70-1113

GE Nuclear Energy

November 27, 1990

Mr. E. D. Flack, M/S 6H3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Flack:

Pursuant to our telephone conversation on 11/14/90, GE is supplying the following additional information relative to our recent extremity monitoring studies.

Extremity monitoring using TLD finger ring badges was initiated on August 6, 1990 at GE-Wilmington in response to a Region II inspection effort (Report 90-17). By August 13, all production personnel (approximately 100) routinely handling unclad uranium pellets were being monitored using weekly TLD finger rings. Eight different representative work locations where fuel pellets are handled were included in the study. TLD finger rings were placed on the palm side of the index finger adjacent to the first finger joint (closest to the tip). Our commercial badge vendor, R.S. Landauer Jr., & Co., provided the badge results and applied a special uranium beta dose conversion algorithm during readout. Finger ring information was collected over a 7-week period and the results were projected to a quarterly total. The results of this study are summarized in Attachment 1.

Since none of the individuals exceeded 25% of the quarterly exposure limit, it was our conclusion that routine extremity monitoring was not required pursuant to 10CFR20.202(a) and extremity monitoring was discontinued on September 30, 1990.

At a GE enforcement conference in Region II offices on August 27, 1990, we discussed the technical difficulties of monitoring the finger tips of worker extremities who must handle fuel pellets. We indicated our plans were to use the first joint badge results as the official dose of record.

At the enforcement conference, we were also asked by Region II to perform a special study to compare finger tip TLD results with first joint TLD results. This information was collected August 27 through September 9, 1990, and is shown in Attachment 2.

During our 11/14/90 telephone conversation, Mr. George Kuzo of Region II and you suggested that an average factor of 1.4 be applied to the measured first joint badge results to extrapolate the dose to the finger tip. Applying this factor, only two of the 99 individuals monitored were close to the 25% of a quarterly limit guideline which requires monitoring - one slightly over and one slightly under.

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We believe that a prescribed application of a correction factor is not necessarily practical nor appropriate. The following information is in response to your questions and suggestions.

1. Sufficient dose conservatism already exists in our current dose assessment method by using an assumed 7 mg/cm² skin thickness (pursuant to NRC form 5) for the TLD dose determination. A thickness of 7 mg/cm² is used because it is a reasonable mean value of the skin of the wholebody (ICRP 26, Pg. 13). A recent (7/90) letter from NRR to the regional offices indicates this skin thickness must be universally applied to all parts of the body in determining compliance with the limits of 10CFR20.101. The actual skin thickness of the fingertips ranges from 44 to 77 mg/cm² (ICRP 23, pg. 49). The 7/90 NRR letter also states that actual skin density values may be used in determining doses for purposes other than for comparison with NRC limits. For uranium betas, using a 7 mg/cm² skin thickness will overestimate the dose to the living fingertip skin cells by about a factor of 2.

2. It should also be noted that because of the uranium pellet size, no more than about 0.85 cm² of the pellet can be touched or contacted by the fingertips. IE notice 86-23 indicates that for purposes of showing compliance with 10CFR20.101(a), calculating a skin dose averaged over 1 cm² is appropriate. Thus in our case, the fingertip dose when averaged over 1 cm² should be 1.2 times less than the reported dose.

   In addition, the beta dose correction algorithm applied during TLD readout is derived from a natural uranium slab and most of the pellets handled are enriched up to 4%. This provides an additional conservatism according to the badge vendor. (Attachment 3.)

3. A single extrapolation factor may not be appropriate for all workers. As shown in Attachment 2, an average factor of 1.34 was obtained from a limited number of workers who volunteered to wear a dosimeter taped to their fingertip. This factor has a significant amount of variation not only from work area to work area because of differences in the way the fuel is contacted, but also from worker to worker due to differing finger sizes and personal work habits. For example, on about 30% of the workers monitored (9 of 30) the ratio of tip to first joint result was 1 or less.

4. There is no current regulation or guidance which allows for calculational methods to extrapolate measured values to the fingertips. It appears that a specific license exemption or authorization to deviate from 10CFR20.202(a) is required to use a calculational method rather than a monitoring device.

   NOTE: The proposed revisions to 10CFR20 (Section 20.3 - Definition of Individual Monitoring) does allow for calculational methods to satisfy the individual monitoring requirement as we interpret it.

5. The proposed revisions to 10CFR20 (20.201) specifically allow for averaging the dose to the skin over a 10 cm^2 area. This essentially means a finger dosimeter could be placed in the middle of the finger and an acceptable dose to the finger would be measured.

6. There is no biological effect difference if the dose is received at the first joint of the finger or approximately 1.5 cm away at the fingertip. In addition, doses received at both the first joint and an extrapolated fingertip result are small (approximately 25% of the 18.75 rem quarterly limit) for the individual with the maximum average weekly dose in our study and even less for the vast majority of workers. (Attachment 4.)

7. Monitoring the fingertips is a technically complex and challenging problem. Regulations and information notices do not address in any degree of detail the correct use, placement, or interpretation of extremity dosimetry, nor are accredited methods generally accepted for the calculation of dose from non-uniform sources. There is no NVLAP accreditation for extremity monitoring devices nor has there been a consistently used method in the fuel fabrication industry for dosimeter placement on the finger. Some guidance was provided in IE Notice 81-26 which stated that the objective should be to place the dosimeter in a position where it will measure the highest dose to the areas of interest. Yet when giving an example of underfoot radiations, it did not provide guidance on where to monitor for the extremities. A supplement to this IE notice was issued 7/19/82 which again referenced the underfoot radiation situation, but only stated that "...extremity monitoring requirements may dictate the placement of additional dosimeters in the feet and ankle area". It did not mandate that monitors must be placed underfoot nor did it address impractical and/or unacceptable monitor placement.

   Parallels can be drawn for not placing a dosimeter on the fingertip where it would also interfere with the worker's actions potentially increasing the likelihood of undesirable results. There is also the potential problem of damage to the device.

8. Our experience in monitoring workers who must perform tasks requiring manual dexterity using the fingertips indicates a monitoring bias may be introduced if dosimeters are applied directly to the fingertip. Dosimeters applied directly to the fingertips can have varying effects on the individual's work habits. The monitored finger may be used more or less than normal resulting in a positive or negative bias. Feedback from our workers was overwelmingly negative on the acceptability of routine fingertip dosimeter placement.

9. You also suggested during our 11/14/90 conversation that methods such as worker rotation or thicker gloves be employed to further reduce worker extremity exposures.

   Worker rotation is not in agreement with the ALARA principle. Studies at Battelle have indicated that worker rotation to reduce the dose to an individual can actually increase the collective dose.

   Our experience with worker rotation is that it unduly creates significant administrative and work scheduling problems. For example, with a limited workforce, certain key skills, training and qualifications are not widely available on every shift and these skills would have to be developed or obtained using overtime. Worker rotation also has the inherent potential for productivity impacts, quality assurance problems, and possible personnel safety concerns associated with unfamiliar tasks, techniques, or equipment.

   Our experience with thicker gloves or requiring a second glove is that it creates problems of worker acceptability. Because of the manipulations that must be performed at certain workstations, additional glove thicknesses interfere with worker manipulations. Productivity, throughput and worker morale suffer as a result.

   We are currently evaluating other methods of dose reduction techniques. These include remote handling devices, special "pusher" - tools and work station hand rests at certain locations. These will be evaluated along with continued extremity monitoring in preparation for the new requirements of 10CFR20.

It is important to keep in focus that the situation being discussed relates to a decision criteria at 25% of a regulatory limit and questions related to "as low as reasonably achievable". It is our contention that the reported dose measured at the first joint on the finger properly represents the dose to the worker extremity for the purpose of evaluating whether routine monitoring is required (i.e., potential to exceed 25% of the quarterly limit). We recognize that with exposures very close to the quarterly limit, more precision, accuracy, rigor and conservatisms will most likely be in the best interest of the workers.

If the NRC decides to require the use of an applied computation for the fingertips, the NRC must also allow for the computation of the appropriate factors for skin thickness at the fingertips (Item 1), the contact surface of items being handled (Item 2), and averaging over 10 cm^2 (Item 5).

If you should have any questions or need further information, please call me at (919) 675-5950.

Very truly yours,

GENERAL ELECTRIC

S. P. Murray, Manager
Nuclear Safety Engineering

cc: Region II Regional Administrator

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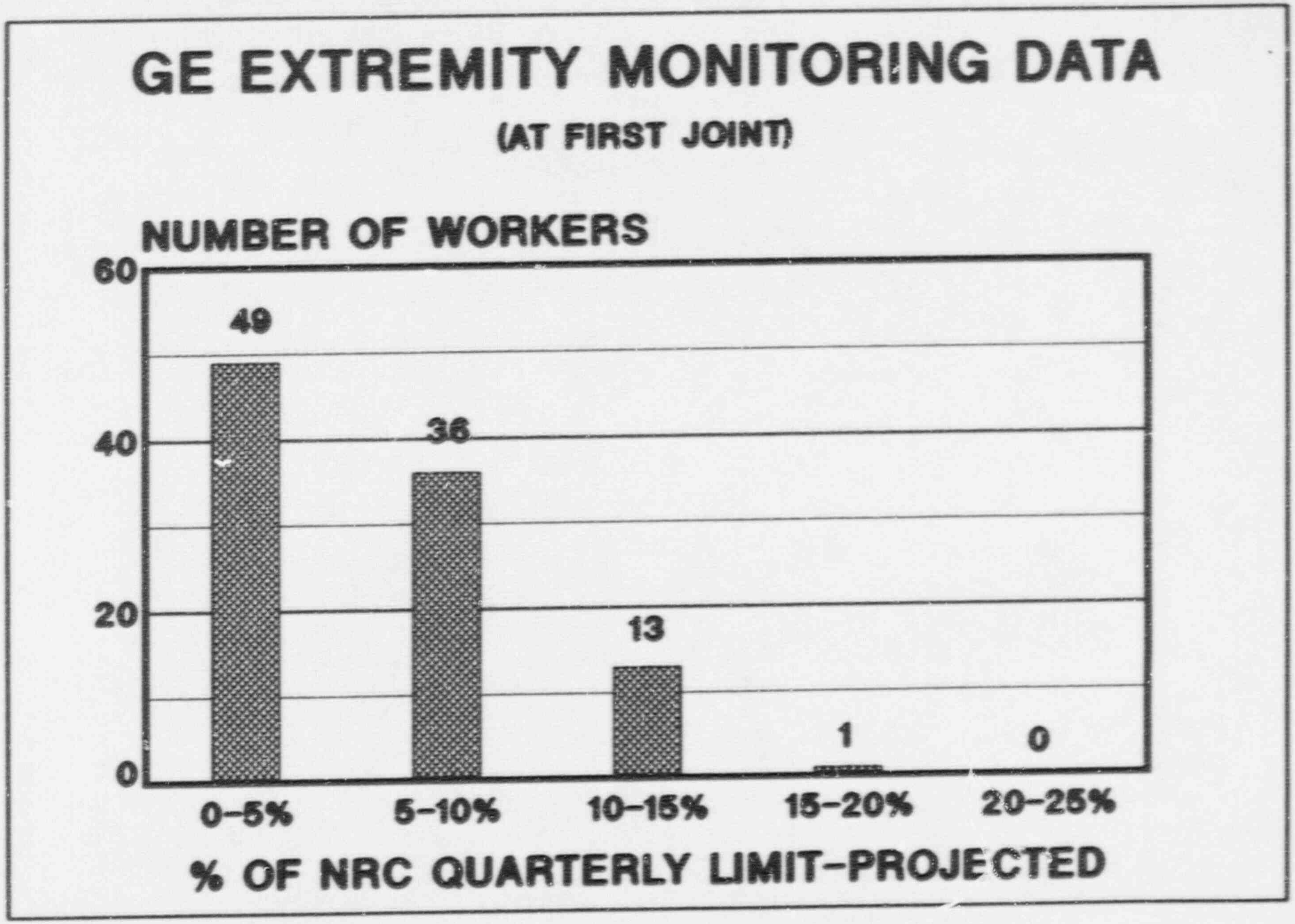
ATTACHMENTS

ATTACHMENT 1



ATTACHMENT 2

EXTREMITY COMPARISONS: TIP VS. FINGER JOINT BADGE

STUDY OF SELECTED WORKERS USING TWO FINGER RINGS

From 8/27 - 9/9/90

		Ratio		Ratio		Ratio		Ratio	Avg. Ratio
Grinder	Tip 120 Joint 100	1.20	Tip 100 Joint 60	1.67	Tip 190 Joint 150	1.27	Tip 220 Joint 150	1.47	1.40
Auto Rod Loader	Tip 110 Joint 90	1.22	Tip 60 Joint 60	1.00	Tip 140 Joint 60	2.33	Tip 70 Joint 50	1.40	1.48
Manual Rod Loader	Tip 110 Joint 110	1.27	Tip 240(1) Joint 60		Tip 70 Joint 50	1.40	Tip 40 Joint 50	0.80	1.15
Rotary Press	Tip 170 Joint 90	1.89	Tip 90 Joint 60	1.50	Tip 80 Joint 80	1.00	Tip 200 Joint 110	1.81	1.55
Hydromet Press	Tip 90 Joint 50	1.80	Tip 80 Joint 50	1.60	Tip M Joint M	1.00	Tip 130 Joint 80	1.62	1.50
Test Press	Tip 100 Joint 70	1.43	Tip 40 Joint 40	1.00	Tip M Joint M	1.00	Tip 40 Joint 40	1.00	1.10
B&W Packer	Tip 80 Joint 80	1.00	Tip 100 Joint 70	1.43	Tip 160 Joint 130	1.23	Tip 140 Joint 110	1.27	1.23
QC	Tip 40 Joint M(2)	1.33	Tip 60 Joint 60	1.00	Tip Missing Joint M				1.17

OVERALL AVERAGE 1.34

(1) Invalid Ratio: Monitoring Problems - Cracked Chip

(2) Minimum Detection Limit 30 mrem

ATTACHMENT 3

Tech/Ops Landauer, Inc.
2 Science Road
Glenwood, Illinois 60425-1586
Telephone (708) 755-7000

November 19, 1990

Mr. Scott Murray
General Electric Company
Mail Code J-26
P.O. Box 780
Wilmington, NC 28402

Dear Scott:

Below is a discussion on the uranium beta corrections for Landauer ring badges. As indicated in earlier discussions, the ring badge contains a single TLD crystal. We normally interpret the reading as if the crystal was uniformly irradiated with photons. Beta particles may cause non uniform irradiation of the chip due to absorption within the crystal. When this occurs a correction factor must be applied. The value of the factor depends on the beta energies.

The correction factor for natural uranium, depleted uranium or slightly enriched as used in commercial LWR fuel elements is 1.89 for the new ring badge (laser engraved styrene cap) and 2.2 for the old ring badge (paper label applied to a polyethylene cap). This factor was determined by exposing rings in contact with a metal slab of uranium. Tests with natural and depleted uranium have shown no affect with respect to the different concentrations of uranium-235.

For contact exposure, the dose is due to a complicated spectra of high and low beta and photon energies. The primary beta sources are thorium-234 and protactinium-234m and 234 which result from uranium-238 decays, and thorium-231 from uranium 235 decays. The primary beta of concern is from protactinium-234m having a mean energy of 0.825 MeV and a yield of 0.98 per disintegration. The betas emitted from the two thorium radionuclides have very low mean energies (less than 0.085 MeV) and very low yields with the exception of a 0.05 MeV beta with a 0.73 yield. Such low energy betas are unable to penetrate to a skin depth of $7 mg/cm^2$. Of course, protective gloves would further reduce skin exposure to the point where the thorium betas can be neglected. No correction is needed for the x rays emitted since these are able to evenly irradiate the chip.

We do not have test data for high enrichments of uranium-235, but I would expect the extremity doses to be primarily due to photons. The correction factor would be small.

To summarize, the content of uranium-235 in depleted and low enriched uranium-238 materials contributes negligibly to the extremity dose, particularly if protective gloves are used. At high enrichments, the extremity dose results primarily from x rays emitted by uranium-235 and thorium-231 and any beta doses are negligible. Application of the uranium correction factor would become more conservative as the U-235 content increases.

Please keep me informed of developments.

Sincerely yours,

Tech/Ops Landauer, Inc.

R Craig Yoder

R. Craig Yoder
Technology Manager

RCY/lw

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GE EXTREMITY MONITORING DATA

(AT FIRST JOINT X1.4)