Source Term Analysis for the WIPP Release Quantity

Jeff Whicker, Matt Griffin, Christine Bullock, Michael McNaughton, William Eisele (Bill), Murray Moore

The calculations below provide an initial rough order of magnitude estimate of the airborne release quantity in Panel 7, Room 7, at the WIPP site starting about February 14, 2014. Further, we provide an initial assessment of the possibility for leakage from more than one drum using 3 lines of evidence: 1) the release quantity relative to the amount in the known breached drum, 2) measured Am-241/Pu-239 ratios in the drum and air filters collected post-release, and 3) the time series of the release.

Estimated release quantity

The data used in this assessment include air concentration measurements from several locations downstream of the identified potential release locations. (Fig. 1) Table 1 provides this data and the source of the information.

Table 1. Data used in revised estimate of airborne release quantity.	**Data values**	**Reference**
Ventilation rate during accident	**60,000 ft^3/min past Station A** **5000 cfm past the CAM 151**	(DOE Investigation Report), data from WIPP ventilation engineer
CAM Air Flow Rate	2.5 ft^3/ min	CAM 151 flow rate data
CAM 151 Activity	2 x 10^7 dpm	(Haye's 2014)
Station A Activity (pre HEPA filters)	8.2 x 10^6 dpm	(DOE Investigation Report)

Approach/Results:

Equations 1 and 2 show the formulas with the estimates of flow rates in the air samplers and the room/stack ventilation rates for CAM 151 and Station A, respectively.

CAM 151

*Release Activity (dpm) = Filter Activity (dpm) * (*$5{,}000\ cfm/2.5\ \mathrm{cfm}$*) [eqn.1]*

Station A

*Release Activity (dpm) = Filter Activity (dpm) * (*$60{,}000\ cfm/2.5\ \mathrm{cfm}$*) [eqn.2]*

Using the equations above, the airborne source term estimates from the air samples are:

CAM 151: 2 x 10^7 dpm (2000/$2.22x10^{12}\ dpm\ \mathrm{per\ Ci}$*) = 0.02 PeCi*

Station A = 8.2 x 10^6 dpm (24,000/$2.22\mathrm{x}\ 10^{12}\ \mathrm{dpm\ per\ Ci}$*) = 0.09 PeCi*
(located upstream HEPA filter- refer to Fig. 1)

Estimated amount in drum 68660

Based on the PE-Ci from the 14 items measured in the parent drum from TA-55 (S855793) then repackaged, we estimate about 15 PE-Ci and assume this amount was roughly divided equally into the two daughter drums, so we assumed 10 PE-Ci in drum 68660, which is the drum with visual damage in WIPP (Fig. 2). Therefore, the estimated airborne release fraction is calculated as the measured airborne release of 0.02-0.09 PE-Ci divided by 10 PE-Ci. This results in release fraction ranging from 2×10^{-3} to 9×10^{-3}. We conclude that these release fractions are comparable with release fractions from Table 5-2 showing measured airborne release fractions from burning of contaminated cellulosic materials provided in the DOE handbook DOE-HDBK-3010-94.

Am-241 to Pu-239 ratios

Multiple air sample filters were analyzed for Am-241 and Pu-239. These filters were taken at multiple times and locations during the release. The Am/Pu ratios of activity on the filters ranged from around 10-20. While the Am/Pu ratio in the items that were packed in the parent drum varied (range from about 2 – 30), the average was about 10. This ratio is consistent with the ratio seen on the filters.

Time profile for release

The time profile of the activity in the air sampling suggests an initial stronger release with most of the activity collected 1-2 hours post release. The activity collected on the filters decreased after this initial release by an order of magnitude. The total release was mostly over after about a day or so. There were no notable secondary peaks in activity suggestive of multiple reactions spaced in time.

Conclusions

The estimated quantity of the release from each of the two independent air samplers was less than 0.1 PE-Ci. The measured Airborne Release Fraction (ARF) from the samplers ranged from 2×10^{-3} to 9×10^{-3}. Given that these ARFs are consistent with the DOE handbook, this provides some confidence that a single drum could release enough airborne activity measured on the air filters. Second, the Am/Pu ratios on the air filters are consistent with the contents in drum 68660 (Fig.2) though there was significant heterogeneity in the ratios in the items in the drum. Last, the time profile suggests a single initiating event though the activity on the filter continued to increase slowly for a day or so. Combined, we conclude that the data suggest that a release from a single drum was sufficient to result in the measured air concentrations. The Am/Pu ratios and the time series provide evidence that the Drum 68660 may have been the source of the leak.

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