AEROTEST OPERATIONS, INC.
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March 06, 2018

ATTENTION: Document Control Desk
U.S. Nuclear Regulatory Commission
White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

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

ARRR Restart Plan

Ladies and Gentlemen:

Enclosed please find the Restart Plan for ARRR. Also enclosed is the supporting affidavit on behalf of Aerotest.

Should you have any questions or require additional information regarding this submission, please contact AO President David M. Slaughter, Ph.D. at (801) 631 5919 or dmsraven@gmail.com

Sincerely yours,

David M. Slaughter, Ph.D.
President and Reactor Admin.
Aerotest Operations, Inc.

Enclosures:
1. ARRR Restart Plan
2. Affidavit

IE26
A020
NRR

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Affidavit For

ARRR Restart Plan

David M. Slaughter, PhD, being duly sworn, states that he is the President of Aerotest Operation Inc., is authorized on the part of said Company to sign and file this response, and that all the matter and facts set forth herein are true and correct to the best of his knowledge.

David M. Slaughter, PhD
President AO and Reactor Admin.

Subscribed and swore to before me, a Notary Public, in and for the State of Utah and County of Salt Lake this 7 day of March 2018.

NOTARY PUBLIC
ARTURO CISNEROS
693497
COMMISSION EXPIRES
DECEMBER 08, 2020
STATE OF UTAH

Notary Public in and for the State of Utah

My Commission Expires: 12/08/2020

ARRR RESTART PLAN
APPROACH TO CRITICAL, CONTROL ROD AND POWER CALIBRATIONS

I. PLAN OVERVIEW

A complete and thorough evaluation of the ARRR reactor characteristics was performed when the reactor was originally started up in 1965. The ARRR restart plan that is delineated below includes selecting fuel elements, modeling of core configurations, requalifying operators on the console, maintenance on the core structure, performing the approach to critical experiment, determining the worth of control rods, and performing a power calibration. The plan uses as a guide NUREG-1537 and well established and proven processes, procedures, and experienced personnel for the current reactor restart and in the future when major changes in the core arrangement necessitate an approach to critical and power calibrations.

The full implementation the plan will take 2 months. Sections II-VI of the plan do not require loading a core, thus are concurrently being performed and remain ongoing. (Handling and movement of fuel during this initial phase is restricted to ascertain a better understanding of the physical attributes of the selected elements.) Section VII. Approach to Critical and Section VIII. Reactor Calibrations require loading the core with fuel. These remaining tasks will begin after the preliminary tasks provided in sections II through VI are successfully completed and Aerotest has received NRC approval of the plan's adequacy. While the actual time required to complete the final two tasks will take less than a week, Aerotest has scheduled a two week window to ensure a careful deliberate process.

II. FUEL ELEMENT SELECTION

One of the first obligations is to select fuel elements for inclusion, using parameters that include initial element conditions at acceptance beginning in 1964, physical inspections of the fuel elements, fuel burnup, element history (fuel kinetics) and fuel management decisions.

General Atomics TRIGA Fuel

The initial aluminum cladded TRIGA elements that populated the 1965 ARRR core were previously irradiated when purchased from General Atomics. These elements came from the 1959-60 New Delhi World Agriculture Fair. Prior to shipment to Aerotest, the elements were inspected on February 22, 1965 with their condition and U-235 content recorded. In its prior operation, the reactor containing these elements operated mostly in a steady-state mode,

being pulsed only 15 times. (Each pulse was approximately $1.00.) It is interesting to note that many of the initial physical markings can still be seen in more recent inspections. Thirty-nine new stainless steel elements were purchased (37 ea. 12 weight % uranium, 2 ea. 8.5 weight % uranium, 20% enriched in U-235) over the last 38+ years. These include, in storage, 12 new unirradiated stainless steel elements (12 weight % uranium, 20% enriched in U-235).

Routine Physical Inspections

Fuel element inspections were focused on understanding and documenting the elements' physical conditions. Visual 360 degree / full length inspections, Sagitta (traverse bend), elongation and seat tests were included in the fuel element assessments.

Current Uranium-235 Loading

Uranium-235 (U-235) loading (or initial loading-fuel burn-up) for each element was taken from 82 core maps in terms of their core location. The total power for each core was determined and the U-235 burnup was estimated for each core ring by the use of neutron flux weighing factors that account for flux as a function of radial position. The approximate peak to average ratio of neutron flux was determined by an earlier research effort on the ARRR reactor. The burnup contribution is accounted for each element in a specific core location and each result is summed for the element's life. The U-235 loading at any specific time can be estimated.

Fuel Dynamics

For each aluminum-clad element that is accepted for reinsertion into the core, an operational history and a fuel chemistry profile were generated to better understand its internal fuel condition. M.T. Simnad's empirical correlations pressure (fission-gas), fuel temperature, loss of hydrogen, and solid phase diagrams for UZrHx and ZrHx (H/Zr ratio), provide an extensive understanding of the fuel dynamics. The design and construction of the 8.5 and 12 weight % TRIGA fuel elements using uranium-zirconium hydride nucleonic and chemical processes have been extensively studied resulting in the ability to predict and avoid unwanted changes. Along these extensive studies, instrumented fuel elements were used to determine temperature distributions in the fuel and cladding and the internal gas pressures under a number of relevant operating conditions. U-ZrHx operating parameters such as fuel temperature, U-235 loading, U-235 burnup rate, and neutron flux/fluence, under certain circumstances change the fuel and cladding properties, resulting in swelling, blisters and/or cracks (Simnad, M.T., "The U-ZrHx Alloy: Its Properties and Use in TRIGA Fuel," August 1980).

Fuel Management Decisions

In recent years, strategic fuel placement and movement (i.e., management) were minimal which most likely contributed to the severity of the cracks in a number of the aluminum-clad fuel elements. This fuel management also resulted in other similar fuel elements to be operated in an environment with lower neutron flux, reduced stress on the elements' cladding by operating under lower fission-gas pressure and fuel temperature, and slower hydrogen off-gassing and chemical kinetics. The accepted and in-reserve aluminum-clad elements will only be placed in the E ring and these elements will be inspected annually. The stainless steel elements will be inspected less frequently, given their newer age, lower burnup and more robust cladding.

Selection of TRIGA Fuel Elements

Extensive reviews of the operational circumstances and physical conditions were conducted on the existing fuel elements, especially for the aluminum-clad fuel elements. The stainless steel elements are the newest elements and showed no damage. The total mass of U-235 is a defining factor to determine the number of elements needed for operation. ARRR will have a mixed core of 12 and 8.5 percent by wt. of U-235. In fact, the majority of the elements are stainless-steel that contain 12 percent by wt. of U-235. Those elements possess a greater U-235 inventory. The total U-235 for the initial 1965 core of 62 elements had approximately 2000 grams which is approximately the same U-235 content contained in stainless-steel elements alone. (Our MCNP modeling effort will provide additional information to the critical number of elements required.)

It is anticipated that only 18 (of the possible 54) aluminum and 39 (of the possible 39) stainless steel fuel elements along with a minimum of 31 (of the possible 43) graphite elements are needed to generate an operational core. Each of the fuel and graphite elements are organized into three functional groups: accepted, in-reserve, and rejected based on the outcome of its graded characteristics.

	Quantity	Grams $_{U-235}$
Aluminum Fuel Elements:		
A. Accepted for placement in E-ring of core,	18	540
B. In-reserve (accepted but not needed)	12	360
C. Rejected	24	
Stainless Steel Fuel Elements:		
A. Accepted for use in core.	39	2,038
B. In-reserve (accepted but not needed)	0	
C. Rejected	0	

Graphite Elements:

A.	Accepted for use in core.	31
B.	In-reserve (accepted but not needed)	10
C.	Rejected	2

III. EVALUATION OF CORE LOCATIONS FOR FUEL, GRAPHITE, AND CONTROL ELEMENTS

A Monte Carlo Neutron Photon code (MCNP5) is being used to evaluate the possible fuel and graphite placements so that the desired core performance can be obtained. Their placement is influenced by the elements' fuel loading, physical condition, U-235 loading (burnup), cladding (aluminum-clad fuel can only be placed in the E ring and not next to a control rod.)

The MCNP5 input file describes the core structure, element array, physical and material characteristics of the fuel and graphite elements, etc., that are associated with the ARRR reactor. The input file incorporates the specific characteristics of individual fuel elements to predict the overall core performance (as opposed to using a less accurate zone/ring method). The evaluation produces a number of proposed fuel and graphite arrangements that meet the performance requirements for the proposed core. One successful simulated core will be selected and the others will be ranked and kept in reserve as possible alternatives. When complete, fuel element serial numbers will be assigned to core locations for the initial approach to criticality.

IV. MAINTENANCE ON CORE STRUCTURE

Two maintenance items for the core are required and are part of this plan: the upper grid plate attached to the core structure and the control rod relocated from the E to the D-ring.

The grid plate was detached to allow the previously 22 stuck elements to be removed. A newly engineered clamp system was designed and RSC approved through a 50.59 process in 2012. These clamps replace existing screws that attached the upper plate to the structure. This change provides easier and robust connections while allowing easier removal for future maintenance activities. The clamp installation was delayed until the indirect transfer of ownership was completed and a comprehensive examination of the core structure could be made.

Given the current location of the regulating rod, E-13, and the distribution of fuel elements in the 2010 core, the impact of this control rod was minimal due to the skewed flux pattern produced by the fuel distribution. It is clear the control rods were operated in a safe manner following RSC approved (and NRC audited) procedures. Their effectiveness (and therefore,

their contribution to safety) can be improved by relocating the regulating rod from E-13 to D-10. This provides better control and its function is less impacted by fuel distribution, allowing for skewed neutron flux patterns needed for perimeter irradiators. The control rod's performance at this location is well understood and shown to be more effective by other TRIGA reactors that use the D ring position for the regulating rod.

V. SIMULATED REACTOR LOADING AND UNLOADING PROCEDURES

All personnel involved with the initial critical experiment are familiar with the fuel transfer operation techniques and procedures required for the reactor critical assembly. The detailed procedures for reactor loading and fuel handling are presented in Section VII.C.

Familiarization with the techniques required to transfer irradiated fuel elements to the reactor core from the fuel element storage racks, located in the reactor pool tank, or new fuel elements from above the pool tank have been developed and practiced by an experienced crew over many years. If any additional training is needed, graphite elements will be used to develop fuel transfer proficiency.

VI. ARRR SENIOR REACTOR OPERATOR RE-TRAINING PROGRAM

To maintain active status, 10 CFR 55.53(e) requires that each licensed reactor operator or senior reactor operator actively perform the functions of a reactor operator or senior reactor operator for a minimum of 4 hours each calendar quarter. The ARRR has been shut down since 2010 and defueled since 2012. From 2010 to the present each ARRR senior reactor operator has maintained active status by performing the functions of a senior reactor operator for a minimum of 4 hours each calendar quarter with the exception of manipulating control rods.

In order to demonstrate that each senior reactor operator's knowledge and understanding of the operation of the reactor and faculty are satisfactory and to re-establish their proficiency the following program shall be conducted prior to and concurrently with refueling operations:

A. Instruction

Each senior reactor operator shall prepare, give or attend lectures involving the reactor console systems and other relevant topics.

B. Simulation

As reactor systems become available and prior to refueling the core, each senior reactor operator shall perform functionality tests on reactor console instrumentation and control systems.

C Console Refamiliarization

As a senior reactor operator practices a console activity another senior reactor operator shall be present to ensure consistent interpretation of operating procedure and anticipated instrument response. Also a senior reactor operator shall be present for each operator after the ARRR core is placed into service to satisfy the required control rod manipulations in the current ARRR requalification program.

VII. REACTOR CRITICAL ASSEMBLY PROCEDURES

The critical assembly of the reactor shall be performed in a manner that will ensure the maximum safety to all personnel involved. The procedures described below include all phases of the critical assembly. Reactor operation procedures and instructions are presented in a separate document.

The transfer of new, unirradiated fuel elements for the critical assembly from the storage area to the reactor room shall be performed in a manner that will comply with recommendations of the Radiological Safety Officer. The following restrictions will apply to all transfer operations:

No more than one fuel element may be transferred to the reactor core at a time. Only one fuel storage container or storage pit shall be opened at any one time.

At least three people will be required for the critical experiment: (1) a Senior Reactor Operator to monitor personnel activity and radiation fields and to document the process, (2) a fuel handler, and (3) a Reactor Operator at the reactor console to monitor and analyze data. It would also be prudent to have a fourth person whose sole function is to provide health physicist services during the fuel transfer.

A REQUIRED STARTUP INSTRUMENTATION

The minimum instrumentation required during the initial critical assembly is shown in Table 1. All normal instrumentation shall remain operative, thereby providing reactor period scrams from Channels 1 and 2, and reactor level scrams from Channels 3 and 4. Sub-critical multiplication measurements will be obtained primarily from Channel 1.

B RESUME OF REACTOR CONDITIONS

Prior to critical assembly, the integrity of all mechanical and electrical components shall be inspected and demonstrated. A neutron check on all the detectors will be performed by checking and calibrating detectors. The nuclear scram and annunciator circuits that are to remain operative are listed in Table 2. The source will be removed and reinserted to check the source interlock system. The addition of fuel elements to the reactor core during the critical assembly may be performed only when:

1. The reactor safety and interlocking systems are functioning, and
2. The safety rod is fully withdrawn and both the shim and regulating rods are fully inserted.

C. FUEL LOADING TECHNIQUES

To ensure that all personnel are completely familiar with the techniques required to perform the critical assembly, a table top discussion of the reactor loading sequence will be conducted prior to the actual fuel transfer. Familiarization with the techniques required to transfer fuel elements to the reactor core from the fuel element storage racks, located in the reactor pool tank, or from above the reactor pool tank for new fuel elements, have been developed by an experienced crew which has performed fuel element transfers together for the past 17 years. The rigid and pneumatic fuel handling tools will be used to transfer fuel and graphite elements to various positions in the reactor core. To maintain control of all fuel and graphite element transfers to the reactor core and to comply with fuel transfer procedures, documentation of element moves shall be maintained. To maintain control of all fuel element transfers to the reactor core and to comply with fuel transfer procedures, a fuel inventory check shall be continuously made during the critical assembly. The ARRR Core Map, Figure 1, shows possible element locations in the reactor core, consisting of 31 graphite elements in rings F and G, a neutron source in ring F, 2 control rods in ring C and 1 in ring D, 39 stainless steel 12 weight % uranium / 20% enriched U-235 and 18 aluminum-clad 8.5 weight % uranium / 20% enriched U-235. The total number of TRIGA fuel elements estimated for criticality is to be provided before loading with graphite or water located in the remaining unfilled positions in rings A, F and G. The loading sequence to be used in the initial critical experiment is shown in Table 3.

D. APPROACH TO CRITICALITY

During the initial critical assembly, the maximum number of fuel elements loaded into the reactor per step shall be that shown in Table 3, or one-half the experimentally determined incremental loading required to achieve criticality, whichever is less. The loading sequence shown in Table 3 was chosen, as opposed to a nearly circular loading array, because

1) The source will not have to be moved during the course of the assembly, thereby eliminating possible errors due to renormalization of the data to more than one source position,

2) A high-worth safety rod is placed near the center of the loaded core providing a high degree of shutdown safety, and

3) Channel 1 detector (criticality monitoring instrumentation) does not have a direct view of the source.

The negative temperature coefficient associated with the TRIGA fuel provides an emergency shutdown mechanism. However, the following precautions shall also be observed: before loading fuel, the shim rod and the regulating rod shall both be in the fully inserted position to suppress

any false period indication caused by fuel insertion. The safety rod shall remain in the fully withdrawn position. The neutron source and the 31 graphite elements will be loaded as shown in Figure 1 prior to loading any fuel elements with the exception of the graphite elements in the west side of ring F to ensure fuel and graphite elements are seated in the lower grid plate with the aid of an underwater camera. Upon completion of a loading step, the safety rod shall be inserted to the lower limit and a subcritical measurement on Channel 1 will be recorded. The safety rod, shim rod and regulating rod shall then be withdrawn and a second subcritical measurement will be recorded.

The multiplication data above, when plotted as a function of fuel mass or of the number of fuel elements, determines the extrapolated criticality. The difference between the extrapolated criticality with all rods withdrawn and the extrapolated criticality with all rods fully inserted is the shutdown reactivity margin at critical expressed in terms of the fuel mass.

E. SUPERCRITICAL LOADING

The critical and excess reactivity loading shall be made in a manner that will result in maximum safety for all personnel.

Fuel loading will follow the procedure used in the critical experiment. The following procedures shall be used after the addition to the core of the fuel element expected to result in supercriticality with all rods out.

1. Insert the safety rod; measure and record the subcritical multiplication.
2. Withdraw the safety and shim rods fully from the core; again measure and record the subcritical multiplication.
3. Withdraw the regulating rod until a stable reactor period is established.
4. Insert the regulating rod, leveling out the reactor on an infinite period at some desired low power level. (not to exceed 6 decades above source level).
5. Insert the shim rod fully to shut down the reactor.

VIII. REACTOR CALIBRATIONS

An evaluation of the ARRR reactor characteristics during this restart include control rod calibrations and reactor power calibration. The methods of determining the reactor characteristics are detailed below and may be changed or expanded as necessary. Detailed reactor operating procedures are presented in a separate document.

A. CONTROL ROD CALIBRATION

The large reactivity worth of the ARRR control and safety rod system does not allow complete positive period calibration of the shim and safe rods due to the \$3.00 license limitation

and the interlock on the safe rod. The safe rod is maintained in the full-out position during reactor operation; therefore, total worth measurements on all rods are obtained using rod drop techniques. Intermediate points on the shim and regulating rods are also obtained with rod drop techniques and will be compared with the period measurements. Both methods require that the xenon poison be minimal – after at least a full weekend of decay. The control rods will be calibrated in terms of rod worth as a function of rod position. Both positive and negative reactor period measurements are used for rod calibration.

1. Period Method

a. Withdraw the safe and regulating rods to their upper limits.
b. Establish 100 watts with the shim rod. Record indications on the Reactor Period Data Sheet.
c. Insert the shim rod to its lower limit and allow reactor power to decay.
d. Withdraw the shim rod to establish a 20 to 30 second reactor period on Channel 1 period meter. Do not exceed a reactor power level of 6 decades above source level.
e. When a constant period is established start a stopwatch when the 4 ampere mark is reached on Channel 3. Do not withdraw the shim rod from this point on.
f. After power has increased one decade stop the stopwatch when the 4 ampere mark is reached again.
g. Insert the regulating rod until an infinite period is established.
h. Record shim and regulating rod positions, stopwatch time and pool temperature on the data sheet.
i. An increment on both the shim and regulating rods have now been calibrated. Using an expanded version of the ARRR In-Hour Equation curves calculate the worth of those increments and record the results.
j. Repeat steps (d) to (i) until the regulating rod is fully calibrated.

2. Drop Method

The total reactivity worth of each control rod is determined by performing individual rod drop tests from criticality. This method uses the long term beta decay neutrons (5 to 20 seconds).

Setup:

1. Turn on and zero the 10 inch recorder located in the reactor cabinet.
2. On the back of the recorder connect the nuclear instrument channel 4 cable to recorder channel 2.
3. Ensure there is sufficient recorder chart paper and its red pen is primed.
4. Chart speed: 1.0 inch per second, Range: 50 mv
5. Set the low level scram settings of Channels 3 and 4 to 6% of full scale to minimize switching of their range scales.
6. Turn off the primary pump to prevent possible effects from water movement.

(A) Regulating Rod Calibration

a. Fully withdraw the safe and regulating rods.

b. Withdraw the shim rod to establish approximately 230 watts reactor power. This ensures the data points will be within the reactivity curves.

c. On the recorder chart paper record the rod to be dropped, the date, time, reactor power, pool temperature, and all rod positions.

d. Bring reactor power to just below the high scram setting for Channel 4.

e. Use the recorder adjust located at the rear of Channel 4 instrument to position the recorder's red pen to the Channel 4 reading established in step (d).

f. Start the recorder chart drive.

g. Scram the regulating rod.

h. Allow the recorder chart drive to run for a minimum of 20 seconds, switching ranges on Channels 3 and 4 as necessary to avoid a low level scram.

i. After 20 seconds stop the recorder chart drive.

(B) Safe Rod Calibration

Repeat the procedure for the regulating rod calibration, except:

a. Withdraw the safe rod to its upper limit and the regulating rod to 450 units.

b. Withdraw the shim rod to establish approximately 2.3 Kw reactor power.

g. Scram the safe rod.

(C) Shim Rod Calibration

The shim rod must be interchanged electronically with the safe rod using the connections at the rear of the reactor console. Repeat the procedure for the regulating rod calibration, except:

a. Withdraw the shim rod (now electronically interchanged with the safe rod) to its upper limit and the regulating rod to 450 units.

b. Withdraw the safe rod to establish approximately 260 watts reactor power. (note: Channel 3 will read higher than Channel 4)

g. Scram the shim rod.

Upon completion of the control rod calibrations:

a. Return the safe and shim rods to their normal electronic connections.

b. Turn on the primary pump.

c. Disconnect the recorder from Channel 4 instrument.

d. Plot the calibration curves (rod position vs reactivity) for the shim and regulating rods using the data obtained in conjunction with the appropriate reactivity curves.

B. ABSOLUTE REACTOR POWER CALIBRATION

. The two techniques that have been used to calibrate the absolute power level of the ARRR are 1) calorimetric and 2) reactivity loss vs reactor power level. The procedures have been modified as circumstances change; the current approved methods are presented below:

1. Calorimetric

The temperatures used in the calorimetric measurements range from 70°F to approximately 90°F. Over this range, with no cooling, the temperature will rise at an average rate of 8.14°F per hour when operating at 250 Kw. The following procedure is used:

a. Ensure the reactor pool temperature is at or near 75°F.
b. Turn off the secondary cooling pump.
c. Bring the reactor to power.
d. A thermocouple plug in the reactor cabinet labeled "TANK OUT" is plugged into a converter whose output is then connected to the input jacks of the reactor cabinet 10 inch recorder.
e. Start the recorder and record until the indicated temperature is between 90°F and 95°F.
f. Turn on the secondary coolant pump. The system is now in normal operation.

2. Reactivity Loss to Power Measurement

After reactor power has been calibrated using the above technique, the most accurate method of determining changes in reactor power is through the use of the reactor power coefficient. The TRIGA fuel used in the ARRR has a strong negative coefficient of reactivity as a function of reactor power level. A measurement of reactivity loss to power must be made with a cold clean core; i.e. no residual xenon poisoning. Normally, a decay period from Friday evening to Monday morning is adequate for making a loss to power determination. The uncertainty in this measurement is ±5 Kw. A new reactor power coefficient will be determined for each change in reactor core configuration. The following procedure is used:

a. Determine the Channel 3 instrument readings for 100 watts and 250 Kw reactor power based on the Channel 3 reading for the reactor power level from the previous day of operation.
b. Start up the reactor and raise reactor power to 100 watts.
c. Record instrument readings on the operational log sheet after reactor power has stabilized.
d. Raise reactor power to 250 Kw and record instrument readings after reactor power has stabilized.
e. Reactor power may now be brought to the operational level or shut down.
f. Using the current reactivity curve for the shim rod, the reactivity loss to power is equivalent to the difference in reactivity between the shim rod readings at 100 watts and 250 Kw.

For the maximum excess reactivity the following procedure is used:

a. Using the current reactivity curves for the shim and regulating rods, the excess reactivity at 250 Kw is equivalent to the sum of the reactivities corresponding to the shim and regulating rod heights at 250 Kw.

b. The maximum excess reactivity is equivalent to the sum of the excess reactivity at 250 Kw and the reactivity loss to power. This value must be $\leq$ \$3.00.

TABLE 1

INSTRUMENTATION REQUIRED DURING CRITICAL ASSEMBLY

Reactor Channel	Detector	Readout
1	Proportional Counter	LOG CRM / Scaler
2	Compensated Ion Chamber	LOG Pico Ammeter
3	Uncompensated Ion Chamber	Pico Ammeter
4	Compensated Ion Chamber	Pico Ammeter

TABLE 2

SCRAM AND ANNUNCIATOR CIRCUITS

OPERATIVE DURING CRITICAL ASSEMBLY

Channel No.	Condition Monitored	Trip Setting
1	Period	$\geq$ 3 sec.
1	Low Level (source interlock)	$\geq$ 120 cpm
2	Period	$\geq$ 3 sec.
2	Low Neutron Detector Voltage	$\geq$ 500 v
2	Loss of Instrument Power	_
3	Low Neutron Flux Level	$\geq$ 5% of full scale
3	High Neutron Flux Level	$\leq$ 98% of full scale and not greater than 120% full power
3	Low Neutron Detector Voltage	$\geq$ 500 v
4	Low Neutron Flux Level	$\geq$ 5% of full scale
4	High Neutron Flux Level	$\leq$ 98% of full scale and not greater than 120% full power
4	Low Neutron Detector Voltage	$\geq$ 500 v
-	Low Pool Water Level	$\leq$ 1 ft. maximum decrease
-	Earthquake	Modified Mercalli IV
-	Pool Water Temperature	$\leq$ 130°F

ANNUNCIATED CONDITIONS

Area Radiation
Water Radioactivity
Building Gas Effluent
Demineralizer Water Flow
Crane Bridge Location

TABLE 3

ARRR FUEL LOADING SEQUENCE

Loading Step	No. Elements Added	Total Elements	Loading Sequence
1	32	32	E5, E6, E7, E8, E9, E4, D4, D5, D6, D7, E10, D3, C4, C5, D8, E11, B2, B3, C6, D9, E12, B1, B4, C7, E13, B5, C8, D11, E14, D12, E15, E16
2	16	48	E3, E2, D2, C2, D1, C1, D18, C12, D17, C10, C9, D16, D15, D14, D13 F17
3	8	56	E2, E1, E24, E23, E22, E21, E20, E19
4	1	57	E18
5			
6			
7			
8			

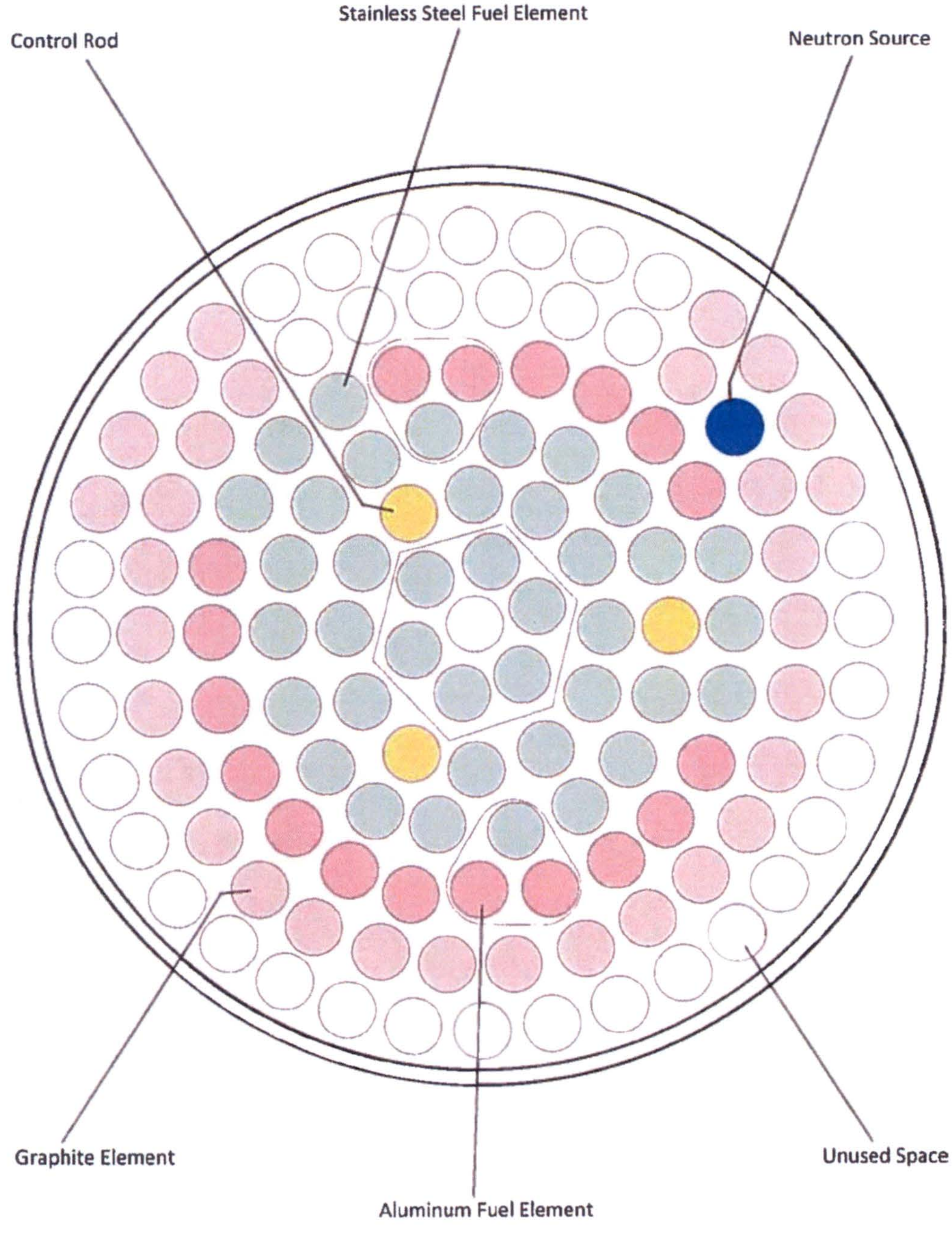

FIGURE 1 – ARRR CORE MAP