Trans. W/ Change No. 4 Dated 8-15-68

APPENDIX A

LICENSE NO. R-98

TECHNICAL SPECIFICATIONS FOR THE

~~AEROJET-GENERAL NUCLEONICS INDUSTRIAL REACTOR (AGNIR)~~

Name Changed to: Aerotest Radiography and Research Reactor (ARRR) 10-22-74

1.0 Definitions

1.1 Shutdown

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 than 0.7% delta k/k cold, clean critical condition; (c) no work is in progress involving refueling operations or maintenance of its control rod mechanisms.

1.2 Reactor Operation

Reactor operation shall mean any condition wherein the reactor is not shut down.

1.3 Operable

A system or component shall be considered operable when it is capable of performing its required function in its normal manner.

1.4 Operating

A component or system is operating if it is performing its required function in its normal manner.

1.5 Experiment

Experiment shall mean any apparatus, device, or material installed in the core or experimental facilities (except for underwater lights, fuel storage racks and the like) which is not a normal part of these facilities.

1.6 Experimental Facilities

Experimental facilities shall mean Glory Hole, vertical tubes, pneumatic transfer systems, central thimble, beam tubes, thermal column, and in-pool irradiation facilities.

1.7 Reactor Safety Circuits

Reactor safety circuits shall mean those circuits, including their associated input circuits, which are designed to initiate a reactor scram.

2.0 Reactor Site

2.1 The reactor and associated equipment is located within an exclusion area, ~~at the Aerojet General Corporation, San Ramon Plant.~~ Chg. 8, 10-22-74*

2.2 A steel, locked perimeter fence shall surround the ~~AGNIR~~ ARRR } Chg 8* facility, forming an exclusion area. The minimum distance from the center of the reactor pool to the boundary of the exclusion area fencing shall be 50 feet. The restricted area, as defined in 10 CFR 20, shall consist of the entire exclusion area.

2.3 The principal activities carried on within the exclusion area shall be those associated with the operation of the ~~AGNIR~~ ARRR * reactor and the use of a hot cell and chemistry laboratory.

3.0 Reactor Building

3.1 The reactor shall be housed in a steel building capable of meeting the following functional requirements:

3.1.1 all circulating fans and air conditioning systems except the system which supplies air to the control room shall have the capability to be shut off from a single control in the control room,

3.1.2 ventilation shall be achieved by gravity ventilators located on the roof of the building, and

3.1.3 a positive air pressure shall be maintained in the control room with respect to the reactor room.

"3.2 An alarm system shall be installed to detect unauthorized entry into the reactor building. The alarm system shall be monitored constantly and its annunciation shall be tested monthly."

Change #5 dtd. 4-20-70.

See 3rd Para 2 Chg #5

4.0 Reactor Pool (Primary System)

4.1 The minimum depth of water above the top of the active core shall be 16 ft. The maximum bulk water temperature shall be 130°F and the minimum 60°F.

4.2 The pH and conductivity of the primary coolant shall be measured at least once each month. Corrective action shall be taken to avoid exceeding a pH of 7.5 or a conductivity of 5 umho/cm.

5.0 Reactor Core

5.1 Fuel Elements

5.1.1 The reactor shall contain no more than 90 TRIGA type fuel elements. The core shall be loaded with not more than 3.30 kg of U-235.

5.1.2 The maximum excess reactivity above cold, clean critical, with or without experiments in place, shall be 3 dollars.

5.1.3 The bath temperature coefficient and the prompt fuel temperature coefficient shall be negative at all operating temperatures and the minimum reactivity decrement at full power shall be 80 cents when measured with respect to source power level.

5.1.4 The coolant void coefficient shall be negative across the active core. Maximum in-core operating void shall be 10% of the coolant core volumes as defined by a cylinder bounded by the grid plates.

5.2 Reflector Elements

5.2.1 The overall reflector elements' dimensions shall be the same as the fuel elements.

5.3 Control Elements

5.3.1 The reactor shall be subcritical by a minimum margin of 0.50 dollar when the maximum worth rod is fully withdrawn from the core.

5.3.2 The maximum rate of reactivity addition for the control rods shall be 11 cents/second. There shall be a minimum of three operable control elements.

5.3.3 The total time for insertion of the control rods following receipt of a scram signal by the safety system shall be a maximum of 600 milliseconds.

6.0 Reactor Safety Systems

6.1 The reactor safety system shall include sensing devices and associated circuits which automatically actuate visual and audible alarms and, when certain pre-set limits are exceeded, scram the reactor. The systems shall be fail-safe (de-energizing shall cause a scram). Table 1 describes the minimum requirements of the safety system.

6.2 The nuclear, process and radiation monitoring instrumentation shall provide the functions and have the set point ranges and associated annunciations listed in Table 2 of these specifications.

6.3 The safety system shall be designed such that no single component failure or circuit fault shall simultaneously disable both the automatic and manual scram circuits.

6.4 Reactor sequences, interlocks and safety circuits shall remain operable while fuel is in the core except that one channel may be removed for maintenance purposes when the reactor is shut down.

6.5 Interlocks shall prevent safety rod withdrawal unless all of the following conditions exist:

6.5.1 The master switch is in the ON position;

6.5.2 The safety system has been reset;

6.5.3 All four nuclear instruments channels are in the OPERATE mode;

6.5.4 The startup channel count rate is greater than 2 cps.

It shall not be possible to withdraw more than the safety rod until it has reached the upper limit interlock, at which time either the shim or regulating rod may be moved, but only one at a time.

6.6 During a critical experiment, subcritical multiplication plots shall be obtained from at least three instrumentation channels. These channels may be used in addition to the normal operating instrumentation in Table 1.

6.7 Process instrumentation with readout in the control room shall be operating to permit continuous indication of pool water temperature and conductivity. Alarms shall be operabled to indicate low water flow, low pool water and improper location of the crane bridge.

7.0 Radiation Monitoring

"7.1 A fixed gamma monitor employing Geiger tube detectors shall be located on the wall connecting the control room and the reactor room. This monitor shall serve as both an area radiation monitor and a criticality alarm and will annunciate through an automatic monitoring system to the San Ramon, California, Fire Department and actuate a siren within the reactor building on high radiation level. The monitor shall have a minimum range of 0 to 20 mr/hr. The annunciation and the siren actuation shall be tested monthly."

Change #5 4-20-70

See 3rd Para 3 Change 5

7.2 During reactor operation, a gas sample shall be continuously withdrawn from the roof vent above the reactor, or from the vicinity of the reactor bridge and glory hole over the reactor core, and pumped through a radioactive gas detection chamber. The gas chamber shall be monitored by a beta-gamma detector which shall have a continuous readout in the control room. An annunciator shall indicate when the gas exceeds 2 mr/hr.

7.3 A fission product water monitor shall be attached to the process water cleanup system loop adjacent to the demineralizer and shall provide continuous indication in the control room. High radiation levels within the demineralizer or pool water shall annunciate an audible alarm on the reactor console. The range of the monitor shall be from 0.1 to 100 mr/hr.

7.4 Portable survey instruments for measuring beta-gamma dose rates in the range of 0.01 mr/hr to 50 r/hr shall be available at the facility.

7.5 Portable instruments for measuring fast and thermal neutron dose rates from 0.1 mrem/hr to 1.0 rem/hr shall be available at the facility.

7.6 Radiation detector packets containing a series of threshold detectors shall be placed at several locations within the reactor building for post-accident radiation analyses.

8.0 Experimental Facilities

8.1 Large-Component Irradiation Box

8.1.1 A large-component irradiation box shall have a maximum volume of 20 cu. feet. The box shall encompass not more than 120^{o} arc of the core and shall be designed so that it can be placed no closer than 5 cm to the outer row of active fuel elements.

8.1.2 The platform shall be positioned remotely relative to the reactor core by a positive drive and shall be captive to the stand which is bolted to the floor of the tank. Positive mechanical stops shall prevent moving the experiment box into the active reactor core. CO_2 shall be used for purging and to maintain a slight positive pressure in the box relative to the pool water pressure.

8.1.3 To remove or install the experiment box, the platform shall be moved two or more feet away from the reactor core. The box shall then be lowered onto the platform and bolted in place with remote handling equipment. The voided box shall be purged of air prior to exposure to neutrons.

8.2 Pneumatic Transfer Facility

8.2.1 A pneumatic transfer facility may be located in any reactor core position. The facility shall be operated with dry CO_2 and exhausted through a filter ventilation system, which is monitored for radioactivity.

8.2.2 The in-core portion of the transfer facility shall have a maximum void volume of 34 cu. in. in the active fuel region. A manual control shall be provided which is capable of overriding the automatic timer control.

8.3 Glory Hole Facility

8.3.1 A dry glory hole facility may be located in any reactor core position. The glory hole shall accept capsules to a maximum of 1.35 in. in diameter.

8.3.2 The glory hole shall be purged with CO_2 to prevent formation of excessive amounts of argon-41. Gas samples shall be taken near the pool when the glory hole facility is operated without a shield plug to insure adequate monitoring of radioactive gases.

8.4 Neutron Radiography Facility

8.4.1 The beam tube shall consist of a two-section tapered tube having a rectangular cross section. The upper and lower sections of the tube shall be equipped with a fill and drain line.

8.4.2 All components contacting the pool water shall be fabricated from aluminum or stainless steel.

"8.4.3 The beam catcher shield shall consist of a movable radiation shield." chge # 2 7-2-70

8.5 Thermal Column

8.5.1 The thermal column shall be positioned remotely on steel locating pins immediately adjacent to the reactor core.

8.5.2 The thermal column shall be composed of a three-foot cube of graphite encased in aluminum containing five rows of 1.5 in. diameter irradiation holes. The rows shall be placed 6 inches apart and contain seven holes per row. Slotted beams shall be provided to allow experiments to be attached directly to the thermal column.

8.6 Vertical Tube

8.6.1 Vertical irradiation tubes, having diameters up to 6 in., may be attached to the thermal column.

8.6.2 The vertical tube shall be purged with CO_2 to prevent the formation of excess amounts of argon-41.

8.7 Other Irradiation Facilities

8.7.1 The central 7 fuel elements of the reactor may be removed from the core and a central irradiation facility installed provided the cross-sectional area of the facility does not exceed 16 in^2.

8.7.2 Two triangular exposure facilities are available which shall allow the insertion of circular experiments to a maximum of 2.35 in. diameter or triangular experiments to a maximum of 3.0 in. on a side.

8.7.3 Irradiation capsules in the shape of dummy fuel elements shall have a maximum inner void volume of 34 cu. in. in the active fuel region.

9.0 Experiment Limitations

9.1 Experiments shall be evaluated in the most reactive condition.

9.2 The documentation of experiments, which shall be reviewed and approved prior to insertion in the reactor, shall include at least:

9.2.1 The purpose of the experiment;

9.2.2 A description of the experiment; and

9.2.3 An analysis of the possible hazards associated with the performance of the experiment.

9.3 The value of the reactivity worth of any single independent experiment shall not exceed 2 dollars. If such experiments are connected or otherwise related so that their combined reactivity could be added to the core simultaneously, their combined reactivity shall not exceed 2 dollars.

9.4 The reactivity worth of any single independent experiment not rigidly fixed in place shall not exceed 1 dollar. If such experiments are connected or otherwise related so that their combined reactivity could be added to the core simultaneously, their combined reactivity worth shall not exceed 1 dollar.

9.5 No experiment shall be installed in the reactor in such a manner that it could shadow the nuclear instrumentation system monitors.

9.6 No experiment shall be installed in the reactor in such a manner that a failure could interfere with the insertion of a reactor control element.

9.7 No experiment shall be performed involving materials which could:

9.7.1 Contaminate the reactor pool causing corrosive action on the reactor components or experiments;

9.7.2 Cause excessive production of airborne radioactivity; or

9.7.3 Produce an uncontained violent chemical reaction.

9.8 Experiments shall not be performed involving equipment whose failure could result in fuel element damage.

9.9 The amount of special nuclear material contained in an experiment shall be limited to 5 grams in the form of solid samples or 3 grams in the form of liquid. Liquid special nuclear materials shall be doubly encapsulated.

9.10 Experiments having moving parts shall be designed to have reactivity insertion rates less than 10 cents/sec except that moving parts worth less than 5 cents may be oscillated or removed at higher frequencies.

"9.11 Solid explosive materials may be brought into the facility for the purpose of being radiographed in the neutron radiography facilities located above the pool, provided that the following conditions are met:

9.11.1 Individual explosive devices shall be limited to 1000 grains equivalent TNT encased in metallic sheathing.

9.11.2 The maximum quantity of explosive material that may be possessed at one time shall be limited to 50 pounds equivalent TNT.

9.11.3 Explosive material shall be stored in designated areas within the reactor facility.

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9.11.3.1 Only the explosive devices to be radiographed within 4 hrs, not to exceed a maximum of ten pounds equivalent TNT, may be removed from the storage area at one time for radiographing, including preparation but excluding packaged shipments.

chge #7 dtd 6/24/71

9.11.3.2 An accountability log shall be maintained to show the amount of explosive material in the reactor facility at all times, and shall contain a description of the explosive, and the location within the facility (e.g., storage, radiographing facility, or shipping dock).

9.11.4 The maximum amount of explosive material contained in devices that may be placed in the radiography facilities at a time shall be limited to five pounds equivalent TNT.

9.11.4.1 Explosive material in the radiation field at one time shall be limited to 1 pound equivalent TNT.

9.11.4.2 Explosive material contained in long device(s) shall be limited to 0.5 pound equivalent TNT per foot."

"9.12 Personnel handling the explosive devices shall be trained and familiar with the devices being radiographed.

9.12.1 Personnel handling the explosive devices shall use special equipment, such as nonsparking tools and shoes, protective clothing, safety shields and grounded benches as required for the explosives being handled.

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9.12.2 Unshielded high frequency generating equipment shall not be operated within 50 feet of any explosive device.

9.12.3 The explosive devices shall be subjected to a total exposure not to exceed 3×10^{11} neutrons/cm^2 and 3×10^3 roentgens of gammas.

9.12.4 Explosive devices that, upon ignition, have or provide a thrust in a definite direction shall be positioned so as to be aimed away from the reactor and components."

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10.0 General Operating Limitations

10.1 Reactor operation shall be permitted only when two or more personnel are in the reactor building, at least one of whom is a licensed Operator.

10.2 The reactor shall not be operated wherever there are significant defects in fuel elements, control rods or control circuitry.

10.3 Upon occurrence of abnormal operation of the reactor, including its controls, safety systems and auxiliary systems, action shall be taken immediately to secure the safety of the facility and determine the cause of the abnormal behavior.

11.0 Fuel Storage and Transfer

11.1 The fuel storage pits located in the floor of the reactor room shall accommodate a maximum of 19 fuel elements (700 gm U-235) in storage racks dry or flooded with water. The fuel storage pits shall be secured with a lock and chain except during fuel transfer operations.

11.2 Additional fuel storage racks may be located in the reactor tank. Each of these storage facilities shall be so designed that for all conditions of moderation k_{eff} shall not exceed a value of 0.8.

11.3 A fuel handling tool shall be used in transferring fuel elements of low radioactivity between the storage pits and the reactor; a shielded fuel transfer cask shall be used for the transfer of highly radioactive fuel elements. The fuel handling tool shall remain in a locked cabinet under the cognizance of the Reactor Supervisor when not authorized for use.

11.4 All fuel transfers in the reactor tank shall be conducted by a minimum staff of three men, and shall include a licensed Senior Operator and a licensed Operator. The staff members shall monitor the operation using appropriate radiation monitoring instrumentation. Fuel transfers outside the reactor tank but within the facility shall be supervised by a licensed Operator.

11.5 Not more than one fuel element shall be allowed in the facility which is not in storage or in the core lattice.

12.0 Administrative Requirements

12.1 Organization

12.1.1 The Reactor Supervisor shall have responsibility of the reactor facility. In all matters pertaining to reactor operations and to these Technical Specifications, the Reactor Supervisor shall be responsible to the President, Aerotest Operations, Inc., a wholly-owned subsidiary of Explosive Technology, Inc. The President, Aerotest Operations, Inc. shall report to the Board of Directors of Aerotest Operations, Inc. which includes the Presidents of both OEA, Inc. and Explosive Technology, Inc."

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12.1.2 The Radiological Safety Officer shall review and approve all procedures and experiments involving radiological safety. He shall enforce rules, regulations and procedures relating to radiological safety, conduct routine radiation surveys and is responsible to the Manager, Aerotest Operations."

see 3rd para. change #5

12.1.3 The Reactor Safeguards Committee shall be composed of not less than five members, of whom no more than three are members of the operating organization. The committee shall meet on call of the chairman and they shall meet at least annually. The committee shall be responsible for, but not limited to the following:

12.1.3.1 Reviewing and approving nuclear safety standards associated with the use of the facility;

12.1.3.2 Reviewing and approving all proposed experiments and procedures and changes thereto, and modifications to the reactor and its associated components;

12.1.3.3 Determining whether proposed experiments, procedures or modifications involve unreviewed safety questions, as defined in 10 CFR 50, Part 50.59(c), and are in accordance with these Technical Specifications;

12.1.3.4 Conducting periodic audits of procedures, reactor operations and maintenance, equipment performance, and records;

12.1.3.5 Reviewing all reported abnormal occurrences and violations of these Technical Specifications, evaluating the causes of such events and the corrective action taken and recommending measures to prevent reoccurrence and; see 3rd Para & change 5

12.1.3.6 Reporting their findings and recommendations concerning the above to the Manager, Aerotest Operations." chg e-5 dtd 4-20-70

12.1.4 The Reactor Supervisor shall have a Bachelor's degree in Engineering or Physical Science and shall have a minimum of 4 years experience in the operation of a nuclear facility during which he shall have demonstrated competence in supervision and reactor operations. He shall hold a Senior Reactor Operator license for the facility.

12.1.5 The Radiological Safety Officer shall have a Bachelor's degree in Biological or Physical Science and shall have a minimum of 2 years experience in personnel and environmental radiation monitoring programs at a nuclear facility. Certification as a Health Physicist by the Health Physics Society is acceptable in lieu of the education and experience requirements given above.

12.2 Procedures

12.2.1 Detailed written procedures shall be provided and followed for the following reactor operations:

12.2.1.1 Normal startup, operation and shutdown of the complete facility and of all systems and components involving nuclear safety of the facility.

12.2.1.2 Refueling operations.

12.2.1.3 Actions to be taken to correct specific and foreseen potential malfunctions of systems or components, including responses to alarms, suspected primary system leaks and abnormal reactivity changes.

12.2.1.5 Preventive or corrective maintenance operations which could have an effect on the safety of the reactor.

12.2.2 Temporary procedures which do not change the intent of previously approved procedures may be utilized on approval by a licensed Senior Reactor Operator and one other qualified individual. Such procedures shall be subsequently reviewed by the Reactor Safeguards Committee.

12.3 Records

In addition to those records required under the facility license and applicable regulations, the following records shall be kept when explosive materials are to be irradiated or radiographed:

12.3.1 The type and quantity of material irradiated.

12.3.2 Date, time of day, and length of exposure.

12.3.3 Total neutron and gamma exposure level.

TABLE 1

NUCLEAR INSTRUMENTATION

Channel (No.)	Detector	Minimum Sensitivity	Information	Minimum Range	Information to Logic Element (Scram)
Startup (1)	BF_3 Proportional Counter	4.5 counts/sec per n/cm^2-sec	Neutron flux, period	source level to 1 watt	Period scram;[a] low count rate scram
Log N (2)	Compensated ion chamber	4×10^{-14} amp/n/cm^2-sec	Power level, period	10^{-2} watts to 120% full power	Period scram
Linear Level Safety (3)	Uncompensated ion chamber	4.4×10^{-14} amp/n/cm^2-sec	Power level	30 watts to 120% full power	High and low level[b] scrams
Linear Level Safety (4)	Compensated ion chamber	4.4×10^{-14} amp/n/cm^2-sec	Power level	10^{-1} watts to 120% full power	High and low level scram

(a) Scrams on Channel 1 are by-passed when signal on Channel 2 exceeds a fixed setting similarly the high voltage is removed from the detector and the detector is shorted.

(b) Low level scram is bypassed on Channel 3 and 4 when Channel 2 is below a fixed setting.

TABLE 2

SAFETY SYSTEM FUNCTIONS

Sensor or Trip Device	No. of Switches or Sensors	Annunciator and Scram Set Point	Annunciator and Alarm Set Point
Short Period; Chs. 1, 2	2	$\geq$ 3 sec.	
High Neutron Flux Level; Chs. 3, 4	2	$\leq$ 98% of full scale and not greater than 120% full power	
High Temperature of Coolant Water	1	$\leq 130^{\circ}F$	
Low Pool Water Level	1		$\leq$ 1 ft max decrease
Seismic Disturbance	1	IV on modified Mercalli Scale max.	
Bridge Crane Location	1		When located off storage position
Low Neutron Detector Voltage; Chs. 2, 3, 4	3	$\geq$ 500 volts	
Low Source Level; Ch. 1	1	$\geq$ 2 cps	
Loss of Instrument Power; Ch. 2,	1	x	
Low Neutron Flux; Ch. 3 & 4	2	$\geq$5% of full scale	
Area Radiation Monitor	1		$\leq$10 mr/hr
Water Radioactivity	1		$\leq$20 mr/hr
Demineralizer Water Flow	1		$\geq$4 gpm
Building Gas Effluent Monitor	1		$\leq$ 2 mr/hr
Master Key Switch	1	Not on "ON" position	
Manual Scram Button	1	Button Depressed	