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NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

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Report No.: 70-1113/90-07 Supplement

Licensee: General Electric Company
Wilmington, NC 28401

Docket No.: 70-1113 License No.: SNM-1097

Facility Name: General Electric Company

Inspection Conducted: September 4-6, 1990

Inspector: Gary B. Kuzo 11 Nov 1990
G. B. Kuzo Date Signed

Approved by: J. P. Potter 11/2/90
J. P. Potter, Chief Date Signed
Facilities Radiation Protection Section
Emergency Preparedness and Radiological
Protection Branch
Division of Radiation Safety and Safeguards

SUMMARY

Scope:

This special, unannounced supplemental inspection involved review of licensee evaluations regarding selected concerns detailed in Inspection Report (IR) No. 70-1113/90-07, dated August 20, 1990, and discussed during an Enforcement Conference conducted August 27, 1990. The reviewed concerns and subsequent licensee evaluations included 10 CFR Part 20 extremity dose assessment and monitoring requirements for personnel handling unclad uranium material and 10 CFR Part 71.5 requirements for transportation of radioactive materials.

Results:

The use of improper beta-dose algorithms for thermoluminescent dosimetry (TLD) measurements of pellet dose rates utilized to reassess extremity skin exposure was identified. Other assumptions/corrections utilized to reassess assigned doses were appropriate. Corrected beta-dose algorithms did not affect the licensee's evaluations and final conclusions. All assigned extremity skin doses were within 10 CFR Part 20 quarterly limits. Pending results of on-going licensee evaluations regarding the need for required monitoring, appropriate extremity dosimetry was being utilized by affected personnel. Licensee actions

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regarding compliance with 10 CFR 70.5 transportation requirements were verified.

Based on this supplemental inspection, apparent violations of 10 CFR Part 20.101(a) and of 10 CFR 70.5 requirements previously documented in IR 70-1113/90-07 dated August 20, 1990, were withdrawn.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*B. Bentley, Manager, Fuel Manufacturing
*G. Bowman, Senior Program Manager, Compliance Improvement
*R. Foleck, Senior Specialist, Licensing Engineering
R. Keenan, Senior Engineer, Nuclear Safety Engineering (NSE)
*S. Murray, Manager, NSE
*R. Robinson, Senior Engineer, NSE
*H. Shaver, Engineer, NSE
*R. Torres, Manager, Radiation Protection (RP)
*C. Vaughan, Manager, Regulatory Compliance
*T. Winslow, Manager, Licensing and Nuclear Material Management

Other licensee employees contacted included engineers, technicians, operators, and office personnel.

*Attended exit interview conducted September 6, 1990

2. Extremity Exposure (83822)

10 CFR 20.101(a) requires that no licensee possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter a total occupational dose in excess of 18.75 rem to the hands and forearms, feet and ankles.

During an August 27, 1990, Enforcement Conference regarding concerns with the extremity monitoring program for personnel handling unclad uranium materials the licensee presented to and discussed with NRC personnel recently identified inaccuracies in their dose assessment algorithms and/or input data utilized to calculate extremity exposure. Based on corrections to these parameters and reassessment of selected extremity doses, the licensee stated that no personnel exceeded quarterly extremity exposure limits specified in 10 CFR 20.101(a). These parameters and their bases, including reduced pellet dose rates and inaccurate exposure time for selected individuals, were reviewed in detail during the current onsite inspection.

a. Effective Pellet Dose Rate

The inspector reviewed and discussed with licensee representatives the bases for reducing pellet dose rates utilized in extremity exposure evaluations. Licensee representatives stated that the dose rate for an unshielded pellet utilized in the extremity dose algorithm decreased to 75 millirem per hour (mrem/hr) in the August 1990 reassessments from the 165 mrem/hr value originally utilized. This decrease dose rate resulted from an increased rate of throughput

of uranium material in the pellet fabrication process, that is reduced time from introduction of UF6 into the fabrication process until actual handling of pellets by workers. The increased rate of material throughput effectively reduced pellet dose rates as a result of decreased ingrowth of the metastable Protactinium-234 (Pa-234m), the major beta-dose contributor in the uranium decay series. In the decay series, ingrowth of the Pa-234m approximated the 24 day half-life of the Thorium-234 (Th-234) parent isotope. For the processed material maximum (equilibrium) dose rates were expected after approximately 120 days or five half-lives.

The inspector reviewed and discussed with cognizant licensee representatives, changes in process material throughput rates. From review of 1986 through 1990 uranium process material balance and accountability records, the inspector verified throughput rates resulting in an average time interval for pellet fabrication of approximately 21 days. Furthermore, licensee representatives stated that pellets were produced on an "as needed" basis and unshielded pellets were not stored for later use. Based on this pellet age dose rates approximately 44 percent of equilibrium values were expected for unclad uranium handled by workers from 1986 through 1990. Although, monthly material balance data prior to 1986 were not available for review, licensee representatives stated that the rate of throughput increased gradually since 1976 and that pellet fabrication times for 1983 and 1984 production were assumed to range from 20 to 30 days. The inspector noted that thermoluminescent dosimeter measurements conducted in 1983, were similar to 1990 data and corroborate this assumed of pellet age.

The inspector noted the licensee assumption of decreasing the effective dose rate to the extremities of personnel handling pellets after 1983, relative to values reported in 1976, was appropriate. No violations or deviations were identified.

b. Dose Rate Verification

The licensee informed NRC representatives that based on August 1990 pellet dose rate measurements of approximately 40 mrem/hr and assuming additional ingrowth of Pa-234m as a result of processing delays, a conservative value of 75 mrem/hr was utilized in the extremity exposure algorithm for the reassessments. The inspector and licensee representatives reviewed and discussed selected references which reported unshielded dose rates ranging from approximately 100 to 200 mrem/hr for processed uranium material at equilibrium. Based on the referenced values and the assumed age of the licensee's processed material, the measured dose rates from unshielded pellets were expected to range from 44 to 88 mrem/hr.

During the onsite audit, the inspector attempted to verify the accuracy of thermoluminescent dosimetry (TLD) measurements. Extremity skin exposure assessments conducted from January 1983

through June 1990, utilized a pellet dose rate of approximately 165 mrem/hr. This dose rate value was based on a 1976 vendor study using TLDs which measured dose rates of approximately 191 millirem per hour (mrem/hr) and 165 mrem/hr at the end and sides of pellets, respectively. Review of the 1976 study details indicated that the TLDs were calibrated properly to a standard uranium slab source. The age of the pellet material was not provided in the report but based on measured dose rate similar to equilibrium value, was assumed to be greater than 120 days.

Subsequent TLD measurements verifying pellet dose rates were conducted in 1983 and in August 1990. The 1983 study reported an unshielded pellet dose rate as approximately 52 mrem/hr. The age of the pellet material was estimated to be approximately [illegible] days. Adjusting the 1983 measured pellet dose rates for Pa-234m ingrowth resulted in a calculated equilibrium dose rate of approximately 76 mrem/hr. For measurements conducted in August 1990, licensee representatives reported a dose rate of 40 mrem/hr. For these measurements, the age of the pellet material was estimated to range from 35 to 40 days and no differences were observed between dose rates on the ends of sides of the pellet. Adjusting the 1990 measured values for ingrowth, an equilibrium dose rate of approximately 60 mrem/hr was calculated. The inspector noted that the equilibrium values for the 1983 and 1990 studies were less than the minimum value, approximately 100 mrem/hr, listed in selected references.

The inspector and licensee representatives reviewed and discussed the relatively low equilibrium dose rates calculated for monitored pellets. Subsequent to licensee discussions with the TLD vendor, the inspector was informed that the TLD was calibrated to a Cesium-137 (Cs-137) standard source and a required beta-dose correction factor of approximately 1.89 was not factored in the the August 1990 dose values reported. Adjusting the reported values by the beta-dose correction factor resulted in a dose rate of approximately 75 mrem/hr from unshielded 30 to 40 day old pellets. Furthermore, for equilibrium conditions, a dose rate value of approximately 110 mrem/hr was calculated. Additional inspection indicated that an appropriate beta-dose appropriate correction factor (2.21) was not applied to the 1983 TLD measurement data. Licensee representatives stated that a change to the extremity monitoring procedures identifying beta-dose correction requirements would be completed in a timely manner.

The corrected 1990 dose rate was similar to the 75 mrem/hr value utilized to reassess potential extremity overexposures as presented by the licensee during the August 27, 1990 Enforcement Conference. The inspector noted that prior to initiation of a extremity monitoring program in August 1990 the TLD measurements were utilized only to verify conservative assumptions utilized in dose assessments calculated from the licensee's extremity exposure algorithm and were not utilized to assess extremity exposures. Exposure results from the

TLD extremity monitoring program initiated in August 1990 were corrected as appropriate. No additional adjustments to the dose rate used to evaluate extremity exposures were required.

The inspector noted that the use of a 75 mrem/hr dose rate in the licensee's overexposure reassessments was appropriate and no violations or deviations were identified.

c. Exposure Time Evaluation

In addition to reducing the effective dose rates utilized in the extremity exposure algorithms, the licensee evaluations identified inaccurate exposure time data for selected individuals involved in the seven occurrences of potential extremity overexposures. The errors involved computer generated duplication of data regarding exposure time to unclad uranium material for the identified individuals. The inspector selectively verified records indicating duplicate exposure times and corrections for individual workers. Licensee adjustments regarding this parameter were appropriate.

No violations or deviations were identified.

3. Extremity Exposure Evaluation (83822)

IR 70-1113/90-07, detailed three occurrences of workers involved with handling unclad uranium materials who apparently exceeded the 10 CFR 20.101 quarterly extremity exposure limit of 18.75 rem as measured through a density thickness of 7.0 milligrams per square centimeter (mg/cm^2). The licensee originally assessed the extremity skin exposure through a skin density thickness of 56 mg/cm^2 and the potential overexposures resulted from the assessment of the dose at 7 mg/cm^2. The assessment of the dose through the reduced density thickness was required for regulatory compliance purposes.

During the August 27, 1990 Enforcement Conference licensee representatives presented their preliminary evaluation of January 1, 1983 through June 30, 1990, extremity doses for personnel handling unclad uranium materials adjusted to a density thickness of 7 mg/cm^2. The licensee identified seven separate occurrences between April 1984 and February 1990 which involved six individual workers assigned quarterly doses exceeding 18.75 rem.

For the seven occurrences of potential extremity overexposures the licensee re-evaluated each separate worker's quarterly exposure based on a dose rate of 75 mrem/hr and any noted corrections regarding inaccurate exposure times. The licensee re-evaluations indicated that for the seven occurrences reviewed in detail no individuals exceeded the 10 CFR 20.101(a) quarterly limit of 18.75 rem. For the seven individual occurrences, quarterly extremity exposure values ranged from 4.51 to 6.66 rem.

That inspector noted that the violation regarding individuals exceeding the 10 CFR 20.101(a) quarterly extremity exposure limit documented in IR 70-1113/90-07 dated August 20, 1990, would be withdrawn.

4. Extremity Dose Monitoring (83822)

10 CFR 20.202(a) requires each licensee to supply appropriate personnel monitoring equipment and require the use of such equipment by each individual entering a restricted area under such circumstances that he receives or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in 10 CFR 20.101(a). 10 CFR 20.202(b) defines personnel monitoring equipment as devices designed to be worn or carried by an individual for the purpose of measuring the dose received.

During the August 27, 1990 Enforcement Conference, the licensee stated that immediate corrective actions for potential extremity monitoring concerns included the distribution and use of extremity TLD monitoring (finger ring) devices.

During the Enforcement Conference, NRC representatives noted that the location and orientation of finger ring TLDs may not accurately measure beta dose to the maximum exposed area of skin, that is the finger tips, for personnel handling unclad uranium material. Licensee representatives stated that physical dimensions of the ring prevented placement of the monitoring device (TLD chip) at the distal end (tip) of the finger. Rings were worn at the most distal joint of the index finger. The licensee committed to evaluate potential correlations of extremity exposure measured at two locations on the index finger, that is between measurements conducted at the first distal joint and at the tip of the finger.

The inspector reviewed and discussed with cognizant licensee representatives the recent implementation of the extremity monitoring program. Routine monitoring was initiated on August 6, 1990, for selected personnel handling unclad uranium. By August 13, 1990, all personnel potentially handling unclad uranium material were provided with finger ring dosimetry. During the Enforcement Conference, licensee representatives initially reported extremity dose rates ranging from 110 to 140 millirem per week (mrem/wk) for workers handling unclad uranium materials. Subsequent to determination of the need for required beta-dose correction factors, the licensee adjusted the reported dose rate range from 200 to 260 mrem/wk. During the onsite audit, the inspector was informed that the maximum weekly dose rate, after beta-dose correction factor adjustments, was approximately 264 mrem/wk for an individual involved in grinding operations.

During the onsite audit, the inspector verified implementation of the licensee study to evaluate the adequacy of the finger ring TLD measurements relative to TLDs taped to the tips of the finger for monitoring extremity skin exposure. The comparisons were being conducted

for workers involved in separate fabrication processes which involved the handling of unclad uranium material including grinding, pressing, rod loading, quality control inspection and packing operations. A total of 31 workers were monitored in eight separate operations. Licensee representatives stated that the comparisons were expected to be completed and final results available for review in October 1990. The inspector noted that these results would be reviewed in a timely manner following their receipt.

The inspector noted that all licensee activities regarding immediate corrective actions and evaluation of the need for routine dosimetry to monitor worker's extremity skin exposure were adequate. No violations or deviations were identified.

5. Transportation (83822)

10 CFR 71.5 requires that each licensee who transports licensed material outside the confines of its plant or other place of use, shall comply with the applicable requirements of the regulations appropriate to the mode of transport of the Department of Transportation (DOT) in 49 CFR Parts 170-189.

IR 70-1113/90-07 dated August 20, 1990, detailed an apparent violation regarding failure to include exclusive use vehicle instructions with selected shipping paper information packages provided to drivers transporting radioactive waste materials.

During the Enforcement Conference licensee representatives stated that the vendor verified that the referenced instructions were provided with the shipping papers as required. However, duplicate documents which would have demonstrated compliance were not maintained in the licensee's files. Subsequently, the licensee provided to the inspector, an August 22, 1990 letter from the transport company which verified that exclusive use vehicle instructions were provided with shipping papers for the affected shipments. The licensee indicated that to avoid similar problems the applicable instructions were updated to require retaining duplicate documents to demonstrate compliance.

That inspector noted that based on the data provided the violation of 10 CFR 71.5 requirements regarding the failure to provide exclusive use vehicle instructions to drivers in accordance with 49 CFR 173.425(b) regulations documented in IR 70-1113/90-07 dated August 20, 1990, would be withdrawn.

6. Exit Interview (30703)

The inspection scope and results were summarized on September 6, 1990, with those individuals indicated in Paragraph 1. The licensee's evaluation of previously identified extremity monitoring concerns were discussed in detail. An additional concern regarding improper beta-dose correction factors for vendor TLD measurements was identified. Other

assumptions utilized in the extremity evaluations were appropriate. The inspector noted that as a result of conservative assumptions, the beta-dose correction factors did not change the licensee reassessment results and conclusions. The final dose assessments, less than 10 CFR 20.101(a) quarterly limits, were appropriate. The licensee's immediate corrective actions regarding routine extremity monitoring outlined during the August 27, 1990 Enforcement Conference were appropriate and that studies to determine routine extremity monitoring requirements were adequate. The inspector informed licensee representatives that results of these studies would be evaluated in a timely manner following their completion.

The inspector informed licensee representatives that apparent violations for personnel exceeding the 10 CFR 20.101(a) quarterly extermity exposure limits and for failure to meet 10 CFR 71.5 requirements detailed in IR 70-1113/90-07 dated August 20, 1990, would be withdrawn.

Licensee representatives acknowledged the inspector's comments. In addition, the inspector was informed that as a result of concerns with vendor TLD processing, reference to beta-dose requirements for extremity monitoring would be included in licensee procedures.