled also for low occupancy periods during the normal work day (i.e. 0800, 1230, 1730 hrs). The other four injections occur during the lower occupancy evening and overnight shifts.

Because of the higher exposure potential in the VUV area, additional controls are implemented for all VUV injections. Prior to injection of beam into the VUV, a public address system announcement is made and a klaxon sounds inside the VUV hall. Occupants are instructed to stand clear of designated areas for the duration of the injection cycle (~10 minutes). A similar announcement is made prior to all scheduled VUV beam dumps. The dosimetry data confirm that this practice has been successful in controlling exposure to personnel during beam delivery from the Booster to the VUV.

The X-Ray Ring is more heavily shielded than the VUV Ring and in general there is no need for visual and audible annunciation due to the lower levels of prompt radiation. For most areas, only a building announcement is made prior to the start of an injection cycle. In a few areas around the X-Ray Ring, such as the walk-way over the X-ray injection line and near the X-4 C, visual warning systems have been provided to alert occupants to the potential for increased radiation fields during injections.

In a number of locations subject to increases in radiation levels during various machine operating conditions (principally injections and increased vacuum events), active radiation monitors (Chipmunks) have been installed as a supplement to the visual and audible warning of injections. The Chipmunks provide additional local real-time audible and visual indication of increasing radiation levels at a particular location, and also provide annunciation within the Control Room. Based on written procedures, the operators monitor these radiation levels and will check affected locations and alter operating conditions as needed. In cases when an abnormal radiation field can not be promptly eliminated, the Radiological Control Division will install temporary posting and erect barriers to exclude personnel from exposure, as well as address other related compliance requirements.

Other Radiological Control Features

In addition to the administrative practices discussed above, there are a number of other radiological control program elements discussed in the current NSLS authorization documents

that provide the radiological safety basis for NSLS operations. These practices are important and ensure that radiological hazards are identified and controlled. None of these program elements have been altered and will continue. A brief description of each practice is provided:

- A Beam Line Safety Review is required for all new beam lines or those which are substantially modified. The purpose of these reviews is to ensure that adequate shielding is included for scatter points, that beam stops are properly specified and located and that bremsstrahlung shields and exclusion zones are established where needed. Review by the ALARA Committee is also conducted in some cases depending upon the circumstances.
- New or modified beam lines are subject to an initial commissioning period at low beam currents to confirm that adequate shielding is provided along the beam line and behind stops. During commissioning, the beam lines are thoroughly surveyed at all scatter points to evaluate shielding. Additional shielding is provided as needed to maintain contact dose rates at less than 500 c/m ($\sim 50 \mu\text{R/hr}$) when operating at maximum stored current.
- A beam line safety check-list is completed by the research team prior to the beginning of each experiment to confirm that required shielding and other safeguards are in place. Operations staff confirm that the check-list has been completed prior to enabling the beam line.
- Access to any beam line vacuum space downstream of beam window is controlled through a padlock and check-list system to ensure that no access is possible to the primary photon beam. This padlock and check-list system is administered and controlled by Operations personnel.
- Access to beam line hatches and to the accelerator enclosure is controlled through a radiation safety interlock system designed and maintained by the NSLS Interlock Engineer and the Interlock Group. Independent interlock testing is performed every six months by a member of the NSLS ESH/Q Section.
- All work on shielding or interlocks systems is controlled through a work authorization system to ensure review of planned work and restoration of protective function following any modifications.

Description of Proposed Dosimetry Policy for NSLS

The review of personnel exposures at the NSLS demonstrates that personnel on the experimental floor are unlikely to receive 100 mrem in a year, and give strong support that the current radiological safety program for NSLS operations has been effective. The installed area monitoring network provides effective coverage of the experimental floor and establishes the required facility monitoring. Therefore, we believe that there is no regulatory basis to require personnel TLDs, and we propose that the regulatory requirement for a TLD to enter the Controlled Area be eliminated. The requirement for facility specific training and radiological training continues for all personnel who are granted unescorted access to the floor.

Although there is no regulatory basis for requiring anyone to wear a dosimeter, we plan an internal NSLS administrative requirement for personnel routinely working on the experimental floor throughout the year to wear a TLD dosimeter. These additional dosimeters will provide a quality check of the continuing effectiveness of the NSLS radiological controls for

personnel with an on-going presence on the floor. Although these dosimeters are not required under Part 835, their use will provide an additional means to track radiation exposure patterns for people working in all areas of the building throughout the year. In addition, as another internal administrative requirement, we will provide dosimetry for all women with a declared pregnancy working on the experimental floor, and for any minor working on the floor.

Conclusion

This analysis demonstrates that there is no regulatory basis to require personnel working on the experimental floor to wear dosimetry. We believe it is clear that the administrative controls, the area monitoring, the posting of all Radiation Areas, and the existing training program are quite adequate to reliably control radiation exposure to personnel on the experimental floor to far less than 100 mrem/year. As such, the current regulatory-based requirement for TLDs for all personnel working on the experimental floor should be eliminated.

Although not required by Part 835, we plan to establish as an internal program requirement that a TLD be worn by all personnel routinely working on the experimental floor, any worker with a declared pregnancy, and any minor working on the experimental floor. These additional internal requirements will provide data points for evaluation of the on-going radiological control program and will provide records for sensitive worker subgroups that NSLS management deems important to monitor.

This modification to the current dosimetry policies has a number of important attributes:

- It eliminates the excessive conservatism of the current TLD requirements.
- It establishes consistency with other U.S. DOE light sources.
- It reduces the administrative burden of managing the TLD program for our many short-term users who receive no recorded dose.
- It reduces the number of badged personnel from ~ 2000 per year to ~ 300 per year.
- It reduces the number of TLD badges issued from ~ 7000 per year to ~ 3500 badges per year.
- It reduces the regulatory vulnerability created by short-term users unfamiliar with NSLS expectations for strict compliance.

The elimination of the current Part 835 dosimetry posting requirement does not substantially change the safety basis described in the current NSLS safety authorization documents and does not conflict with applicable provisions of the NSLS Accelerator Safety Envelope, which state:

- “Radiological Control Division personnel shall deploy and manage radiological postings...” and
- “Personnel and area radiation TLD dosimeters shall be deployed and managed by the Radiological Control Division.”

Concurrence with these changes will be obtained from the Radiological Control Division Manager and his staff.

Figure 1. Locations of Area Monitors at the X-Ray Ring

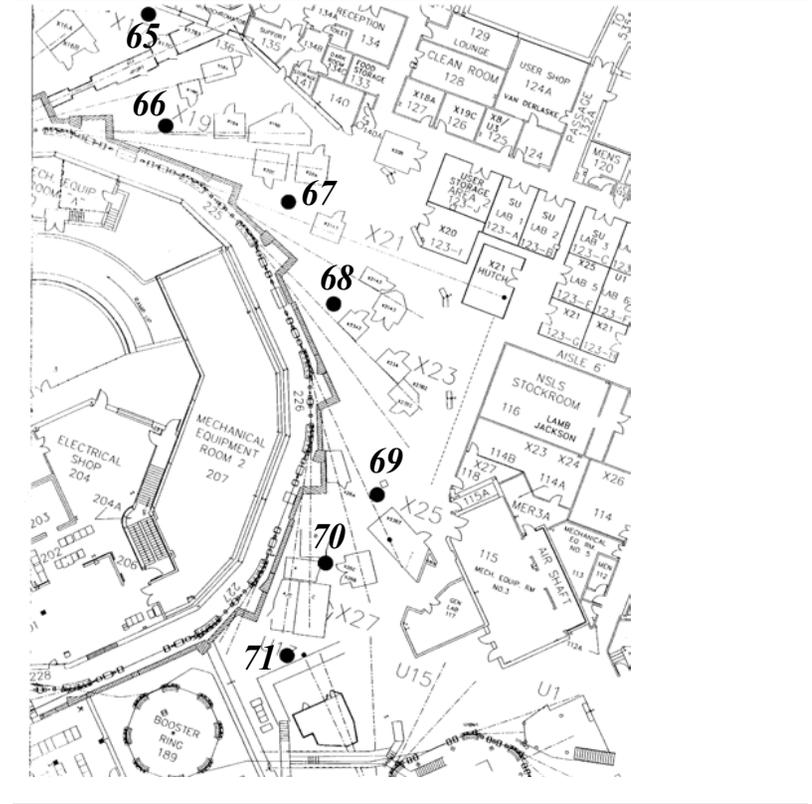
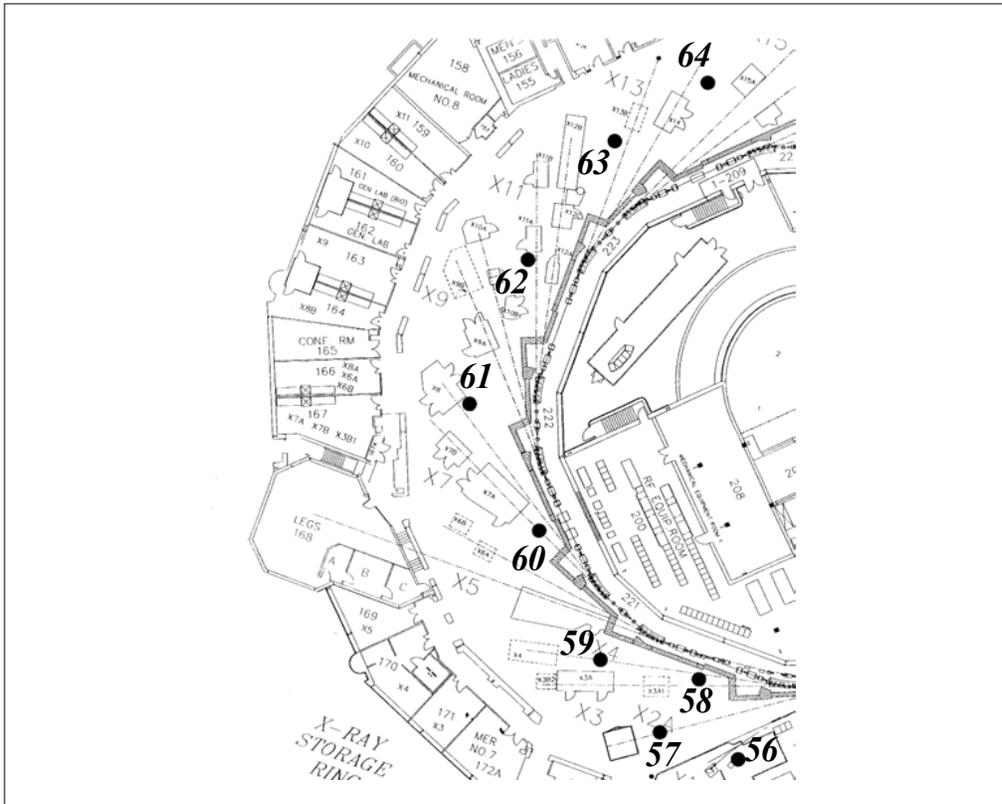


Figure 2. Locations of Area Monitors at the VUV Ring

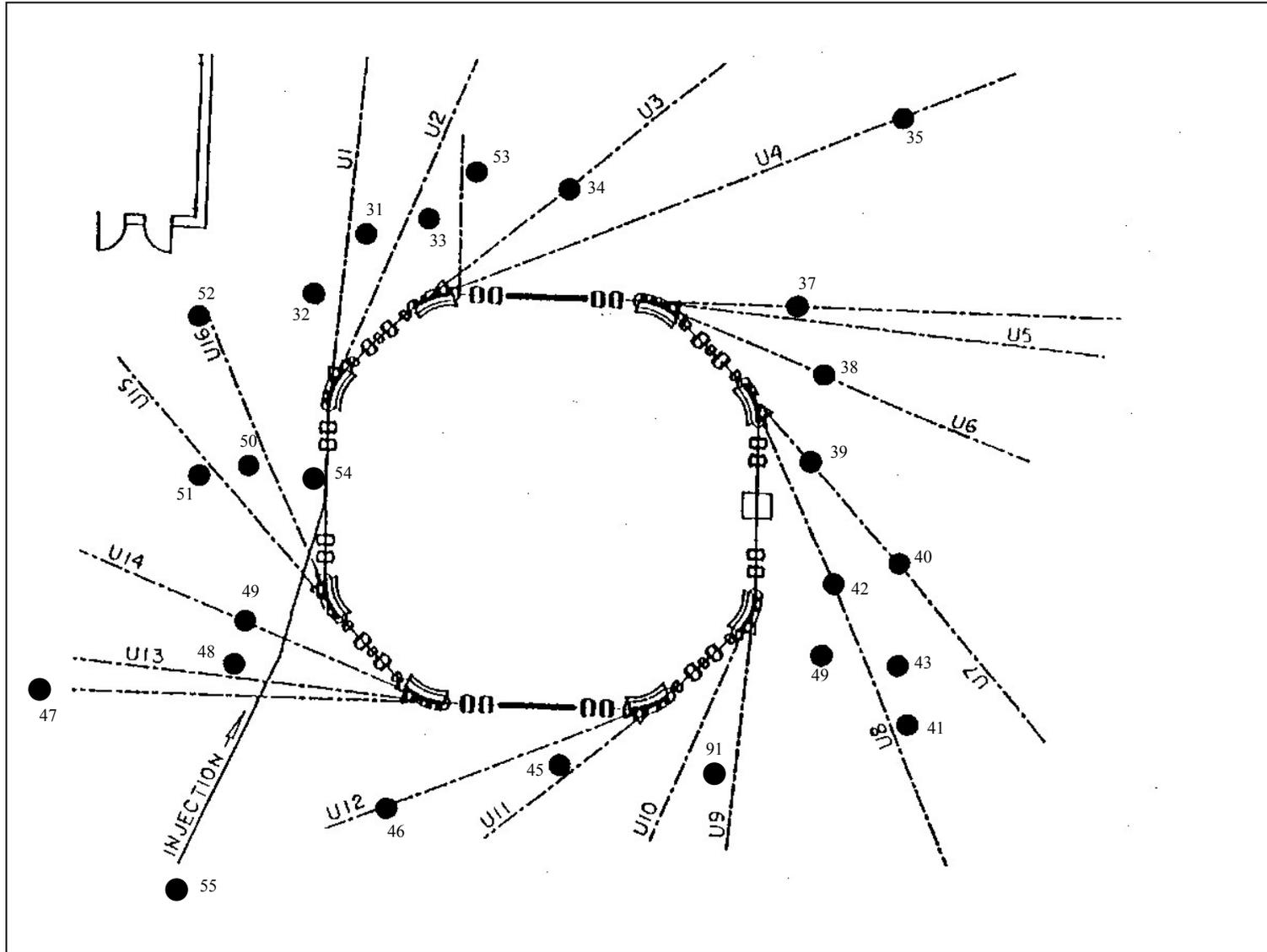
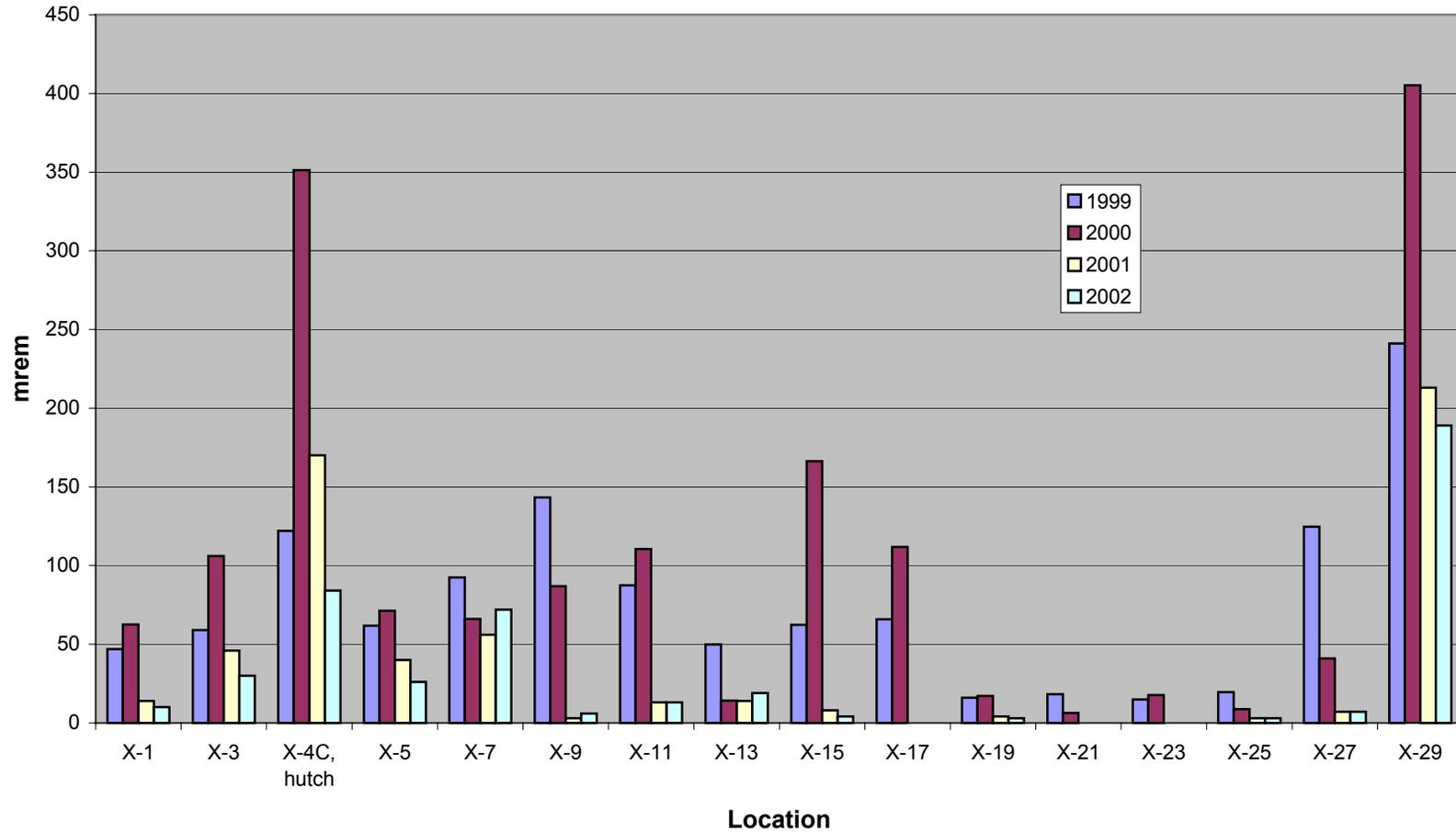
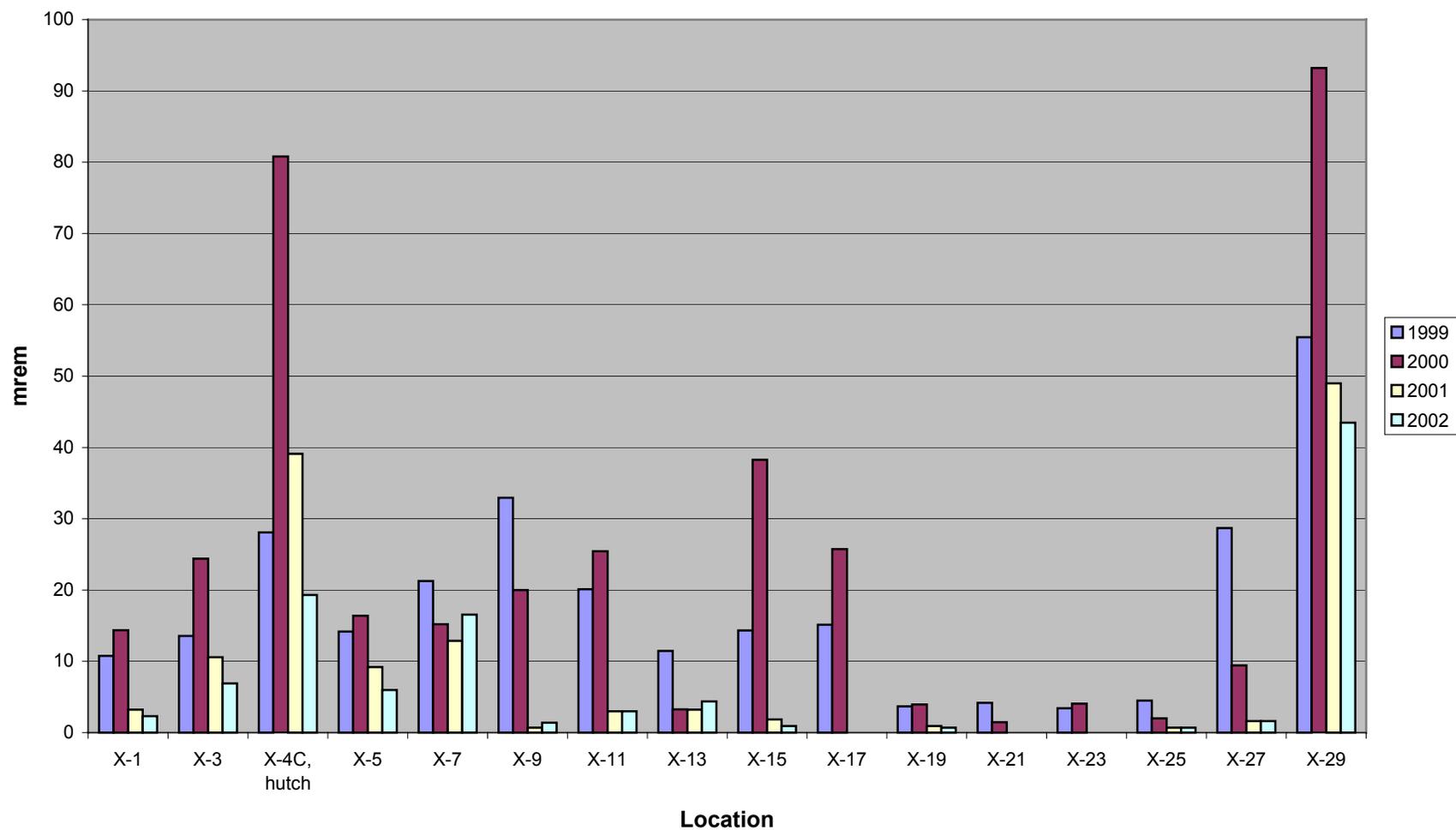


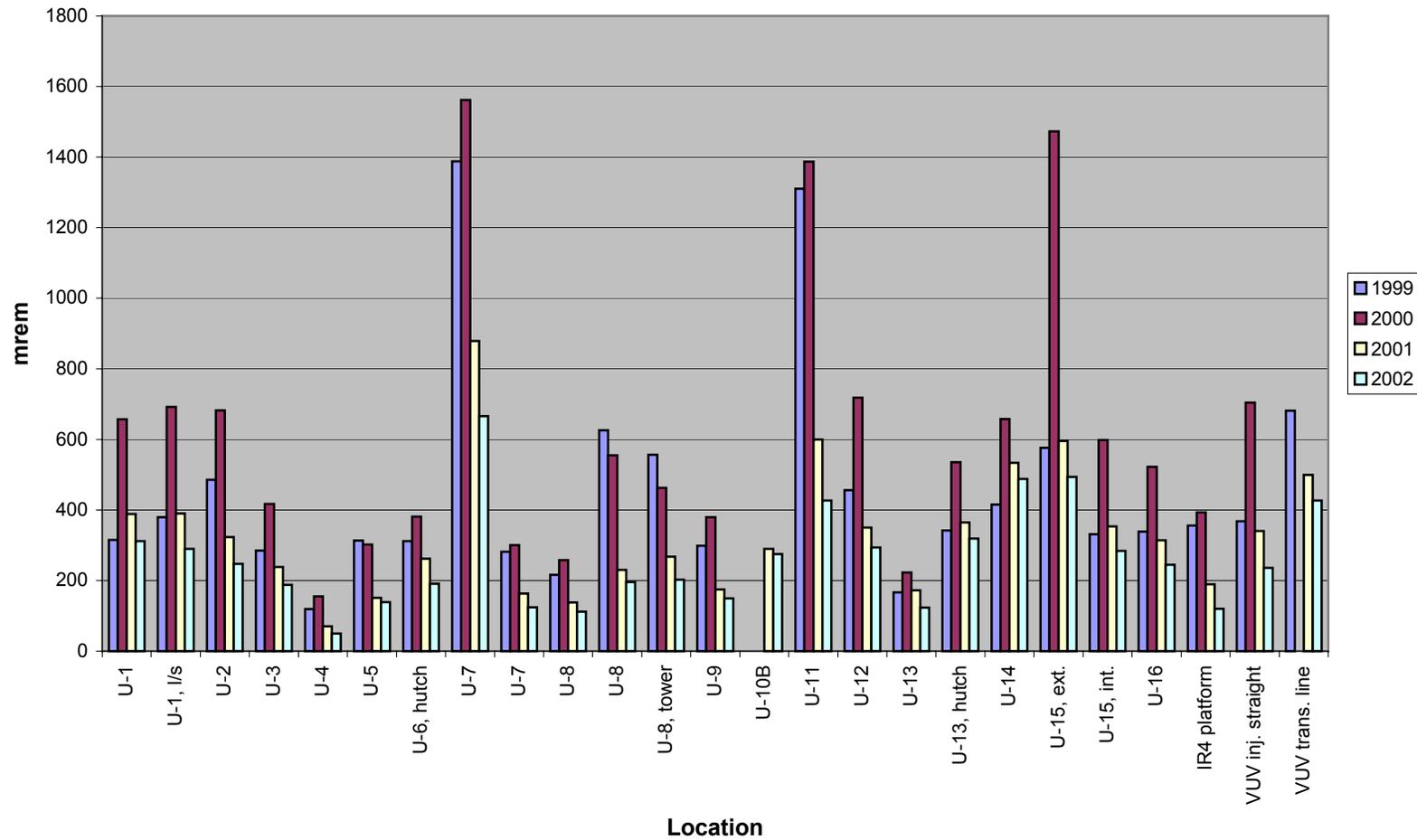
Figure 3. Area Monitoring Results for the X-Ray Ring 1999-2002
Uncorrected for Occupancy



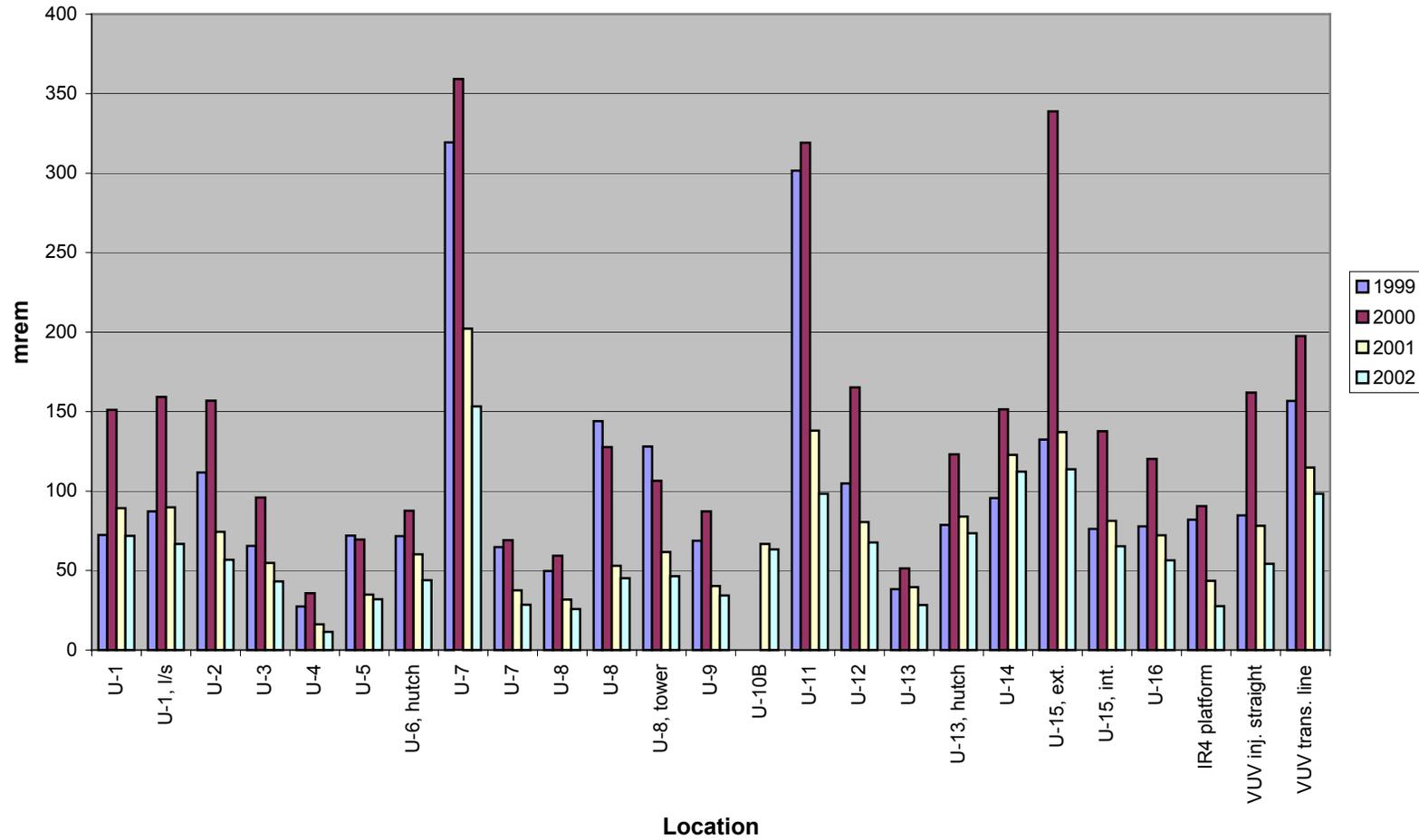
**Figure 4. Area Monitoring Results for the X-Ray Ring 1999-2002
Corrected for Occupancy**



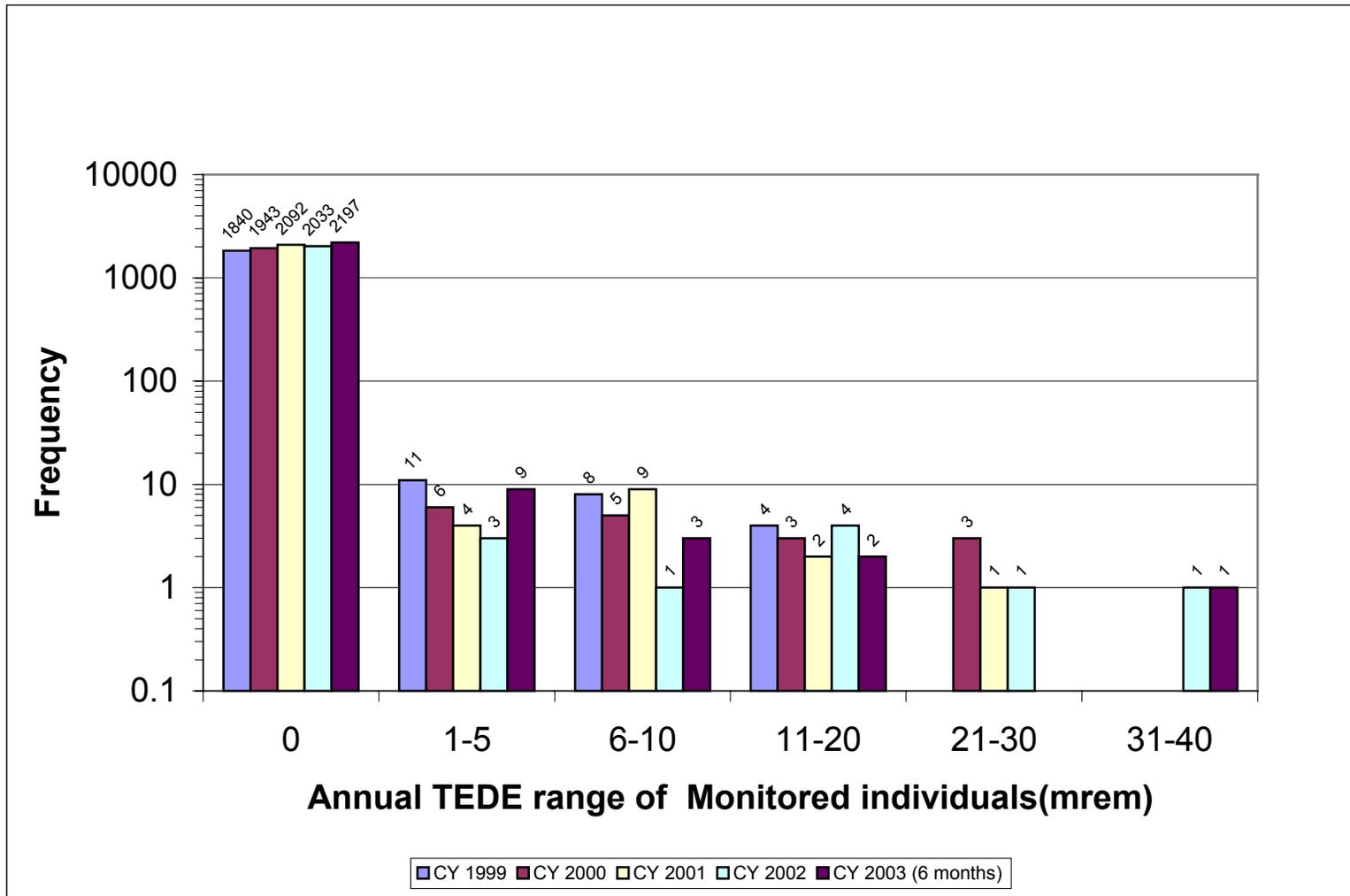
**Figure 5. Area Monitoring Results for the VUV Ring
Uncorrected for Occupancy**



**Figure 6. Area Monitoring Results for the VUV Ring
Corrected for Occupancy**



**Figure 7 – TEDE Distribution by Year for the NSLS Department
CY 1999 through First 6 Months of 2003**



**Figure 8 – TEDE Distribution for all NSLS Monitored Persons
For 1999 – through first 6 months of 2003**

