



**DEPARTMENT OF THE AIR FORCE  
AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH (AFMC)  
BROOKS CITY-BASE TEXAS**

20 December 2006

MEMORANDUM FOR AFRL/MLS-OL

4750 STAFF DRIVE, BLDG 2330, RM 112  
TINKER AFB OK 73145-3317

FROM: AFIOH/SDR

2350 Gillingham Drive  
Brooks City-Base TX 78235-5103

SUBJECT: Consult Letter, IOH-SD-BR-CL-2006-0096, Direct-Reading Dosimeter, AT-138, Response to Pulse X-Ray Units Used for Nondestructive Inspection

1. Introduction: Mr. Michael Paulk, Chief, USAF Nondestructive Inspection (NDI) Office, requested the Air Force Institute for Operational Health, Radiation Surveillance Division, Health Physics Consulting Branch (AFIOH/SDRH) evaluate the response of the Arrow-Tech direct-reading dosimeter, AT-138, to the new NDI digital pulse x-ray radiation systems. Under the written direction of Capt Piper Williams, TSgt Luz Vining and SSgt Sarah Jornacion conducted a series of tests at the 33MXS NDI Lab, Eglin AFB, FL on 2 Oct 2006. The NDI pulse x-ray system used was the Golden Engineering XR200 x-ray source (Delta x-ray P/N 27-GOL-XR-200, S/N 3161). This evaluation concludes that Arrow-Tech direct-reading dosimeters are comparable to the TLDs when exposed to the digital pulse NDI X-ray systems.

2. Background:

a. The Arrow-Tech direct-reading dosimeter, AT-138, is a pocket-size, carbon fiber electroscope with an ion chamber for detecting and indication of integrated exposure to gamma and x-ray. It has a thin wall which permits the penetration and detection of radiation. The dose range is 0-500 mR and is designed for gamma and x-ray use.

b. IAW T.O. 33B-1-1, section 6.3.10.2, thermoluminescent dosimeters (TLDs) are the primary dosimetry device and are accepted as a legal record of radiation exposure. However, wearing an additional direct-reading dosimeter provides instant quantification of radiation exposure.

3. Methodology: Four AT-138s were exposed for 99 pulses three times. For the first two exposures; four AT-138s were zeroed and placed two inches apart along the top edge of a 12 inch by 12 inch board, while the TLDs were kept in a low radiation area, (away from the x-ray machine,) see Attachment 1. The board was positioned two feet from the

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pulse x-ray head. For the final exposure, a TLD was positioned one inch below each of the four AT-138s; two TLDs remained in the low radiation area as controls. The six TLDs were returned to AFIOH, Radiation Dosimetry Laboratory for processing.

4. Findings: Measurements indicated that the AT-138 direct-reading dosimeter is capable of accurately measuring pulsed x-ray radiation. Tests conducted on 2 Oct 2006 showed that there is only a 4.9% variation between AT-138 dosimeter and Panasonic UD802 TLD responses when exposed in a pulse x-ray environment. This variation is due to interpretation of the data; the smallest, marked increment is 10 mR.

5. Recommendations: It is the recommendation of AFIOH that when using pulse x-ray systems Air Force NDI personnel should wear the AT-138 direct-reading dosimeters as supplemental radiation monitoring devices.

6. If you have any questions, please contact Capt Piper Williams at DSN 240-6034, piper.williams@brooks.af.mil, or call the ESOH Service Center at 1-888-232-ESOH. To assist us in improving our services, please complete and return the attached critique form.

//signed//

SCOTT M. NICHELSON, Lt Col, USAF, BSC, CHP, CIH  
Chief, Radiation Surveillance Division

Attachments:

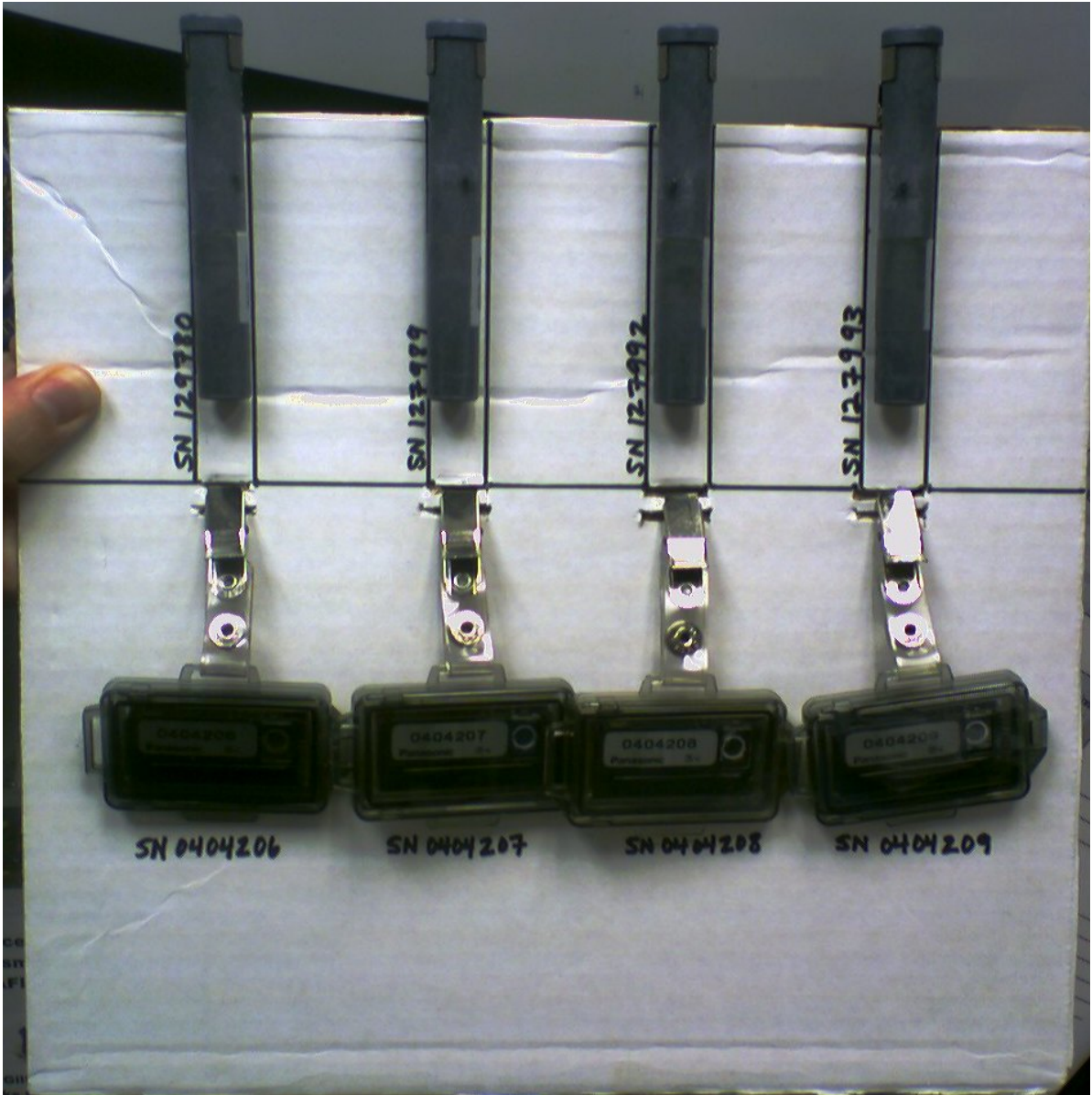
1. Picture of Board Setup
2. Data and Calculations
3. Critique

cc:

Mr. Daryl Inglet, 77 AESG/TAO

Attachment 1

Picture 1. Board Setup



Attachment 2

Data and Calculations

Table 1. AT-138 and TLD Results

AT-138 S/N	1st Exposure Results (mR)	2nd Exposure Results (mR)	3rd Exposure Results (mR)	Average of AT-138 Results (mR)	TLD S/N	TLD Results (mrem)
129780	40	60	80	60	0404206	47
127789	60	70	60	63	0404207	73
127992	60	80	80	73	0404208	63
127993	40	40	60	47	0404209	50
			Average	<b>61</b>		<b>58</b>

\*The background, using the control TLDs, was subtracted to obtain dose results.

$$\text{Variation} = \frac{\text{Average of AT-138 Results} - \text{Average of TLD Results}}{\text{Average of AT-138 Results}} \times 100\%$$

$$\text{Variation} = \frac{61\text{mR} - 58\text{mR}}{61\text{mR}} \times 100\% = 4.9\%$$

This variation is due to interpretation of the data; the smallest, marked increment is 10 mR.

Attachment 3

<b>POINT OF CONTACT:</b>	<b>Capt Piper C.M. Williams</b>	<b>BASE NAME:</b>	<b>Brooks City-Base</b>
<b>POC PHONE:</b>	<b>DSN 240-6034</b>	<b>DIVISION:</b>	<b>AFIOH/SDRH</b>
<b>STINFO NUMBERS:</b>	<b>IOH-SD-BR-CL-2006-0096</b>		

This survey is used to help us improve our service to you. Your answer will be held in confidence and will significantly impact on how we allocate resources to meet your needs. Please return this completed form promptly.

**Grading Scale:**

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Satisfied	Extremely Satisfied

A	Timeliness: Did you receive your results within the published time limits?	1	2	3	4	5	6
B	Accuracy: Is the report in the proper format? Are your address and other data correct?	1	2	3	4	5	6
C	Content: Does the report answer your questions and provide the necessary data? Are our services per dollar adequate when compared to civilian sector?	1	2	3	4	5	6
D	Customer Support: Have we been courteous and helpful in meeting your special needs (priority service, reporting, format, etc.)?	1	2	3	4	5	6
E	Consult Service: Have we answered your questions and provided necessary materials or reviewed to support your mission requirements?	1	2	3	4	5	6
F	Overall Rating: How would you rate our overall service to you?	1	2	3	4	5	6

**Comments / Suggestions:** Are there other services that you would like provided in the future? Are there any specifics of your current service you would like to discuss? (Use additional pages if more space is required)

**Please return to:**

AFIOH/SDR  
 Attention: Lt Col Scott M. Nichelson  
 Chief, Radiation Surveillance Division  
 2350 Gillingham Drive  
 Brooks City-Base TX 78235-5103