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I. Plant Conditions

The Unit 2 core was offloaded to the spent fuel pool.

II. Description of Event

A. Event:

On September 19, 1991, at approximately 0300 PDT, while performing radiographs of pipe welds in Residual Heat Removal (RHR)(BP) Heat Exchanger (HX) Room 2-2 during the Unit 2 fourth refueling outage, two contract radiographers observed that their Pocket Ion Chambers (PICs) had gone off scale high. Both radiographers wore 0-200 mR PICs and thermoluminescent dosimeters (TLDs). In addition, one radiographer wore a 0-2 R high range PIC, and the other a 0-1 R PIC. Both low range and high range PICs were off scale high.

The radiographers placed the radiography source (73 curies, Iridium-192) in a safe condition and notified PG&E radiation protection personnel. PG&E radiation protection personnel verified that the radiography source was fully retracted in a safe position and began investigating the cause of the radiographers' PICs reading off scale high. On September 19, 1991, at approximately 0320 PDT, debriefing of the radiographers began.

On September 19, 1991, at 0415 PDT, Operations declared a non-emergency event. Based on an initial worst-case estimate that one individual may have exceeded the criteria for an immediate report, the NRC was notified at 0506 PDT of the potential overexposure in accordance with 10 CFR 20.403(a)(1). 10 CFR 20.403(a)(1) requires an immediate report for events involving licensed material that may have caused a whole body exposure of 25 rem or more.

On September 19, 1991, at approximately 0830 PDT, analysis of the TLDs was completed. One TLD read approximately 10 rem and the other approximately 3 rem. The contract radiographers were sent offsite for medical evaluation at a local hospital as a precautionary measure. An Unusual Event (UE) was declared at 0852 PDT due to the offsite medical support. The UE was then immediately terminated. The NRC was notified of the UE in accordance with 10 CFR 50.72(a)(1)(i) at 0929 PDT.

To obtain more accurate readings, the TLDs were recalibrated and new element correction factors were derived. This changed the TLD readings to approximately 11.5 rem and 3.1 rem whole body. It was then determined, by reenactment of the event and subtraction of exposures incidental to working at a nuclear facility, that one radiographer received 15.2 rem whole body from the exposed Iridium-192



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radiography source. Due to the very high exposure gradients close to the source, part of his whole body had received an exposure that was greater than the dose received at the TLD. The other radiographer was determined to have received 3.0 rem whole body from the exposed Iridium-192 radiography source. Based on the reenactment and discussions with the radiographers, no extremity exposure was greater than the whole body exposure. The medical evaluation and subsequent follow-ups to date have not demonstrated any physiological changes in either individual, and at these exposure levels it is unlikely that there will be any such changes.

In order to perform a radiograph, the source must be directed out of its shielded camera with a drive cable and into an unshielded guide tube. Radiation from the source penetrates the object being inspected and exposes a radiation-sensitive film behind the object. The source is then retracted into the shielded camera so the radiographer can retrieve the film without being exposed to the source radiation. The overexposures occurred at the completion of a radiograph when the radiographers did not realize that the source was not completely retracted. The radiographers are believed to have performed two or three additional radiographs after the event, before reading their PICs and discovering them to be off scale high.

By their procedures, the radiographers are required to perform a radiation survey at four points of the camera equipment after each radiograph to verify that the source is fully retracted into its safe position. The radiographers instead chose to leave their survey instrument near the camera. In addition, personnel statements indicate that the radiographers noted problems with their radiation survey instrument on the 10x scale, but assumed it was working because it appeared to read correctly on the 1x scale. A second survey instrument was operable and available, but the radiographers were not using it in the area at the time of the event.

Since the radiography source is licensed to the contractor under a California license, the requirements of 10 CFR 20.405 are not applicable to PG&E for this event. The event does not meet the reporting criteria of 10 CFR 50.73, and this voluntary report is being submitted for information only. Any required reporting in accordance with Title 17 of the California Code of Regulations, including personnel exposure information, is the responsibility of the contractor.

B. Inoperable Structures, Components, or Systems that Contributed to the Event:

None.



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C. Dates and Approximate Times for Major Occurrences:

1. September 19, 1991; 0300 PDT: Event/Discovery date. Two contract radiographers performing radiography discovered their dosimetry was off scale high.
2. September 19, 1991; 0320 PDT: Debriefing of the radiographers began.
3. September 19, 1991; 0415 PDT: Operations declared a non-emergency event due to the potential personnel overexposures. Initial estimates indicated a potential exposure of greater than 25 rem whole body.
4. September 19, 1991; 0506 PDT: An immediate notification to the NRC required by 10 CFR 20.403(a)(1) was made.
5. September 19, 1991; 0852 PDT: A UE was declared when the radiographers were transported to an offsite medical facility.
6. September 19, 1991; 0929 PDT: A one-hour, non-emergency notification to the NRC required by 10 CFR 50.72(a)(1)(i) was made regarding the declaration of the UE.

D. Other Systems or Secondary Functions Affected:

None.

E. Method of Discovery:

Contractor personnel, during the performance of scheduled radiography, identified the problem when they read their PICs and found them off scale high.

F. Operators Actions:

Operations declared a non-emergency event when informed of the overexposure and made the required notifications. When the radiographers were transported to the offsite medical facility for assistance, Operations declared a UE and made the required notifications.



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G. Safety System Responses:

None.

III. Cause of the Event

A. Immediate Cause:

The radiographers were exposed to their unshielded radiation source.

B. Root Cause:

1. Mechanical failure of the source to fully retract into the shielded camera between radiographs. The radiography contractor had the camera inspected and evaluated by an outside consultant, with the following preliminary conclusions:

- The shielded "S" tube in the camera was slightly misaligned.
- The drive cable for the source was slightly bowed and stiffened.
- The above two conditions appeared to be so slight that they would not have been discovered during normal maintenance and testing.
- The above two conditions, combined with the unique position and alignment of the camera equipment during the event, caused the source to remain outside the shielded "S" tube when thought to be fully retracted. The camera could not have been locked with the source in this position.

2. Personnel error in that the contract radiographers failed to follow their applicable procedures.

- a. The radiographers failed to carry a survey meter to the camera to verify the source was in the stored position when reentering the radiography location.
- b. The radiographers did not attempt to lock the source inside the camera between radiographs.



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C. Contributory Causes:

1. Failure of the survey meter on the 10x scale.
 - a. The radiographers did not recognize previous indications that the 10x scale was not working properly.
 - b. The meter was not checked for response to a radiation source on all scales prior to its use.
2. Failure to use a camera that automatically locks upon retracting the source. Though not currently a legal requirement, auto-locking cameras for Iridium sources are available to the radiography industry.
3. Failure to use alarming dosimeters that were available. (Note: While use of alarming dosimeters is currently required by 10 CFR 34, applicable California regulations do not require their use at this time for California licensees.)

IV. Analysis of the Event

The radioactive source in this event was a localized source licensed to the contractor and normally kept inside a shielded camera. Immediately upon discovery of the overexposure, the source was verified to be retracted inside the camera, and the camera was secured by PG&E. Since the event occurred within the Protected Area of the plant, there was no possibility of radiation exposure to the general public. It is unlikely that the two radiographers will have any physiological effects, as discussed earlier. No other workers were exposed due to this event. Consequently, the health and safety of the public were not adversely affected by this event.

V. Corrective Actions

A. Immediate Corrective Actions:

1. The source was retracted, the camera locked, and the room verified to be in a safe condition.
2. All radiography by the contractor was placed on hold.
3. A management meeting was held and an action plan initiated to document immediate investigative and corrective actions.
4. A new contractor was brought onsite to complete the radiography work during the refueling outage.



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5. The special work permit for radiography was revised to require continuous coverage by a radiation protection technician until long-term corrective actions are implemented.

B. Corrective Actions to Prevent Recurrence:

The following actions taken by PG&E at Diablo Canyon Power Plant (DCPP) will provide barriers against recurrence of this type of event. Any additional corrective actions taken by the contractor are expected to be reported under their license, in accordance with Title 17 of the California Code of Regulations.

1. Radiological Control Procedure RCP D-270, "Control of Radiography," was revised to require verification that the radiographer has alarming dosimetry, and that the radiographer's survey instrument has been response checked on each scale.
2. Technical and Ecological Services (TES) Quality Control procedures will be revised to ensure that DCPP radiography contracts require the use of auto-locking cameras for use with Iridium sources. (Auto-locking cameras for cobalt sources are not readily available in the radiography industry.)
3. Procurement Quality Assurance (PQA), in conjunction with its assessment of a supplier of on-site radiography services for placement or maintenance on the Qualified Suppliers List (QSL), will obtain information on the supplier's past radiation safety performance for evaluation by the DCPP Radiation Protection department. Radiation Protection's evaluation will be factored into PQA's assessment of the subject supplier for placement or maintenance on the QSL.

VI. Additional Information

A. Failed Components:

None.

B. Previous Similar LERs:

None.



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