# SOME ASPECTS OF IMPLICATION OF NEW ICRP RECOMMENDATIONS INTO NEUTRON RADIATION MONITORING AT IHEP

A.G. Alekseev, V.N. Lebedev, S.A. Kharlampiev

Institute for High Energy Physics, Protvino, 142284, Russia

## INTRODUCTION

New Radiation Safety Standards developing by National Commission on Radiation Protection of Russian Federation (NCRP) will base on the ICRP Recommendations given in the ICRP Publication 60 (1). It changes the approach to exposure reglamentation realized in actual Russian radiation safety standards and requires to estimate consequences of this reconsideration for radiation monitoring practice of the Institute for High Energy Physics (IHEP).

## PROBLEMS OF TRANSITION TO ICRP-60 RECOMMENDATIONS

Present Radiation Safety Standards and the ICRP Recommendations (ICRP-60) differ in:
— the recommended quality factor dependence on linear energy transfer (LET);
— the basic and operational quantities for radiation risk evaluation for external exposure;
— occupational and public dose limitation.
The effective dose concept adopted by Russian NCRP instead of the critical organ concept requires from radiation safety services to use in their activity new ICRP operational quantities as well as new dose limits. When the ICRP-60 Recommendation will be introduced into neutron radiation monitoring practice, correspondent changes can be in:
— procedure of metrological maintenance;
— instruments used in the neutron radiation monitoring;
— organizational and limitational base of neutron radiation monitoring.

## METROLOGICAL BASE OF THE IHEP RADIATION MONITORING

The metrological base of the IHEP radiation monitoring have been revised recently when the neutron reference fields (2) used for metrological maintenance of routine dosemeters have been certified (3) in terms of the neutron ambient dose equivalent rate. These neutron reference fields are:
— standard commercial calibration system UKPN-1M with $^{252}Cf$ and $^{239}Pu-Be$ radionuclide sources and a collimator made of polyethylene with 3% of $^{10}B$;
— $^{252}Cf$ and $^{239}Pu-Be$ radionuclide sources in free air;
— $^{252}Cf$ in 30-cm diameter iron or polyethylene moderator.
The $Q(L)$ dependence recommended in ICRP Publication 21 (4) has been put on the basis of the certification. So, for IHEP radiation monitoring practice where new operational quantities are already used, implication of the ICRP-60 recommendations will be reduced to re-certification of the reference fields in terms of $H^*(10)$ based on new $Q(L)$ dependence.

## ACCURACY OF AREA MONITORING

Possible changes in routine dose measurements accuracy concerned with implication of the ICRP-60 recommendations have been estimated for routine instruments most widely used in IHEP area monitoring such as rhodium monitors (RM) and passive monitors (PMS) usually calibrated in $^{239}Pu-Be$ field. RM is a counter with rhodium foil converter in polyethylene moderator of 10-inch diameter and is usually used in controlled areas. PMS is a $^6LiF$ - $^7LiF$ pair in polyethylene moderator of the same diameter and is used in supervised areas.

The systematic errors of ambient dose equivalent measurements have been calculated for RM and PMS in the IHEP radiation fields where neutron spectra have been measured (2,5,6). The energy dependences of ambient dose equivalent factor $h^*(10)$ of (7) based on the $Q(L)$ dependence of ICRP-21 and of (8), where $h^*(10)$ has been recalculated on base of the $Q(L)$ dependence of ICRP-60, are used for calculating $H_0$ — neutron ambient dose equivalent in a radiation field. The energy dependences of detector response to neutrons, $R(E)$, for RM and PMS, under the condition of their calibration in the $^{239}Pu-Be$ reference field are used for calculating $H_{RM}$, $H_{PMS}$ — responses of the dosemeters in terms of ambient dose equivalent for both $Q(L)$ dependences.

Table 1. Mean ratios of $H_{RM}/H_0$, $H_{PMS}/H_0$ , and $H_0^{60}/H_0^{21}$ calculated for three groups involving most available neutron spectra of IHEP radiation fields.

| Ratio | $Q(L)$ dependence | Pu-Be | Behind upper and side shielding at exp. hall [5] | Behind side shielding and far from it , [6] | Reference fields on base of $^{252}Cf$ [2] |
|---|---|---|---|---|---|
| $H_{RM}/H_0$ | ICRP-21 | 1 | 0.75 | 1.26 | 1.21 |
| | ICRP-60 | 1 | 0.79 | 1.17 | 1.13 |
| $H_{PMS}/H_0$ | ICRP-21 | 1 | 0.72 | 1.11 | 1.15 |
| | ICRP-60 | 1 | 0.75 | 1.04 | 1.04 |
| $H_0^{60}/H_0^{21}$ | | 1.26 | 1.18±0.05 | 1.34±0.04 | 1.38±0.06 |

The RM and PMS measurement systematic error is given by deviation of ratio $H_{RM}/H_0$ or $H_{PMS}/H_0$ from 1. Mean values of this ratio for three groups of neutron spectra are presented in Table 1. One can see that systematic error will reduce with transition to ICRP-60 recommendations in case of considered dosemeters and neutron spectra.

The difference in absolute values of ambient dose equivalents of ICRP-21 and ICRP-60 in IHEP workplace fields can be also found in Table 1 where the ratios $H^{60}/H^{21}$ of these values calculated for the three neutron spectra groups are given. Transition to ICRP-60 will lead to dose increase up to 1.4 times while the neutron fluence remains the same.

## APPLICABILITY OF EXISTING RADIATION MONITORING INSTRUMENTS

ICRP-60 recommends the occupational dose limit to be equal 100 mSv per 5-year period. The annual occupational dose limit of 20 mSv will be in this case in 2.5 times lower than the former one. It can lead to correspondent reduction of working range of dosemeters used in radiation monitoring and can result in impossibility of further application of some dosemeters. When transit to ICRP-60 recommendations, there are two factors working in the same direction: 1) dose limit changes and 2) the increase of ambient dose equivalent up to 40 percents mentioned above. The administrative control dose levels established in IHEP are recalculated in Table 2 for new dose limits in simplest way, i.e. divided by 2.5 (except supervised area where ICRP-60 recommended annual dose level is directly applied).

In Table 2 we have estimated the possibility of application of available monitoring instruments in case of adopted ICRP-60 recommendations by comparison of minimal doses measured by the instruments with new levels, so Table 2 contains ratios of minimal measurable doses to new levels. The values of minimal measurable dose have been recalculated by multiplying by a factor of 1.4, reflecting with some conservatism the fact of the ambient dose equivalent factor increase after transition to ICRP-60 recommendations. According to ICRP-35 Recommendations [9], an instrument could be still used in radiation monitoring if its minimal measurable dose less than new value of control dose level in 10 times and over.

As it is seen from Table 2, all the instruments will preserve their applicability in case of simple decrease of dose levels as recommended by ICRP-60.

## PERSONNEL MONITORING

Brief analysis of personal exposure on base of personnel monitoring data for 1990–1993 years has shown that annual personnel doses greater than 20 mSv had occured in approximately 1% cases (10–12 cases per year instead of about one case for 50-mSv limit), while the mean annual personnel dose was about 3 mSv. Since new ICRP-60 Recommendations allows to exceed 20-mSv annual limit in case when mean dose over a 5-year period does not exceed 20 mSv, such low mean annual doses and overexposure frequency allow us to meet to new requirements without considerable changes in personnel radiation monitoring procedure. Reconsideration of administrative classification of workplaces seems to be enough to optimize personal exposure.

Table 2. Ratio of minimal measurable dose to established control dose level recalculated according to ICRP-60 requirements on dose limits, for basic IHEP dosimetric instruments

| Established for: | Area 1 | Area 2 | Supervised | Individual |
|---|---|---|---|---|
| Control level, $H_{est}$ | 91 $\mu$Sv/h | 17 $\mu$Sv/h | 1 mSv/year | 2.8 mSv/run |
| Dosemeter | $H_{min}/H_{est}$ | | | |
| | Active | | | |
| RM | 0.0046 | 0.025 | – | – |
| DPN • | 0.0018 | 0.0094 | – | – |
| $^3He$-ion.chamb.* | 0.014 | 0.076 | – | – |
| | Passive | | | |
| PMS | – | – | 0.014 | – |
| MK-20 nucl.film | – | – | – | 0.07–0.014 |
| TLD IKS ♡ | – | – | – | 0.05 |
| TLD6011,7011 ◇ | – | – | – | 0.022–0.07 |

• $^{10}B$ - covered counter in polyethylene moderator of 10" diameter, used in radiation monitoring of injection channel

* $^3He$ - filled ionization chamber in polyethylene moderator of 10" diameter, used in investigational measurements

♡ alumophosphate TL-dosemeter for individual photon dose monitoring

◇ $LiF$ TL-pairs for individual neutron dose monitoring (production of NPO "Praktika", Moscow State University, Russia)

## CONCLUSIONS

The transition to ICRP-60 recommendations will not involve any changes in instruments used in the IHEP routine neutron radiation monitoring. Modification of the IHEP metrological base will be not nesessive too, but we shall need in new certification of the instruments used for metrological maintenance.

The decrease of the annual dose limits will require optimization in the monitoring instruments application at some supervised areas and new classification of workplaces in controlled areas.

It has been shown, for most widely used in IHEP neutron radiation monitoring dosemeters such as RM and PMS, that transition to ICRP-60 recommendations concerned with operational quantities will not increase systematic error of the IHEP neutron dose measurements if the calibration procedure remains the same. The mean absolute values of measured doses will increase on 18% in radiation fields behind the upper and the side accelerator shielding, and on 30–40% — in other available IHEP radiation fields.

## REFERENCES


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