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Determination of Possible Damage/Degradation of the Sandia National Laboratories Personal Nuclear Accident Dosimeter (PNAD)

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Abstract

This report describes the results of an inspection performed on the existing stock of SNL Personal Nuclear Accident Dosimeters (PNADs). The current stock is approximately 20 years old, and has not been examined since their initial acceptance. A small random sample of PNADs were opened (a destructive process) and the contents visually examined. Sample contents were not degraded and indicate that the existing stock of SNL PNADs is acceptable for continued use.

Acknowledgement

The authors thank B. Elkin of the Radiation Protection Department for his support and guidance regarding this work.

Acronyms and Abbreviations

NaF	Sodium Fluoride
PNAD	Personal Nuclear Accident Dosimeter
SNL	Sandia National Laboratories

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Introduction

Purpose

This report describes the results of a random sampling of Sandia National Laboratories (SNL) Personal Nuclear Accident Dosimeters (PNADs) to determine if they have degraded with age.

History

SNL PNADs were designed and fabricated nearly 20 years ago. Figure 1 contains a picture of an intact PNAD plus an opened PNAD with the NaF tablet, cadmium covered copper foil, and metalic foils removed for display. PNADs do not require any type of maintenance. The metallic foils and NaF tablet are protected from potential environmental insults by being sealed inside of a robust plastic housing. When members of the SNL workforce perform tasks that involve potential criticality issues, they are required to wear a PNAD. If an accidental criticality were to occur, the metallic foils and the NaF tablet would become activated. The degree of activation can be used to determine a worker dose from exposure to neutron radiation.

This work was prompted by a Lessons Learned announcement regarding foil degradation in a different style PNAD used by another DOE facility[1]. The existing inventory of SNL PNADs is approximately 300, and is adequate for foreseeable needs. A sample size of six (6) was established. This represented a balance between a representative sample size and preserving the existing inventory as much as possible.

A physical description of the SNL PNAD plus experimental results indicating the accuracy for neutron dosimetry purposes is available[2].

Scope

PNADs were opened (a destructive process) and the contents were visually inspected. Deterioration, if present, would consist of foil oxidation and/or possible crumbling of the NaF tablet.

This activity was performed in accordance with an approved sampling plan[3].

Discussion

The style of PNAD mentioned in the Lessons Learned announcement[1] contained a sulfur tablet plus metallic foils. Although the sulfur tablet was physically separated from the

metallic foils, both were encased in the same holder. It is not clear if the sulfur reacted with the metallic foils, but there was significant degradation of the metallic foils. The SNL PNAD design does not contain a sulfur tablet. Instead, a pressed tablet consisting of NaF mixed with a polymer binder is used. This tablet is expected to be chemically stable.

Results

Six (6) PNADs were randomly selected and evaluated[3]. The PNADs are identified in Table 1. The foils and NaF tablets were removed from their respective plastic housings and visually examined. All materials were then arranged for display as shown in Figures 2 and 3. PNAD components showed no signs of aging or deterioration. Foils were clean and shiny indicating no oxidation or other corrosive signs. All NaF tablets were intact and showed no signs of swelling, flaking, crumbling or discoloration. The glue joints between the plastic housing body and top cover all appeared to be strong and fully intact.

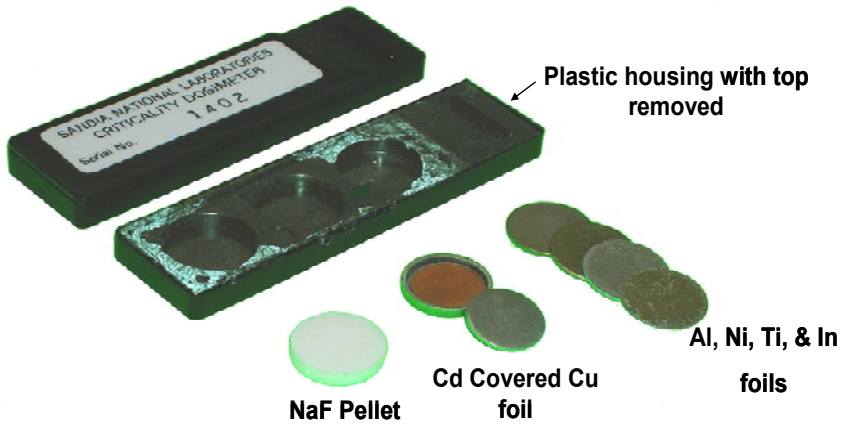

Figure 1: An intact PNAD measures 19 mm by 7 mm by 65 mm long.

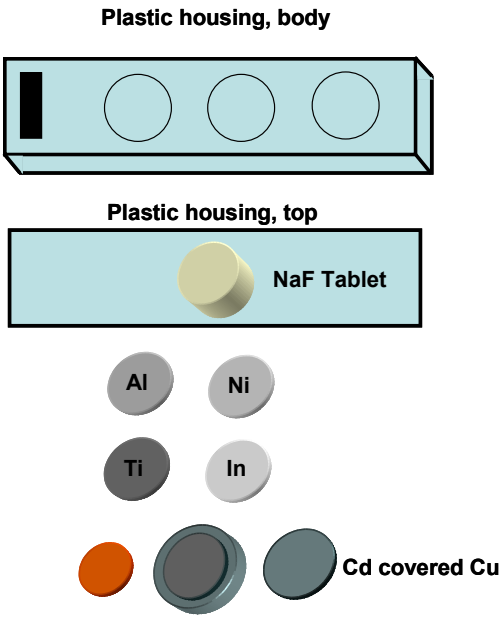

Figure 2: Diagram showing arrangement of PNAD components.

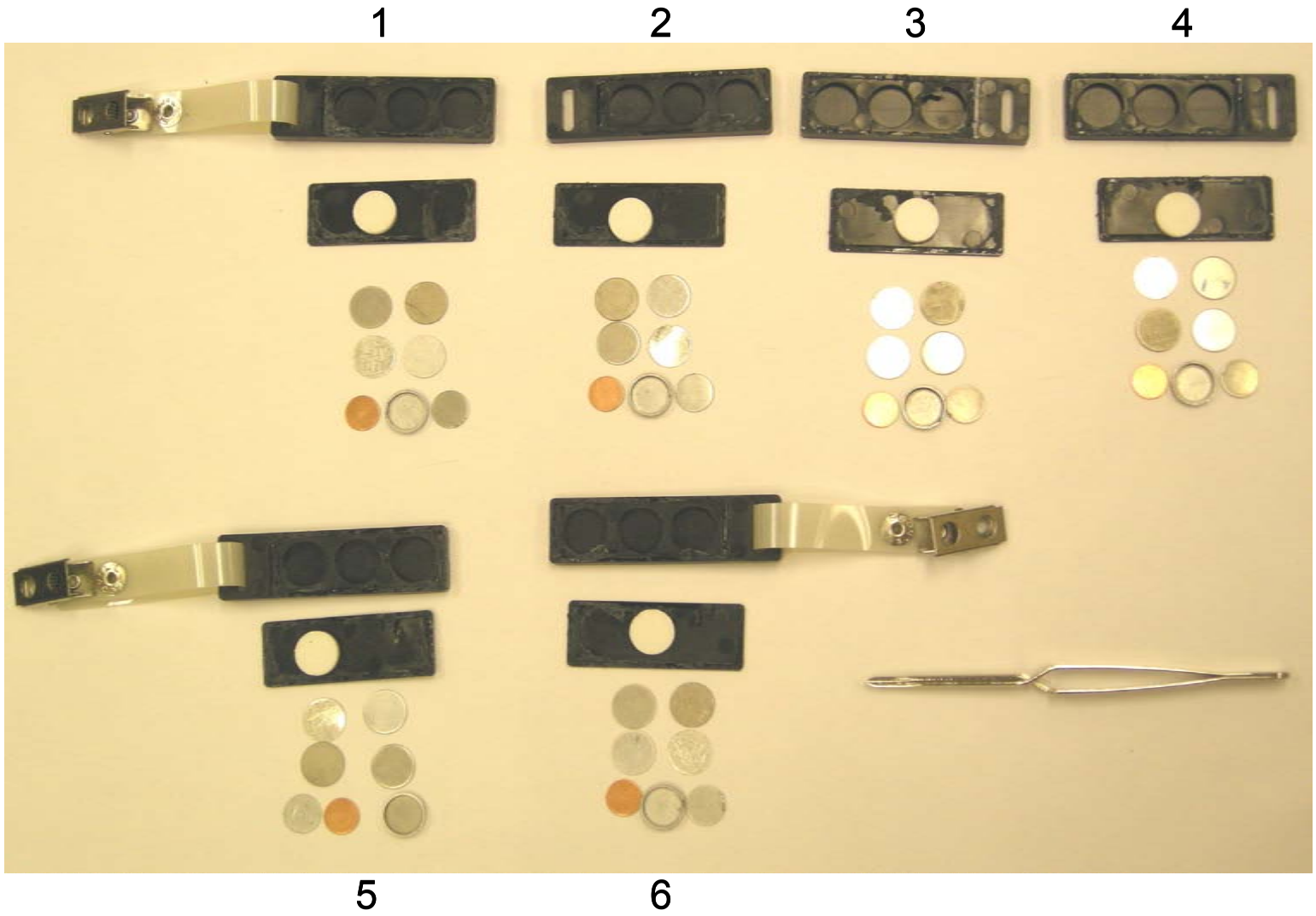

Figure 3: Each PNAD was opened and displayed as indicated. The numbers shown correspond to the sample ID # in Table 1.

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Table 1: PNAD Information

Sample #*	PNAD SN	Comment
1	0515	
2	None	Never Issued
3	None	Never Issued
4	None	Never Issued
5	0522	
6	0520	

* As indicated in figure 2.

Conclusions

The SNL PNADs are of robust design, and unless a plastic housing shows obvious physical damage the devices are suitable for continued use.

Recommendations for Further Analysis

1. PNAD materials used in this evaluation should be retained with the remaining un-issued PNADs and annually inspected for any signs of deterioration. This will allow for a periodic re-assessment of PNAD materials and provide a conservative indicator of PNAD performance. The remaining inventory of intact PNADs will then be protected from being slowly "sampled away".
2. Determination of a recommended "Shelf Life" is beyond the scope of this report. However, these devices show no signs of deterioration after almost 20 years. As such, it is probably conservative to assume that intact PNADs are good for up to 5 more years from the date of last evaluation.

References

[1]DOE Lessons Learned – Foil Degradation in Personal Nuclear Accident Dosimeters Alters Response; Identifier: 2008-LL-PNNL-0001.

[2]Personal Nuclear Accident Dosimetry at Sandia National Laboratories, SAND96-2204, September 1996.

[3]Sampling and Analysis Plan for the Determination of Possible Damage/Degradation of the SNL Personal Nuclear Accident Dosimeter (PNAD), SNL Radiation Protection Department (04128), February 22, 2008.

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