THE UNIVERSITY OF MICHIGAN

SCHOOL OF PUBLIC HEALTH

ANN ARBOR, MICHIGAN 48109

Department of Environmental
and Industrial Health

Memorandum

TO: Robert Alexander

FROM: Phillip Plato

DATE: May 31, 1979

RE: Progress Report No. 20, Contract No. NRC-01-77-180, May, 1979

Results of Test #2

To date, 19 of the 59 processors have submitted their reported doses for Test #2. Tables 2 and 3 show the individual performance of all processors for whom we have results. Table 5 summarizes the performance of the processors for Test #1 and Test #2. Among all the categories tested, 22% were passed in Test #1 and 31% were passed in Test #2. Although this reflects changes made my some processors in their data analysis, it apparently does not indicate a significant improvement among all the processors. The most dramatic areas of improvement are Category I (gamma), Category III (low-energy X ray), and Category IV (beta).

Results of Blind Tests

We now have all the results for Tests #1 and #2 that were administered blindly to 7 of the large commercial processors. Table 4 shows the individual performance of the 7 processors. Table 6 summarizes the results of the blind tests.

The blind test results are considerably worse than the results for the open tests. This is probably because there are some significant differences in the calibration procedures currently followed by these processors and the procedures required by the HPSSC Standard. This does not mean that the procedures currently being used by the processors are incorrect, only that they are not standardized.

We have questioned each of the 7 blind-tested processors to determine if they knew we were blind testing them. Six replied that they did not know anyone was blind testing them. The 7th replied that they thought that they were being tested by the utility company through which we were funnelling dosimeters, but that they did not treat the utility's dosimeters

much different than dosimeters from their other customers. So we conclude that our subterfuge was successful.

Reasons for Poor Performance

Toward the end of April, you requested that we determine why the processors were not showing a significant improvement in Test #2 over Test #1. We agreed that Dr. Hudson and I would visit the large (greater than 10,000 dosimeters per month) processors that supply dosimeters to NRC licensees. These site visits would enable us to question these major processors on their calibration procedures and, using our electrometer and one of our NBS-calibrated ionization chambers, to check the calibration of their photon sources. By the end of May, we had visited all 8 of the processors that you and we agreed should be visited. We are currently preparing a special report on our site visits and our conclusions.

Letter of Complaint

During March, we received a copy of a letter that one processor sent to NBS in which they complained that our irradiation procedures were not consistent. This complaint was based on the fact that they were being tested by Battelle Northwest (BNW) in addition to the pilot study conducted by The University of Michigan (UM). The standard deviation among their dosimeters irradiated by BNW was about 10%, whereas the standard deviation among the dosimeters irradiated by UM was about 20%.

During our site visit of this processor, we discovered that the TLDs they were sending to BNW had been carefully screened by their quality control department to ensure that only those dosimeters with good reproducability were being tested. However, their customer service department was sending us their regular-customer TLDs. Their own in-house data showed that the standard deviations among these two types of dosimeters is expected to be 10% for the screened dosimeters and 20% for the regular-customer dosimeters.

We graciously accepted their apology for having leaped before they looked!

Calibrations

We completed our calibration of our 2 Shonka-Wyckoff ionization chambers that had been sent to NBS for calibration. We are preparing a calibration report which we will send to NBS. Since NBS did not send us the calibration factors for these chambers, our report will serve as a quality control check on our calibration abilities.

Summary

The pilot study is on schedule. We are concentrating our efforts on Task 3, data analysis. The site visits we made during April and May provided us with useful information for Task 3.

Phil P. Plato

Phillip Plato

PP/mf

Table 1. SUMMARY OF HPSSC STANDARD PREPARED BY THE UNIVERSITY OF MICHIGAN

	Radiation Category	Interval	Test Range	Number of Dosimeters Per Test	Tolerance Level (L) (see footnotes) Shallow (7 mg/cm^2)	Deep (1000 mg/cm^2)
I.	Gamma (Co-60)	1 Accident:	10-800 rad	10	no test	a
		2 Protection:	30-100 mrem	10	no test	b
		3	101-300 mrem	10	no test	b
		4	301-10,000 mrem	10	no test	b
II.	X Ray (30-300 keV)	1 Accident:	10-800 rad	10	no test	a
		2 Protection:	30-100 mrem	10	c	c
		3	101-300 mrem	10	c	c
		4	301-10,000 mrem	10	c	c
III.	X Ray (15-30 keV)	Accident:	no test			
		1 Protection:	150-300 mrem	10	c	c
		2	301-10,000 mrem	10	c	c
IV.	Beta (Sr-90)	Accident:	no test			
		1 Protection:	150-300 mrem	10	c	no test
		2	301-10,000 mrem	10	c	no test
V.	Neutrons (Cf-252)	Accident:	no test			
		1 Protection:	100-300 mrem	10	no test	c
		2	301-5,000 mrem	10	no test	c
VI.	Photon Mixtures (Cat. I & II)	Accident:	no test			
		1 Protection:	50-100 mrem	10	c	c
		2	101-300 mrem	10	c	c
		3	301-10,000 mrem	10	c	c
VII.	Photon and Beta Mixtures (Cat. I or II & IV)	Accident:	no test			
		1 Protection:	200-300 mrem	10	c	c
		2	301-10,000 mrem	10	c	c
VIII.	Photon and Neutron Mixtures (Cat. I & V)	Accident:	no test			
		1 Protection:	150-300 mrem	10	no test	c
		2	301-5,000 mrem	10	no test	c

For each dosimeter, a performance index is calculated by:

$$P = \frac{H' - H}{H}$$ where: H = delivered quantity, H' = reported quantity

For each depth of each interval, an average performance index, $\bar{P}$, and its standard deviation, S, are calculated.

A processor passes a category if, for each depth of each interval:

$$|\bar{P}| + 2S \leq L$$

where:

a: $L = 0.3$

b: $L = 0.3$ or $6/\sqrt{H}$ whichever is larger

c: $L = 0.5$ or $15/\sqrt{H}$ whichever is larger

Table 2: PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

Summary of Results for Test #1 (first row) and Test #2 (second row)

Processor And Type	I: Gamma				II: High-Energy X Ray							III: Low-Energy X Ray				IV: Beta		V: Neutron		VI: Gamma plus X Ray						VII: Gamma plus Beta				VIII: Gamma plus Neutron	
	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
1 TLD	F	F	F	F	F	F	P	F	F	F	F					P	P			P	P	P	P	F	F	P	P	P	P		
2 TLD	P	P	P	P																											
3 TLD	F	P	P	P	F	P	P	P	P	F		F	P	F	P	P	P			P	P	P	P	P	P	P	P	P	P		
	P	P	P	F	F	P	P	P	P	F	F	P	P	P	P	P	P			P	P	P	P	F	F	P	P	P	P		
4 Film	F	F	F	F	F	P	P	P	P	P	P	P	P	F	F	P	F			P	P	P	P	P	P	P	P	F	F		
5 TLD	F	P	F	F	F	P	P	P	P	F	F	P	P	F	F	P	P	P	F	P	P	P	P	F	P	P	F	F	F	P	F
6 Film	F	F	F	F	F	P	P	P	P	F	F	F	P	F	F	P	F	P	F	P	P	P	P	F	F	P	P	P	F	P	F
7 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	F	F	F	P	P	P	P	P	P	P	P	F	F	F	F
8 Film	F	F	F	F	F	P	P	F	F	P	P	P	P	F	F	P	F	F	F	P	P	F	F	F	F	P	P	F	F	P	F
	F	F	P	F	F	P	P	F	F	P	P	P	P	F	F	P	F			P	P	F	F	F	F	P	P	P	F		
9 TLD	F	F	F	P	F	P	P	P	P	F	F					P	P	P	P	P	P	P	P	P	F	P	P	P	F	P	P
10 TLD	F	F	F	F	F	P	P	P	P	F	F	F	F	F	F					P	P	P	P	F	F						
	F	P	F	F	F	P	P	P	P	F	F	F	F	F	F					P	P	P	P	F	F						
11 TLD	F	P	F	P	F	P	P	P	P	F	F									P	P	P	P	P	P						
	F	P	F	F	F	P	P	P	P	P	P									F	F	F	F	P	P						
12 TLD	F	F	F	F														P	F												
13 TLD	P	P	P	F	P	P	P	P	P	F	F	P	F	P	F	P	F	P	F	P	P	P	P	F	F	F	P	F	F	F	F
14 Film	F	F	F	F	F	P	P	P	P	F	F	F	F	F	F	F	F	P	F	P	P	P	P	F	F	F	P	F	F	F	F
15 TLD	P	P	P	P	F	P	P	P	P	F	F	P	P	F	F	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F
16 TLD	F	P	F	F	F	P	P	P	P	F	F					P	P	P	P	F	P	P	P	F	F	P	P	P	P	F	P
	P	P	P	P	F	P	F	F	F	P	F					P	P	P	F	P	P	P	P	P	P	F	F	P	P	P	P
17 Film	F	F	F	F	F	P	P	P	F	F	F	F	F	F	F	P	F	F	F	P	P	P	P	F	F	P	P	F	F	P	F

Note: Intervals shown under each category are defined in Table 1. Key: D = deep, S = shallow, P = pass, F = fail. Blank spaces indicate no participation in a particular category. For each category, a processor must pass each depth of each interval in order to pass the category.

Table 2: PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

Summary of Results for Test #1 (first row) and Test #2 (second row)

Processor And Type	I: Gamma				II: High-Energy X Ray							III: Low-Energy X Ray				IV: Beta		V: Neutron		VI: Gamma plus X Ray						VII: Gamma plus Beta				VIII: Gamma plus Neutron	
	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
18 TLD	P	P	F	P	F	P	P	P	P	F	P	P	P	P	F	F	P	F	F	P	P	P	P	P	P	P	P	F	P	P	F
19 TLD	P	P	P	P																											
	F	P	F	F																											
20 TLD	F	P	P	F												P	P									P	P	F	F		
21 TLD	F	P	P	P												F	F									F	P	F	P		
	F	F	P	F												P	F									P	P	F	F		
22 TLD	F	P	P	F	F	P	P	F	F	F	P					P	F			P	P	P	P	P	P						
	F	P	F	F	F	P	F	P	P	P	P					P	F			P	P	F	P	P	P						
23 TLD	P	F	P	P	P	P	P	P	P	P	P	F	P	F	F	F	F	P	P	P	P	P	P	P	P	F	P	F	F		
24 TLD	P	P	P	P	F	P	P	P	P	F	F	P	P	F	F	P	P	F	F	P	P	P	P	F	P	P	P	P	P	F	F
25 TLD																										P	P	F	P		
26 TLD	F	P	P	F																											
27 Film																				P	F	P	P	F	F	P	P	P	P	P	F
28 Film	F	F	F	F	F	F	F	F	F	F	F									F	F	F	F	F	F						
29 Film	F	P	F	P	F	P	P	P	P	F	F	P	F	F	F					P	P	P	P	P	P						
	F	P	F	F	F	P	P	P	P	F	F	P	F	F	F					P	P	P	P	F	F						
30 TLD	P	P	P	F	P	P	P	F	P	P	P	P	P	F	F			F	F											P	F
31 TLD	F	P	P	P								F	P	F	P	P	F									P	P	F	F		
	F	P	F	F								P	P	P	F	P	F									P	P	P	F		
32 Film	F	P	P	F												P	F														
	F	F	F	F												P	F														
33 Film	F	P	P	F	P	P	P	P	P	F	F	F	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	F
34 Film	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P	P	P	P	F	P	P	P	P	F	F	P	P	P	P	P	F

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	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
35 TLD	F	F	F	F	F	P	P	F	F	F	F	F	P	F	F	F	F			P	P	F	F	F	F	F	F	F	F		
36 TLD	F	F	F	F								F	F	F	F			F	F	F	F	F	F	F	F					F	F
	F	F	F	F								P	P	F	F			F	F	P	P	P	P	F	F					F	F
37 TLD	F	P	P	P	F	P	P	P	F	P	P																				
38 TLD	F	P	P	P	F	P	P	P	P	P	P	P	F	P	F				F											P	F
	P	P	P	P	F	P	P	P	P	P	P	P	P	P	P				P											P	F
39 TLD																															
40 Film		P	P	F		P	P	P	P	F	F	P	P	F	F	F	F	P	P	P	P	F	P	F	F	F	F	F	P	F	F
		P	P	F		F	F	F	F	F	F	P	P	F	P	F	F	F	F	P	P	F	P	F	F	P	P	F	P	F	F
41 TLD	F	F	P	P												P	P									P	P	P	P		
42 TLD	F	P	P	P	F	P	P	P	P	F	F					F	F														
43 TLD	F	P	P	F	F	P	P	P	P	P	P	P	F	F	P	P	F	F	F	P	P	P	P	P	P	P	P	P	F	F	F
	F	P	F	F	F	P	P	P	P	F	F	P	P	F	P	P	P	F	F	P	P	P	P	F	F	P	F	P	F	P	F
44 TLD	F	P	P	P												F	F									P	F	P	F		
45 TLD																				F	F	F	F	F	F						
46 Film	F	P	F	F	F	P	P	P	F	F	F	P	P	F	F	F	F			P	P	P	F	F	F	F	F	P	F		
47 Film																															
48 TLD	P	F	P	F												F	F	P	F							P	P	F	F	P	F
49 TLD	P	P	F	F	F	P	P	P	P	F	F	P	P	P	F	P	F	P	P	P	P	F	P	F	F	P	P	P	P	P	F
50 Film	F	F	P	P	F	P	P	P	P	P	P	P	P	F	F	P	F	F	P	P	P	P	P	F	F	P	P	P	P	P	P
51 TLD	F	P	P	F												F	F	P	F							F	P	F	F	P	F

Note: Intervals shown under each category are defined in Table 1. Key: D = deep, S = shallow, P = pass, F = fail. Blank spaces indicate no participation in a particular category. For each category, a processor must pass each depth of each interval in order to pass the category.

Table 2: PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

Summary of Results for Test #1 (first row) and Test #2 (second row)

Processor And Type	I: Gamma				II: High-Energy X Ray							III: Low-Energy X Ray				IV: Beta		V: Neutron		VI: Gamma plus X Ray						VII: Gamma plus Beta				VIII: Gamma plus Neutron	
	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
52 TLD	F	F	P	P	F	P	P	P	P	F	F							P	P							P	P	F	F	P	F
53 TLD	F	P	F	F	F	P	P	P	F	P	P	P	P	F	F	P	F									P	P	P	F		
54 (withdrew)																															
55 TLD																				P	P	P	P	P	P						
																				P	P	P	P	P	P						
56 TLD																															
57 TLD	F	F	F	F	F	P	P	P	F	F	F																				
58 TLD	F	F	F	F												P	F	P	F							F	P	F	P	F	F
	P	P	P	P												P	P	F	F							P	P	P	P	F	F
59 (withdrew)																															
60 TLD	P	F	P	F																											
	F	P	P	F																											
61 TLD	P	P	P	F	P	P	P	P	P	F	F					F	F			P	P	P	P	P	P	P	P	F	F		

Notes: Intervals shown under each category are defined in Table 1. Key: D = deep, S = shallow, P = pass, F = fail. Blank spaces indicate no participation in a particular category. For each category, a processor must pass each depth of each interval in order to pass the category.

Table 3: PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

Summary of Results for Test #1 (first row) and Test #2 (second row)

Processor And Type	I: Gamma				II: High-Energy X Ray							III: Low-Energy X Ray				IV: Beta		V: Neutron		VI: Gamma plus X Ray						VII: Gamma plus Beta				VIII: Gamma plus Neutron	
	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
70 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P	P		
71 TLD	P	P	P	P																											
	P	P	P	P																											
72 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P	P	P	P	P						
73 RTA																		P	P											P	P
74 TLD	P	P	P	P																											
	P	P	P	P																											
75 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P	P		
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P	P		
76 TLD	P	P	P	P		P	P	P	P	P	P							P	P	P	P	P	P	P	P					P	P
	P	P	P	P		P	P	P	P	P	P							P	P	P	P	P	P	P	P					P	P
77 Track Etch																		P	P											P	P
78 Albedo																		P	P											P	P
																		P	P											P	P
79 TLD	P	P	P	P																											
80 TLD																				P	P	P	P	P	P						
81 Albedo																														P	P
82 Ring	P	P	P	P	P	P	P	P	P	P	P																				
83 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P	P		
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P				P	P	P	P	P	P	P	P	P		
84 TLD	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P					P	P	P	P	P	P	P	P		
85 TLD	P	P	P	P																											
86 TLD																															

Note: Intervals shown under each category are defined in Table 1. Key: D = deep, S = shallow, P = pass, F = fail. Blank spaces indicate no participation in a particular category. For each category, a processor must pass each depth of each interval in order to pass the category.

Table 4: PERFORMANCE TESTING OF PERSONNEL DOSIMETRY SERVICES

Summary of Results for Test #1 (first row) and Test #2 (second row)

(Blind)

Processor And Type	I: Gamma				II: High-Energy X Ray							III: Low-Energy X Ray				IV: Beta		V: Neutron		VI: Gamma plus X Ray						VII: Gamma plus Beta				VIII: Gamma plus Neutron	
	1D	2D	3D	4D	1D	2S	2D	3S	3D	4S	4D	1S	1D	2S	2D	1S	2S	1D	2D	1S	1D	2S	2D	3S	3D	1S	1D	2S	2D	1D	2D
91 Film	F	P	P	P												F	F	F	F							P	P	F	P	P	P
	F	F	P	F												P	F	P	F							P	P	F	P	P	F
92 Film	F	P	F	F												F	F	F	F							F	P	F	P	F	F
	F	F	P	P												P	F	F	F							F	P	F	P	P	F
93 Film	F	P	F	F												P	F	P	F							F	P	F	F	F	P
	F	P	P	F												P	F	F	F							P	P	F	F	P	F
94 Film	F	F	P	F												F	F	F	F							P	P	F	F	F	F
	F	F	P	F												P	F	F	F							P	P	F	F	F	F
95 TLD	F	P	P	P												P	P	F	F							P	P	P	F	P	F
	F	P	P	F												P	P	F	F							P	P	P	F	F	F
96 TLD	F	P	P	P												P	F	F	F							P	P	P	P	P	F
	P	F	P	F												P	F	P	F							P	P	P	P	P	F
97 Film	F	F	F	F												F	F	F	F							F	P	F	F	F	P
	F	F	F	F												F	F	F	F							F	P	F	F	F	F

Note: Intervals shown under each category are defined in Table 1. Key: D = deep, S = shallow, P = pass, F = fail. Blank spaces indicate no participation in a particular category. For each category, a processor must pass each depth of each interval in order to pass the category.

Table 5. Summary of all intervals and categories passed for the open tests of Tests #1 and #2

Category	Test	Total No. of Processors	Percent Passing by Interval 1 Shallow	Interval 1 Deep	Interval 2 Shallow	Interval 2 Deep	Interval 3 Shallow	Interval 3 Deep	Interval 4 Shallow	Interval 4 Deep	Category
I	#1	64		28%		67%		66%		42%	17%
	#2	24		42		83		58		38	33
II	#1	46		13	96	98	80	80	28	30	4
	#2	14		14	93	93	79	79	50	50	0
III	#1	33	67	58	27	18					3
	#2	12	92	83	50	58					42
IV	#1	42	71		33						33
	#2	13	92		54						54
V	#1	30		70		23					20
	#2	10		60		20					20
VI	#1	41	90	90	78	83	46	51			44
	#2	15	100	100	73	80	53	53			40
VII	#1	41	80	90	49	54					29
	#2	11	91	82	73	55					36
VIII	#1	31		71		26					26
	#2	9		78		22					22

* *

Test	Total No. of Categories Tested	Total No. of Categories Passed	Total No. of Intervals Tested	Total No. of Intervals Passed
#1	328	22%	917	54%
#2	108	31	307	61

Table 6. Summary of all intervals and categories passed for the blind tests of Tests #1 and #2

Category	Test	Total No. of Processors	Percent Passing Interval 1 Shallow	Interval 1 Deep	Interval 2 Shallow	Interval 2 Deep	Interval 3 Shallow	Interval 3 Deep	Interval 4 Shallow	Interval 4 Deep	by Category
I	#1	7		0%		71%		57%		43%	0%
	#2	7		14		43		36		29	0
II	#1										
	#2										
III	#1										
	#2										
IV	#1	7	43		14						14
	#2	7	86		14						14
V	#1	7		14		0					0
	#2	7		29		0					0
VI	#1										
	#2										
VII	#1	7	57	100	29	43					14
	#2	7	71	100	29	43					14
VIII	#1	7		71		29					14
	#2	7		57		0					0

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Test	Total No. of Categories Tested	Total No. of Categories Passed	Total No. of Intervals Tested	Total No. of Intervals Passed
#1	35	9%	84	36%
#2	35	6	84	38