APPENDIX A

LICENSE NO. R-53

TECHNICAL SPECIFICATIONS

FOR

THE UNIVERSITY OF OKLAHOMA

REACTOR MODEL AGN-211P (S.N. 102)

November 10, 1978

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1.0 DEFINITIONS

1.1 Shutdown - The reactor is considered shutdown when both control rods and both safety rods are fully inserted.

1.2 Operation - The reactor is considered to be in operation at any time a control or safety rod is not fully inserted.

1.3 Operable - A component or system is considered to be operable when it is performing its intended function correctly or is believed to be capable of performing its intended function.

1.4 Explosive Material - A material (liquid or solid) which is characterized as severe, dangerous or very dangerous Explosive Hazard in "Dangerous Properties of Industrial Materials" by N. I. Sax, Third Ed. (1968).

1.5 Experimental Facility - The term experimental facility is understood to refer to any beam port in the biological shield or any irradiation or experimental facility which may be installed temporarily or permanently in the pool for the purposes of subjecting a sample or device to neutrons or gamma rays.

1.6 Experiment - An experiment is understood to be:

a. Any apparatus, sample, device or material placed in an experimental facility for purposes of neutron or gamma irradiation.

b. Any sample, device, apparatus or material whose purpose is to influence in any way the operation or behavior of the reactor (for example, a pile oscillator).

1.7 Reactivity Worth - The reactivity worth of an experiment is the absolute value of the change in reactivity $\Delta\rho$, where ρ = k-1/k, that can occur as a consequence of inserting, removing, or simply moving, the experiment.

1.8 Safety Channel - A safety channel is understood to be any system of sensors, electronics or measuring devices whose purpose is to provide protective information (alarm) or action (scram).

1.9 Safety Channel Calibration - The term safety channel calibration is understood to mean the adjustment and testing of any channel whose sensor output is required to respond in an acceptable range or below or above a defined limit.

1.10 Limiting Safety System Settings - A limiting safety system setting is a maximum or minimum setting on or of an automatic protection device (scram). Table 1 lists the safety channels and the associated limiting safety system settings.

2.0 SAFETY LIMITS AND LIMITING SYSTEM CONDITIONS

2.1 Reactor Power - The reactor power shall not exceed 100 watts. (Note: The University of Oklahoma reactor has operated for 20 years at 15 watts or below. The Reactor Manufacturer's Operations Manual (Dec. 1958) states that the reactor may be operated intermittently at a power level of 1000 watts with polyethelene-UO_2 fuel elements. The University of Oklahoma fuel elements have an epoxy clad and have shown no evidence of deterioration over the years. In Aug. 1978 the epoxy clad on all twelve fuel elements was totally removed and replaced with fresh epoxy. Prior experience indicates the clad will be good for several years with possible spot repairs necessary at each annual inspection of the clad. It is anticipated that at power levels over 15 watts and increase in the fission product concentrations in the pool water can be expected. At 15 watts the air monitor,

which senses air drawn directly from above the pool water surface, sees no activity above background. We expect none up to powers of 100 watts.

To ensure that no unknown factors of importance are present the following conservative power increase program will be employed:

30 days at 30 watts

30 days at 45 watts

30 days at 60 watts

30 days at 75 watts

The concentration of gross fission products in the pool water will be determined at each power level to ensure conformity with appropriate regulations. Special emphasis will be placed on detection of fission gases in the air above the pool water.

It is also noted that detailed radiation surveys taken at 15 watts indicate the facility may be operated at 100 watts in full conformity with regulations and good practice with the proposed shield modifications.)

2.2 Pool Water Level - The minimum level of the pool water shall not be less than nine (9) inches from the top of the pool tank to provide biological shielding.

2.3 Pool Water Temperature - The minimum pool water temperature during operation shall not be less than 5° C.

2.4 Pool Water Monitor (PWM) - The pool water monitor refers to the system which consists of a 2 x 2 NaI (Tl) detector placed at the center of a cylindrical tank filled with water from the reactor pool. A pump circulates the pool water to the water-monitor detector and through an ion-exchanger and filter system and back to the pool. The water

intake to the water monitor system is located at the bottom of the pool near the bottom edge of the graphite reflector.

The purpose of the water monitor system is to measure the build-up of radioactivity in the pool water during reactor operation. Because the fuel elements are epoxy clad polyethylene-uranium oxide some high-yield gaseous fission products will slowly diffuse out of the fuel into the water as the fuel temperature and the density of the fission products in the fuel elements increases.

The pool water monitor shall have a limiting safety scram setting at two (2) times the equilibrium reading for a power of 100 watts.

2.5 Pool Water Conductivity - The pool water conductivity is measured before startup and after shutdown and shall be maintained at less than 2.5 micromhos/cm.

2.6 High Power Pool Shields - At any power level above 15 watts, four iron-plate (one inch thick) pool cover gamma-shields shall be installed. The iron-plate gamma shields span the top of the pool tank reducing the background in the reactor room from gamma rays leaving the fuel and scattering in the water.

2.7 Console Shield - At any power level above 15 watts the supplemental concrete block shield (a row of 8 x 16 x 3 block) between the reactor and the operator's console shall be in place. The purpose of this supplemental shield is to maintain the exposure rate at less than 2 mr/hr at the console at 100 watts.

3.0 REACTOR FUEL AND REACTIVITY LIMITS

3.1 The reactor shall operate with 12 fuel elements or less of the type supplied by the reactor manufacturer.

3.2 The total excess reactivity (ρ) including the reactivity worth of any experiments and with all safety and control rods withdrawn shall not exceed 0.65% at any pool water temperature. The purpose of this rigid limit is to ensure that it is not possible to put the reactor on a prompt period under any condition.

4.0 CONTROL AND INSTRUMENTATION

4.1 The fine control rod, coarse control rod, and two safety rods shall be operable and the carriage position of the control rods shall be displayed at the console whenever any rod is above its lower limit.

4.2 The reactivity worths of the control and safety rods shall be such that the reactor will be subcritical when: (a) both safety rods are fully withdrawn and both control rods fully inserted, or (b) either of the safety rods or the coarse control rod is fully inserted.

4.3 Each of the safety channels in Table I shall be operating whenever any control or safety rod is not in its fully inserted position. Each of the operating safety channels shall sound an alarm and cause automatic reactor shutdown if the limiting safety system setting is reached.

4.4 Prior to any operation of the reactor the required checkout procedure shall be followed.

4.5 A reactor staff study made in the summer of 1978 indicated that all current reactor instrumentation is operating properly and is satisfactory for increased power level operation. Three recommendations were made:

a. Increase the sensitivity of the water monitor.

b. Increase the sensitivity of the air monitor.

c. Withdraw the log N ionization chamber back several centimeters to allow it to be recalibrated for 100 watt operation.

All three of these recommendations will be implemented prior to any power increase over 15 watts.

5.0 LIMITATIONS ON EXPERIMENTS

This specification applied to all experiments placed in permanent or temporary facilities.

5.1 Highly corrosive materials will be doubly contained.

5.2 No explosive material will be irradiated without written approval of the Reactor Safety Committee. Such approval will be specific stating exact conditions under which the sample exposure may take place.

5.3 Any sample or experiment in liquid form or containing liquids will be doubly contained if inadvertent release would affect reactor safety or result in serious contamination of the reactor's facilities.

5.4 No part of the concrete biological shield will be removed or replaced to accommodate experiments without the written permission of the Reactor Safety Committee.

6.0 SURVEILLANCE REQUIREMENTS

6.1 Safety channels listed in Table I shall be fully inspected and calibrated annually to ensure their correct operability.

6.2 The reactivity worth of each control and safety rod shall be measured annually.

TABLE I

REACTOR SAFETY SYSTEMS WHICH PRODUCE SCRAMS

DEVICE	FUNCTION	LIMITING SAFETY SYSTEM SETTINGS
1. Log Power Channel	High Power Limit	200 watts
	Low Power Limit	Less than neutron startup source current reading
	Short Period Limit	5 seconds
2. Linear Power Channel	High Power	160 watts
3. Reactor Tank Water Level	Low Pool Water	9 inches below reactor tank top
4. Pool Water Temperature	Low Pool Water Temperature	5° C
5. Pool Water Circulating Pump	Pump must be operating	Scram if pump power not on
6. Pool Water Monitor	Detect excessive water activity	Scram at 2 times the 100 watt equilibrium level

6.3 All control (2) and safety (2) rods shall be physically removed and inspected once each year and rod drop times measured.

6.4 A power calibration (gold foil) shall be performed once each year.

6.5 A contamination survey of the reactor laboratory room shall be made at least monthly except when no reactor operations have occurred.

6.6 All 12 fuel elements will be removed from the reactor and a visual inspection of all surfaces will be conducted at least once each year. Any necessary repairs to the epoxy clad will be made as in the past.

7.0 REACTOR AND FUEL SAFETY

The purpose of these procedures is to provide protection for the reactor and its fuel and to avoid accidents to the uninformed.

7.1 The reactor laboratory is a large room containing two entrances. The front entrance requires passage through two locked doors. The rear entrance (cargo and equipment) is a double-door assembly.

7.2 The normal state of both entrances is a locked condition. The rear entrance door is always in a locked state. The front entrance (both doors) may be unlocked during student labs.

7.3 Keys to the reactor room are issued according to the authorizations set forth in the Physical Security Plan.

7.4 Reactor Fuel - The AGN-211P has 12 fuel elements, 20% enriched. These 12 elements are normally kept in the core at all times. When the fuel elements are removed for inspection (once every year), they will be stored in the reactor fuel element storage facility immediately adjacent to the reactor (See description in Physical Security Plan).

8.0 ADMINISTRATIVE DIRECTION

8.1 Organization - The administrative organization, whose function is to ensure that the reactor is operated in a competent manner fully complying with Federal regulations, is shown in Figure 1.

8.2 Reactor Director - Responsible for the general administration of the facility. In this capacity the Director shall have the authority and responsibility for the facility and, within the limitations set forth by the facility license, shall make policy decisions on all phases of the reactor operation, appoint personnel and be advised in all matters concerning reactor safety by the Reactor Safety Committee, the Radiation Safety Committee and the University Radiation Safety Officer.

8.3 Reactor Supervisor - Has over-all responsibility for the daily operation and maintenance of the reactor facility and training and supervision of reactor staff personnel. The Reactor Supervisor is responsible to the Reactor Director.

All operations which involve physical alteration of the fuel will be directly supervised by the Reactor Supervisor.

8.4 Reactor Safety Committee - The Reactor Safety Committee shall be composed of not less than five members, of whom no more than three nor less than one are members of the operating organization. The Committee shall meet on call of the Chairman and they shall meet at least quarterly. The Committee shall be responsible for, but not limited to the following: (1) reviewing and approving safety standards associated with the use of the facility, (2) reviewing and approving all proposed experiments and procedures and changes thereto, and modifications to the reactor and its associated components, (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, (4) conducting periodic audits of procedures, reactor operations and maintenance, equipment performance, and records, (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, (6) reporting their findings and recommendations concerning the above items to the Reactor Director and higher authorities.

The Reactor Safety Committee shall function in accordance with a written charter which includes provisions for frequency of meetings, quorum, submission and contents of reports presented to the Committee, scope of sub-committees and dissemination of minutes.

8.5 University Radiation Safety Officer - Has over-all responsibility for radiological safety and shall see that necessary radiation surveys are conducted in the Reactor Laboratory.

The Radiological Safety Officer shall review the radiological safety aspects of reactor experiments and shall advise the Reactor Director in all matters relative to radiological safety of the reactor and its operations.

8.6 Reactor Staff Qualifications - All personnel directly associated with the reactor shall meet the minimum standard qualifications set forth in ANS 15.4 "Standards for Selection and Training of Personnel for Research Reactors."

8.7 Procedures - Detailed written procedures shall be provided for

a. Normal Start-up

b. Normal Operation

c. Normal Shut-down

d. Refueling or rearrangement of fuel

e. Emergency procedures involving radiation

f. Special maintenance which could conceivably affect reactor safety.

8.8 Record Retention - Records to be retained for a period of not less than six years are:

a. Operating logs

b. Check-out and shut-down forms

c. All data relevant to reactor performance

d. Principal maintenance operations

e. Facility contamination surveys

f. Records of experiments performed

g. Production of radioisotopes

8.9 Records to be retained for the life of the facility -

a. Gaseous and liquid radioactive effluents intentionally released to the environs

b. Any off-site environmental monitoring surveys

c. Fuel inventories and transfers

d. Facility drawings

e. Records on training of personnel

f. Reactor Safety Committee minutes.

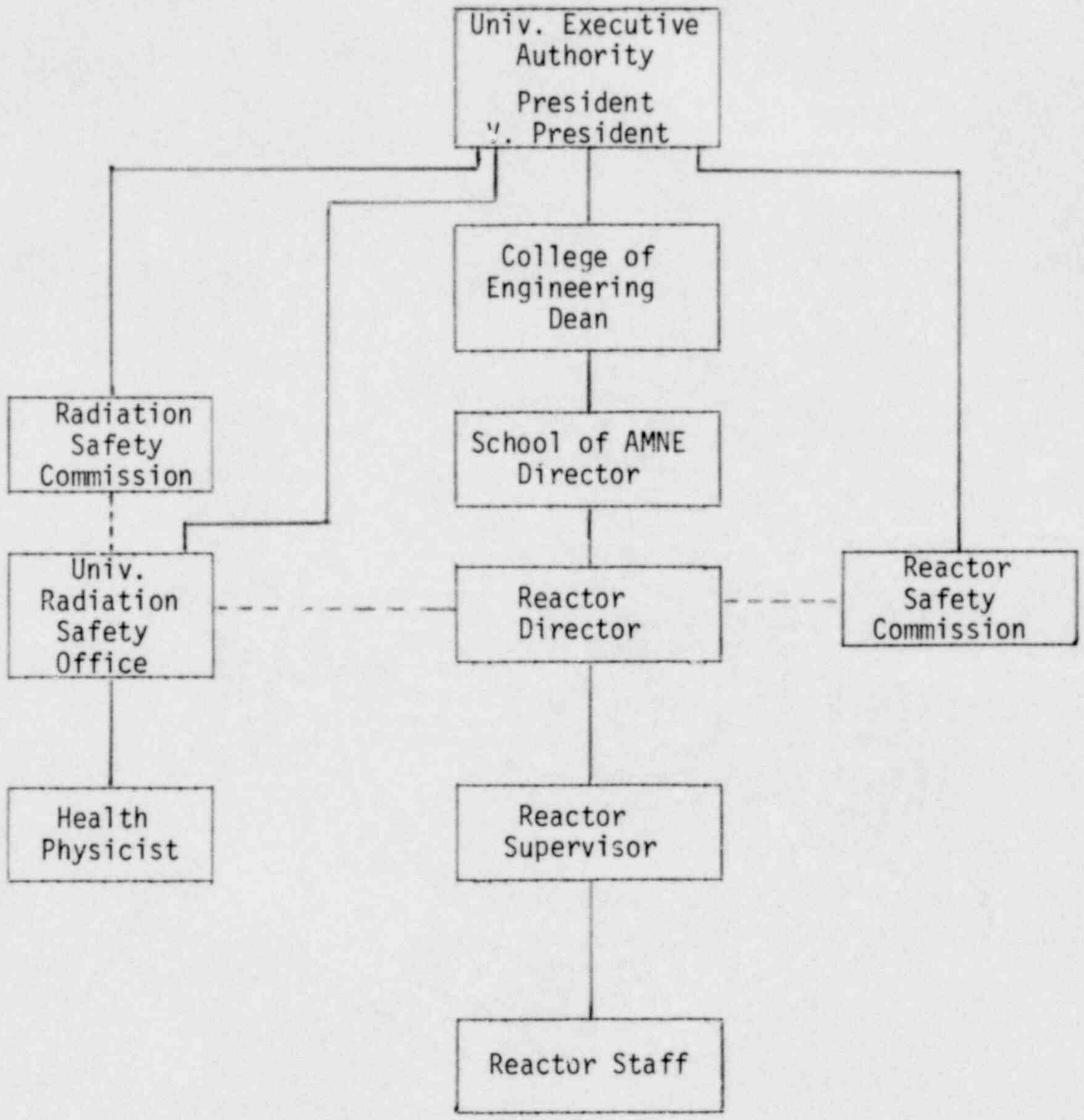

Figure 1 Administrative Organization of University of Oklahoma Reactor