

September 21, 1989

Mr. L. J. Cunningham  
Chief of Radiation Protection Branch, NRR  
U. S. N.R.C.  
Washington, DC 20555

Re: Alnor Electronic Dosimeter Model RAD-85

Dear Mr. Cunningham:

On August 29, 1989, I spoke with Jim Wigginton of your office concerning a potential problem with our RAD-85 model dosimeter. After discussing the situation and our actions to prevent problems, he recommended we proceed on the course we were taking and report to you after we had full information.

The situation is as follows:

1. In February of 1988, we began delivering RAD-85's to the U.S. market. This was after three years of development and testing and six months of deliveries to European utilities. This product had been fully tested to meet all known standards for electronic alarming dosimeters in both Europe and the U.S. including the ANSI and PTB standards.

The dosimeter received German PTB approval and we advised all potential U.S. clients that the dosimeter did not meet the ANSI N. 13 standard of 100 hour battery life but was, in fact, closer to 50 hours in normal operations.

2. From the time of introduction through 1988, we delivered approximately 5,000 RAD-85's in Europe and approximately 1,200 in the United States.
3. In late 1988, we were informed by clients in Germany that they were seeing some interference being caused in our dosimeters by "TIG" welding machines.
4. We investigated the situation and found that there was, in fact, a potential for RF interference under extreme circumstances in the RAD-85. The problem appeared infrequent if at all in the U.S. deliveries. Some problems were suspected but could not be verified.

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The general standard for testing of RF interference, OSHA, ANSI and IEC is that an instrument should withstand 10 volts per meter and that exposure to the human body, especially the eyes of more than ten volts per meter, is a health hazard. All RAD-85's withstood much higher levels than ten volts per meter. However, the indications were that the true operating conditions, especially around "TIG" welding machines was higher than the standards.

5. In late 1988, Alnor determined that by adding bypass capacitors and a layer of silver paint on the interior of the case, we could substantially improve the RF shielding. We employed outside consultants to verify the results of our modification.

We then took the decision to offer this modification to all previously delivered customers and began the modification in early 1989. Due to the pressure this caused on our manufacturing, we also suspended new deliveries until June of 1989 in the U.S.

6. In early June, we began new production of RAD-85's in our factory in Turku, Finland. That production included a new processor board which was designed to incorporate the bypass capacitors which were added as a retrofit to the previously delivered and subsequently modified dosimeters.

This board was also being supplied by a different sub-contractor.

7. In July of 1989, we began deliveries of these new units. After testing, calibration, etc., the Commonwealth Edison Plant, Braidwood, began putting the dosimeters in operation for their upcoming refueling outage. During the week of August 21, they reported several dosimeters going completely blank and not recovering for no apparent reason.

From August 24 through August 28, Alnor's technical engineers investigated the problem and believed it to be a problem with the battery initialization procedure.

During transportation of the dosimeters, we typically set the memory registers to indicate the battery at 100% charge no matter what the true state of the charge. This prevents the dosimeters from giving a "low battery" alarm during transportation. During installation this override must be removed or dosimeters with very low or dead batteries may be issued and the user would think they had a full battery charge. This would cause a dosimeter to fail without a low battery alarm first.

We are in the process of rewriting our Operations Manual to emphasize the importance of this initialization procedure.

8. On Tuesday, August 29, it became apparent that the initialization procedure was not the problem but that the failures were appearing on people wearing walkie talkies.

Testing then indicated that if either the antenna or transmitter cord of the Motorola walkie talkies at 158 MHZ 1W, got within 10cm of the RAD-85's, they would go blank.

We immediately pulled all dosimeters manufactured since June off the market and out of the plants. We notified Bob Gregor and Jim Wigginton of the situation and began our investigation.

9. We also began batch testing of all previously delivered and modified dosimeters.
10. Our investigation over the next four days revealed the following:
  - a) That we, in fact, had two different models of RAD-85's from a radio frequency point of view. Those manufactured prior to June, 1989 and those manufactured since June of 1989.
  - b) That those manufactured prior to June, 1989 were much less susceptible to RF interference than the June model. Even those manufactured prior to June and not modified with silver paint were better than the June models.

- c) However, we discovered we could make all models fail under very extreme conditions if in direct contact with the antenna of a 900 MHZ 2 watt transmitter directly over the display of the dosimeter.
- 11 This prompted us to contact the NRC on Sunday, September 3, 1989, in case this new information fell within the notification requirements of 10 CFR part 21.
12. We then retained DLS Electronics Inc. of Chicago, IL to assist us in the testing. DLS is a NVLAP accredited RF testing laboratory.
- a) They verified that the June dosimeters were the worst for RF interference. However, even these dosimeters did not fail until exposed to 70 volts per meter of 900 MHZ or 156 volts per meter at 150 MHZ. Even the worst case scenario was 7 times the OSHA recommended value for human safety from RF radiation and the standard referenced in ANSI & IEC.
  - b) The previously manufactured and modified RAD-85's far exceed the performance of the June batch.
13. Even though these tests indicated the RAD-85 was not affected by RF until well in excess of the standards for human safety, our analysis has shown that in actual operation, the electronic dosimeter may be subject to this level of RF exposure.

This is because it is standard practice to wear walkie talkies on a belt with the antenna touching the chest area or using the microphone with the cord draped across the chest area. This is the exact area in which a dosimeter should be worn if utilized properly. This, in effect, means an electronic dosimeter must operate when in direct contact with an RF transmitter, transmitting RF radiation far in excess of the acceptable standards for human safety.

14. Alnor has done further development to solve the problem and discovered several solutions. The solution we have adopted is to paint the entire RAD-85 with continuous conductive material and then to seal the paint. This paint will be on the outside of the dosimeter and most probably be of nickel. Our testing indicates that this will prevent RF interference even under the most extreme conditions.

This solution will be instituted on all RAD-85 model dosimeters produced since June, 1989 and all future production.

15. Alnor has or will take the following actions:

- a) Alnor has loaned at our loss RAD-80 model dosimeters to those plants needing delivery from the June forward production. These RAD-80's will be replaced with shielded RAD-85's when they are available.
- b) Alnor will issue a supplement to its Operations Manual for all pre-June, 1989 deliveries informing of the proper operation to avoid RF interference.
- c) Alnor has replaced its production manager for failure to follow our QA/QC procedures involving the new processor board testing and documentation.
- d) A new manager of manufacturing operations has been appointed in our Turku, Finland factory. He will report on an interim basis to the CEO of the Group, not the president of Alnor, Finland.
- e) Mark Kyrel, a noted expert on QA/QC in Sweden has been retained to oversee our QA/QC in our Finnish operations. The QA/QC manager in Finland will report to Mr. Kyrel and Mr. Kyrel will report to the CEO of the Group.
- f) All dosimeters coming out of production will be tested for RF interference on an individual basis, not a type test of small batches.

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- g) Dick Condon, Chairman of Orion Corp, a member of the Board of Directors of the Alnor Group, has and will maintain an active advisory role in this situation.

We hope that our actions have been satisfactory and alleviate any of the NRC's concerns. If we can provide any further information or assistance, please feel free to contact us.

Sincerely,



Stephen F. Grover  
President

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**SUPPLEMENT****RAD-85 OPERATIONS MANUAL**

All microprocessor based electronics are susceptible to RF interference. The RAD-85 is no exception to this rule.

Alnor has provided proper RF shielding of the RAD-85 for normal use. However, there is a potential for RF interference under extreme circumstances.

Alnor recommends that procedures be instituted that prevent the dosimeter from being exposed to RF transmissions at closer than 2 inches.

10/11/89 RAD-85 Supplement sent concerning RF was sent to:

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