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

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Report No.: 70-1113/90-11

Licensee: General Electric Company
Wilmington, NC 28401

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

Facility Name: General Electric Company

Inspection Conducted: September 24-28, 1990

Inspector: _____ 11/1/90
D. Kasnicki, Fuel Facilities Inspector Date Signed

Approved by: _____ 11/19/90
E. J. McAlpine, Chief Date Signed
Radiation Safety Projects Section
Nuclear Materials Safety and Safeguards Branch
Division of Radiation Safety and Safeguards

SUMMARY

Scope:

This routine, unannounced inspection was conducted in the areas of Nuclear Criticality Safety, Operations Review, and followup regarding 10 CFR 21 reportable items. Within this scope the inspection completed followup on an incident involving a pump explosion, addressed GE's receipt of an NRC Information Notice, and followed up on an Unresolved Item (URI) as potentially being a Licensee-Identified Violation (LIV), which was identified during a previous inspection.

Results:

In the areas inspected, violations or deviations were not identified. GE's investigation, response, and corrective actions to the pump explosion incident appeared thorough and complete. The NRC Information Notice in question had been received.

The URI was not an LIV since circumstances were such that internal procedures were not violated. However, followup on this URI identified other weaknesses in GE's maintenance/calibration program and operations' interface with that activity. Accordingly, eight Inspector Followup Items (IFI) to assist with further investigation into those weaknesses were identified.

GE had informed the inspector of a recent event which was undergoing internal investigation during the time of this inspection. Further followup on this event will be performed during a subsequent inspection.

## 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 Nuclear Safety Engineer
*D. McCaughey, Nuclear Safety Engineer
*S. Murray, Manager, Nuclear Safety Engineering
*R. Pace, Program Manager
*H. Strickler, Manager, Environmental Protection and Industrial Safety
*R. Torres, Manager, Radiation Protection
*C. Vaughan, Manager, Regulatory Compliance

Other licensee employees contacted during this inspection included operators.

*Attended exit interview

2. 10 CFR 21 Reporting of Defects and Noncompliance (36100)

10 CFR 21 requires the reporting to the NRC of defects and noncompliance which could create a substantial safety hazard. The inspector discussed this requirement with GE representatives who indicated that their program had not identified any reportable items.

No violations or deviations were identified.

3. Followup on NRC Information Notice 90-27: Clarification of Recent Revisions to the Regulatory Requirements for Packaging Uranium Hexaflouride ($UF_6$) for Transportation (88020, 92701).

The inspector verified through discussion with GE representatives that they had received this information notice and distributed it to affected GE management. Discussion did not lead to further questions.

No violations or deviations were identified.

4. Incident Followup: Small Pump Explosion (88020, 92701)

In accordance with 10 CFR 20.405(a)(1)(iv) and (a)(2), GE submitted a 30-Day Incident report for an April 29, 1990, incident involving the pump explosion. On Sunday, April 29, 1990, at approximately 4:30 a.m., a pump servicing an ammonium diuranate (ADU) clarifier overflow tank appeared to have exploded. A subsequent investigation found that a weak solution of ammonium nitrate had been concentrated in the pump which had been inadvertently left in operation. The down stream valve was closed such

that the "dead headed" pump had heated and concentrated the solution until there was a rapid thermal decomposition resulting in the separation of the pump housing halves. All ADU systems were shut down from April 20 to May 4, until the cause of the incident was identified and corrective actions taken to assure safe operation. There were no injuries or over-exposures resulting from the incident and no other equipment damage. The inspector had previously discussed this incident with GE representatives and toured the area where the pump explosion occurred (NRC Inspection Report No. 70-1113/90-06). Discussions at that time indicated that GE's investigation of this incident was almost complete but that they were not yet ready to finalize their findings and corrective actions.

On April 27, 1990, at approximately 5:00 a.m., ADU weekly production was shut down in one of the lines for cleaning pernormal proceudres. The piping and clarifier were flushed out with nitric acid, recirculated, and then pumped to a receiver tank for processing upon restart. The piping down stream from the clarifier overflow tank pump was manually valved out and a recirculation line valve was partially opened (ball valve handle at 45°). The pump was left on or turned on soon afterwards. The solution left in the piping was a combination of ammonia, water, and nitric acid. Investigations performed after the explosion found that the down stream valve allowed approximately 20 gallons of solution in the piping to leak back to the pump and that the recirculation valve was nearly closed, even though the valve handle positions implied it was partially open. The "dead headed" pump, over a period of approximately 43 hours, boiled off the water in the solution which had leaked back to the pump and resulted in a concentrated solution of ammonium nitrate. Running hot, the pump heated the concentrated ammonium nitrate until there was a rapid thermal decomposition. The decomposition resulted in a rapid pressure increase which blew the 6" Wilfley pump casing apart at the center gasket which was held together with eight bolts. The suction half of the pump struck a steel pipe, bending it 15°, and skidded off for another 16 feet before coming to rest. No other equipment sustained damage. The outlet half of the pump and impeller remained intact. No personnel were in the immediate area at the time of the incident and localized contamination was cleaned up per routine work area procedures.

Within three hours of the explosion, a multifunctional investigation team was assembled. An investigation was initiated that included pictures of the accident site. Samples were pulled of all liquid and solid deposits in and around the pump and associated piping. Industrial and Radiation Safety personnel were notified. Due to the potential damage exceeding $2,000, the NRC Operations Center was notified per 10 CFR 20.403(b)(4) on April 29, 1990, at approximately 2:30 p.m.

The ADU system, including line 4, remained shut down from April 29 to May 4, until other potential sources of ammonium nitrate were identified and applicable corrective actions taken. A consultant expert in explosions from Hazards Research Corporation, Mt. Arlington, N.J., was contracted to evaluate the findings and make recommendations. All operations in the fuel manufacturing process were reviewed by the

consultant to determine locations where ammonium nitrate could be produced and accidentally concentrated. These locations included the ADU lines, uranium recovery unit (URU), waste treatment, and associated HVAC systems. Corrective actions were completed or planned activities were made to address each of these areas. On-site and off-site analyses of the samples taken from the pump and associated piping confirmed the presence of concentrated ammonium nitrate. These samples included floor liquids, air sample filters, crystals found on the floor, and smears from internal pump parts. The presence of concentrated ammonium nitrate was positively identified with infrared spectroscopy. The consultant confirmed that the incident description above could have caused the explosion. No ignition or detonation occurred. A rapid thermal decomposition in a confined space resulting in a rapid pressure increase caused the pump halves to separate. Short term corrective actions for the ADU acid flush procedure were to water flush piping before and after the addition of nitric acid to prevent the possibility of accumulation of ammonium nitrate in pumps. Further, the replacement of the recirculation valves with restricting orifices in the clarifier underflow and overflow should prevent the "dead heading" of the pumps in these applications. A checklist was prepared that will require a physical verification of pump operation after the acid flushes. The consultant confirmed that these actions were appropriate to prevent the conditions necessary to cause a recurrence.

Since all process and storage tanks are vented to a central scrubber exhaust system, selected ductwork was opened and samples taken of any deposits. Analysis of accumulated material in the filter housings down stream of scrubbers found detectable levels of ammonium nitrate. The consultant noted that the cake would not thermally decompose without the introduction of high heat levels. The risk of violent reactions in the area appeared low.

Corrective actions taken consisted of: (1) Startup of ADU operations was initiated on May 4, under additional procedural controls. Pump status is now routinely checked using written checklists and tanks are not permitted to operate when nearly empty. Where the ammonium hydroxide and nitric acid solutions could be mixed in the ADU flush, additional water flush and drain steps were added. (2) In addition, on line 5 a computer program was written to interlock the pumps with respective tank level indicators to shut the pumps off on low level, which might prevent a concentrating condition. (3) The ADU and URU (Uranium Recovery) operators were informed on why the incident occurred and the importance of following the modified procedures to prevent the accident from recurring. (4) Physical modifications to equipment included: (a) The clarifier overflow pump valves in the ADU lines were removed and replaced with restricting orifices in the recirculation loop where solids were not present; (b) To prevent pump "dead heading", pump suction and selected discharge valves were either removed or tagged open for similar pumps depending on the size of storage tanks and associated maintenance needs; (c) In places where automatic valve positions could be manually overridden, pumps were fitted with switches which prevent continuous operation without "hands-on" activation by the operator. (5) Procedural controls were added to prevent

any work in the ductwork or filter housings until accumulations were either evaluated or cleaned out by sweeping or washing. Radiation Protection personnel who evaluate Radiation Work Permits (RWPs) which are required for any ventilation work, were also notified of the new restrictions. (6) GE Wilmington also notified other domestic uranium fabricators, ANI, and our foreign associates of the pump explosion in order to warn of the potential safety concern. In addition, long-term corrective actions were being evaluated to augment or replace procedural controls. The ADU system was restarted following GE's Wilmington Safety Review Committee concurrence with the findings and short-term corrective action described above.

During this inspection the inspector reviewed GE's completed file on this incident which contained the following documentation: Class I Investigation Report dated May 25, 1990, Pump Explosion Technical Report dated May 30, 1990, Unusual Incident Report dated April 29, 1990, Uranium Users Group letter dated May 9, 1990, and NRC 30-Day Incident Report dated May 29, 1990. The inspector noted that GE's intended long-term corrective actions are to: 1) assess risk for operations which have been identified as having potential risks; and 2) introduce engineered controls (e.g. temperature, flow, or level interlocks) into selected operations. Also, regarding ammonium nitrate accumulations in HVAC ducts, an area for which the risk has already been assessed, GE has implemented duct cleanouts prior to mechanical, welding, or cutting operations. The review of the incident file, discussion with GE representatives, and the inspector's tour of the affected area indicated that GE's response to this incident appeared adequate.

No violations or deviations were identified.

5. Density Indicator; V-108 Tank, Waste Treatment Facility (88025, 88015, 88020, 92701)

One of the findings from GE's first quarter 1990 quarterly nuclear safety audit discussed in a previous inspection report (No. 70-1113/90-06) was of particular interest because it involved a sludge density monitor, i.e. an active engineering control (AEC) associated with criticality safety and the possible violation of a procedural Nuclear Safety Requirement (NSR). The density monitor had been found with the upstream valve turned off effectively disabling it. The procedural NSRs do make provisions for this disabled configuration. At the time of that inspection GE representatives were still working on the resolution to this finding and discussions with them regarding the status of their investigation into the scenario surrounding the observed configuration did not make it clear as to whether or not any NSRs had been violated. This finding was identified as potentially a Licensee-Identified Violation (LIV) and is of particular interest since while a lot of credit is taken for AECs, they are only as good as the administrative controls which keep them operable.

GE representatives had stated that their investigation into this finding indicated that, as per an operator, less than two hours had passed between the time when the density monitor had been disabled for maintenance and the time when the audit finding was made. The procedural NSR requires that the sludge be sampled and laboratory analyzed every two hours when the density monitor is not operable. Accordingly, this finding was not a violation of the procedural NSR and therefore is not an LIV. URI 90-06-01 is closed, however, followup on this item identified other weaknesses in GE's maintenance/calibration program and operations' interface with it. These weaknesses are discussed below.

No documentation could be found to substantiate the fact that the density monitor had been disabled for less than two hours. GE representatives could not find the Maintenance Work Request (MWR) associated with the work that was being done on the density monitor at the time of the audit finding. In the process of trying to find the MWR, it became apparent that GE's computerized maintenance control system may not be good tool for auditing maintenance/calibration work on such items. To attempt to find such an MWR, the computer had to be queried in a multitude of ways, and negative results were not a guarantee that the desired item was not in the data base, but only that the data base had not been queried in a proper way so as to retrieve the desired item. This appears to be a programmatic weakness and further investigation into this computer system's ability to provide the auditability of maintenance/calibration work will be performed during subsequent inspections; this is Inspector Followup Item (IFI) 90-11-01. Operators maintain a log of laboratory samples associated with the V-108 tank, and no entries were made in this log for the time interval in question; this fact, however, is inconclusive since no samples would have been submitted if the first two-hour time interval had not passed. Operators also maintain an operations log associated with the V-108 tank, and no entries related to maintenance of the density monitor were made in it for the time interval in question. The monitoring of this operation also includes a daily sludge density laboratory sample whether or not the density monitor instrumentation is operable. The inspector reviewed these records for the entire month of March, and none of these samples showed the density limit as having been exceeded. GE representatives had stated that, at the time of the audit finding, one of the two operators on duty knew that the density monitor had been disabled for maintenance and the other did not. This appears to be a programmatic weakness and further investigation into mechanisms used by maintenance to communicate the status of out-of-service safety related equipment to operations will be performed during subsequent inspections; this is IFI 90-11-02. Also, further investigation into mechanisms used within operations to communicate the status of out-of-service safety related equipment will be performed during subsequent inspections; this is IFI 90-11-03.

GE operation's initial corrective action to this V-108 tank density monitor finding was to implement a flagging system which uses a red plastic tag as an administrative tool to enhance control when the density monitor is disabled. An operator, having been notified by a maintenance technician that the monitor will be disabled, moves the red plastic tag

from the density monitor's piping where it is normally hanging, to the control room console. This flagging system was procedural'zed in PROD No. 80.76 dated July 2, 1990. The inspector observed, through a review of the procedure and the observation of the red tag at the V-108 tank, that the implementation of this corrective action appeared adequate.

GE representatives also informed the inspector that Regulatory Compliance had told operations that the above described corrective action was not strong enough and recommended stronger controls. The stronger controls recommended were. 1) As an interim measure, use chains and padlocks to lock open density monitor valves and have Radiation Protection serve as key custodian, 2) Reintroduce the use of flow indicators in the density monitor lines; 3) Introduce Radiation Protection oversight when the density monitors are inoperable and operations are in the two-hour sampling mode. These stronger controls were in the process of being implemented during this inspection and the inspector followed up on the status of this implementation. This followup is discussed below.

The flow indicators which were being reintroduced into the system had been functionally and administratively, but not physically, removed from the system some time ago due to difficulty in keeping them operable which, GE believes, was related to the consistency of the sludge at that time. The characteristics of the sludge are different now, and GE believes that they will work. At the time of this inspection the flow indicators were operable but not yet wired to the control room console. The inspector stated, and GE agreed, that physically leaving instrumentation in a system from which it has functionally and administratively been removed is not a good practice. GE's administrative mechanisms for assuring that such instrumentation is physically removed from systems will be investigated further during subsequent inspections and this is IFI 90-11-04. The flow indicators were listed in the "equipment" section of the effective revision of the operating procedure, but this procedure did not address operator actions for a "no flow" alarm. The inspector stated, and GE agreed, that the procedure should address these operator actions, but the flow indicators should not be addressed at all by the procedure until the flow indicators are fully operable and have been approved for use. In general, the procedure should not get ahead of the work or vice versa; GE's administrative mechanisms for assuring this will be investigated during subsequent inspections and this is IFI 90-11-05.

The inspector and GE representatives observed that the upstream and downstream valves nearest the density monitors had indeed been locked open. But tracing the overly complex piping configuration revealed that there were other in-series isolation valves which had no locks, and therefore this system still had no more control on it than was true previously. The inspector stated, and GE representatives agreed, that the overly complex piping configuration was probably a large contributing factor to this situation occurring. GE's planned actions regarding this overly complex piping configuration will be followed up during subsequent inspections and this IFI 90-11-06. At the time of this inspection no

temporary procedure to address the administration of the locks and keys had been written or issued. GE's administrative mechanisms related to the control of operations with temporary procedures will be investigated further during subsequent inspections and this is IFI 90-11-07.

Regarding all of the discussion above, the inspector observed that GE had evidence of good intentions, but appeared to, organizationally, have difficulty following through on those intentions. GE representatives concurred with the observation. The insepctor asked whether a project such as the one discussed above, typically has someone, e.g. an engineer, charged with the responsibility of serving as a coordinator and overseer of the essential details to make it work. The inspector learned that engineering level nuclear safety training (nuclear criticality safety and radiological safety) for engineers is something that GE has discussed but, beyond that not prusued. It should be noted that engineers do receive traing pursuant to 10 CFR 19.12. GE's intentions in regard to nuclear safety training for engineers will be followed up on during subsequent inspections and this is IFI 90-11-08.

6. Inadvertent Below Limits Release to On-Site Process Lagoon (88015, 88020, 88025)

GE experienced a non-reportable, inadvertent release of uranium to their on-site process lagoon which exceeded internal limits but did not exceed legal limits applicable to off-site releases. The release appears to have been related to a uranium filtration process failure which subsequently caused a failure in an active engineering control (AEC) sampling/analyzing system. GE has categorized this event as a Class II incident as per internal procedures and was actively pursuing the investigation during the time of this inspection. Initial documentation associated with this investigation indicated a root causes analysis including the analysis of previous similar failures. This event will be followed up on during a subsequent inspection when GE's internal investigation has been completed.

Exit Interview

The inspection scope and results were summarized on September 28, 1990, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results listed below. Although reviewed during this inspection, proprietary information is not contained in this report. Dissenting comments were not received from the licensee.

| Item No. | Description and Reference |
|---|---|
| (Closed) URI 90-06-01 | V-108 tank density monitor - followup on internal audit finding. (Paragraph 5) |
| (Open) IFI-90-11-01 | Investigate maintenance computer system's ability to provide auditability of maintenance/calibration work. (Paragraph 5) |
| (Open) IFI 90-11-02 | Investigate administrative mechanisms maintenance uses to communicate status of down safety equipment. (Paragraph 5) |
| (Open) IFI 90-11-04 | Investigate GE administrative mechanisms to assure that administratively and functionally deleted safety instruments are physically removed. (Paragraph 5) |
| (Open) IFI 90-11-05 | Investigate GE administrative mechanisms to assure that procedure is not ahead of work and vice versa. (Paragraph 5) |
| (Open) IFI 90-11-06 | Followup on GE intentions regarding overly complex V-108 piping configuration. (Paragraph 5) |
| (Open) IFI 90-11-07 | Investigate GE administrative mechanisms related to control of operations with temporary procedures. (Paragraph 5) |
| (Open) IFI 90-11-08 | Followup on GE intentions regarding nuclear safety training for engineers. (Paragraph 5) |