VENTILATION SYSTEM FOR A RADIOMETALLURGICAL BUILDING. DESIGN, COMMISSIONING AND OPERATING INSTRUCTIONS

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Abstract—The ventilation system of a radiometallurgical building, belonging to the Junta de Energia Nuclear of Spain, is described. The building is located at the Centro Nacional de Energia Nuclear Juan Vigón of the Junta de Energia Nuclear in Madrid and is destined to house a 1000 Ci (1 MeV) β-γ metallurgical cell. This cell will be operated by the Metallurgy Division for dismantling experimental loops, handling irradiated materials, disassembling irradiated fuel elements and other operations. The hot cell will be mainly used for handling materials irradiated in the adjacent JEN-1 pool reactor.

Design criteria of the ventilation system are shown in the first part of the paper. Zoning of the building according to the contamination probability is indicated. A brief outline is given of the ventilation system design, with indication of the selected equipment to obtain these conditions.

The cell filtration system is described in detail because of its importance in preventing outleakage of contaminated dusts that may follow a failure of the ventilation system.

The air flow control system and monitoring and warning equipment used are described. Finally the commissioning procedure and operating instructions are presented.

DISCUSSION

W. N. SAXBY (*U.K.*):

From his experience and measurements does Mr. Steele consider that it would be practicable to handle long irradiated plutonium in quantity by using a combination of (a) local shielding, both against neutrons and X/γ radiations around apparatus within the glove-box and (b) distant handling by the use of long manual handling tools. This if practicable would give flexibility and be less expensive than the complicated automatic handling systems.

I would also like to ask what instruments Mr. Steele used for measuring the neutron dose rates in arriving at his personal exposures.

T. A. STEELE:

Fabrication of small amounts (<10 kg/year) of recycled plutonium would be possible under local shielding conditions using careful planning. Fabrication of large amounts (>100 kg/year) of recycled plutonium having an isotopic composition of 0.1 w/o Pu^{238}, 34.9 w/o Pu^{239}, 35 w/o Pu^{240}, 10 w/o Pu^{241} and 20 w/o Pu^{242} would require automated fabrication and inspection techniques.

As for the method we use for neutron personal monitoring, at Argonne the Kodak NTA neutron film is used; however, in the plutonium facility the energy and intensity of the neutron background are not sufficient to make the film useful. At the plutonium facility, neutron exposures are assigned as a function of the neutron backgrounds, working times and the gamma radiation exposures.

D. K. CRAIG (*South Africa*):

It seems to me that very little airborne plutonium has any chance of reaching the functional areas of the lung. Do you not think that it would be more appropriate to use a respirable fraction sampling device (a size selection sampler) for your personal air sampler?

What is the source of the relatively high levels of airborne Pu that you have reported, apart of course from glove fractures and other breaks in the seals of your glove-boxes or contaminants? Finally, have you attempted to make any correlation between the results obtained n the personal air samplers and the results of analyses for the plutonium content of urine samples and, if so, what are the results?

S. T. HERMISTON:

1. The particle diameters that I referred to in my talk were the activity median aerodynamic diameters (A.M.A.D.). This is the most appropriate unit of measurement if we are interested in the amount of deposition in the lung. For instance, the ICRP Task Group on Lung Dynamics has proposed a lung model, which allows deposition patterns to be assessed from a knowledge of the A.M.A.D.'s. For comparison with our own results, this Task Group suggests a A.M.A.D. of 1μ to be used, if the actual A.M.A.D.'s have not been determined by practical measurements.

2. It would seem to me that a size selection sampling device might well be used, particularly if air contamination levels are approaching maximum permissible concentrations. We are looking into this: our difficulty at the present time is that I am unaware of any size selection device which closely matches current lung deposition models. In many areas where air contamination levels are well below the maximum permissible concentration, measurements of total air contamination will be sufficient to demonstrate that working conditions are satisfactory.

3. The main source of plutonium air contamination in working areas, is leakage of activity through gloves. For this reason, on our major plutonium production facilities we have eliminated the use of gloves, by the use of a "sealed face", and provide completely separate ventilation for maintenance and operating areas.

4. We have not yet attempted to correlate the results obtained with personal air samplers, with plutonium in urine measurements. When "insoluble" plutonium is being handled, faecal measurements made during the first four days following a possible exposure are the most profitable to make. However, due to the difficulties of collecting much samples, we have no detailed results to report. Mr. Johns, from Winfrith, has carried out such sampling programme, and may wish to comment.

T. F. JOHNS (*U.K.*):

We have considerable information on the relationship between the readings of personal air samplers and subsequent excretion in urine and faeces. We have, at Winfrith, an area in which large (tonne),

quantities of PuO_2/UO_2 fuel elements are manufactured in a large number of free-standing glove-boxes. Our experience is that there is no chronic contamination of the air; the exposure of individuals arises from a small number of discrete incidents, in most of which PuO_2 is released to the air as the result of damage to one of the gloves. The airborne contamination is very localised in both space and time, and usually only the individual working at that particular glove-box is significantly exposed. In most of these incidents we find good agreement between the estimate of personal exposure made from the personal air sampler, on one hand, and from faeces measurements on the succeeding five days, on the other. This confirms that the personal air sampler does give a good measure of the amount of plutonium inhaled. On the other hand we have found little or no plutonium in the urine of such individuals, and this urine data strongly suggests that only a small proportion of the PuO_2 initially taken into the body is retained in the lungs. This confirms Dr. Craig's suggestion that these gross measurements of intake lead to an over-estimate of the hazard (because of the large particle size of much of the aerosol).

There is one other point to which I would draw your attention. Although our experience shows that normal installed air samplers usually lead to a gross underestimate of the exposure of individuals, we are hopeful that a new air sampling system which we have recently installed will obviate the need for many personal air samplers. This system, which is demonstrated outside this hall, provides an air sampling point near the operating face of each glove-box, and gives an alarm in case of unusually high airborne levels.

D. C. LAWRENCE (*U.S.A.*):

1. What type of filter media are used and how are they counted?
2. How do they propose to solve the Radon–Thoron problem for their personal-alarm type air sampler?
3. Why do they use glass filter paper?

S. T. HERMISTON:

1. We use glass fibre papers. The detector in the personal sampler with alarm is a semi-conductor. However, for accurate assessment of the filter papers from the sampler we allow 72 hr to elapse from the end of sampling to allow daughter products of radon and thoron to decay. We then assay the papers using scintillation counters.

2. Whether we need be concerned about interference from natural activity on the P.A.S. with alarm, depends on the alarm setting. When the contamination is "insoluble" plutonium oxide, with a relatively high MPC in air, this interference is not important. On the other hand, if the contaminant is soluble plutonium with an MPC in air only 1/20 of that for insoluble plutonium, then it is possible that alpha energy discrimination might be used to achieve a desired sensitivity.

3. The glass fibre paper that we use has a very good efficiency over all particle sizes of interest. I will be pleased to supply you with the specification for this paper, if you wish.

M. GIUBILEO (*Euratom*):

Vorrei sapere se i dati di dosimetria esterna esposti nella tabella si riferiscono a dosi alfa oppure alle comuni dosi beta-gamma globali.

J. CHASSANY:

Les doses intégrées citées sont des doses "en profondeur" indiquées par les films dosimètres.

HUB. WJIKER (*Netherlands*):

In Fig. 2 I noticed the following sequence in the colours used when going from a less dangerous to a more dangerous zone: white, blue, green, yellow, red. My question is: why has green been taken for a more dangerous zone than blue and not the other way round? We are accustomed to the use of green for safety, e.g. in traffic.

J. CHASSANY:

Les zones de travail sont définies dans le *Dictionnaire des Sciences et Techniques Nucléaires*, 1963.

C. O. WIDELL (*Sweden*):

I would like to answer your question about the colour code. This is a code adopted by ISO and almost adopted by the Committee ISO/TC 85/SC 2, Radiation Protection. Green for safety and red for danger.

S. A. KHAN RANA (*Pakistan*):

The speaker has pointed out that there were no cases of internal contamination. Could I ask him the criteria on the basis of which this conclusion was arrived at and which particular group of workers was subjected to the examinations?

J. CHASSANY:

Le personnel affecté aux Ensembles Industriels est contrôlé systématiquement par le Service Médical. Ces contrôles consistent en des examens spectrométriques pour le dépistage des contaminations β γ et

concernent l'ensemble du personnel. Les contrôles de la contamination interne α sont pratiqués sur les travailleurs de l'Usine d'Extraction de Pu et comprennent des prélèvements d'urine. Par ailleurs le Service de Protection contre les Radiations a la possibilité de détecter une contamination dès son origine dans tous les lieux fréquentés par le personnel. Si, à la suite de ses contrôles, il estime qu'un agent a pu être exposé il le dirige immédiatement vers le Service Médical qui procède alors à des examens particuliers.

R. BAZIRE (*France*):

Dans quelle mesure les appareils de prélèvement tiennent-ils compte de la granulométrie du Plutonium?

J. POMAROLA:

Nous avons deux types de circuits dans l'installation en vue du contrôle de la contamination du Pu^{239}:

1. Ceux qui permettent d'obtenir une alarme et une mesure en continu de la contamination.

2. Ceux qui permettent d'obtenir une évaluation de la dose reçue au poste de travail, par des prélèvements continus sur filtre. Dans les deux cas nous tenons compte de la granulométrie:

1. Les appareils d'alarme par impacteur ou sur filtre.

2. Les filtres utilisés sont des filtres en papier alpha et fibre de verre dits "absolus" dont l'efficacité est de 99,98% pour des aérosols de 0,3 μ, en moyenne, mais qui peuvent arrêter aussi des poussières de 0,1 μ.

M. GIUBILEO (*Euratom*):

A proposito delle determinazioni granulometriche sull'aria contaminabile da plutonio, vorrei conoscere se ritiene sufficiente per il controllo del personale l'efficienza dei filtri fino a 0,3 micron di diametro. Tenendo conto che generalmente le particelle più fini di 0,5 micron costituiscono la metà della quantità totale, esse sono le più interessanti dal punto di vista tossicologico, anche per la possibilità di una solubilizzazione nei liquidi biologici e di un passaggio nelle vie linfatiche.

J. POMAROLA:

Je ne crois pas que nous puissions répondre de manière complète à la question qui vient d'être posée, parce que cela nous entrainerait dans un débat extrêmement long. Ce que je peux dire c'est ceci: lorsque je dis que les poussières, les aérosols retenus, ont une dimension de 0,3 micron, il s'agit d'une dimension moyenne. Les filtres sont capables d'arrêter des poussières jusqu'à 0,1 micron, mais ils sont presque totalement efficaces pour les poussières de 0,3 micron, tandis que le pourcentage des poussières de 0,1 micron arrêtées est beaucoup plus faible. On peut admettre que 99% des poussières de 0,3 μ sont arrêtées mais non pas celles de 0,1 μ. Nous avons fait des expérimentations à la fois sur des aérosols liquides et sur des aérosols solides par émission dans des installations et cela nous a permis de déterminer quel type de filtres il fallait adopter pour les prélèvements et quel type d'appareillage pour les alarmes. Nous nous sommes arrêtés, pour les installations de radiométallurgie, aux impacteurs, puisque là nous nous trouvions exclusivement en présence de poussières solides d'une certaine granulométrie. Pour les autres laboratoires, en particulier les laboratoires de radiochimie nous utilisons des filtres absolus.

D. K. CRAIG (*South Africa*):

If I understand correctly, Mr. Pomarola said that his particles had a mean size of 0.3 μ physical diameter. I would like to emphasize that it makes little sense to talk of an 0.3 μ diameter plutonium particle in terms of its inhalation hazard to man, as this is equivalent to an aerodynamic equivalent sphere of about 6 microns, which has little chance of reaching the functional areas of the lung or of staying in the body for a long enough time to present a hazard. I think that it is very important to attempt, in our air sampling, to determine the respirable fraction of the aerosol of interest by using some sort of size selection sampler.