

Jason S.



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

October 26, 2000

MEMORANDUM TO: Gary M. Holahan, Director  
 Division of Systems Safety and Analysis  
 Office of Nuclear Reactor Regulation

FROM: Farouk Eltawila, Acting Director *F. Eltawila*  
 Division of Systems Analysis and Regulatory Effectiveness  
 Office of Nuclear Regulatory Research

SUBJECT: RADIOLOGICAL CONSEQUENCES OF SPENT FUEL POOL  
 ACCIDENTS OCCURRING UP TO 10 YEARS AFTER FINAL  
 REACTOR SHUTDOWN

As part of its effort to develop generic, risk-informed requirements for decommissioning, NRR requested (Reference 1) that RES evaluate the offsite radiological consequences of beyond-design-basis spent fuel pool accidents. In response to that user need, RES completed an in-house analysis (References 2 and 3) using the MACCS code (Reference 4). The focus of that work was estimation of consequences of accidents occurring between 30 days and 1 year after final reactor shutdown. Recently, NRR requested (References 5 and 6) that RES extend the consequence evaluation to accidents occurring up to 10 years after final shutdown.

RES performed the requested calculations using the release fractions in Table 1 and the fission product inventories at 30 and 90 days and 1, 2, 5, and 10 years after final shutdown. The release fractions in the first row of Table 1 are the sum of the in-vessel and ex-vessel release fractions in NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," February 1995 (Reference 7). NUREG-1465 has received significant peer review and is representative of a low pressure core-melt accident. The release fractions in the second row of Table 1, other than those for ruthenium and fuel fines, also are from NUREG-1465. In this case, the ruthenium release fraction is that for a volatile fission product, and the fuel fines release fraction is that from the Chernobyl accident (Reference 8). Results of the RES calculations for distances of 1, 10, and 50 miles are given in Tables 2 and 3.

Table 1 Fission Product Release Fractions

Source Term	Release Fractions								
	Xe,Kr	I	Cs	Te	Sr	Ba	Ru	La	Ce
NUREG-1465	1	.75	.75	.31	.12	.12	.005	.0052	.0055
NUREG-1465 (modified)	1	.75	.75	.31	.12	.12	.75	.035	.035

I-48

Table 2 Results based on NUREG-1465 Source Term

Case	Decay Time	Mean Consequences <sup>a</sup> (Surry population, 95% evacuation)			
		Individual Risk of Early Fatality (within 1 mile)	Individual Risk of Cancer Fatality (within 10 miles)	Societal Dose (rem) (within 50 miles)	Early Fatalities (within 10 miles)
77a	30 days	$1.27 \times 10^{-2}$	$1.88 \times 10^{-2}$	$5.58 \times 10^6$	2.21
77b	90 days	$9.86 \times 10^{-3}$	$1.82 \times 10^{-2}$	$5.43 \times 10^6$	1.37
77c	1 year	$7.13 \times 10^{-3}$	$1.68 \times 10^{-2}$	$5.28 \times 10^6$	.736
77d	2 years	$5.64 \times 10^{-3}$	$1.58 \times 10^{-2}$	$5.12 \times 10^6$	.481
77e	5 years	$3.18 \times 10^{-3}$	$1.43 \times 10^{-2}$	$4.90 \times 10^6$	.192
77f	10 years	$1.63 \times 10^{-3}$	$1.29 \times 10^{-2}$	$4.72 \times 10^6$	.0778
78a <sup>b</sup>	30 days	$8.36 \times 10^{-4}$	$9.92 \times 10^{-4}$	$4.12 \times 10^6$	.0720
78b <sup>b</sup>	90 days	$6.83 \times 10^{-4}$	$9.62 \times 10^{-4}$	$4.02 \times 10^6$	.0461
78c <sup>b</sup>	1 year	$5.44 \times 10^{-4}$	$9.09 \times 10^{-4}$	$3.95 \times 10^6$	.0301
78d <sup>b</sup>	2 years	$4.41 \times 10^{-4}$	$8.71 \times 10^{-4}$	$3.87 \times 10^6$	.0208
78e <sup>b</sup>	5 years	$2.54 \times 10^{-4}$	$8.14 \times 10^{-4}$	$3.77 \times 10^6$	.00882
78f <sup>b</sup>	10 years	$1.47 \times 10^{-4}$	$7.70 \times 10^{-4}$	$3.69 \times 10^6$	.00400

<sup>a</sup>Accident frequencies approximately  $10^{-6}$ /year or less.

<sup>b</sup>Based on early evacuation.

**Table 3 Results based on NUREG-1465 (modified) Source Term**

Case	Decay Time	Mean Consequences <sup>a</sup> (Surry population, 95% evacuation)			
		Individual Risk of Early Fatality (within 1 mile)	Individual Risk of Cancer Fatality (within 10 miles)	Societal Dose (rem) (within 50 miles)	Early Fatalities (within 10 miles)
79a	30 days	$4.43 \times 10^{-2}$	$8.24 \times 10^{-2}$	$2.37 \times 10^7$	191
79b	90 days	$4.19 \times 10^{-2}$	$8.20 \times 10^{-2}$	$2.25 \times 10^7$	162
79c	1 year	$3.46 \times 10^{-2}$	$8.49 \times 10^{-2}$	$1.93 \times 10^7$	76.9
79d	2 years	$2.57 \times 10^{-2}$	$8.42 \times 10^{-2}$	$1.69 \times 10^7$	19.2
79e	5 years	$8.96 \times 10^{-3}$	$7.08 \times 10^{-2}$	$1.45 \times 10^7$	1.34
79f	10 years	$4.68 \times 10^{-3}$	$6.39 \times 10^{-2}$	$1.34 \times 10^7$	.360
80a <sup>b</sup>	30 days	$2.01 \times 10^{-3}$	$4.79 \times 10^{-3}$	$1.35 \times 10^7$	5.38
80b <sup>b</sup>	90 days	$1.87 \times 10^{-3}$	$4.77 \times 10^{-3}$	$1.29 \times 10^7$	3.61
80c <sup>b</sup>	1 year	$1.50 \times 10^{-3}$	$4.33 \times 10^{-3}$	$1.12 \times 10^7$	.951
80d <sup>b</sup>	2 years	$1.12 \times 10^{-3}$	$3.70 \times 10^{-3}$	$9.93 \times 10^6$	.149
80e <sup>b</sup>	5 years	$3.99 \times 10^{-4}$	$2.93 \times 10^{-3}$	$8.69 \times 10^6$	.0162
80f <sup>b</sup>	10 years	$2.05 \times 10^{-4}$	$2.64 \times 10^{-3}$	$8.13 \times 10^6$	.00601

<sup>a</sup>Accident frequencies approximately  $10^{-6}$ /year or less.

<sup>b</sup>Based on early evacuation.



Gary M. Holahan

4

- References:
1. Memorandum from G. Holahan to T. King dated March 26, 1999
  2. Memorandum from A. Thadani to S. Collins dated November 12, 1999
  3. Memorandum from F. Eitawila to G. Holahan dated August 25, 2000
  4. Code Manual for MACCS2, NUREG/CR-6613, May 1998
  5. Memorandum from R. Barrett to J. Flack dated August 25, 2000
  6. Memorandum from S. Collins to A. Thadani dated September 11, 2000
  7. Accident Source Terms for Light-Water Nuclear Power Plants, NUREG-1465, February 1995
  8. Chernobyl Ten Years On, Radiological and Health Impact, An Appraisal by the NEA Committee on Radiation Protection and Public Health, November 1995

cc: T. Collins  
R. Barrett  
J. Hannon  
J. Wermiel  
G. Hubbard

Distribution:  
SMSAB R/F  
DSARE R/F  
JSchaperow R/F  
CTinkler  
TKing  
MFederline  
AThadani

C:\MYFILES\Checkout\30daysto10yearsrev2.wpd

OAR in ADAMS? (Y or N)	Y	Publicly Available? (Y or N)	N
---------------------------	---	---------------------------------	---

To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure "E" = Copy with attachment/enclosure  
"N" = No copy \*Concurred dates

OFFICE	SMSAB	AC:SMSAB	AD:DSARE
NAME	JSchaperow:mb	JFlack	FEitawila
DATE	10/26/00*	10/26/00*	10/26/00*

Template= RES-006 Accession Number ML003763874 RES File Code \_\_\_\_\_