



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
WASHINGTON, D.C. 20555-0001

January 10, 2020

MEMORANDUM TO: File

SUBJECT: NUREG-0570, "TOXIC VAPOR CONCENTRATIONS IN THE CONTROL ROOM FOLLOWING A POSTULATED ACCIDENTAL RELEASE," RE: POTENTIAL ERROR IN EQUATION 2.2-1

In December 2019, Mr. Shawn Williams, Senior Project Manager, Nuclear Regulatory Commission, received an informal e-mail from a member of the public indicating a potential error in NUREG-0570, "Toxic Vapor Concentrations in the Control Room Following a Postulated Accidental Release," June 1979 (ADAMS Accession No. ML063480551).

The member of the public stated:

I believe there is an error in NUREG-0570, Section 2.2.1, Equation 2.2-1. The exponent in the denominator for the  $2\pi$  term may be incorrect. It is listed as being  $3/4$ ; however, I believe it should be  $3/2$ .

$$x(x, y, z, h) = \frac{Q}{(2\pi)^{3/4} \sigma_{X1} \sigma_{Y1} \sigma_{Z1}} \cdot \exp \left\{ -\frac{1}{2} \left[ \frac{x^2}{\sigma_{X1}^2} + \frac{y^2}{\sigma_{Y1}^2} \right] \right\} \cdot \left\{ \exp \left[ -\frac{1}{2} \frac{(z-h)^2}{\sigma_{Z1}^2} \right] + \exp \left[ -\frac{1}{2} \frac{(z+h)^2}{\sigma_{Z1}^2} \right] \right\} \quad (2.2-1)$$

Where  $x$  = concentration ( $g/m^3$ )

$Q$  = source strength ( $g$ ) =  $m_{v0}$

$\sigma_{X1}, \sigma_{Y1}, \sigma_{Z1}$  = adjusted standard deviations of the puff concentration in the horizontal along-wind ( $X$ ), horizontal cross-wind ( $Y$ ), and vertical cross-wind directions ( $Z$ ), respectively ( $m$ ).

$x, y, z$  = distances from the puff center in the  $X, Y$ , and  $Z$  directions, respectively ( $m$ ).  $z$  is also the effective above-ground elevation of the receptor, e.g., the fresh-air intake of a control room.

$h$  = effective above-ground elevation of the source.

To account for the initial volume of the puff, it is assumed that

$$\sigma_{X1}^2 = \sigma_{X1}^2 + \sigma_0^2 \quad (2.2-2)$$

$$\sigma_{Y1}^2 = \sigma_{Y1}^2 + \sigma_0^2 \quad (2.2-3)$$

$$\sigma_{Z1}^2 = \sigma_{Z1}^2 + \sigma_0^2 \quad (2.2-4)$$

$$\sigma_{X1}^2 = \sigma_{Y1}^2 \quad (2.2-5)$$

and letting  $x = x_0 - ut$

$$\sigma_0 = [m_{v0} / (2^{1/2} \pi^{3/2} \rho_v)]^{1/3} \quad (2.2-7)$$

where

$\sigma_0$  = initial standard deviation of the puff ( $m$ )

$\sigma'_{X1}, \sigma'_{Y1}, \sigma'_{Z1}$  = standard deviation of puff concentration in the

An NRC staff member informally investigated the comment and agreed with the error that was provided above.

The NRC staff member pointed out that RG 1.111, "Methods for Estimating Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," (ADAMS Accession No. ML003740354), Section 1.b. "Plume Element Models" contains the correct version of the equation.

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**ADAMS Accession No.: ML20010D233**

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