TECHNICAL PROGRAM CHAIRMAN'S SESSION

REALISTIC ESTIMATES OF THE CONSEQUENCES OF NUCLEAR ACCIDENTS

Sponsored by Technical Program Chairman

All Papers Invited

1. Fission Product and Aerosol Behavior, *H. A. Morewitz* (EPRI-Palo Alto)*

A review of reactor accidents and destruct tests shows that when water was present only a very small fraction of the volatile fission product inventory (other than noble gases) was released to the environment. (See Tables I and II.) In addition, the iodine component was released over a period of days. However, in those situations where water was absent, the release of volatile fission products was large and rapid.

The role of water in both limiting and delaying the release of iodine can be explained by the chemical form of iodine in intact fuel rods, namely cesium iodide which has been directly measured. It is one of the most stable compounds of iodine, but it easily dissolves in water to form ions that are stable. The only ways to obtain gaseous forms of iodine from a water solution of CsI are by the slow processes of either contacting the solution surface with air or by reacting the solution with carbohydrate material (paint, etc.). Of the other volatile fission products, most dissolve in water. Rubidium, strontium, barium, cesium, and their oxides dissolve in water after first reacting to form their respective hydroxides. Arsenic and selenium oxides are directly soluble in water. However, tellurium and its compounds (except the acid and the hydride) are largely insoluble in water. In reactor accidents and destruct tests where water was absent, up to 45% of the tellurium was released to the atmosphere in the form of fine particles (<1-μm diam), yet in all cases when water was present, no tellurium was released. This result is still unexplained, but may relate to the fallout of the fine particles due to growth caused by condensation of water vapor.

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TABLE I

Destruct Tests

FACILITY	DRY / WET	C / U	ATMOSPHERIC RELEASE			PLUME DISTANCE TO BKG. (mi)	CONTAMINATED AREA	ENERGY (MW.s)
			IODINE	FP	NOBLE GAS			
KIWI-TNT	D	U	6.45%	67%	~100%	250 @9000' (AM)	380 Acres	10^4
SNAPTRAN-2	D	U	70%	21%	6×10^5 Ci 75%	18 @500' (AM)	<32 Acres	54
SNAPTRAN-3	W	U	0	0	3.2×10^4 Ci <4%	21 @1200' (AM)	<1 Acre	45±4
SPERT-1	W	U	<0.01% (ND)	<0.79%	NA	NA	Very Small	31 + 4 Chemical
BORAX-1	W	U			NA	<1 (GM)	<9.2 Acres	135

NOTE:

D = Dry
W = Wet
U = Uncontained
C = Contained
Ci = Curies

GM = Ground Measurement
AM = Aircraft Measurement
ND = Not Detected
NA = Not Available

TABLE II

Reactor Accidents

Facility	Dry/Wet	C/U	Atmospheric Release			Plume Distance to Bkg. (mi)	Contaminated Area	MW(th)	MWd	Off-Site Person (rem)	Individual Whole-Body Dose (max)	Max Thyroid Dose
			Iodine	FP	Noble Gas							
WINDSCALE-1	D	U	2×10^4 Ci (12%)	1600-Ci Te 600-Ci ^{137}Cs 80-Ci ^{89}Sr 9-Ci ^{90}Sr	3.4×10^5 Ci	200^+ (est)	200 sq mi	~250 (est)	4000 150 channels	NA	4.5 rem on site <20 mrem off site	Adult = 9.5 rem Child = 16 rem (off site)
SL-1	W	C^-	80 Ci (<0.5%)	~0.1-Ci ^{90}Sr ~0.5-Ci ^{137}Cs	10^4 Ci	50 (GM)	75 acres	3	186	0	27 rem on site	(Off site) 0.035 rad Adult = 5.5 rad (on site)
NRX	W	C	NA	10,000 Ci in 10^6 gal water	NA	$\frac{1}{4}$ (GM)	Reactor building	30	NA	0	16.1 rem on site	Off site 0
TMI-2	W	C^+	17 Ci	ND	10×10^6 Ci	20 (AM)	RCB + auxiliary building	2720	2.42×10^5	2000 (WB)	4.18 rem on site 70 mrem off site	Off site 0
WTR	W	C	0 Ci	5000 Ci in 1.6×10^6 gal water	261 Ci	$\ll 1$	RCB		(1 element)		2.1 rem on site off site 0	Off site 0
CR-3	W	C^+	0 Ci	70-Ci ^{131}I in 4×10^4 gal water, 2-Ci ^{131}I + 1000-Ci ^{133}Xe in containment air	0 Ci	0	RCB			0	0	0

NOTE:

D = Dry
W = Wet
U = Uncontained
C = Contained
Ci = Curies
GM = Ground measurement
AM = Aircraft measurement
ND = Not detected
NA = Not available
WB = Whole body.