



Department of Energy
Washington, D.C. 20545

May 24, 1979
NR:D:HGR R#76

Robert L. Ferguson
Program Director for Nuclear Energy

THREE MILE ISLAND EMERGENCY RESPONSE—INFORMATION REQUESTED BY THE
PRESIDENT'S COMMISSION; FORWARDING OF

The Naval Reactors program provided emergency response assistance to the Commonwealth of Pennsylvania, the Nuclear Regulatory Commission and General Public Utilities following the March 28, 1979 reactor accident at the Three Mile Island plant. Department of Energy message R151741Z May 79 requested information concerning this assistance for transmittal to the President's Commission on Three Mile Island.

A major part of the Naval Reactors program support to the Commonwealth of Pennsylvania was provided by the Piquetteburgh Naval Reactors Office, the Schenectady Naval Reactors Office, the Bettis Atomic Power Laboratory and the Knolls Atomic Power Laboratory through the Emergency Action Coordination Team function. Information concerning this assistance has not been included in this letter in accordance with the guidelines of the above request which states that this information would be provided separately.

Additional assistance provided by the Naval Reactor program included performing radiochemical analyses as detailed in enclosure (1), consultation on radiolysis considerations as reported in enclosure (2), temporary loan of 6 radiological control supervisors to assist General Public Utilities in their initial radiological recovery operations, and consultation with the Interagency Dose Assessment Group composed of representatives from the Nuclear Regulatory Commission, the Environmental Protection Agency, and the Department of Health Education and Welfare.

If additional information or details are required, I would be happy to cooperate further.

H. G. Rickover
H. G. RICKOVER
Director, Division of
Naval Reactors

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Enclosure

Copy to:
R. J. Catlin, EV-10
Major General, J. K. Bratton, DP-20

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From : TECHNICAL DIRECTOR
WPN
Date : MAY 21, 1979
Subject : THREE MILE ISLAND UNIT 2 ASSISTANCE

To : File

This memorandum summarizes the assistance provided to the Nuclear Regulatory Commission during the Three Mile Island Unit 2 accident. This does not include assistance provided to the Emergency Action Coordination Team that is reported elsewhere.

- I. Analyses were made on several reactor coolant and containment gas samples. These included:
 - a. Reactor coolant sample #1 - Sampled March 29, 1979
 - b. Containment gas sample #1 - Sampled March 31, 1979
 - c. Containment gas sample #2 - Sampled April 2, 1979
 - d. Waste gas tank sample #1 - Sampled April 2, 1979
 - e. Reactor coolant sample #2 - Sampled April 10, 1979

The most extensive analyses were performed on reactor coolant sample #1 for selected fission products as well as for core structural materials. The results of all analyses performed are appended to this memorandum as Attachment 1.

- II. Evaluations of the initial coolant and containment gas analyses were made to estimate the extent of damage to the reactor core.

Based on the results of the radiochemical analyses as well as data presented in the Final Safety Analysis Report of Three Mile Island Unit 2, preliminary conclusions were that a large fraction of the fuel rods experienced loss of cladding integrity, 10 to 40% of the fuel experienced high temperatures (in excess of 3200°F), the fuel did not experience temperatures in excess of the 5000°F melting temperature and melting of core structurals and control rods did not occur.

Enclosure (1)
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- III. Consultation was provided on the adequacy of oxygen recombination in the reactor coolant environment.

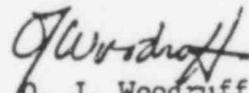
Based on calculations of generation rates of oxygen from radiolysis and upon estimated hydrogen concentration in the coolant, it was concluded that oxygen formed would recombine with hydrogen.

- IV. Assistance was also provided in obtaining needed equipment for recovery operations at Three Mile Island.

Approximately 8 tons of lead bricks for shielding were delivered to Harrisburg via Pittsburgh area Air Force Reserve aircraft. In addition, flame arrestors were procured from the Kent Manufacturing Company of Glen Burrie, Maryland and delivered to Three Mile Island.

- V. The major portion of this work, chemistry analyses, was performed by personnel of the Development Laboratories Operations and Materials Technology activities of the Bettis Laboratory. Personnel from many other projects and activities assisted as required for technical and administrative support.

The information developed by the Laboratory was provided to the following Nuclear Regulatory Commission personnel; V. Stello, G. Gibson, M. Barrett and S. Bland, et al.



O. J. Woodruff
Technical Director

Attachment 1

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TABLE I TMI-2 Reactor Coolant Sample #1
 Sampling Date: March 29, 1979
 All radioactivities corrected
 for decay to 1200 March 30, 1979

	<u>T_{1/2} Used</u>	<u>μCi/ml at 1200 3/30/79</u>	
I-133	20.8 h	6750 ⁽¹⁾	
I-131	8.04 d	13500 ⁽¹⁾	
Cs-136	13.1 d	176 ⁽²⁾	
Cs-134	2.06 y	63 ⁽²⁾	
Cs-137	30.2 y	275 ⁽²⁾	
Sr-89, 90	-	5.4 ⁽²⁾	
Ba-140	12.79 d	21.2 ⁽²⁾	
Te-132	78 h	203 ⁽²⁾	
Mo-99	66.02 h	1530 ⁽²⁾	
Ru-103	39.4 d	0.72 ⁽²⁾	
Ru-106	368 d	0.36 ⁽²⁾	
Ce-141	32.5 d	0.37 ⁽²⁾	
Ce-144	285 d	0.36 ⁽²⁾	
Rb-86	18.65 d	< 185 ⁽²⁾	MDA ⁽⁶⁾
In-114m	49.5 d	< 0.17 ⁽²⁾	MDA
Cd-115m	44.6 d	< 1.4 ⁽¹⁾	MDA
Ag-110m	252 d	< 0.022 ⁽²⁾	MDA
Zr-95	64 d	< 0.54 ⁽²⁾	MDA
Mn-54	312 d	< 0.037 ⁽²⁾	MDA
Fe-59	44.6 d	< 0.034 ⁽²⁾	
Co-60	5.27 y	< 0.30 ⁽²⁾	MDA
Others			
Gross α ⁽³⁾	(7.2 ± 2.4) × 10 ⁻⁴ μCi/ml (no decay correction)		
Total Uranium ⁽⁴⁾	2.6 μg/ml		
Total Boron ⁽⁵⁾	1750 ppm		

TABLE II TMI-2 Containment Gas Sample #1
Sampling Date: 0700 March 31, 1979

	<u>$\mu\text{Ci/ml}^{(1)}$ decay corrected to 0700 March 31, 1979</u>
Xe-133 g	743
Xe-133 m	8.0
Xe-135	3.5
I-131	0.025
I-133	< 0.01

Revised April 30, 1979

TABLE III TMI-2 Containment Gas Sample #2
Sampling Date: 1030 April 2, 1979

	$\mu\text{Ci/ml}^{(1)}$ on April 3, 1979			
	<u>Aliquot 1</u>	<u>Aliquot 2</u>	<u>Average</u>	
Xe-133 g	28.6	17.7	23.2	
Xe-133 m	0.33	0.21	0.27	
Xe-135	0.01	0.0023	0.0062	
I-131	0.0074	0.012	0.0097	
I-133	< 0.0061	< 0.0061	< 0.0061	MDA ⁽⁶⁾
Cs-137	< 0.0054	< 0.0054	< 0.0054	MDA ⁽⁶⁾

Water in gas samples, $\mu\text{Ci/ml}$ decay corrected to 1030 April 2, 1979

Cs-136	0.028 ⁽²⁾
Cs-134	0.014 ⁽²⁾
Cs-137	0.055 ⁽²⁾
I-131	3.9 ⁽¹⁾
Gross α	< 9.2×10^{-8} MDA ⁽⁶⁾
Others ⁽²⁾ :	N ₂ 79.0%, O ₂ 21.0%, H ₂ < 0.1%

TABLE IV TMI-2 Waste Gas Tank Sample #1
Sample Date: April 2, 1979

	$\mu\text{Ci/ml}$ on April 3, 1979		<u>Average</u>	
	<u>Aliquot 1</u>	<u>Aliquot 2</u>		
Xe-133 g	4200	6100	5200	
Xe-133 m	43	63	53	
Xe-135	1.6	2.6	2.1	
I-131	0.012	0.16	0.09	
I-133	< 0.14	< 0.15	< 0.15	MDA (6)
Cs-137	< 0.1	< 0.1	< 0.1	MDA (6)

Others (7): N₂ 79.2%, O₂ 13.2%, H₂ 11.4%;
 Hydrocarbons: CH₄ 0.04 mole percent
 (ethane, propane and butane detected and all
 were < 0.01 mole percent each)

TABLE V TMI-2 Reactor Coolant Sample #2
 Sampling Date: April 10, 1979
 All radioactivities corrected for
 decay to 1200 March 30, 1979

	<u>μCi/ml at 1200 March 30, 1979</u>	
	<u>Note (1)</u>	<u>Note (2)</u>
I-131	24000	-
Cs-136	210	180
Cs-134	75	72
Cs-137	340	290
Ba-140	420	390
La-140 (decay corrected with parent T _{1/2})	270	-
Xe 133 g	< 300	MDA ⁽⁶⁾
Sr-89, 90	-	730
Mo-99		2300
Ru-103		0.030
Ru-106		< 0.083 MDA ⁽⁶⁾
Te-132		19
Gross α ⁽³⁾	1.3 x 10 ⁻³ μCi/ml (no decay correction)	
Gross β ⁽³⁾	4.0 x 10 ⁻³ μCi/ml (no decay correction)	
Total Uranium ⁽⁴⁾	1.4 μg/ml	
Total Boron ⁽⁵⁾	2400 ± 100 ppm (duplicate analyses)	
pH	7.65	

NOTES

(Applies to Tables I thru V)

- (1) Direct GeLi spectrum analysis of aliquot
- (2) Radiochemical separation
- (3) Direct alpha or beta counting
- (4) Mass spectrometry
- (5) Quinalizarin colorimetric analysis
- (6) MDA is minimum detectable activity where

$$\text{MDC} = \text{Minimum Detectable Counts} = 1.645 \sqrt{2 \left(\frac{\text{Total Count Rate}}{\text{Counting Time}} \right)}$$

$$\text{and MDA} = \frac{\text{MDC} \times \text{decay factor} \times \text{yield factor}}{\text{Counting efficiency} \times \text{dilution factor} \times \text{aliquot volume}}$$

- (7) Gas chromatography

TABLE VI

Typical Particle Analyses of Filter Paper Residue From Three-Mile Island Samples*

	Weight Percent																		
	<u>Si</u>	<u>Fe</u>	<u>Mg</u>	<u>S</u>	<u>Cl</u>	<u>K</u>	<u>Ca</u>	<u>P</u>	<u>Na</u>	<u>Al</u>	<u>Ti</u>	<u>Mn</u>	<u>Cu</u>	<u>Zn</u>	<u>Sn</u>	<u>Cr</u>	<u>Ni</u>	<u>Pb</u>	
(A) <u>WG-1</u> **																			
(1) Long, Black Fibers	54 26	.5 .1	-- --	7 4	27 41	11 20	1 8	-- --	-- --	-- --	-- .4	-- --	-- --	-- --	-- --	-- --	-- --	-- --	
(2) Long Yellowish- White Fibers as Separated	25 19 30	5 -- --	-- -- --	7 10 5	33 42 50	3 -- --	19 19 8	-- -- --	-- -- --	7 -- --	-- -- --	.3 3 --	-- -- --	-- -- 5	-- -- --	-- -- --	-- -- --	6 1 --	-- -- --
(3) Yellow-white Fiber Still on Collection Filter	27	30	--	6	11	4	20	1	--	--	.6	--	--	--	--	--	--	--	--
(4) Y-W Fiber on Tan Spot	9	8	--	3	51	6	19	--	--	--	.7	1	--	--	--	2	--	--	--
(5) Particles on Y-W Fiber	25	27	--	6	8	4	18	1	--	6	1	.2	--	3	--	--	--	--	1
(6) Flat Flake	39	6	--	.3	.1	17	--	.5	--	36	2	--	--	.3	--	--	--	--	--
(7) Small Round Particles	50 45	28 22	-- 1	4 3	1 .4	3 1	4 14	2 1	-- --	-- 9	1 .6	2 1	3 .6	1 .5	-- --	-- .4	-- .1	-- 1	-- 1
(8) Small Particle Clump	3	.7	--	5	2	--	4	--	14	1	--	--	58	2	10	--	1	.2	--
(B) <u>CG-2</u> ***																			
(1) Fiber	82	1	--	--	--	--	--	4	--	9	--	--	--	--	--	--	--	4	--
(2) Angular Particles	95 96	.1 --	-- --	-- --	.2 --	-- --	-- --	1 1	2 1	1 1	-- --	-- --	-- --	.2 --	1 .6	-- .1	-- --	-- --	-- --
(3) Particle Clump	36	38	--	2	.2	4	2	.7	.2	15	2	--	.4	.2	--	.5	--	--	--

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TABLE VI
(con't)

		Weight Percent																	
		Si	Fe	Mg	S	Cl	K	Ca	P	Na	Al	Ti	Mn	Cu	Zn	Sn	Cr	K ₂	Pb
(C) Asbestos Standards																			
(1) Chrysotile -																			
NBS		39	1-3	32	--	--	--	--	--	< .1	~ .3	--	.5	--	--	--	--	.1	--
Bettis		46-	.5-	37-	1-2	.3	--	--	3	--	--	--	--	--	--	--	--	.6	.2
		59	3	46															
(2) Amosite -																			
NBS		50	15-28	11	--	--	--	--	--	.1	~ .3	--	1.5	--	--	--	--	--	--
Bettis		44-	6-	6-	1-3	--	--	--	2	--	--	--	1	--	--	--	--	.2	--
		65	44	20															
(3) Anthophyllite																			
NBS		58	2-4	24	--	--	--	--	--	.1	~ .7	--	1	--	--	--	.1	1	--
Bettis		68	5	23	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(4) Crocidolite																			
NBS		49	15-27	4	--	--	--	--	--	5	~ .5	--	.1	--	--	--	--	--	--
Bettis		60	18	16	4	2	--	--	--	--	--	--	--	--	--	--	--	--	--

* Energy Dispersive X-ray Microanalyses May Show Large Ranges for Mixtures of Materials of Distinct, but of Various, Compositions.

** WG-1 means Waste Gas Tank Sample #1.

*** CG-2 means Containment Gas Sample #2.

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