AEROTEST OPERATIONS INC
AEROTEST RADIOGRAPHY AND RESEARCH REACTOR
LICENSE NO. R-98
DOCKET NO. 50-228

ENVIRONMENTAL REPORT
(DATED MARCH 31, 2005)

REDACTED VERSION*

SECURITY-RELATED INFORMATION REMOVED

*REDACTED TEXT AND FIGURES BLACKED OUT OR DENOTED BY BRACKETS

AEROTEST OPERATIONS, INC.

Aerotest Radiography and Research Reactor (ARRR)

Environmental Report

March 2005

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Aerotest Operations, Inc.
3455 Fostoria Way
San Ramon, CA 94583

1.0 Introduction

1.1 Purpose of the Environmental Report

This Environmental Report supports an application by Aerotest Operations, Inc. to the U. S. Nuclear Regulatory Commission (NRC) to amend Facility Operating License R-98 (Docket No. 50-228) to renew the license for the Aerotest Radiography and Research Reactor (ARRR), currently set to expire on April 16, 2005, for an additional 40 years. The ARRR is a steady state 250 kW TRIGA-type nuclear reactor that was originally licensed in 1965 and has been operated continuously since that date.

As required by the National Environmental Policy Act of 1969 (NEPA), the NRC must consider environmental aspects of proposed Commission actions. As required by Part 50.30, Title 10 of the Code of Federal Regulations (CFR), this Environmental Report has been prepared in accordance with 10 CFR Part 51 to aid the Commission in complying with NEPA in connection with the proposed amendment to renew Facility License No. R-98 for the ARRR. This Environmental Report considers the probable environmental effects that can be attributed to the continued operation of the ARRR.

1.2 Need for Amendment to Renew Facility Operating License R-98

The Amendment to renew the license of the ARRR is needed to allow continued operation of the ARRR. The ARRR is one of a limited number of nuclear reactors in the United States capable of providing a neutron source for research and development and services such as neutron radiology. The ARRR is used mainly for neutron radiology. Neutron radiology is used for non-destructive testing and failure analysis of components used by the aerospace, military, and industrial communities. Specific uses of neutron radiography performed at the ARRR include the following:

1. Verification of the presence, absence, or correct placement of explosives, adhesives, o-rings, plastic components, and similar materials;
2. Detection of ceramic residue in the core of cast turbine blades prior to assembly in aircraft engines.
3. Verification of the integrity of welds in propellant tanks used in space flight;
4. Inspection of sustained-release drug delivery systems prior to use in patients with cancer and various neurological and skeletal disorders.

In addition to neutron radiology, the ARRR is used as a neutron source for activation analysis, irradiations, and radiation damage studies. Irradiation services for activation analyses have included: crude oil and hydrocarbon samples for oil companies; plastic slides impregnated with microscopic quantities of fissionable materials; ocean silt samples for the Bureau of Mines; and, silver iodide in snow samples from cloud seeding. Other irradiation services performed at the ARRR have included: calibration of power reactor fission detectors; radiation damage effects studies of solid state electronic components; detection of gunshot residue in paraffin; lattice deformation studies in ammonium perchlorate; and, spallation experiments with uranium dioxide.

The ARRR is also used for research and development for new neutron radiography equipment and image quality indicators including conversion screens, neutron detectors, and beam definition devices.

2.0 Facility and Site Characteristics

2.1 Location

The ARRR site is located in the town of Danville in Contra Costa County, California. The site is in the San Ramon Valley, about 23 miles east of San Francisco and 10 miles east of Oakland. It is separated from the East Bay urban complex by a series of ridges and hills up to 1600 ft high. The site is located approximately 9 miles south of Walnut Creek. Interstate 680 passes approximately 0.4 miles west of the site. Access to the ARRR site is via an extension to the site access road, Fostoria Way. The north end of the ARRR facility faces Fostoria Way with industrial buildings located on the opposite side of the street. The ARRR site is surrounded on the other three sides by Pacific Gas and Electric which uses the property for testing and research.

The ARRR site was originally selected to be above the potential flooding level and at a location where no earth fractures were known to exist. Although the ARRR was originally in an area of sparse population, this is no longer applicable. Currently, approximately 50% of the area within a one mile radius of the ARRR facility has been developed into suburban communities of single family homes and condominiums including a housing development located on the golf course of the Crow Canyon Country Club and portions of a housing development located on the Canyon Lakes Golf Course. Numerous light industrial, retail and community facilities are located within the one mile radius including the San Ramon Regional Medical Center which is approximately one-half mile from the ARRR facility. Approximately 35% of the area within a three mile radius of the ARRR facility has been similarly developed and includes a third golf course. The residential population within the three mile radius of ARRR facility is conservatively bounded at 44,076 which is the US Census 2000 population for the 94583 zip code in which the facility is located.

Despite the development since the ARRR facility was constructed, the surrounding area within the one mile radius remains significantly less populated than the areas surrounding similar TRIGA reactors in the United States which are typically located on university campuses and in hospitals with surrounding highly populated areas. As described in the ARRR Updated Final Safety Analysis Report (USAR), locating TRIGA reactors in highly populated areas has been evaluated as acceptable because the maximum credible accident for a typical TRIGA reactor could be expected to affect only those personnel within the facility and would have no significant impact on the public heath and safety.

2.2 Reactor

The ARRR is a TRIGA Mark I type reactor that was designed and constructed by the Nuclear Division of Aerojet-General in 1964. It is an open pool type reactor with the pool (i.e., reactor tank) located below ground level. The reactor achieved initial criticality on July 9, 1965 with a licensed steady-state thermal power limit of 250 kW. The TRIGA reactor fuel elements, reflector elements, control rods, control rod drive mechanisms, control rod drive controls, and reactor protection system were purchased from General

Atomics and were incorporated into the ARRR without any significant changes. There is no pulsing capability which is sometimes a design feature for similar reactors.

TRIGA reactors were conceived and developed by the General Atomic Division of General Dynamics Corporation with the objective of providing a training, research, and isotope production reactor containing intrinsic safety features designed to significantly reduce the probability and consequences of a nuclear accident. To achieve this goal, General Atomic designed the TRIGA reactor fuel to have intrinsic physical properties that shut down the reactor or limit its power to a safe value in the event of an inadvertent addition of positive reactivity. General Atomic also designed the TRIGA reactor fuel element such that fuel clad temperature will remain significantly less than 660°C and well below the melting point of both the aluminum and stainless steel fuel cladding following an instantaneous loss of all cooling water following extended full power operation. As described in the ARRR Updated Final Safety Analysis Report (USAR), the ARRR relies entirely on the design of the TRIGA fuel elements for the prevention and mitigation of any credible accidents. The design of the TRIGA fuel and Technical Specification imposed operating limits allow the ARRR to respond to any credible event with no hazard to the public without reliance on any engineered safety features. No specific structures, systems, or components are assumed to be operable for the prevention or mitigation of any accident or the protection of the public health and safety.

The reactor fuel, control rod drives, control rods, and experimental systems are similar to many other systems used throughout the United States. These items have well-established operating experience. The design of the ARRR fuel is similar to those of approximately 40 TRIGA fueled reactors currently operating world-wide with half in the United States. Twenty-four of these reactors are of the same approximate age as the ARRR. Since a large number of these reactors have been in operation for many years, considerable operational information is available and their characteristics are well documented.

There are 6 other TRIGA reactors approved for steady state operation at 250 kW and an additional 7 that can be pulsed. Of the former, 3 are in the United States and are located at Argonne National Laboratory - West (constructed in 1977), University of Maryland (1974), and Reed College (1968). There are 23 TRIGA reactors approved for steady state operation between 300 and 14,000 kW.

The ARRR reactor fuel, instrumentation, and control systems are of proven design, based on past operating experience of systems with the same or similar designs. The potential for and consequences of an accident at the ARRR are no greater than those of other similar reactors using the same fuel systems.

As described in the ARRR Updated Final Safety Analysis Report (USAR), the largest ground motion expected from a reasonably expectable maximum earthquake on the fault closest to the ARRR facility can be adequately modeled within guidelines in NRC Regulatory Guide 1.60 by a design response spectrum anchored at a high frequency asymptote of 0.50 g. ARRR components are designed for lateral acceleration in excess

of [redacted] Therefore, the ARRR design is sufficiently conservative to assure that the reactor can be safely shut down in the event of a major earthquake and that the potential for core damage that might result in the release of fission products is very small.

2.3 Reactor Building

The ARRR reactor building is made of steel with internal rooms built of fire resistant framing and sheetrock covering. The reactor control room and certain offices are housed in a single building. The reactor tank is embedded in the floor, extending 22 feet below and one foot above the floor surface. A [redacted] thick by [redacted] high block wall made of normal density concrete encloses the reactor area above the floor level. The top of this shield is covered with an [redacted] thick wooden shield. An automatic sprinkler system covers the entire building.

A [redacted] fence surrounds the ARRR facility to form the exclusion area required by and defined in 10 CFR 100 and the restricted area, as defined in 10 CFR 20.

2.4 Cooling, Makeup Water and Cleanup Systems

The ARRR cooling system is comprised of five basic parts: the reactor tank; the primary cooling loop; the secondary cooling loop; the demineralizer system; and, the reactor tank water make-up system.

The reactor tank water provides natural circulation convective cooling of the reactor core, acts as neutron moderator and reflector, and provides neutron and gamma shielding. The reactor tank is an aluminum cylinder [redacted] in diameter and [redacted] deep. The tank is open on the top with no openings below the water surface. When filled to its normal operating level of [redacted] (i.e., [redacted] above the top of active fuel), the reactor tank contains about [redacted] gallons of water.

The primary cooling loop provides forced circulation for mixing of the reactor tank water and, when required for reactor water tank temperature control, removes heat from the reactor tank water via a heat exchanger to the secondary cooling loop. All of the primary cooling loop piping connections are located in the reactor tank trench or in the heat exchanger building where drainage is provided to the waste storage tanks. Any leakage of the pump packing gland or fittings is collected in the liquid waste holding tanks. Leakage detection is provided by a moisture sensor located in the trench that will shut off the primary cooling loop pump and the demineralizer system pump and activate the demineralizer system low flow alarm in the control room if leakage is detected.

The secondary cooling loop, when required for reactor water tank temperature control, removes heat from the primary loop heat exchanger to the environment via the main or auxiliary evaporative cooling tower.

The demineralizer system maintains purity of the reactor tank water and provides a mechanism of monitoring representative samples of reactor tank water for radioactivity.

The reactor tank water make-up system provides demineralized water to maintain the level of the reactor tank water.

2.5 Ventilation Systems

The ARRR building ventilation systems are designed with two objectives: provide normal heating, cooling, and ventilation functions for personnel comfort and equipment cooling; and, to protect personnel from exposure to airborne radioactivity and prevent the spread of contamination. The ARRR accident analyses, described in the ARRR USAR, do not assume that the ARRR building acts as either a containment or confinement to mitigate the release of radioactivity following a reactor accident.

Personnel protection from exposure to airborne radioactivity and prevention of the spread of radioactive contamination is based on a ventilation strategy that assumes that leakage from the fuel elements or a spill of material from an irradiated experiment will be the primary source of airborne radioactivity and contamination. Confinement of airborne radioactive material to the reactor area is enhanced by a ventilation system that does not provide outside air directly into the reactor area. Areas adjacent to the reactor area are supplied with outside air and are maintained at a pressure that is slightly positive relative to the reactor area.

During any radiological event that could spread contamination or airborne radiation within the building or release it to the environment, the reactor ventilation system, chemical laboratory hood blower, and rest room vent fans are shut off to reduce the potential for spread of contamination and airborne radiation. Ventilation systems that maintain areas adjacent to the reactor area at a pressure slightly higher than the reactor area are not shut off. Any inleakage into the reactor area is directed out of the building through three gravity ventilators in the roof over the reactor area. This prevents air from entering the reactor building through the reactor area and minimizes the potential for spreading airborne radiation or contamination from the reactor area to other parts of the building.

2.6 Liquid Waste Storage

The ARRR license does not require a system for collecting potentially contaminated water around the reactor. However, because the reactor building originally housed a hot cell, a radioactive liquid waste system was installed. The hot cell was removed from the building in 1969 but the liquid waste system was left in place. This liquid waste storage system ensures that potentially contaminated liquid waste is properly collected, segregated, stored, and disposed.

The liquid waste storage system uses a sump tank to collect liquids from the trenches around the reactor, the heat exchanger building, the demineralizer building, and one of the chemical laboratory sinks. In order to minimize waste volume due to a large leak, a moisture detector is installed in the trench. This detector automatically shuts-down both the primary and demineralizer pumps whenever water flows to the trench.

Once collected in the sump tank, potentially contaminated liquids are completely isolated from the sanitary sewer system. An automatic sump pump moves the waste to the primary waste storage tank, one of two above ground storage tanks that are used for storage of liquid wastes which could be contaminated. The primary waste storage tank can be monitored by a GM counter connected to a ratemeter in the control room. A high liquid level indicator annunciates on the console when the level reaches about [redacted] from the top of the tank. When the primary tank is nearly full (which occurs infrequently), samples are taken for laboratory analysis of the level and type of radioactivity and a special discharge permit is obtained from the Central Costa County Sanitary District prior to discharge. A second above ground tank is available to store waste while the primary tank liquid is being analyzed for radioactivity prior to release.

3.0 Environmental Effects of ARRR Facility Operation

Construction of the ARRR facility was completed in 1964. The last significant construction activity at the ARRR facility was an addition to the reactor building that was completed in 1981. Since 1964, when the ARRR facility was built, there has been no noticeable effect on the terrain, vegetation, nearby waters, or aquatic life. The societal, economic, and esthetic impacts of the construction of the facility have been no greater than that associated with the construction of any other small industrial facility in the area.

No additional construction is anticipated that would be expected to have any significant effect on the terrain, vegetation, wildlife, or nearby waters or aquatic life.

3.1 Nuclear Fuel Cycle

At initial criticality, the ARRR core included [redacted] aluminum clad TRIGA fuel elements. The design was intended to allow for more fuel elements to be added, as necessary, to compensate for fuel burn up. Because aluminum clad TRIGA fuel elements are no longer manufactured, most of the fuel elements added to the ARRR are stainless steel clad. As of 2004, the ARRR contains [redacted] active fuel elements consisting of [redacted] aluminum clad elements and [redacted] stainless steel clad. Aluminum clad elements contain approximately [redacted] to [redacted] grams of U-235. Stainless steel clad elements contain approximately [redacted] grams of U-235. The addition of new fuel elements is limited by the ARRR license which currently allows possession of no more than 5.0 kilograms of U-235 with no more than 3.30 kilograms and 90 fuel elements loaded in the core lattice.

The ARRR has a rated thermal power level of 250 kW; however, the ARRR has been operating at 180 kW or below since 1992 and at 150 kW or below since 2000. The ARRR is used only for research and neutron radiography and is shut down except during normal working hours. The ARRR is typically critical and at power for approximately 31 hours per week. Between 1992 and 2003, average power generation at the ARRR has averaged 333,300 kW-hours per year. Between 2000 and 2003, average power generation at the ARRR has averaged 242,600 kW-hours per year.

Section 302(b)(1)(B) of the Nuclear Waste Policy Act of 1982 provides that the NRC may require, as a precondition to issuing or renewing an operating license for a research or test reactor, that the applicant shall have entered into an agreement with the Department of Energy (DOE) for the disposal of high-level radioactive waste and spent nuclear fuel. Aerotest Operations, Inc has a fully executed contract with DOE (DOE Contract: DE-CR01-83NE44484, dated July 14, 1983) that provides that DOE retain title to the fuel and that DOE is obligated to take the spent fuel and/or high-level waste for storage or reprocessing when the ARRR facility is decommissioned. Because the ARRR has entered into such a contract with DOE, the applicable requirements of the Waste Policy Act of 1982 have been satisfied.

3.2 Radiation Exposure of Personnel

The ARRR Technical Specifications require that Aerotest Operations establish and implement programs to maintain exposure and release as low as reasonably achievable (ALARA) in accordance with the guidelines of ANSI/ANS-15.11-1993. Management actively uses plant design features and personnel policy and practices to minimize both individual and collective exposure. Nearly all exposure of Aerotest personnel is the result of routine operations. Neutron radiography technicians receive the largest individual exposures when changing the aluminum film cassettes and setting up the radiography shots.

Design features intended to minimize exposure include the [redacted] thick high density concrete that surrounds the reactor pool and the active radiography area which includes [redacted] thick wooden beams on top which act as a neutron shield. Additionally, when the radiography tray is in either shooting position, several pieces of shielding are fitted together to shield personnel from the N-Ray tunnel. Personnel exposure is further reduced by locating a decay box for the aluminum film cassettes within arms reach of the N-Ray tunnel. The decay box is used to allow activated aluminum film cassettes to decay for at least two half-lives before the film cassettes are changed. When film cassettes are transported to the dark room, the technician must use a wheeled cart that keeps the activated cassettes away from their bodies.

Individual radiation exposure is minimized by rotating the assignments of neutron *radiography technicians. Employee doses for those performing radiography averaged* 2.07 rem per year for the last five years. Employee doses for persons not routinely performing neutron radiography are almost always under 1 rem per year, with most under 0.5 rem per year.

Non-routine radiation exposure includes maintenance on the N-Ray imaging system Non-routine radiation exposures are always pre-planned and emphasize component substitution using spare parts. This allows maintenance and repairs to be deferred until the component has decayed and been decontaminated and allows the work to be performed in areas with low background radiation.

Although individual exposures have trended higher between the end of 2001 and the end of 2004 because of staff reductions, the effectiveness of the ARRR ALARA program has been demonstrated because the collective exposure has not increased commensurate with the large increase in the number of radiographs made in the last several years.

Radiation exposure for all ARRR personnel are maintained as low as reasonably achievable and well within the limits established in 10 CFR 20; therefore, radiation exposure from continued operation of the ARRR does not pose a significant risk to operating personnel or the general public.

3.3 Radioactive Gaseous Effluents

The primary sources of airborne radiation under normal operating conditions is the production of Nitrogen-16 (^{16}N) in the reactor water tank and the production of Argon-41 (^{41}Ar) from the neutron activation of air in the reactor pool tank and air filled experimental facilities.

Nitrogen-16 (^{16}N) is a gamma emitting isotope with a 7.1 second half-life that is produced by fast neutron irradiation of oxygen in the water in the reactor water tank via the reaction ^{16}O (n,p) ^{16}N. Personnel are shielded from the ^{16}N gamma by the water above the top of core. Personnel exposure to ^{16}N gamma is further reduced by operating the primary cooling loop which increases the transit time for ^{16}N to reach the water surface. However, some ^{16}N is transported by either diffusion or convection current and reaches the reactor water tank surface before it decays. Once at the top of the pool, ^{16}N can exchange with atmospheric nitrogen, leave the water, and become airborne. Due to the short half-life, ^{16}N released to the atmosphere will not travel far from the reactor water tank before it decays. Therefore, the environmental effects of the release of ^{16}N to the environment are negligible.

Argon-41 (^{41}Ar) is produced by neutron activation of the argon in air dissolved in the reactor water tank water or in the air in experiments involving irradiation. Technical Specifications require that experiments with the potential for activation of significant quantities of air are purged with CO_2 to minimize the formation of ^{41}Ar and that ^{41}Ar presence is monitored during these experiments.

Aerotest Operations, Inc. uses the Environmental Protection Agency's COMPLY program for calculating emissions of ^{41}Ar for annual reporting and verification of compliance with the requirements of 40 CFR 61, National Emission Standards for Hazardous Air Pollutants, for radionuclides. The EPA COMPLY program determinations of annual ^{41}Ar production and the resulting effective dose equivalent are based on geometry and observed values and are computed using air monitor counts, reactor operating hours, atmospheric dilution, and the number of irradiations performed. Between 1993 and 1997, the ^{41}Ar release rates were consistent and averaged 16.7 curies/year resulting in an effective does equivalent of 0.5 mrem/year. Beginning in 1998, the ARRR has performed fewer irradiation experiments and more neutron radiography resulting in a significant reduction in the amount of ^{41}Ar produced. Between 1998 and 2003 (the last year for which data is available), the ^{41}Ar release rate was consistent and averaged 0.052 curies/year resulting in an effective does equivalent of 0.0016 mrem/year.

The very low levels of ^{16}N and ^{41}Ar released to the environment as a result of the operation of the ARRR result in an effective dose equivalent to the public that is very small fraction of applicable limits established in 10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 61. Therefore, radiation exposure resulting from gaseous radioactive effluents

resulting from the continued operation of the ARRR does not pose a significant risk to operating personnel or the general public.

3.4 Radioactive Liquid Wastes

Small quantities of liquid radioactive waste are generated by regeneration of the reactor water demineralizer and, infrequently, from liquids irradiated as part of sample irradiation. Otherwise, all the low level liquid waste generated at the ARRR is from the reactor pool. The pool water contains very low levels of long half-life radioactivity so it is necessary only to store the water until the short half-life material decays and activity levels are verified to be low enough for discharge to the sewer system. Disposal of readily soluble or dispersible radioactive material into the sanitary sewer system is permissible provided that the concentration, when diluted by the average daily quantity of industrial and domestic waste discharged at the plant, does not exceed the limits indicated in 20.2003 of the Federal and Section 30287 of the State regulations. Up to 1 curie per year of radioactive waste may be disposed of in this manner. Any contaminated liquid waste that does not meet criteria for disposal into the sanitary sewer system is stored for ultimate disposal by a licensed waste disposal company.

It should be noted that the ARRR generates very little liquid radioactive waste. Since 1992, there have been three discharges from the liquid waste storage system to the sanitary sewer system. Approximately 500 gallons was discharged in August of 2004, approximately 400 gallons was discharged in September of 2000, and approximately 900 gallons was discharged in April of 1992. Each discharge was performed in accordance with a Special Discharge Permit issued by the Central Conta Costa Sanitary District. Based on samples performed by a certified laboratory, the amount of radioactivity released during each discharge was a very small fraction of the annual limit imposed by applicable regulations. Future discharges are expected to occur very infrequently based on Aerotest Operations, Inc. efforts to minimize generation of radioactive liquid waste.

Based on the very low volume and the very low activity in radioactive liquid waste expected to be generated from the continued operation of the ARRR, radiation exposure resulting from radioactive liquid effluents does not pose a significant risk to operating personnel or the general public.

3.5 Radioactive Solid Wastes

Annual generation of solid radioactive waste at the ARRR facility is minimal and consists of neutron activated experiments, wastes from experiment handling (e.g., gloves, holders, plastic sheeting, tape, swipe samples and filter paper, etc.), check and calibration sources, and waste from the reactor water demineralizer (e.g., filters, ion exchange resin, etc.). This waste is stored in drums for several years where it typically decays to exempt levels and is ultimately disposed as regular waste. Otherwise, solid radioactive waste is disposed by a licensed radioactive waste disposal company.

Other than reactor fuel elements and reactor components, the ARRR generates essentially no high-level waste. Disposal of any high-level radioactive waste and spent nuclear fuel will be conducted in coordination with the Department of Energy, under the agreement described in Section 3.1 of this report.

3.6 Thermal Effluents

The ARRR is licensed to operate at a thermal power level of 250 kW; however, the ARRR has been operating at 180 kW or below since 1992 and at 150 kW or below since 2000. These lower steady state power levels provide the exposure times that became necessary due to the conversion to faster Kodak x-ray film for neutron radiography. Additionally, the ARRR is used only for research and neutron radiography and is shut down except during normal working hours. The ARRR is typically critical and at power for approximately 31 hours per week.

Thermal energy produced by the ARRR heats the reactor tank water. The primary cooling loop removes heat from the reactor tank water via a heat exchanger to the secondary cooling loop. The secondary cooling loop, when required for reactor water tank temperature control, removes heat from the primary loop heat exchanger to the environment via an evaporative cooling tower.

The environmental effects of thermal effluents from the evaporative cooling tower needed to cool the ARRR are negligible. Therefore, thermal effluents resulting from the continued operation of the ARRR is not expected to have any significant effect on the terrain, vegetation, wildlife, or nearby waters or aquatic life.

3.7 Hazardous and Chemical Waste

Annual generation of hazardous or chemical waste at the ARRR facility is very small. The ARRR's principal activity, neutron radiography, requires that the industrial X-Ray film, containing small amounts of silver, is processed with automatic film processors. The primary waste stream from this process, containing small amounts of silver, is collected and stored in 55 gallon, non-corrosive drums which are removed by a hazardous waste broker within the 90 day period. The drums are stored in a non-corrosive spill tray capable of containing at least 85 gallons of spillage/leakage. The secondary waste stream, a combination of the developer/rinse water from the automatic film processors, is collected and pumped into metal replacement "Super Cans." The effluent from the "Super Cans" discharges into the sanitary sewer system in the line that includes a sampling location.

The only other potential waste stream is generated in the Chemistry Laboratory which is not used on a regular basis. The regular sink drains into the sanitary sewer while the radioactive waste is directed into the liquid waste storage system described in Sections 2.6 and 3.4 of this report.

The ARRR facility waste water is discharged into underground pipelines and is collected and cleaned by the Contra Costa County Sanitary District (CCCSD). To ensure compliance with discharge requirements, CCCSD samples and analyzes Aerotest photo processing waste water semiannually. Holding tank waste water is analyzed prior to release to the sanitary system. Aerotest Operations is a recent recipient of CCCSD's Annual Pollution Prevention Award, which recognizes outstanding efforts to protect the local water environment by minimizing or eliminating harmful discharges into the sewer or storm drain systems.

Three solvents (acetone, methanol, and ethanol) are used in small amounts to remove adhesive from the aluminum trays used for the neutron radiography process. None of these solvents is used in quantities large enough to cause runoff into the sanitary sewer system.

Very small quantities of industrial waste (e.g., fluorescent light tubes, batteries, etc) are disposed of in accordance with a program administered by the CCCSD.

The generation of hazardous or chemical waste at the ARRR facility is very small and the material that is generated is handled in accordance with all federal, state, and local regulations, the environmental effects from hazardous or chemical waste generated as the result of the continued operation of the ARRR facility is negligible.

3.8 Environmental Monitoring

Radioactive gas and airborne particulate are the only radioactive material potentially released to the environment as a result of the routine operation of the ARRR. The radiation monitoring systems associated with reactor operations at the ARRR facility are provided and maintained as a means of ensuring compliance with radiation limits established under 10 CFR Part 20. Monitoring is performed at the ultimate source (i.e., the areas just above the reactor water tank) by the building gaseous effluent monitor and the building particulate sampler as described in the Updated Final Safety Analysis Report. Both of these instruments are required to be operable by the Technical Specifications. These monitors provide a very conservative estimate of radioactive material potentially released to the environment because the samples are collected at the point of release in the reactor high bay area where the ventilation system is designed to minimize the potential release to the environment.

In addition to the monitoring for radioactive gas and airborne particulate, radiation sensitive badges (i.e., TLDs and calcium sulfate) are located in selected areas of the Aerotest Operations, Inc. facility for routine monitoring of facility radiation levels. Currently, 19 locations are monitored.

3.9 Environmental Consequences of Potential Accidents

NUREG/CR 2387, "Credible Accident Analyses for TRIGA and TRIGA-Fueled Reactors," S.C. Hawley and R.L. Kathren, US Nuclear Regulatory Commission, April 1982, identified the maximum hypothetical accident for a TRIGA reactor as the fission product release directly to the atmosphere following a fuel handling accident that causes clad rupture and severely damages the fuel element. NUREG/CR 2387 states that very conservative assumptions in the analysis resulted in calculated dose equivalents to the maximum exposed individual at <1 mrem to the total body from noble gases and <1.2 rem to the thyroid from radioiodines. Furthermore, NUREG/CR 2387 states that the calculated dose equivalents are extremely conservative and thus represent an extreme upper limit. If such an accident occurred, exposure levels would more realistically be one to several orders of magnitude lower. Therefore, even under the worst of circumstances, the potential exposure to personnel outside the facility from any credible fuel-handling accident would be small and of little or no health significance. Whole body and thyroid lifetime dose equivalents are well within those put forth by regulatory requirements or by international bodies concerned with radiation protection (ICRP 1977, 1978; NCRP 1971, 1975, 1976).

Based on the discussion in the ARRR Updated Safety Analysis Report, any credible accident at the ARRR ranging from failure of experiments to the largest core damage and fission product release would result in doses of only a small fraction of 10 CFR Part 20 guidelines and are considered negligible with respect to the environment. Considering the low probability of any accident at the ARRR and the low consequences of an accident, continued operation of the ARRR does not pose a significant risk to operating personnel or the general public.

3.10 Long Term Effects of Facility Operation

There are no plans to significantly change the design, usage, operating characteristics, or radiological release practices of the ARRR facility if the license is renewed. As described in the report and the ARRR Updated Final Safety Analysis Report, operation of the ARRR facility does not have any significant effect on the terrain, vegetation, wildlife, or nearby waters or aquatic life. Operation of the ARRR does not result in any significant release of gaseous or liquid radioactive effluents and the generation of solid radioactive waste or chemical or hazardous waste is minimal. Therefore, continued operation of the ARRR facility has a minimal impact on the environment and does not pose a significant risk to operating personnel or the general public.

4.0 Cost and Benefits of Facility and Alternatives

The ARRR is one of a limited number of nuclear reactors in the United States capable of providing a neutron source for research and development and services such as neutron radiology. The unique services provided by the ARRR facility are listed in Section 1.2 of this report. It is likely that a similar facility would eventually have to be constructed if the ARRR does not continue to operate. Therefore, continued operation of the ARRR facility is considered beneficial.

5.0 Conclusion

Based on the discussion in the ARRR Updated Safety Analysis Report and this report, Aerotest Operations, Inc. believes that there will be no adverse impact on the environment as the result of the continued operation of the ARRR facility.