

U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 030-28902/87-01

Docket No. 030-28902

License No. 20-00320-21

Priority 1

Category B

Licensee: E.I. Dupont
NEN Products
575 Albany Street
Boston, Massachusetts 02118

Facility Name: E.I. Dupont/NEN Products

Inspection At: Boston, Massachusetts

Inspection Conducted: January 6, 1987

Inspectors: *Edwin A. Wurtz* 2/18/87
Edwin A. Wurtz, Ph.D. date signed
Health Physicist

Steven R. Courtemanche 2/26/87
Steven R. Courtemanche date signed
Health Physicist

Approved by: *John R. White* 2/24/87
John R. White, Chief date signed
Nuclear Materials Safety Section C

Inspection Summary: Special announced inspection on January 6, 1987, to review the circumstances of a reported exposure to the skin of the right thumb of a chemist on December 15, 1986.

Areas Inspected: Notification of incident, interviews with personnel, and review of licensee dose estimate.

Results: No apparent violations of Commission rules, regulations or license conditions were identified.

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DETAILS

1. Persons Contacted

- *Leonard Smith, Radiation Protection Section Supervisor
- Robert Becker, Chemist
- John Henderson, Supervisor
- Mark Johnson, Area Supervisor
- *Larry Geller, Labeled Compounds Production Manager for Boston Facility

*Denotes those present at exit interview.

2. Notification of Incident

On December 17, 1986, at approximately 3:00 p.m., a licensee representative contacted the NRC Region I office to report a radiation dose to a portion of the skin of one hand of a worker which was potentially in excess of regulatory limits. A chemist working with sulfur-35 labelled, buffered, sulfuric acid solution detected skin contamination on his right thumb while performing a personal contamination survey after the completion of his work at approximately 3:00 p.m. on December 15, 1986. The initial surveys of the workers thumb indicated that the activity, which measured 330,000 counts per minute with an end window geiger-mueller (GM) counter and 19 microcuries with a sodium iodide (NaI) detector measuring bremsstrahlung was confined to approximately one square centimeter of area. A small quantity of sulfur-35 was also detected in the individual's urine. The licensee's preliminary estimate of the dose to the basal layer of skin beneath the contamination was between 40 to 400 rems. The regulatory limit is 18.75 rems extremity exposure per quarter.

Subsequent communication with the licensee indicated that the actual dose to the basal layer of skin may have been substantially less than the preliminary estimate due to the immobilization of the sulfur-35 contamination on the surface of the skin.

No apparent violations of Commission rules, regulations or license conditions were identified.

3. Interviews with Personnel

On January 6, 1987, a special inspection was conducted to review the incident reported by the licensee on December 17, 1986. During the inspection the following licensee personnel were interviewed: the chemist, the chemist's supervisor, the area supervisor, and the section supervisor of radiation protection. The details of these interviews are summarized below.

a. Chemist

The chemist told the inspectors that he was conducting a routine synthesis of ^{35}S -PAPS which involves the reaction of approximately 300 millicuries of $[^{35}\text{S}] - \text{H}_2\text{SO}_4$ (330 millicuries per milliliter) with cold nucleotide precursor in the presence of enzyme and buffer salts in a water bath at 30°C . To analyze the amount of product formed, 1 microliter aliquots are removed from the reaction vessel at various times, and diluted into 1 milliliter of water in small capped vials. During this procedure the chemist said that he wore double latex gloves. The outer pair of gloves were removed and his hands monitored, before taking the sample to the high pressure liquid chromatography (HPLC) equipment to analyze the sample. At some time shortly after 3:00 p.m. on December 15, 1986 the chemist had finished with the procedure and began to clean up for the day. He removed his two pair of gloves and monitored his hands using a GM detector. He found his right thumb to be contaminated. He washed his hands to remove the contamination, but was unsuccessful. He notified his supervisor of the contamination, and a contamination survey of the area was carried out. A urine sample was taken from the chemist and analyzed for activity. A blood sample was also taken.

b. Supervisor

The supervisor told the inspectors that, following the discovery of the contamination, the Radiation Safety Office was notified and a GM survey of the work area was performed. The following areas of contamination were identified: 1) Chemist's lab coat - 9 areas of contamination ranging from 7,000 cpm to 120,000 cpm; 2) Felt tip pen used at HPLC - activity quite high but not recorded; 3) Top of refrigerator door - 30,000 cpm; 4) Work tray - 200,000 cpm; 5) Three control knobs on HPLC equipment - 30,000 cpm to 6,000 cpm; 6) Outside of reaction flask - greater than 300,000 cpm. An examination by the supervisor of gloves which had been used by the chemist determined that 15 were contaminated and one had a one square centimeter hole in the thumb. The supervisor stated that although the chemist had followed contamination control procedures, such as changing gloves prior to leaving one area to perform an operation in another area, that the sample vial taken to the area where the HPLC equipment was to be used may have been contaminated. This could have resulted in contamination of the chemist's gloves and the other items which were found contaminated. All contaminated areas were decontaminated.

c. Area Supervisor

The area supervisor told the inspectors that as a result of this contamination incident the chemist was being retrained in cleanliness and that his work area would be monitored frequently. In addition, all future syntheses of ^{35}S -PAPS will be performed in a glove box by individuals trained in glove box techniques.

d. Radiation Protection Section Supervisor

The Radiation Protection Section Supervisor (RPSS) provided the inspectors with a description of the incident and the investigation of the incident by Radiation Protection. The RPSS told inspectors that the Radiation Safety Office audits operations to insure that individuals are wearing appropriate protective clothing and gloves for the particular operation being performed. The operation being performed by the chemist involved in the contamination incident had been reviewed by Site Safety according to the RPSS. The chemist had been instructed in the appropriate procedures to be used to control contamination. Since there was no evidence of any sulfur-35 labeled volatile compounds produced during the operation, procedures allowed the operation to be conducted on lab benches according to established procedures for high specific activity tritium labeled nucleotides. There were no sealed septum, needles or inert atmosphere required.

The RPSS provided the inspectors with the licensee's Serious Safety Incident Report and dose estimate which is discussed in Section 4 of this report and is included as appendix A to this report. The RPSS also informed inspectors that the urine bioassay sample taken on December 15, 1986 was only 30 cpm above the background (16 cpm). The $\frac{1}{2}$ milliliter urine sample was counted with approximately 20% counting efficiency. Therefore, the urine sample contained approximately 0.14 microcuries of sulfur-35 per liter of urine. A second urine sample taken on December 17, 1986 showed no detectable activity. It is unlikely that the total uptake of sulfur-35 exceeded 0.5 μ Ci which is equivalent to a 0.1 MPC-hour uptake.

The RPSS told the inspectors that he believed the cause of the contamination incident was poor contamination control by the chemist as indicated by the large number of items found to be contaminated. He felt that the chemist's thumb probably became contaminated when touching contaminated glassware with gloves which had a hole in the thumb. He indicated that in the last few years there had been a company policy to reduce the amount of radioactive waste and that this policy may have inadvertently resulted in some individuals wearing gloves too long. However, he said there was a policy that no worker should wear contaminated gloves and that they should not deliberately handle contaminated items; rather, they should use implements to prevent direct contact with contaminated glassware or the glassware should be decontaminated before touching with gloves. The chemist was to be retrained in contamination control techniques.

No apparent violations of Commission rules, regulations or license conditions were identified.

4. Dose Assessment

The licensee quantified the amount of sulfur-35 on the chemist's right thumb using a GM detector and a NaI detector. Sulfur-35 is a pure beta particle emitter with a maximum beta particle energy of 0.167 MeV and an average energy of .0610 MeV. (Table of Isotopes, Seventh Edition, Lederer and Shirley, eds.). The GM detector is able to detect beta particles emitted from sulfur-35 immobilized on the outer surface of the skin. The NaI detector detects bremsstrahlung radiation produced in the skin by the beta particles emitted by sulfur-35 located in all layers of the skin, thereby providing a measure of the total amount of sulfur-35 contamination in the skin of the thumb. The energy discriminator of the NaI detector was set to allow photons of 40 keV energy or greater to be counted. Both the GM and NaI detectors were calibrated using a carbon-14 standard source plated on a thin aluminum sheet placed on top of a sheet of lucite. Carbon-14 has a maximum beta particle energy of 0.156 MeV and an average energy of .0467 MeV (Table of Isotopes, Seventh Edition, Lederer and Shirley, eds.). Therefore, a correction factor of 1.1 was used by the licensee to account for the higher maximum beta particle energy of sulfur-35 and, consequently, greater bremsstrahlung production.

The chemist's contaminated thumb was counted on several different occasions over a period of several days by the licensee. The results of these measurements are included in the licensee's investigation of the incident (Appendix A of this report). Using the NaI detector the licensee estimated that the total sulfur-35 activity immobilized on the thumb was 18 microcuries. Slightly greater than 4 microcuries of this amount was localized in the top layer of the skin as indicated by the activity measured using the GM detector.

The total activity in the thumb decreased substantially in the first 48 hours after the contamination incident. Efforts were made by the licensee to remove the contamination using several different agents, but none of these efforts appeared to be successful according to licensee representatives. The decline in sulfur-35 activity in the thumb, rather, appears to be due to the normal sloughing of contaminated skin from the outer region of the stratum corneum or horny layer of the skin on the thumb. The thickness of this layer above the basal cell layer or stratum germinativum is estimated for finger tips to be 370 ± 112 micrometers according to ICRP No.23. The cell renewal time defined as the average time for all cells of the stratum germinativum to reach the surface of the stratum corneum is estimated to be 34 ± 2 days for the palms of the hand and 20.8 ± 2.3 days for the backs of the hand (ICRP No. 23).

Using this information and the information that 95% of the sulfur-35 activity was sloughed within 3 days of the original contamination, it is possible to estimate that 95% of the sulfur-35 activity was localized in the top 10% of the stratum corneum or top 37 micrometers. No activity was detected after 4 days, indicating that it is unlikely that any sulfur-35 was immobilized below approximately 50 micrometers beneath the outer surface of the skin. Therefore, beta particles emitted by the immobilized

sulfur-35 would have to penetrate approximately 320 micrometers of dead cells in the stratum corneum before reaching the live cells of the stratum germinativum. The range of beta particles in water with the maximum beta particle energy of 0.167 MeV of sulfur-35 is approximately 286 micrometers. Consequently, in this contamination incident it is unlikely that any significant dose was delivered to the basal layer of skin cells by the sulfur-35 contamination. An independent dose assessment using published and recognized information on beta-ray dose distribution (Tables of Beta-ray Dose Distributions in Water, Air and Other Media, W.G. Cross et. al., 1982) confirms that no significant dose would be delivered to the basal layer of skin cells. This dose assessment agrees with that of the licensee, i.e. no overexposure was received by the chemist as a result of the skin contamination incident (see the attached appendix).

No apparent violations of Commission rules, regulations or license conditions were identified.

5. Exit Interview

The inspectors described the extent of the special inspection to investigate the possible overexposure which had been reported to Region I. Licensee representatives were told that further evaluation of the incident would be done at the Region I office and that the Commission's findings would be communicated to them in an inspection report.