

R. M. WESTER *and ASSOCIATES, INC.*

215 INDACOM DRIVE - ST. PETERS, MISSOURI 63376

(636) 928-9628 - FAX (636) 928-9857

RMWester.com

FAX TRANSMISSION COVER SHEET

DATE: 11/10/06

TIME: 4:05 pm

TO: Mr. Bob Gattone

COMPANY: USNRC

NUMBER: 630-515-1259

FROM: Robert M. Wester

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COMMENTS: Attached, is an addendum to the University of Missouri- St. Louis incident report, dated October 4, 2006, that you requested. Please call if you have any questions or comments.

ADDENDUM:

1. 10CFR Part 20.2201 (4, 6) requires that exposure estimates and corrective measures taken after the incident, dated October 4, 2006, in which a bag of dry waste containing a maximum of 4.0 milli-Curies of Phosphorous-32 was removed by a member of the University custodial staff, be documented.

a. DOSE ESTIMATION. No removable contamination was detected in the surveyed areas, equipment, personnel, and custodian automobile associated with this occurrence. Therefore, any exposure potential would be due to radiation levels associated with the self contained waste. The unshielded beta dose in air (Shleien) is given as:

$$H(\text{rem/hr}) \approx 300 n C/d^2$$

Where n = fraction of beta disintegrations = 1.0
 c = activity in Curies = 0.004 Curies
 d = distance in feet

Solving for H(rem):

$$H(\text{rem}) \approx 300 n C t/d^2$$

The estimated time and distance during initial trash gathering is 0.5 minute (0.0083 hr), 2 feet from which:

$$H(\text{rem}) \approx 300 (1.0) (0.004 \text{ Curies}) (0.0083 \text{ hr}) / (2\text{ft})^2 = 2.49 \text{ milli-rem} \quad (\text{For unshielded air})$$

The estimated time and distance during the transportation by cart to the dumpster is 20 minutes (0.33 hr), 2.0 ft from which:

$$H(\text{rem}) \approx 300 (1.0) (0.004 \text{ Curies}) (0.33 \text{ hr}) / (2.0 \text{ ft})^2 = 102.0 \text{ milli-rem} \quad (\text{For unshielded air})$$

The beta material was shielded by all of the dry lab trash in the collection container and consisted mostly of paper and plastic. Moreover, the trash was surrounded by two plastic garbage bags. The beta stopping range for the composite trash material was not available from reference tables, however, the composite material should be near the 1.0 cm for plastic (at 1.71 MeV). Therefore, the beta dose due to betas escaping from the shielded waste materials within the bag should be negligible.

For photon exposures, the Bremsstrahlung fraction is used in this case to convert beta activity to associated gamma activity:

$$f = 3.5 \text{ Exp-04 } Z E_{\text{max}}$$

Where Z=Atomic Number and E_{max} is maximum decay energy

$$f = 3.5 \text{ Exp-04 } (15) (1.71 \text{ MeV}) = 8.98 \text{ Exp-03}$$

The gamma activity is given as:

$$\text{Act}(\text{Gamma}) = f \text{ Act}(\text{Beta}) = 8.98 \text{ Exp-03 Act}(\text{Beta})$$

From which application of the unshielded beta exposures in air, given above, becomes:

$$\begin{aligned}\text{Act (2.49 milli-Rem)} &= 0.022 \text{ milli-rem} \\ \text{Act (102.0 milli-Rem)} &= 0.916 \text{ milli-rem}\end{aligned}$$

The Half Value Layer (HVL) for polyethylene is calculated (at the closest table entry of 1.5 MeV) using the mass attenuation coefficient (μ) as follows:

$$\text{HVL} = \ln(2)/\mu = \ln(2)/0.0592 = 1.17 \text{ cm (0.46 in)}$$

The sum of the above gamma doses are approximately one milli-Rem. Therefore, it is easy to see that the application of just one HVL attenuates the total gamma exposure to an undetectable dose.

A filled, double layered, large waste garbage bag containing an estimated 10 gallons of waste should have a cylindrical radius of at least 12 inches. This bag radius should fully attenuate the gamma dose to even less than one milli-Rem, and would be comparable to the background rate. Therefore, the total shielded dose to the custodian should be below 1 milli-Rem. Even if the total contact times reported were in error by a factor of 3, the dose equivalent to the whole body would be:

$$H \leq 3 \text{ milli-rem (Shielded) Custodian}$$

The calculated dose estimates, above, regarding this occurrence due to radioactive field emissions are greatly below the stochastic dose threshold and are comparable to the background dose. Furthermore, the total whole body dose estimate is far below applicable occupational ALARA exposure regulatory limits. Therefore, there is no acute exposure risk due to this occurrence beyond natural stochastic doses associated with the background.

b. CORRECTIVE MEASURES. Retraining of the custodial staff was performed on October 4, 2006. The preexisting radioactive labels on waste storage containers were replaced with new oversized radioactive material labels to further facilitate personnel hazard communication. The use of bright yellow radioactive material bags was also implemented to facilitate hazard communication.

2. REFERENCES.

- a. Bernard Shlcien, et. al., "Handbook of Health Physics and Radiological Health," 3rd Edition, 1998.
- b. Robert Weast, et. al., "CRC Handbook of Chemistry and Physics," 64th Edition, 1983.
- c. James Voss, "Los Alamos Radiation Monitoring Notebook," February 2001.
- d. Herman Cember, "Introduction to Health Physics," 3rd Edition, 1996.