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

October 31, 1997

Randall J. Charbeneau, Director
and Professor of Civil Engineering
Center for Research in Water Resources
J.J. Pickle Research Campus
The University of Texas at Austin
Austin, Texas 78712

SUBJECT: INCONSISTENCIES FOUND IN NUREG/CR-4370, VOLUME 1

Dear Mr. Charbeneau:

Based on your correspondence, dated August 4, 1997, my staff has reviewed the equations used for operational accident scenarios in both NUREG/CR-4370, Volume 1, *Update of Part 61 Impacts Analysis Methodology* (January 1986) and NUREG-0782, Volume 4, *Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste"* (September 1981).

In your correspondence, you note inconsistencies in the units in the equations for the following accident scenarios: container drop/spill off-site dose and container fire off-site dose. My staff found no inconsistencies in the units in the equation (see enclosure), but an NRC naming convention and a lack of units in NUREG/CR-4370 may have led to the misunderstanding.

NRC uses χ/Q to denote the atmospheric dispersion factor, which generally has units of sec m^{-3}. The puff model used in Regulatory Guide 1.111, which is the basis for equations 4-100 and 4-105, of NUREG/CR-4370, and equations G-33 and G-36, of NUREG-0782, is a rate-based equation where Q is equal to the activity released over set amount of time. In proper mathematical terms, the atmospheric dispersion factor should be denoted as χ/Q'.

In NUREG/CR-4370, on page 4-73, it is noted that the χ/Q for the container drop/spill off-site dose scenario needs to have units of yr m^{-3}. Unfortunately, on page 4-75, in discussing the χ/Q for the container fire off-site dose scenario, there is no discussion of the proper units for the calculation. In NUREG-0782's discussion on the container fire off-site dose scenario, it is

NRC FILE CENTER COPY

9711070098 971031
CF SUBJ
103 CF

noted that χ/Q is in units of sec m^{-3}, and the values calculated for both the χ/Q and site selection factor are the same as the values in NUREG/CR-4370. Therefore, NUREG/CR-4370 should have noted that χ/Q for the container fire off-site dose scenario is in units of sec m^{-3}.

Sincerely,

[Original signed by:]

Michael J. Bell, Chief
Performance Assessment and HLW
Integration Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: as stated

Ticket: DWM-187

DISTRIBUTION:	Central File	PAHL r/f	DWM r/f
JHickey	DFauver	LBell	NMSS r/f
TMcCartin	DWM t/f	MFederline	JGreeves
RJohnson	CPaperiello		

DOCUMENT NAME: S:\DWM\PAHL\CAMTEXAS.REP

OFC	PAHL		PAHL		PAHL			
NAME	CMcKenney/kv		KMcConnell		MBell			
DATE	10/6/97		10/7/97		10/8/97			

OFFICIAL RECORD COPY

Unit Evaluations of NUREG/CR-4370, Volume 1 Methodology for Estimating Doses from Operational Releases

Section 4.6.1 Container Drop/Spill Off-site Dose Analysis

The off-site dose from a container drop or spill can be found by the following equation:

$$H = \sum_n f_r \cdot V_q \cdot f_q \cdot f_c \cdot C_n \cdot (\chi/Q) \cdot EDF \cdot PDCF$$

where:

H	= 50 year dose commitment (mrem);
f_r	= fraction of package contents released (unitless);
V_q	= volume of the container (m^3);
f_q	= frequency of accident (yr^{-1});
f_c	= operational dispersibility factor (unitless);
C_n	= radionuclide concentration in the waste stream ($Ci\ m^{-3}$);
χ/Q	= the atmospheric dispersion factor ($yr\ m^{-3}$);
EDF	= exposure duration fraction (yr); and
PDCF	= pathway dose conversion factor ($mrem\ m^3\ Ci^{-1}\ yr^{-1}$).

Unit Analysis -

$\underline{mrem} = (\cancel{unitless}) \cdot (\cancel{m^3}) \cdot (\cancel{yr^{-1}}) \cdot (\cancel{unitless}) \cdot (\cancel{Ci\ m^{-3}}) \cdot (\cancel{yr\ m^{-3}}) \cdot (\cancel{yr}) \cdot (\underline{mrem}\ \cancel{m^3\ Ci^{-1}\ yr^{-1}})$

Therefore, the units in the equation are consistent with the desired results.

Section 4.6.2 Container Fire Off-site Dose Analysis

The off-site dose from a container fire can be found by the following equation:

$$H = \sum_n V \cdot f_r \cdot 20^{-IFL} \cdot C_n \cdot (\chi/Q) \cdot EDF \cdot PDCF$$

Enclosure

where:

H = 50 year dose commitment (mrem);

V = volume of waste involved in the fire (m^3);

f_r = radionuclide release fraction (s^{-1});

20^{-IFL} = flammability multiplier for waste form based on the flammability index, IFL (unitless);

C_n = radionuclide concentration in the waste stream ($Ci\ m^{-3}$);

χ/Q = the atmospheric dispersion factor ($sec\ m^{-3}$);

EDF = exposure duration fraction (yr); and

PDCF = pathway dose conversion factor ($mrem\ m^3\ Ci^{-1}\ yr^{-1}$).

Unit Analysis

$\underline{mrem} = (\cancel{m^3}) \cdot (\cancel{s^{-1}}) \cdot (\cancel{unitless}) \cdot (\cancel{Ci\ m^{-3}}) \cdot (\cancel{sec\ m^{-3}}) \cdot (\cancel{yr}) \cdot (\underline{mrem}\ \cancel{m^3\ Ci^{-1}\ yr^{-1}})$

Therefore, the units in the equation are consistent with the desired results.