GE Energy

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Subject: Annual Report for NTR, 2004
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Enclosure: Annual Report No. 45 (3 copies)

Enclosed are three signed copies of Annual Report No. 45 for the General Electric Nuclear Test Reactor (NTR) located at Vallecitos Nuclear Center near Sunol, California.

If there are any questions or additional information required, please contact me at the number below.

Sincerely Yours,

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GENERAL ELECTRIC NUCLEAR TEST REACTOR

ANNUAL REPORT NO. 45 FOR THE YEAR 2004

LICENSE R-33
DOCKET 50-73

MARCH 2005

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General Electric Nuclear Test Reactor

Annual Report No. 45

This report summarizes the operation, changes, tests, experiments, and major maintenance at the General Electric Nuclear Test Reactor (NTR), which were authorized pursuant to License R-33, Docket 50-73, and 10CFR50, Section 50.59, for the period of January 1, 2004 through December 31, 2004.

I. General

Specific information about the operation of the NTR during the reporting period is presented as follows:

1. There were 236 reactor startups with the reactor operated at or above critical for 608.54 hours. Total power generation equaled 593.67 EFPH equivalent to 2.47 MWd in 2004.
2. The average radiation exposure to regular full-time NTR Operations personnel was 0.54 Rem.
3. There were two reactor scrams and four unscheduled shutdowns of the reactor by the operator prior to reaching criticality.
4. There were no occurrences during 2004 that required notification of the NRC. An information call was made advising the NRC's NTR Project Manager of an equipment failure. This failure resulted in the NTR Control Rod Drives not responding to a "drive-in" signal from the Reactor Plant Control Panel. Details are provided in the section of this report entitled "Unscheduled Shutdowns."

II. Organization

The details of changes in the status of personal that occurred during the reporting period are described as follows:

1. There was no change in the status of Mr. Edward Ehrlich who continued as Manager NTR and SRO. Mr. Ehrlich qualified NDT Level II in January 2004.

2. There was no change in the status of Mr. Dennis Smith who continued as a part-time GE employee (pensioner) providing SRO duties, Quality Assurance (QA) consulting and NDT training services, and SRO tutoring. Mr. Smith as also the NTR bi-annual requalification program administrator for 2004.

3. Mr. Tim Peterson, Specialist, NTR, continued his operational duties governed by his Reactor Operators license. Following Scram 04-01 Mr. Peterson was administratively suspending from licensed Reactor Operator duties associated with starting up and operating the reactor at the control panel while he underwent remedial training and testing. Mr. Peterson was restored to full Reactor control panel operating duties upon his completion of that training and testing. Mr. Peterson continues to be receiving periodic observation checks of his attention to his RO duties and his knowledge and understanding of the responses of the reactor to different reactivity changes.

4. Mr. Art Raya continued on the NTR staff as a contract employee to perform NDT neutron radiography tasks and non-reactor system maintenance tasks under the direction and supervision of the licensed SRO staff and certified Level II and III NDT persons.

5. Mr. Daniel Thomas completed licensing for Senior Reactor Operator in April 2004, and thereafter commenced full time SRO duties. Mr. Thomas also performs NDT neutron radiography and other non-licensed NTR functions under the direction of NDT Level II & III Certified persons while participating in training and testing for NDT Level II Certification.

6. Mr. Charles Bassett terminated his SRO training in early 2004 upon accepting a new position as Manager of Facilities and Quality Assurance at the Vallecitos Nuclear Center.

III. Facility Changes, Tests, Experiments, and Procedure Changes Approved by the Facility Manger

In accordance with written procedures, facility changes, tests, experiments, and procedure changes can only be approved by the Facility Manager. Specific information about the reporting period is presented as follows:

A. Facility Changes

Pursuant to 10CFR50.59(a), there were two facility changes made in 2004 requiring Facility Manager, Regulatory Compliance and VTSC approval.

1. Emergency Lighting was added on the North Room Mezzanine area.
2. NTR received an ATF User Permit and installed, in the NTR setup room, a Type II Indoor explosive storage magazine as a required condition for the ATF permit. The more restrictive explosive quantify limits of the NTR Reactor License and Technical Specifications apply to the use of this NTR magazine, as compared to the less restrictive ATF limits for use of the magazine. The magazine is used for overnight storage of explosive devices, sent to NTR for Neutron Radiography, that are non-exempt from ATF regulations. This non-exempt category represents a small fraction of the explosives that are shipped to NTR for Radiography.

B. Tests

Pursuant to 10CFR50.59(a), there were no special tests performed during 2004 requiring Facility Manager approval.

C. Experiments

Pursuant to 10CFR50.59(a), there were no new experiments in 2004 requiring Facility Manager approval.

D. Procedure Changes

Pursuant to 10CFR50.59(a), there were procedural changes initiated to incorporate editorial or typographical corrections, changes to technical data or requirements, or to clarify or provide additional information. Changes made during 2004 were made with Facility Manager approval and after Regulatory Compliance review when required. Details of the changes are presented below:

1. SOP 6-4, Daily Surveillance Checks.
   Revised (Rev. 939) to reorganize the pre-reactor startup checks to reflect a more logical sequence and an improved man-machine interface between the instrumentation and the check sheet. In the new check sheet, procedural and check sheet numbers correlate. One additional item was added to the procedure and check sheet to record the verification of a second person n site and who is capable of performing an emergency reactor shutdown if the reactor operator became incapacitated.

2. SOP 6-1, Staffing
   Revised (Rev. 941) to incorporate a posted instruction for an emergency shutdown of the reactor by a second person that has been trained to perform that emergency shutdown in the event the reactor operator became incapacitated.

3. SOP 9-12, Security
   Revised (Rev. 940) to incorporate security changes requested by the NRC. The change improved access control to the NTR Protected and Vital Areas including control of visitors.

4. SOP 6-2, Control Room Entry
   Revised (Rev. 942) to use terminology that is consistent with the device control labels and refer to SOP 9-12 for the action to be taken if the device is not working properly.

5. SOP 9-9, Visitor Radiological Control
   Revised (Rev. 944) title to reflect procedure's content.

6. SOP 9-1, Safety Responsibility and Authority
   Revised (Rev. 945) to incorporate the responsibilities of a second person on site and who is capable of performing an emergency shutdown of the reactor if the reactor operator became incapacitated.

7. SOP 2-4, Picoammeter Channels
   Revised (Rev. 947) to modify the allowable setting of the Reactivity Testing Picoammeter in order that during normal operations a useable "on-scale" reading can be obtained. Required due to a shift of the core flux relative to the position of detector on the core top hat.

8. SOP 10-4, Explosive Handling
   Revised (Revs. 948 and 943) to control the movement and storage of explosives outside of the NTR areas and to clarify needed explosive related information for explosive devices shipped to the NTR for Neutron Radiography.

9. SOP 9-16, Record Retention
   Revised (Rev. 949) to change the period of record retention for commercial non-destructive test quality records.

IV. Major Preventative or Corrective Maintenance

Routine preventive maintenance and surveillance checks were performed as required and scheduled during the reporting period.

Noteworthy corrective maintenance activity performed during the reporting period consisted of the following:

- The schedule for performing certain preventative maintenance and surveillance tasks (PMs) was modified, to distribute the tasks over the required period of performance and within the required interval, to improve the resource loading of that work. For example, in some cases this required re-performing a PM originally scheduled and completed in the 1st Quarter of the year, again in the third or forth quarter. Also, some annual PMs that had been scheduled and documented as 4th quarter 2004 PMs but were scheduled to be performed in early Jan of 2005, were realigned as 1st quarter PMs. This schedule realignment results in the early Jan 2005 performance of the PM being recorded as satisfying the 4th Quarter 2004 annual PM requirement (well within the required interval between the 2003 and 2004 PM completions), and also satisfying that PM completion as a 1st Quarter 2005 PM. This realignment was discussed with the NRC project manager (Ref. NTR Memo M2004-014 dated 9/24/04) and approved by the Vallecitos Technological Safety Council. (VTSC)
- Lead Brick Shielding of the South Cell was painted to minimize the personnel exposure to lead.
- Reactor inlet and outlet thermopiles, which provide a reactor delta T signal to the log count rate meter system, were installed in the primary thermopile "wells" as replacements for defective thermopiles which were removed. However the pre-installation calibration check of those thermopiles did not support their use in service to perform a reactor thermal power calorimetric. Long term data from the thermopiles is being collected to determine if they can be reliably correlated to the alternate Tc2-Tc5 reactor inlet and outlet temperature measurement that are being used for the reactor calorimetric or if different thermopiles will be needed
- The Control Room Stack Gas and Particulate Monitor data recorder was replaced with a newer version of that recorder when the older version did not satisfy the linear calibration PM check.

V. Unscheduled Shutdowns

During the reporting period, there were two reactor scrams. There were also four unscheduled manual shutdowns prior to attaining criticality.

<u>Scrams</u>:

1. Scram 04-01 was a 2 out of 3 channel linear power, hi-power scram which occurred shortly after a reactor startup. The reactor operator divided his attention between the reactor operation and other activities in the control room. The period following a reactor startup is a period of rapid xenon burnout and reactor heatup, which requires frequent control rod adjustment until the reactor conditions stabilize. The power trace showed a period of over two minutes of slow power rise without control inputs to lower power, during which power rose from <100 % to above the 120% scram setpoint on two channels, which automatically scrammed the reactor. Power did not increase above the 125% power level trip point defined by the NTR technical specification.

   This was the same reactor operator that had been controlling the reactor during a prior 2 of 3 channel liner hi-power scram in 2003. That scram, its investigation and corrective actions were described in the NTR Annual Report for 2003 and corrective actions at that time included formally promulgating instructions to the staff that "Activities of others that would distract the Reactor Operator especially during the first 15 minutes of a startup when temperature is increasing and xenon is burning out should be avoided; and the Reactor Operator should not engage in other than RO activities (including answering the telephone and updating explosive logs) during that time when the reactor is still in a transient condition". The operator was suspended from further reactor control panel duties and an investigation was conducted to determine and evaluate the specific deficiencies of this operator and any other factors that contributed to this scram.

   The investigation identified that the reactor operator did not adhere to the specific disciplinary and remedial training corrective actions of the previous similar event in 2003 and his suspension from licensed reactor control duties was maintained until the following formal individual corrective action and re-training plan was completed over about a six week period.

   a. A formal review of NTR SOP Safety Responsibilities and Authorities was conducted with the operator.

   b. The operator received positive performance counseling on adherence to instructions and attention to his reactor operator duties.

c. The operator received reactivity and reactor control remedial technical training and received both written and oral examination on reactor and reactivity control and transient reactor behavior and parameters. Following this training, the operator's test results were graded with highly satisfactory results and the record of this testing was added to his biannual requalification file.

The scram evaluation also concluded that 1) certain NTR work routines, and 2) a lack of control room discipline protocols on the part of NTR staff and support personnel were additional possible contributors to distracting the operator. The following additional corrective actions were therefore also taken to address those other possible contributors.

d. Changes were made in NTR work routines, and guidelines for control room discipline were published in the NTR Communications Log (Standing Orders) and reviewed with the staff.

e. The entire NTR staff (including NTR support staff personnel) participated in formal training on "Safety Responsibilities of the NTR support staff" which reviewed the responsibilities and procedures that the NTR support staff must follow to prevent distractions to the reactor operator and how they can further support the reactor operator in carrying out his duties in ensuring attention to reactor monitoring and control.

Following the staff training and individual training, counseling, and testing, the operator's watch standing knowledge and discipline were observed under a training watch. The operator's performance on the observation watch was satisfactory and only then was the operator restored to normal Reactor Operator watchstanding duties.

The operator remains on a periodic observation program of his knowledge of and attention to watchstanding duties and reactor performance (especially transient response).

2. While operating the reactor at full power during high summer ambient conditions and correspondingly high secondary cooling water temperatures, the operator initialed a manual scram after receiving a primary high temperature (warning) alarm [130 degree setpoint] and after not getting an expected immediate response of a reversal of the increasing temperature after his initial action of inserting control rods to lower reactor power and reverse the temperature rise.

The high temperature alarm was due to a slow increase in the secondary cooling water temperature due to the high summer ambient temperature. The operator said he considered the transient response of the reactor temperature indication to the power reduction control inputs to be inadequate as the reactor temperature indication continued to rise after the control rods were inserted. Rather than risk a rapid rise in primary temperature and the potential for an automatic high temperature scram [140 degree scram setpoint], the operator decided to scram the reactor.

A subsequent investigation and evaluation determined:

- The secondary cooling water flow was at maximum as it should have been,
- The primary reactor flow was within its normal range and unchanged.
- Under summertime high temperature ambient conditions, it is normal for NTR to occasionally have the primary outlet temperature rise to and above the high temperature (warning) alarm [normal setpoint of 130], and NTR SOPs allow the warning alarm to be temporarily reset to as high as 135 degrees.
- The reactor power response to the control rod insertion was as expected and the transient response of the primary temperature to the power reduction was also as expected.

It was determined that there were two causes that led to what was concluded as an over-reaction by the operator to a normal condition and a normal transient response.

a. The operator did not allow enough time for the primary temperature to respond to the power change by not taking into account the time difference between the almost immediate primary power reduction response and the much slower, ~ 30 second, primary temperature response to a nominal reactor power reduction.

b. The operator's assessment of a continuing rise in primary temperature following the reduction in reactor power was based on a more rapid change in the tenth of a degree digit of the temperature instrument readout and/or the rise from an indicated 130.9 F to 131.0 F on the primary exist temperature digital readout, rather than a rapid rise of the single digit degree part of the readout (which would have been abnormal). So while the primary temperature will continue to rise following a reduction in power, the rate of rise is slow and will turn after about 30 seconds.

The operator received instruction in expected primary temperature transient responses and in reading and validating panel data readouts. The high temperature warning alarm was temporarily raised to 132 degree as is usually required during hot summer weather.

No changes in radiation levels or in the off-gas or particulate levels were noted following these scrams or during any subsequent reactor startups.

Unscheduled Shutdowns:

The four unscheduled shutdowns prior to achieving critically were operator-initiated shutdowns that were initiated following equipment failures that prevented a control rod response to a control input.

1. & 2. The NTR control rod drive motors are capacitor start and run motors. When a capacitor fails it will prevent the control rod from being driven out, and it can result in a high current draw transient that will cause the fuses in the motor drive out circuit to fail. The operator will usually then attempt to drive the control rod in, and with a defective capacitor, the fuses in the drive-in circuit can also fail. This situation occurred on one occasion for control rod drive #1 motor and on a different occasion on the control rod drive #2 motor. In both events, the reactor was shutdown with the safety rods and remaining control rods

   Corrective action for both occasions consisted of verifying that the cause of the failure of the control rod to drive out and then the failure of the control rod to drive in was due to a capacitor that had blown and that the fuses in both the drive-in and drive-out circuits had also blown. The drive motor capacitors were replaced with heavier duty capacitors and the fuses were replaced. The drive motors were tested for control and speed and put back in service.

3. The third occasion of a control rod not responding to a control input, occurred when the Fine Control Rod would not drive in. The reactor was shutdown with the safety rods and remaining control rods. Investigation determined that the Fine Control Rod drive-in limit switch had not reset when that control rod was withdrawn. It was assessed that the failure to reset was due to grease from the lead screws that had contaminated the small plunger of the limit switch causing the small plunger to remain depressed after the pressure of the limit switch arm was removed. Because that drive limit switch did not reset, the drive-in signal remained interrupted as occurs when the drive reaches it full in position and that limit switch plunger is depressed and interrupts the drive-in signal to the motor. The limit switch was cleaned, cycled and found to be operating normally and the system restored to operation.

4. Several weeks later, the Fine Control Rod again would not drive in, and it was determined that the plunger of the limit switch had again remained in the depressed position after the pressure of the limit switch arm was removed. The limit switch was again cleaned, tested and verified as now properly operating. As this was the next to the last scheduled reactor run for the year, the NTR manager determined, in consultation with Regulatory Compliance and the VSTC Chariman, that the reactor could be operated while the necessary parts were sourced and procedures were prepared to replace the limit switch. In addition, until the limit switch was replaced, a

temporary procedure, ER 04-26, was reviewed and issued and followed for the remaining two startups of the year wherein the drive-in function of all control rods would be tested during the reactor startup as soon as they were withdrawn from their full in positions.

The Fine Control Rod Limit switch was replaced with a new limit switch during the annual NTR beginning-of-the-year maintenance period following the end of year shutdown and prior to any reactor startups in 2005.

VI. Radiation Levels and Sample Results at On-Site and Off-Site Monitoring Stations

The data below are from sample and dosimeter results accumulated during the reporting period. Except for the NTR stack data, these data are for the entire VNC site and include the effects of operations other than the NTR.

A. NTR Stack

Total airborne releases (stack emissions) for 2004 are as follows:

Alpha Particulate, 1.07E-6 Ci (predominantly radon-thoron daughter products)
Beta-Gamma Particulate, 2.39E-6 Ci
Iodine-131, 8.79E-6 Ci
Noble Gases, 2.39E+2 Ci

Noble gas activities recorded from the NTR stack integrate both background readings and the actual releases. Background readings may account for as much as 50% of the indicated release.

B. Air Monitors (Yearly average of all meteorological stations.)

Four environmental air monitoring stations are positioned approximately 90 degrees apart around the operating facilities of the site. Each station is equipped with a membrane filter, which is changed weekly and analyzed for gross alpha and gross beta-gamma.

Alpha Concentration:
- Maximum, 3.63E-13 μCi/cc (predominantly radon-thoron daughter products)
- Average, 2.71E-13 μCi/cc

Beta Concentration:
- Maximum, 5.24E-13 μCi/cc
- Average, 5.88E-14 μCi/cc

C. Gamma Radiation

The yearly dose results for the year 2004 as determined from evaluation of site perimeter environmental monitoring dosimeters showed no departure from normal stable backgrounds.

D. Vegetation

No alpha, beta or gamma activity attributable to activities at the NTR facility was found on or in vegetation in the vicinity of the site.

E. Water

There was no release of radioactivity in water or to groundwater greater than the limits specified in 10CFR20, Appendix B, Table 2, Column 2.

F. Off-Site

The results of samples collected from off-site locations indicate normal background for the regional area.

VII. Radiation Exposure

The highest annual dose to full time NTR Operations personnel was 0.68 Rem and the lowest was 0.37 Rem. The average radiation exposure to personnel was 0.54Rem per person.

VIII. Conclusion

The General Electric Company concludes that the overall operating experience of the NTR reflects another year of safe and efficient operations. There were no reportable events.

GENERAL ELECTRIC COMPANY
Vallecitos and Morris Operations

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Nuclear Test Reactor