U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

Region I

Report No. 30-10811/80-01

Docket No. 30-10811

License No. 37-02895-01 Priority II Category C

Licensee: National Valve and Manufacturing Company

158 49th Street

Pittsburgh, Pennsylvania

Facility Name: National Valve and Manufacturing Company

Inspection at: Pittsburgh, and Etna, Pennsylvania

Inspection conducted: May 9, 15 and 16, 1980

Inspectors: Francis Costello — 6/17/80
F. Costello, Radiation Specialist — date signed

for D. R. Stearns — 6-17-80
C. Stearns, Radiation Specialist — date signed

M. Campbell — 6/17/80
M. Campbell, Radiation Specialist — date signed

Approved by: for John D. Kinneman — 6-17-80
H. Crocker, Acting Chief, Materials Radiological Protection Section — date signed

Inspection Summary:

Inspection on May 9, 15 and 16, 1980 (Report No. 30-10811/80-01)
Areas Inspected: Special, announced inspection of the circumstances surrounding an overexposure to 29 curies of Iridium-192 and an exposure within NRC regulations to 41 curies of Iridium-192, incidents, interviews with employees, evaluations of doses received, permanent facility controls, training, exposure records, utilization logs, survey meter and dosimeter calibration, and licensee audits. The inspection involved 27 inspector-hours on site by three NRC inspectors.
Results: Of the eleven areas inspected eight items of noncompliance were identified in seven areas. (Infraction - exposure in excess of 10 CFR 20.101(a) limits, Paragraph 4; Infraction - failure to evaluate exposures, Paragraph 4; Infraction - failure to survey entire length of guide tube upon completion of shot, Paragraph 3; Infraction - failure to provide required training to radiographers Paragraph 6; Infraction - failure to equip cells in accordance with 10 CFR 34.29(b), Paragraph 5; Infraction - failure to calibrate dosimeters as required by 10 CFR 34.33. Paragraph 9; Deficiency - failure to maintain records of unannounced inspections of radiographers, Paragraph 10).

DETAILS

1. Persons Contacted

*W. Biddle, Senior Vice President, Piping Division
*R. Jackson, Quality Assurance Manager
*G. Koch, Quality Control Manager
Radiographer A
Radiographer B

*Denotes those present at the exit interview.

2. Incidents

On May 9, 1980 during a routine, unannounced inspection, the inspector determined that two unusual events had occurred, one on February 11, 1980 and one on March 18, 1980 which could have resulted in overexposures to the radiographers involved. Accordingly, on May 15-16, 1980, a special inspection was conducted to evaluate these exposures.

3. Interviews with Employees

On May 15 and 16, 1980 Region I inspectors visited the facility and interviewed personnel to determine the details of the events.

Radiographer A stated that on February 11, 1980, he was performing radiography with a 41 Curie source of Ir-192, in a Technical Operation Model 490 exposure device, on a pipe at the licensee's Etna facility. He had started an exposure of the pipe when he realized that he had neglected to calculate the appropriate time for the shot. After performing the calculation, he proceeded to approach the radiography source to change the film cassette for the exposure. His survey meter read zero while approaching the exposure device and as he placed the survey meter on top of the exposure device. Ordinarily the survey meter would read between 10-30 mR/hr in this position. He did not survey the source guide tube. He changed the film cassette, and returned to the crank. When he attempted to crank out the source, he realized that the source was already in the fully exposed position and that he had failed to retract it before approaching it to change the film. He checked his dosimeter and noted that it was off scale (200 mR). He retracted the source, surveyed the guide tube with a different survey meter, and locked the device. He reported the incident to the Radiation Safety Officer, who sent his film badge for processing and restricted Radiographer A to non-radiography work. Upon processing, Radiographer A's film badge read 270 mRem and he was allowed to return to radiography work.

Radiographer B stated that on March 18, 1980. he was performing radiography using a Technical Operation Model 490 exposure device with a 29 curie source of Iridium-192 at the licensee's Pittsburgh facility. At the conclusion of an exposure, he placed his survey meter on top of the exposure device without surveying the entire guide tube. He walked to the end of the source guide tube, removed the film, returned to the exposure device and began to disconnect the source guide tube. He noticed that the guide tube connection was more difficult to unscrew than usual. After disconnecting the source guide tube, he recognized the end of the radiography source protruding from the exposure device. He left the area immediately and retracted the source by turning the crank approximately ½ turn. He read his dosimeter and found it was off scale (200 mR). He reported the incident to the Radiation Safety Officer. His film badge was processed and read 60 mRem. He was allowed to return to radiography work.

Radiographer B stated that he had observed no evidence of burns or skin damage on either hand.

Condition 16 of License No. 37-02895-03 requires that all radiographers make a survey of the exposure device and the entire length of the source tube after each exposure. 10 CFR 34.43(b) requires that a survey be made of the circumference of the exposure device and of the source guide tube. The finding that neither Radiographer A nor Radiographer B surveyed the entire length of the source guide tube constitutes noncompliance with Condition 16 of License No. 37-02895-03 and with 10 CFR 34.43(b).

4. Evaluation of Doses Received

a. Radiographer A

Until the time of the inspection, the licensee had accepted the film badge results as being indicative of the radiographers' exposure. Upon review of the incidents with the inspectors, the radiation safety officer agreed with the inspector's conclusion that a further evaluation was necessary.

The Quality Assurance Manager, the inspectors, and Radiographer A reenacted the incident in which he was involved. The same exposure device, source, and collimator were used, as well as a piece of pipe identical in diameter and wall thickness to the one being radiographed at the time of the incident.

After setting up the shot in the same configuration as during the incident, the radiographer's actions in approaching the source and changing the film were timed by both NRC and licensee representatives. A maximum exposure time of approximately 40 seconds was estimated based on this reenactment. The radiographer had approached the source from behind the collimator and also stood behind the collimator while changing the film. The distance between the source inside the collimator and his film badge was approximately 19 cm. The only parts of the radiographer's body which came closer than 19 cm to the source and which were not shielded by the collimator during the reenactment were the radiographer's hands. To change the film on the pipe, the radiographer placed one hand on the pipe opposite the collimator and one on the pipe approximately 5 cm from the source along the circumference of the pipe.

Self reading dosimeters were placed on a ring stand at 40 cm from the source behind the collimator in the direction of the radiographer's torso and exposed for one minute. These dosimeters read 82 and 87 mR. The source strength was 19 curies at the time of the reenactment.

Correcting this measurement for distance and source strength at the time of the incident indicates a dose rate at 19 centimeters from the source equal to

$$84.5 \frac{\text{mR}}{\text{minute}} \times \frac{41 \text{ Curies}}{19 \text{ Curies}} \times \left(\frac{40 \text{ cm}}{19 \text{ cm}}\right)^2 \times .957 \frac{\text{rad}}{\text{R}} \times 1 \frac{\text{rem}}{\text{rad}} = 773 \frac{\text{mrem}}{\text{minute}}$$

For an exposure time of 40 seconds, this indicates a whole body dose of 515 mrem. Since the individual did not spend the entire 40 seconds at the closest distance, 19 centimeters, this represents the upper limit on his exposure.

Two high level dosimeters were placed on the pipe, one opposite the collimator and one on the pipe 5 cm above the collimator at the point of closest approach to the source. These were exposed for 10 minutes and indicated a dose rate of 1.4 R/min and 7.0 R/min respectively. Corrected for source decay, these readings indicate radiation levels in the places where the radiographer placed his hands of 3.3 rem/min and 16 rem/min respectively. This hand exposure took place over a shorter period of time than the maximum 40 seconds whole body exposure.

The inspectors calculated a theoretical dose at 19 centimeters using a 41 Curie Iridium-192 source and a three half-valve layer tungsten collimator as follows:

$$\text{Unshielded Exposure rate} = R = \frac{\Gamma A}{r^2}$$

where $\Gamma = 4800 \frac{\text{R} - \text{cm}^2}{\text{hr} - \text{Ci}}$

$A = 41$ Curies

r = distance from source = 19 centimeters

Dose in rem $= R \times f \times QF$

where $QF = 1$ rem/rad for Iridium-192 gamma rays

and $f = .957$ rad per R

Theoretical unshielded dose rate = 8.7 rem/min

Assuming a factor of 8 reduction because of the tungsten collimator (manufacturer's specification is 3 half-value layers) reduce this dose rate to 1.1 rem/min. This is consistent with the measurements made with the pocket dosimeter.

From these measurements, the inspectors calculated that Radiographer A received a maximum of 515 mrem whole body. Considering the inaccuracies of all reenactments, this is satisfactory agreement with the film badge. They concluded that his film badge, which read 270 mrem, accurately reflects his whole body dose and that his hands received less than the quarterly limit for extremity dose (18.75 rem).

b. Radiographer B

The inspectors and Radiographer B reviewed the incident in which he was involved. It was determined that this incident could not be reenacted using an exposed source safely. Dose estimates were made by calculation.

A Technical Operations Model 490 exposure device was set up in approximately the same configuration as during the incident. Radiographer B's actions in removing the source guide tube were timed by both NRC and licensee representatives. The approximate time for removal of the tube was determined to be 6 seconds. The fingers of Radiographer B's left hand were measured to be approximately 2 centimeters from the source. His film badge was approximately 71 centimeters. Doses were estimated using the exposure calculated as follows:

$$\text{Unshielded Dose in Rem} = \frac{\Gamma A t}{r^2} \times f \times QF$$

Where $\Gamma = 4800 \ \frac{R - cm^2}{hr - Ci}$

$A = 29$ Ci

t = time of exposure = 6 seconds = .0017 hours

r = distance from source

f = .957 rad per R

QF = 1 rem/rad for ^{192}Ir gamma rays

The inspectors evaluated the dose to Radiographer B as follows:

1. Dose to radiographer's hand at 2 cm is 56 rem

2. Dose to radiographer's film badge at 71 cm is 46 mrem

The agreement with the radiographer's film badge, which read 60 mrem, is acceptable and indicates that the 6 second estimate of exposure time is reasonable. The film badge is judged to be the best indication of the whole body dose. Thus, it is concluded that Radiographer B received 60 mRem to his whole body and 56 Rem to his left hand.

The finding that Radiographer B received greater than 18.75 Rem to the fingers of one hand represents noncompliance with 10 CFR 20.101.

The finding that the licensee did not perform an evaluation of the extremity exposure of Radiographer B constitutes noncompliance with 10 CFR 20.201(b).

5. Permanent Facility Controls

During the reenactment of the two incidents, the inspectors observed that neither the enclosed cell nor any of the open bays which the licensee uses as permanent radiographic facilities were equipped with the alarms or warning devices required by 10 CFR 34.29(b).

The finding that neither the enclosed cell nor the open bays were equipped with the required warning devices constitutes noncompliance with 10 CFR 34.29(b).

6. Training

The inspectors reviewed the training records and determined that, while the licensee had provided all radiographers with the required initial training, the 18 hours per year of radiation safety retraining required by Condition 16 of License 37-02895-03 had not been provided.

Radiographer A. when observing a zero reading on his survey meter while surveying the exposure device, did not know that this indicated that his meter was not properly functioning.

The finding that Radiographer A was unable to interpret a survey meter reading of zero next to a radiography camera and that neither Radiographers A nor B received retraining on radiation safety constitutes noncompliance with 10 CFR 19.12 and Condition 16 of License No. 37-02895-03.

7. Exposure Records

The inspectors reviewed exposure records for 1979 and 1980. They determined that no radiographer had received more than 1.25 rem to the whole body in any calendar quarter.

No items of noncompliance were identified.

8. Utilization Logs

The inspectors reviewed utilization logs for the period of February 11 - March 30, 1980. They determined that these logs were filled out in accordance with the licensee's procedures.

No items of noncompliance were identified.

9. Survey Meter and Dosimeter Calibration Records

The inspectors reviewed calibration records for the licensee's survey meters and pocket dosimeters. They determined that the survey meters were calibrated on a quarterly basis as required but that no dosimeter calibrations had been performed.

The finding that no dosimeters had been calibrated constitutes noncompliance with 10 CFR 34.33.

10. Licensee Audits

Licensee representatives stated that unannounced inspections of radiographers had been performed but that no records of these inspections were available.

Section 13(b) of Supplement 6g to the licensee's application requires that records of the licensee's inspections be maintained.

The finding that no records were available to document the unannounced inspections constitutes noncompliance with Condition 16 of License No. 37-02895-03.

11. Exit Interview Management Meeting

The inspectors met with licensee representatives denoted in Paragraph 1 on May 16, 1980. The inspectors summarized the purpose and scope of the inspection and the findings. There was agreement that an overexposure had occurred and that the cause was the failure to survey the entire length of the guide tube at the conclusion of a radiography exposure.

A management meeting was held at the Regional Office in King of Prussia, Pennsylvania on May 27, 1980. Messrs. Biddle and Jackson attended as the representatives of the licensee. Messrs. J. Allan, G. Smith, H. Crocker, J. Joyner, F. Costello and J. Glenn represented the NRC. The NRC representatives expressed their concern about the seriousness, the repetitive nature, and the number of items of noncompliance. Mr. Biddle stated that the licensee planned to re-evaluate and upgrade their audit program to ensure future compliance with NRC regulations and the conditions of their license.