February 7, 2012

Ms. Sandra Warren, General Manager
Aerotest Operations, Inc.
3455 Fostoria Way
San Ramon, CA 94583

SUBJECT: AEROTEST OPERATIONS, INC. – NRC NON-ROUTINE INSPECTION REPORT NO. 50-228/2012-201

Dear Ms. Warren:

On January 17 & 18, 2012, the U. S. Nuclear Regulatory Commission (NRC, the Commission) completed an inspection at your Aerotest Radiography and Research Reactor facility (Inspection Report No. 50-228/2012-201). The enclosed report documents the inspection results which were discussed on January 18, 2012, with you and other members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records and interviewed personnel. Based on the results of this inspection, no findings of significance were identified. No response to this letter is required.

In accordance with Title 10 of the *Code of Federal Regulations,* Section 2.390, "Public inspections, exemptions, and requests for withholding", a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (Agencywide Documents Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, please contact Craig Bassett at (301) 466-4495 or by electronic mail at Craig.Bassett@nrc.gov.

Sincerely,

/RA/

Johnny H. Eads, Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-228
License No. R-98

Enclosure: NRC Inspection Report No. 50-228/2012-201
cc w/encl: See next page

cc w/encl:

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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No:	50-228
License No:	R-98
Report No:	50-228/2012-201
Licensee:	Aerotest Operations, Inc.
Facility:	Aerotest Radiography and Research Reactor
Location:	3455 Fostoria Way San Ramon, CA 94583
Dates:	January 17 & 18, 2012
Inspector:	Craig Bassett
Accompanied by:	Patrick Isaac, Inspector/Project Manager
Approved by:	Johnny H. Eads, Jr., Chief Research and Test Reactors Oversight Branch Division of Policy and Rulemaking Office of Nuclear Reactor Regulation

EXECUTIVE SUMMARY

Aerotest Operations, Inc.
Aerotest Radiography and Research Reactor
Report No: 50-228/2012-201

The primary focus of this non-routine, announced inspection was the onsite review of selected aspects of the Aerotest Operations, Inc. (the licensee's) 250 Kilowatt (kW) Class II research reactor safety program including: 1) conformance to License conditions and Technical Specification requirements, 2) maintenance and surveillance, and 3) fuel handling and inspection. The licensee's program was acceptably directed toward the protection of public health and safety, and in compliance with the U.S. Nuclear Regulatory Commission (NRC) requirements. One Unresolved Item was identified.

Conformance to License Conditions and Technical Specification Requirements

- License conditions were being met.
- Actions required by the Technical Specification requirements were generally being completed.

Maintenance and Surveillance

- Maintenance was being completed in accordance with Technical Specifications and procedural requirements.
- The program for completing surveillance checks, tests, verifications, and calibrations was being implemented in accordance with applicable Technical Specifications requirements.

Fuel Handling

- Fuel movements and inspections were completed and documented in accordance with the requirements specified by procedure.
- One Unresolved Item was identified for possibly operating the reactor with damaged fuel elements.

REPORT DETAILS

Summary of Plant Status

Aerotest Operations, Inc. (Aerotest, the licensee) had ceased to operate the TRIGA Conversion research reactor on October 15, 2010. Prior to that time the reactor had been operated for neutron radiography, to complete surveillance requirements, and for reactor operator training. During this inspection, the reactor remained shutdown.

1. Background Information

The licensee received a license to operate the facility on June 9, 1965, and commenced operation of the research reactor July 9, 1965. The reactor was licensed to operate at 250 kilowatt (kW).

On July 6, 2010, the NRC issued an order that approved the transfer of the license to operate the facility if Aerotest and a potential transferee could complete the transaction prior to September 13, 2010. However, due to various uncertainties involving various issues including the future disposition of the spent fuel present at the facility and the costs involved, the potential transferee declined to proceed with the transaction. Aerotest also submitted a proposal to the Department of Defense to allow the facility to continue to operate. That proposal was not approved by the Department of Defense. Therefore, Aerotest voluntarily ceased operating the research and test reactor on October 15, 2010. Since that date various entities have expressed interest in purchasing the operation but no sale has resulted to date.

2. Conformance to License Conditions and Technical Specification Requirements

a. Inspection Scope (IP 69001)

The inspectors reviewed the following to ensure that the licensee was meeting certain license conditions and complying with various TS requirements:

- Fuel movement and examination records
- Quarterly Maintenance Check Lists for 2011
- Fuel handling equipment and reactor instrumentation
- Various records and data sheets related to fuel movement
- Data Sheets for Fuel and Graphite Transfer forms for 2011
- Selected Operational Log Sheets for the past three months
- Selected Pool Water Analysis sheets for 2011 and to date in 2012
- Reactor Safeguards Committee (RSC) meeting minutes for the past five years
- Selected Aerotest Radiography and Research Reactor (ARRR) Startup/Shutdown Sheets for 2011
- Section IV of the ARRR Procedures Manual entitled, “Critical Assembly and Power Calibration,” PCN No. 6, RSC approval dated November 2, 2005, with the latest Temporary Change (PCN No. 6A) dated December 12, 2011

- Section VIII of the ARRR Procedures Manual entitled, “Maintenance Procedures,” PCN No. 2, RSC approval dated January 14, 1993
- Annual Summary of Changes, Tests, and Experiments at Aerotest Radiography and Research Reactor (ARRR) for the following periods: from July 1, 2009, to June 30, 2010, report issued July 15, 2010; and from July 1, 2010, to June 30, 2011, report issued July 28, 2011

The inspectors toured the facility and observed the status of offices, support areas, the Reactor Bay, and the mezzanine area. The inspectors also observed the reactor pool/tank area including the fuel remaining in the core grid and the fuel that had been transferred to storage.

b. Observations and Findings

(1) TS Section 4 – Reactor Pool

TS Section 4 required that the primary system have various capabilities.

Through records review and interviews with licensee personnel, the inspectors determined that there was an instrument in the reactor pool to monitor the depth of the water and that it would alarm if the level fell below 16 feet above the top of the core. The temperature of the pool water was monitored and the water was cooled as needed. Also, the pH and conductivity of the primary coolant was being measured once each month as required.

(2) TS Section 5 – Reactor Core

TS Section 5.1, “Fuel Elements,” required that the reactor contain no more than 90 TRIGA type fuel elements and that the maximum excess reactivity did not exceed a specified amount.

Through records review and interviews with the licensee, the inspectors verified that the reactor core had contained 87 fuel elements with a total U-235 loading of less than 3.3 kilograms (kg). In addition, every quarter the licensee verified that the maximum excess reactivity was less than 3 dollars.

(3) TS Section 6 – Reactor Safety Systems

TS Section 6.7 required that process instrumentation with readout in the Control Room be operating to permit continuous indication of pool water temperature and conductivity and that there be alarms to indicate low water flow, low pool water, and improper location of the bridge crane.

Through records review, observations, and interviews with the licensee, the inspectors verified that process instrumentation was functioning to indicate pool water temperature and conductivity. Alarms were operable

to indicate low water flow, low pool water, and improper crane bridge location; the alarms were being checked quarterly.

(4) TS Section 11 – Fuel Storage and Transfer

TS Section 11 required that the licensee store fuel in specific locations and transfer fuel only under certain conditions.

Through records review, observations, and interviews with the licensee, the inspectors verified that the licensee was not storing fuel in the floor of the Reactor Room (which was allowed). All fuel was stored in a locked vault or in the reactor pool/tank. The fuel handling tool was locked in a specified location under the cognizance of the Reactor Supervisor. Not more than one fuel element was allowed in the facility which was not in storage or in the core lattice.

c. Conclusion

The licensee was generally meeting the License Conditions and applicable Technical Specification requirements were being completed.

3. Maintenance and Surveillance

a. Inspection Scope (IP 69001)

To determine that maintenance and surveillance activities were being completed as required by TS Sections 3, 4, 5, 6, and 7, the inspectors reviewed:

- Quarterly Maintenance Check Lists for 2011 and to date in 2012
- Selected ARRR Pool Water Analysis sheets for 2011 and to date in 2012
- Section IV of the ARRR Procedures Manual entitled, “Critical Assembly and Power Calibration,” PCN No. 6, RSC approval dated November 2, 2005, with the latest Temporary Change (PCN No. 6A) dated December 12, 2011
- Section VIII of the ARRR Procedures Manual entitled, “Maintenance Procedures,” PCN No. 2, RSC approval dated January 14, 1993
- Annual Summary of Changes, Tests, and Experiments at Aerotest Radiography and Research Reactor (ARRR) for the following periods: from July 1, 2007 to June 30, 2008, report issued on July 11, 2008; from July 1, 2008, to June 30, 2009, report issued July 15, 2009; from July 1, 2009, to June 30, 2010, report issued July 15, 2010; and from July 1, 2010, to June 30, 2011, report issued July 28, 2011

b. Observations and Findings

(1) Maintenance

As noted previously, following the reactor shutdown in October 2010, the reactor had not been operated but Startup/Shutdown sheets have been

completed to log the completion of various activities including quarterly maintenance, control rod calibration, excess reactivity and loss-to-power checks, and thermal power calibration. Records showed that routine maintenance activities were conducted at the required frequency and in accordance with the TS and/or the applicable procedure.

(2) Surveillance

During a previous inspection, it was verified that, prior to October 2010, daily, monthly, quarterly, semiannual, and annual surveillance tests, checks, verifications, and calibrations were completed on schedule and in accordance with licensee procedures and TS requirements. All of the recorded results for the surveillance checks reviewed by the inspector were within the associated TS and/or procedurally prescribed parameters. The records and logs reviewed were accurate, complete, and being maintained as required.

After October 2010, the licensee continued to complete the monthly, quarterly, semiannual, and annual test and calibrations as required. During this inspection the inspectors verified that the checklist developed to ensure that appropriate oversight was maintained over the various surveillance items was being completed. These included such things as pool water temperature, air filter changeout, water conductivity, and cycling the pumps. These items were checked on a daily or weekly basis even though this was not required because the reactor was shut down and not operating.

c. Conclusion

Maintenance was being completed in accordance with TS and procedural requirements. The program for surveillance checks, tests, verifications, and calibrations was being implemented in accordance with applicable TS requirements.

4. Fuel Handling and Inspection

a. Inspection Scope (IP 69001)

The inspectors reviewed selected aspects of the following to verify that fuel movement and handling was being conducted as required by TS Section 5.1.1 and Section 11 and to ascertain that the status of the fuel was checked so that operation of the reactor complied with TS Section 10.2:

- Current Core Configuration Map
- Current Fuel Element Storage Location Map
- RSC meeting minutes for the past eighteen years
- Selected ARRR Operational Log Sheets for 2011
- Fuel handling equipment and reactor instrumentation
- Various records and data sheets related to fuel movement

- Data Sheets for Fuel and Graphite Transfer forms for 2010 and 2011
- Fuel movement and examination records including video of fuel inspection
- Listing of the Stuck Fuel Elements and Graphite Elements including a description of each
- Letter from Licensee to the NRC, Aerotest Radiography and Research Reactor (ARRR) concerning Fuel Element Inspection, letter dated July 25, 1992
- Section IV of the ARRR Procedures Manual entitled, "Critical Assembly and Power Calibration," PCN No. 6, RSC approval dated November 2, 2005, with the latest Temporary Change (PCN No. 6A) dated December 12, 2011
- Annual Summary of Changes, Tests, and Experiments at Aerotest Radiography and Research Reactor (ARRR) for the following periods: from July 1, 2002 to June 30, 2003, report issued on July 1, 2003; from July 1, 2003 to June 30, 2004, report issued on July 1, 2004; from July 1, 2004, to June 30, 2005, report issued on July 28, 2005; from July 1, 2005 to June 30, 2006, report issued on July 21, 2006; from July 1, 2006 to June 30, 2007, report issued on July 27, 2007; from July 1, 2007 to June 30, 2008, report issued on July 11, 2008; from July 1, 2008, to June 30, 2009, report issued on July 15, 2009; from July 1, 2009, to June 30, 2010, report issued on July 15, 2010; and from July 1, 2010, to June 30, 2011, report issued on July 28, 2011

b. Observations and Findings

(1) Conditions Prior to the December 2011 Fuel Inspection

As documented in the letter dated July 25, 1992, noted above, the licensee had made a commitment to the NRC to inspect twenty percent (20%) of the fuel elements in the core each year. Later it was suggested that all the elements in the core would be inspected every five years. This inspection protocol was discussed by the RSC during their annual meeting on January 10, 1995. The inspectors verified that the licensee continued to conduct fuel inspections according to this protocol.

Based on the results of past fuel inspections, the licensee noted that several fuel elements had become deformed such that they were stuck in the reactor core, making them nearly impossible to remove without damaging the fuel. During a review of the Reactor Safeguards Committee meeting minutes for the past eighteen years it was noted that sticking or stuck fuel elements had been mentioned on various occasions. The RSC meeting minutes from 1995 mentioned that four aluminum (AL) clad elements could not be safely removed from the core. It was noted that one AL element had been removed and replaced with a new stainless steel (SS) clad element. (It was noted that the element removed was not one designated as being stuck.) During the RSC meeting in 2010 it was mentioned that 24 fuel AL elements and 5 graphite elements were stuck. A plan had been developed by the licensee to purchase more SS elements and replace the ones that were stuck but, due to procurement

problems and because the number of stuck AL elements kept growing, the licensee had not been able to obtain enough SS elements to replace all the stuck AL elements. The inspectors also noted that, although the RSC was aware of the stuck elements, it was not recorded in the meeting minutes that the committee ever gave approval for the licensee to operate with elements in that condition. Through interviews with licensee personnel and calls to management personnel who had worked at Aerotest in the past, it was surmised that licensee management must have given approval for operating the reactor with elements that could not be removed.

In January 2006 the licensee attempted to inspect all the fuel by removing all fuel possible from the core. Those elements that could be removed were placed in storage. The licensee then used an underwater video camera to conduct an inspection of those elements that were stuck in place. After that was completed, an inspection of all the remaining elements was also completed and the elements were returned to their original positions in the core. At that point there were approximately 20 Al elements and 5 graphite elements that could not be removed. No new or unusual problems were identified during that inspection. In 2007 an Al fuel element was noted with a crack in the cladding. It was removed, placed in storage in the pool, and replaced with a SS element.

During this inspection, the inspectors verified that the fuel movements were conducted in compliance with procedure and pre-planned fuel moves. It was noted that the licensee was documenting the various movements that had been completed and maintaining the required records. Although reactor fuel was not required by the TS to be inspected, the licensee had inspected 20 percent (20%) of the fuel elements annually in order to remain cognizant of the physical status of the fuel and the licensee attempted to inspect all the fuel every five years.

(2) Potential TS Violation As Indicated By The 2011 Fuel Inspection

TS Section 1.1 defines shutdown as the reactor, with fixed experiments in place, shall be considered to be shut down (not in operation) whenever all of the following conditions have been met: (a) the console key is in the "off" position and the key is removed from the console and under the control of a licensed operator (or stored in a locked storage area); (b) sufficient control rods are inserted so as to assure the reactor is subcritical by a margin greater that 0.7% delta k/k cold, clean critical condition; and (c) no work is in progress involving refueling operations or maintenance of its control rod mechanisms.

TS Section 1.2 states that reactor operation shall mean any condition wherein the reactor is not shut down.

TS Section 10.2 states that the reactor shall not be operated whenever there are significant defects in the fuel elements, control rods, or control circuitry.

During December 5-12, 2011, the licensee attempted to complete an inspection of all the fuel to comply with their commitment of inspecting all the fuel elements every five years. As in previous inspections, those elements that could be removed were placed in storage along the side of the reactor tank, in storage baskets on the floor of the pool, or in storage holes in the thermal column. At that point the licensee noted that there were 27 Al elements and 11 graphite elements that were stuck and could not be removed. (It was noted that none of the SS elements had become stuck.) The licensee then used their underwater video camera to conduct an inspection of those elements that could not be removed from the core grid. The licensee found that, of those elements stuck in the core, there were four that had signs of cracks in the cladding. (The licensee now has 5 Al fuel elements that have cracks in the cladding (including the one found in 2007)). After the stuck element inspection was completed, an inspection of all the remaining elements was also completed. No significant problems were noted in those elements that had been removed. Because of the cracking problem noted in some of the stuck elements, the elements that had been removed from the core were not returned to the core but left in their respective storage locations. No cause for the cracking could be determined but the licensee surmised that it may have been caused from age and the environment in which the elements were maintained (immersed in water for almost 50 years).

On January 9, 2012, the licensee notified the NRC about the cracks that had been noted in the fuel elements. The licensee submitted a letter documenting the problems on January 9 and an amended letter was submitted on January 11, 2012. The licensee initially indicated that the cracks may have been in a non-fuel area of the elements. In a follow-up to the amended letter to the NRC, follow-up letter dated January 20, 2012, the licensee indicated that the cracks noted were indeed in the fuel portion of the elements. (The NRC had been notified of the cracked element removed from the core in 2007 by a phone conversation between the licensee and Project Manager on September 19, 2011.)

In the January 11, 2012 letter to the NRC, the licensee indicated that the last time the reactor went critical was December 5, 2011, at 100 watts for an excess reactivity measurement. The licensee also conducted a loss-to-power which required brief reactor operation at 250 kilowatts (kW) on October 4, 2011. On that date a thermal power calibration was also performed for one minute and five seconds at 205 kW and the reactor was operated for about one second at 250 kW for a loss-to-power check.

As noted above, the licensee operated the reactor following the 2006 fuel inspection (the last time that all the fuel was inspected) until October 2010 when the facility ceased reactor operation. The cracks in the fuel

elements may have occurred at any time since the 2006 fuel inspection. Because it could not be determined when the cracks in the fuel occurred, the licensee was informed that operating the reactor with possible defective fuel was a potential TS violation. This issue will be identified as an Unresolved Item (URI) by the NRC and will be reviewed during a future inspection (URI 50-228/2012-201-01).

(3) Review of Other Aspects of Past Operational History

The results of the analyses of the Continuous Air Monitor (CAM) samples and the water monitor samples taken during the past five years did not indicate any unusual or high activity during that period. A review of reactor operations records and the licensee's Annual Reports did not indicate any unusual occurrences during the past ten years.

It was noted that the licensee had taken a sample of the resin used to clean the pool water for the period from 2004 to 2007 and a separate sample of the resin used during the period from 2007 to 2010 when operations were discontinued. These resin samples, along with a pool water sample, were sent to an independent laboratory for analysis. The licensee requested that the laboratory check for all isotopes present including those that would indicate fuel element failure such as Cesium-137. The analyses of these samples indicated that there had been much higher levels of Cesium-137 (Cs-137) in the resin for the 2004-2007 period as compared to the 2007-2010 period (i.e., 1.1E7 picoCuries per sample (pCi/sample) for the 2004-2007 sample compared to 3.4E4 pCi/sample for the 2007-2010 sample). This lead the licensee to believe that: (1) the resin did a reasonable job of removing radioactivity from the pool water, and (2) the cracked fuel element removed from service in 2007 must have been seriously damaged and removing it from service stopped/greatly reduced the release of Cs-137 into the pool water. This appeared to be a reasonable assumption. The analytical results of the pool water sample indicated a trace of Cs-137 in the water (i.e., 9.1E1 pCi/sample).

It was noted that the licensee had operated the reactor at the maximum power level for many years. No record of over-power operation was noted. The maximum authorized power level was 250 kW but, over twelve years ago, the licensee reduced the typical operating power level from 250 kW to levels varying between 132 kW and 150 kW in an effort to reduce personnel radiation exposures. This produced positive results in that the annual personal exposure of some individuals was decreased by as much as one rem. This also reduced the operational stress on the reactor core.

Through the reviews noted above, reviews of other operations, maintenance, and surveillance records, and interviews with licensee personnel, the inspectors could not determine a likely cause for the cracks in the fuel. The NRC will continue to review the circumstances

surrounding the cracks in the fuel including the videos provided by the licensee of the cracks and the current condition of the stuck fuel elements. The licensee was informed that the issue of cracks in the fuel will be considered an Inspector Follow-up Item (IFI) and will be reviewed during subsequent inspections (IFI-50-228/2012-201-02).

c. Conclusion

Fuel element cracking was reported to the NRC. An Unresolved Item was identified for possibly operating the reactor with defective fuel. An Inspector Follow-up Item was identified concerning a review of the cause of the cracked fuel elements.

5. Exit Interview

The inspection scope and results were summarized on January 18, 2012, with members of licensee management. The inspectors described the areas inspected and discussed the inspection findings. No dissenting comments were received from the licensee. Although proprietary information was reviewed during the inspection, no such material is included in this report.

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel

C. Bauman	Research and Development Manager
A. Meren	Reactor Supervisor and Reactor Operations Manager
T. Richey	Neutron Radiography Manager
S. Warren	General Manager and Radiological Safety Officer
M. Wilkinson	Quality Assurance Manager

INSPECTION PROCEDURES USED

IP 69001	Class II Non-Power Reactors

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-228/2012-201-01	URI	Operating the reactor with possible defective fuel was identified as a potential TS violation.
50-228/2012-202-01	IFI	Follow-up on the issue of cracks in the fuel elements.

Closed

None

LIST OF ACRONYMS USED

ADAMS	Agencywide Documents Access and Management System
ARRR	Aerotest Radiography and Research Reactor
10 CFR	Title 10 of the *Code of Federal Regulations*
Cs-137	Cesium-137 (isotope)
IFI	Inspector Follow-up Item
IP	Inspection Procedure
kW	kilowatt
No.	Number
NRC	Nuclear Regulatory Commission
pCi/sample	picoCuries per sample
PCN	Procedure Change Notice
RSC	Reactor Safeguards Committee
TS	Technical Specification
URI	Unresolved Item