

White Paper
GSI – Dose Estimate from Radium Radiographer to
Employees not Routinely Working in Production Areas
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Background

During the TBD-6000 work group meeting held on April 26, 2013, NIOSH was asked to develop a dose estimate for personnel who did not routinely work in the production areas of the General Steel Industries (GSI) site. During the work group meeting, it was discussed that a previous dose estimate prepared by NIOSH for exposures to those not actively engaged in radiography might provide a good starting point. The previous estimate is contained in the DCAS white paper titled “Dose Estimates for Portable Radiography Sources,” dated August 2011.

Previous Estimate

The previous white paper estimated radiation dose to workers exposed to radium radiography that occurred outside of the radiography room in building 6. The estimate was based on worker reports that a boundary was set up at 1.5 times the required distance. At the time the radiography work was conducted, the required distance was a point where dose rates reached 2 mR/hr. Based on the inverse square law, 1.5 times this distance would have resulted in a boundary at which dose rates were 0.89 mR/hr.

It was reported by workers that the exclusion area delineated by the boundary was not always observed. Thus, the previous estimate assumed a person could be traversing the exclusion area 10% of the time the sources were unattended. Based on a review of GSI-related documents, it was further assumed the sources were exposed for 144 minutes per eight hour shift but unattended for 136 minutes per shift. This combined with the assumption that the exclusion area boundary was ignored 10% of the time the sources were unattended results in an individual walking through the area for 13.6 minutes per shift. In the previous estimate, it was assumed that a worker could have traveled across the boundary at any distance from the source.

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Using these parameters, the average dose rate while walking through the area was determined and the person was assumed to receive that dose rate for 13.6 minutes per shift, as well as receiving 0.89 mR/hr for 130.4 minutes per shift (144 minutes – 13.6 minutes).

Adjustments to Previous Estimate

For this white paper, some adjustments were made to the previous estimate. Because it cannot be definitively established that the exclusion area boundary was set at 1.5 times the required distance, the boundary is assumed to be set at 2 mR/hr, instead of 0.89 mR/hr. This adjustment requires the recalculation of the dose received by walking through the boundary because the size of the area is reduced and the dose rate at the boundary is increased. With the smaller area, the assumption that an individual spent 13.6 minutes per shift walking through the area results in over 33 trips per shift through the boundary while sources are exposed and unattended. Since this revised estimate is intended to apply to people that would not have a normal work area in the vicinity, this result appears to be unrealistic. This estimate will therefore assume the individual walked through the area twice per shift. That would represent one trip through the exclusion area to get to an intended location and a return trip. It is still considered bounding because the worker is assumed to traverse the exclusion area each and every shift for the 136 minutes during which the sources were exposed and unattended.

In the original analysis, when not traversing the exclusion area, the worker is assumed to spend the remainder of their time at the boundary of the exclusion area. Since this revised estimate is intended for employees that do not spend their entire workday in the production areas, 100% occupancy time at the radiography boundary appears to be unrealistic. This estimate will assume they spent 25% of their time next to the boundary. This does not indicate they only spent 25% of their time in the production area, it indicates they only spent 25% of their time at the boundary of the radiography and 75% elsewhere in the plant.

Results

Using the values stated above, and applying the same techniques that were used in the previous white paper, results in a dose of 0.103 mR per trip through the exclusion area or 0.206 mR/shift. Multiplying this by the average of 406.25 shifts per year results in an annual dose of 84 mR from cutting across the boundary.

Added to that dose is the dose received while standing next to the boundary. This estimate assumes that this occurred 25% of the time the sources were exposed or 243.75 hrs/yr (3250 work hours x 30%

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source utilization x 25% occupancy). At 2 mR/hr this results in an annual dose of 487.5 mR. Adding the dose from walking through the area results in a total annual dose of 571.5 mR.

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