

Quality Assurance Program for Hand-Foot Contamination Monitors

Oscar T. B. Alvarez and Linda V. E. Caldas

Instituto de Pesquisas Energéticas e Nucleares,
Comissão Nacional de Energia Nuclear
Av. Prof. Lineu Prestes 2242, 05508-000, São Paulo, SP, Brazil.
E-mail: obordon@yahoo.com ; lcaldas@ipen.br

Abstract. To ensure that hand-foot contamination monitors meet the performance specifications of the manufacturers and comply with the standards of national and/or international radiation protection organizations, a quality assurance program (Q.A.) should be established. In this work, as a part of a Q.A, some quality control tests were developed and implanted following mainly a Brazilian standard (NBR-12604) and a British guidance (HS(G)49). The procedures were applied to an Eurisys/Sirius hand-foot contamination monitor. The following tests were performed: measurement of the response uniformity for alpha and/or beta contamination, measurement of instrument linearity, checks on beta rejection characteristics, periodical movement of the detector covering Mylar sheet and cleaning of the feet windows, teaching of staff members for good use of the instrument, and weekly controls of the background count rates. Each time sources were needed, circular and rectangular flat sources of Am-241 and Cl-36 were used.

1. Introduction

Hand-foot contamination monitors, often located at the exit of controlled areas, are designed to perform measurements of activity spread over the surface of hands and soles of shoes or feet; they are very important instruments of the personnel contamination monitoring. These instruments are equipped with detectors for hands and feet. To ensure that such equipment meets the performance specifications of the manufacturers and comply with the standards of national and/or international radiation protection organizations, a quality assurance program (Q.A.) must be established.

Quality control and quality assurance are not well-defined concepts and they are often incorrectly used interchangeably. Quality control represents an integral and most tangible aspect of quality assurance. It comprises a series of distinct technical procedures, which ensure the production of a satisfactory product. Quality assurance is an all-encompassing program, including quality control that extends to administrative, educational, and preventive maintenance methods [1].

As part of a quality control program, some tests were developed to check that the condition of an instrument has not deteriorated. These tests comprise measurements of instrument linearity; check on beta radiation rejection; uniformity of response; and background count rates.

2. Methodology

2.1. Linearity test

The knowledge of the response of each instrument for a wide range of dose rates is important. The ideal relationship between instrument reading and dose rate should be linear, and deviations from linearity should be known [2].

The only satisfactory way to check the linearity of an alpha and beta contamination monitor is by using sources of known output. Normally a satisfactory test can be accomplished using three small sources. The ratio of the instrument indication to the emission rate should be determined, and should agree with the mean of all three ratios to within $\pm 30\%$ [3].

A linearity test was performed with a Eurisys/Sirius hand-foot monitor; only the feet detectors were checked. The tests for hand detector are still in development. The linearity test was performed using 16 mm in diameter sources. For alpha radiation, Am-241 sources with emission rates of 414 s^{-1} , 236 s^{-1} and 103 s^{-1} , were used, and for beta radiation tests were performed using Cl-36 sources with emission

rates of 248 s^{-1} , 140 s^{-1} and 62 s^{-1} . Each source was placed at the same well-defined position, and the indication determined. Figures 1 and 2 show the results obtained relative to the left foot detector of the monitor. In the first case, the highest variation among the ratio values was 6%; in the second case, it was 22.5%. In both cases the values were within the recommended limits [3].

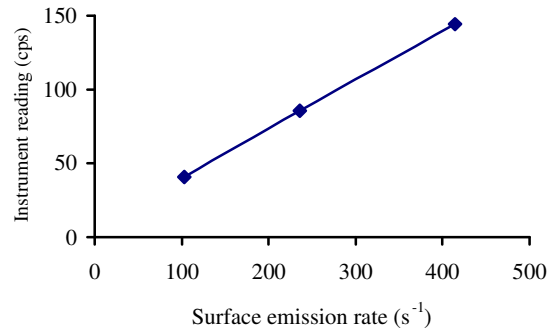


FIG.1. Linearity test of the left foot detector of an Eurisys/Sirius hand-foot contamination monitor using an Am-241 source.

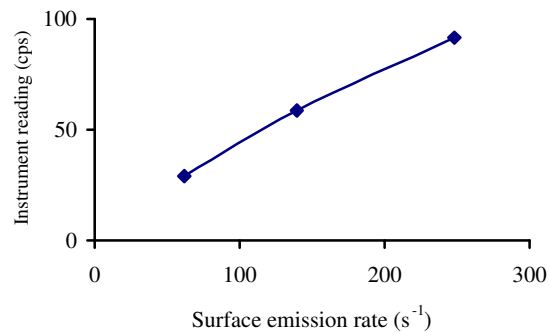


FIG.2. Linearity test of the left foot detector of an Eurisys/Sirius hand-foot contamination monitor using a Cl-36 source.

2.2. Response uniformity for alpha and beta radiation

The instrument has to be checked to ensure that the response to alpha and beta activity is reasonably uniform over the whole area of the detector. The test should identify areas of the detector that have inadequate detection efficiency. The criterion for the test is that no more than 30% of the total probe area should have a detection efficiency that is less than 30% of the mean value [3].

A test was realized to check the response uniformity of feet detectors in an Eurisys/Sirius hand-foot contamination monitor (the test for hand detectors is in development, because its design makes difficult the source placing). To perform the test, sources of Am-241 (419 s^{-1}) and Cl-36 (248 s^{-1}), both of 16 mm in diameter, were utilized. One measurement was taken for each area of 4 cm^2 of the sensitive windows. The results can be observed in Table 1. The response uniformity should be over 70%, so the results are within the recommended values.

The homogeneity of each detector is lower for alpha than for beta particles that may be caused by electrical field-effects and charge collection [4].

Table 1. Response uniformity of an EurisyS/Sirius hand-foot contamination monitor

Source	Cl-36		Am-241	
Detector	Left foot	Right foot	Left foot	Right foot
Uniformity	> 85%	> 85%	> 77.5%	> 82.5%

2.3 Beta rejection

Instruments designed to measure simultaneously alpha and beta contamination, with separated indication of each one, in the case of alpha channel the response for beta contamination should be less than 5% of the corresponding response to alpha activity [5].

This test was performed using a Cl-36 source with 36 mm in diameter (foot detectors) and 15cm x 10cm (hand detectors). The response was recorded in the beta channel and in the corresponding alpha channel, to determine the alpha/beta counting ratio. Table 2 shows the results for a hand-foot EurisyS/Sirius monitor. For the determination of the alpha/beta ratio, the beta radiation background was considered. All ratios are higher than the recommended values. The person responsible for the maintenance of the equipment was informed, and he has to verify and correct the problem.

Table 2. Results of alpha/beta rejection in an EurisyS/Sirius hand-foot contamination monitor.

Detector	Beta channel (cps)	Alpha channel (cps)	Alpha/Beta counting ratio (%)
Left foot	185.2	15.6	10
Right foot	164.7	15.6	10
Left hand	289.0	44.5	16
Right hand	302.3	32.9	11

2.4 Background count rates

The observed background count rate or indication in an area of known low levels of beta and alpha radiation should not exceed that stated by the manufacturer. If the background count rate is high, it could be due to contamination of the detector window. After cleaning, the result should be checked to ensure that any residual contamination does not prejudice the detection of beta or alpha activity at the maximum acceptable level for the area of use [3].

Once a week background levels were recorded, and a control graph was obtained. Each time that an abnormal behavior is observed, it must be verified; irregular growth may indicate contamination, radioactive sources close to the detector, increase of gas flow, etc. Example of background follow-up graph is shown in Fig.3.

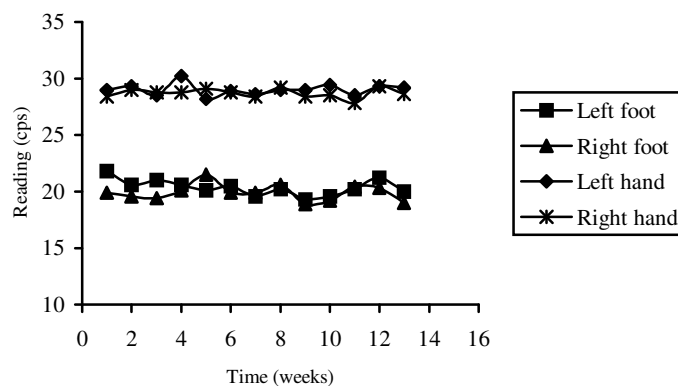


FIG.3. Background control results for the four detectors of an Eurysis/Sirius hand-foot monitor.

2.5 Mylar protection

Sometimes, feet detectors have an optional Mylar sheet to protect them from dirt, contamination or other particles. It is important to follow the manufacturer specification to move the Mylar roll to avoid hand contamination, or that some artifacts fall down on the sensitive windows.

2.6 Staff training

Although staff often is well trained to use the monitors, it is important to offer recycling training for good use of instruments; it was observed that sometimes the workers are not sure about the correct position of hands into the monitor. It is usual to see them put the hands in contact with the protective grids that may increase contamination risks.

3. Acknowledgement

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4. References

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