From: Jason Schaperow
To: internet:rogaunt@sandia.gov
Date: Tue, Jul 11, 2000 3:11 PM
Subject: Plume Energy

Please see the attached file (WordPerfect8 format). Also, I just FAXed you a copy of the attached file (FAX number (505)-844-8719), in case you do not have a program handy to read it. Thank you very much.

Sincerely,
Jason

CC: Ali Behbahani, Allen Notafrancesco, Charles Tink...

7/11/00 at 3:15
I called R. Gaunt. Not in, so I left msg that
I e-mailed this and FAXed this to him.

I-37

July 11, 2000

Randy,

The calculation below assumes (1) the number of fuel assemblies in one core is completely oxidized and (2) all of the oxidation energy goes into the plume. I request that you check the calculation below. I also request that you provide additional estimates of plume energy considering (1) the number of fuel assemblies being oxidized may be the entire spent fuel pool inventory of 3.5 cores, (2) complete oxidation of all zirconium will not take place, (3) some of the oxidation energy goes into fuel heat-up and degradation, and (4) any other factor you consider to be relevant. My draft report on spent fuel pool accident consequences is due to NRR by Friday, July 14.

Plume Energy for Spent Fuel Pool Accident

For BWR6, Page 13 of *Nuclear Systems I*:
Clad thickness = .813 mm
Clad outer diameter = 12.27 mm
Clad length = 4.1 m
8x8 array of fuel rods in an assembly

Page 296 of *Nuclear Systems I*:
density of zircalloy 2 = 6500 kg/m^3

Clad outer radius = 6.135 mm
Clad inner radius = 5.322 mm

volume of zircalloy in one rod = 3.14 x (6.135^2 - 5.322^2) mm^2 x 4.1 m x 1 m^2 / 10^6 mm^2
= 1.199×10^{-4} m^3

volume of zircalloy in one assembly = 1.199×10^{-4} m^3 x 64 = 7.674×10^{-3} m^3

Core in Millstone 1 (BWR) has 580 assemblies.

volume of zircalloy in 1 core = 4.451 m^3

4.451 m^3 x 6500 kg/m^3 = 2.893×10^4 kg = 2.893×10^7 g

Page 22 of NUREG/CR-6218, *A Review of the Technical Issues of Air Ingression During Severe Reactor Accidents*: 2892 cal / g of Zr oxidized

2.893×10^7 g x 2892 cal / g x 4.184 j / cal x 1 w sec/ j = 3.500×10^{11} w sec

The oxidation is assumed to occur over 30 minutes (i.e., 1800 sec).

3.500×10^{11} w sec x 1 Mw/ 10^6 w / 1800 sec = 194 Mw

A large BWR (BWR4, Peach Bottom 2 and 3) has 764 assemblies.

Therefore, the plume energy = 194 Mw x 764 / 580 = 256 Mw