50-39

LRL:CTE
Docket 50-39

APR 8 1958

Curtiss-Wright Corporation
Research Division
Quehanna, Pennsylvania

Attention: Dr. Carlyle J. Roberts
Chief, Research Reactor Division

Gentlemen:

Transmitted herewith is a notice of proposed issuance of a facility license authorizing Curtiss-Wright Corporation to operate a pool-type research reactor. Also attached is a copy of a memorandum setting forth the principal factors considered in reviewing the application.

The notice is being submitted for publication in the Federal Register.

You will note that the proposed license incorporates a condition that until equipment providing forced circulation has been installed the power level is limited to a maximum of 100 kilowatts.

Sincerely yours,

H. L. Price
Director
Division of Licensing and Regulation

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Enclosures:
1. Notice of Proposed Issuance
2. Memorandum

D-88

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UNITED STATES ATOMIC ENERGY COMMISSION

DOCKET NO. 50-39

THE CURTISS-WRIGHT CORPORATION

NOTICE OF PROPOSED ISSUANCE OF FACILITY LICENSE

Please take notice that the Atomic Energy Commission proposes to issue a utilization facility license to the Curtiss-Wright Corporation, 50 Rockefeller Plaza, New York 20, New York, substantially as set forth in Annex "A" below, unless within fifteen (15) days after the publication of this notice in the Federal Register a request for a formal hearing is filed with the Commission as provided by the Commission's Rules of Practice (10 CFR Part 2). A construction permit authorizing the Curtiss-Wright Corporation to construct the reactor was issued by the Commission on June 20, 1957, and amended February 14, 1958. For further details see (1) the application submitted by Curtiss-Wright Corporation, and amendments thereto, and (2) a memorandum dated April 8, 1958 submitted by the Director, Division of Licensing and Regulation, which summarizes the principal safety factors considered in reviewing the application for license, both on file at the Commission's Public Document Room, 1717 H Street, N. W., Washington, D. C. A copy of item (2) above may be obtained at the Commission's Public Document Room or upon request addressed to the Atomic Energy Commission, Washington 25, D. C., Attention: Director, Division of Licensing and Regulation.

FOR THE ATOMIC ENERGY COMMISSION

H. L. Price
Director
Division of Licensing and Regulation

Dated at Germantown, Maryland
this 8th day of April, 1958.

ANNEX "A"

PROPOSED LICENSE

1. The Atomic Energy Commission (hereinafter "the Commission") finds that:
   a. The utilization facility (hereinafter "the facility") authorized for construction by Construction Permit CPRR-11 issued to the Curtiss-Wright Corporation (hereinafter "Curtiss-Wright") has been constructed in accordance with the specifications contained in the application;
   b. There is reasonable assurance that the facility can be operated without endangering the health and safety of the public;
   c. Curtiss-Wright is technically and financially qualified to operate the facility;
   d. Issuance of a license to possess and operate the facility will not be inimical to the common defense and security or to the health and safety of the public;
   e. Curtiss-Wright has filed with the Commission, as proof of financial protection, pursuant to 10 CFR 140, copies of Binder No. 13 issued by the Mutual Atomic Energy Liability Underwriters, covering the facility, in the amount of $250,000.
2. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses Curtiss-Wright:
   a. Pursuant to Section 104c of the Act and Title 10, CFR Chapter 1, Part 50, "Licensing of Production and Utilization Facilities" to possess and operate as a utilization facility the nuclear research reactor facility designated below;
   b. Pursuant to the Act and Title 10, CFR, Chapter 1, Part 70, "Special Nuclear Material", to possess and use 4.5 kilograms of contained uranium 235 as fuel for operation of the facility;
   c. Pursuant to the Act and Title 10, CFR Chapter 1, Part 30, "Licensing of Byproduct Material", to possess, but not to separate, such byproduct material as may be produced in the operation of the facility.
3. This license applies to the facility which is owned by Curtiss-Wright and located near Quehanna, Pennsylvania and described in Curtiss-Wright's application dated October 24, 1956 and amendments thereto dated December 21, 1956, February 14, 1957,

January 27, 1958, and February 21, 1958, (all herein "the application"). The facility is a light water-cooled and -moderated research reactor designed to operate at a thermal power level of 1,000 kilowatts.

4. This license shall be deemed to contain and be subject to the conditions specified in Section 50.54 of Part 50; is subject to all applicable provisions of the Act and rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

   a. Operating Restrictions

      (1) Curtiss-Wright shall operate the facility in accordance with the application.

      (2) Curtiss-Wright shall not operate the facility at a power level in excess of 1000 kilowatts (thermal); provided, however, that Curtiss-Wright shall not operate the facility at a power level in excess of 100 kilowatts (thermal) until provision has been made for cooling by forced circulation.

   b. Records

      In addition to those otherwise required under this license and applicable regulations, Curtiss-Wright shall keep the following records:

      (1) Facility operating records, including power levels.

      (2) Records showing radioactivity released or discharged into the air or water beyond the effective control of Curtiss-Wright as measured at the point of such release or discharge.

      (3) Records of emergency scrams, including reasons for emergency shutdowns.

   c. Reports

      (1) Curtiss-Wright shall immediately report to the Commission any indication or occurrence of a possible unsafe condition relating to the operation of the facility.

      (2) Curtiss-Wright shall inform the Commission of its completion of installation of forced circulation cooling equipment.

5. This license is effective as of the date of issuance and shall expire at midnight June 19, 1977.

FOR THE ATOMIC ENERGY COMMISSION

Director
Division of Licensing and Regulation

Date of Issuance:

MEMORANDUM

BY THE

DIVISION OF LICENSING AND REGULATION

IN THE MATTER OF

CURTISS-WRIGHT CORPORATION

DOCKET NO. 50-39

Part I - Introduction

Curtiss-Wright Corporation, on October 24, 1956, submitted an application for a Class 104 license (defined in Section 50.21 of Part 50, "Licensing of Production and Utilization Facilities", Title 10, Chapter 1, CFR) to construct a utilization facility and to conduct studies related to shielding, component development, radiation damage and neutron physics.

Curtiss-Wright submitted amendments to its license application dated December 21, 1956, February 14, 1957, January 27, 1958 and February 21, 1958.

Notice of proposed issuance of a construction permit was published in the Federal Register June 4, 1957 (22 FR 3902). Accompanying the notice was a memorandum submitted by the Division of Civilian Application summarizing the principal features of the proposed facility and experiments and the principal factors considered in reviewing the application for license. Construction Permit CPRR-11 was issued June 20, 1957.

Part II - Location and Description of the Reactor

The reactor is located at the Curtiss-Wright Research and Development Center at Quehanna, Pennsylvania. This center is located on an 80 square mile tract of land, surrounded by a low population density area, in the north central portion of the State. Of the 51,175 total acres controlled by Curtiss-Wright, 8,579 are owned outright and 42,596 are leased from the State of Pennsylvania for 99 years. The reactor itself will be located a minimum of 3 miles from the present boundary of the property. The closest towns of any appreciable size are about 10 miles distant from the reactor. The area within a 25 mile radius of the reactor has an average population density of approximately 28 people per square mile.

The reactor pool is housed in a large bay 48 feet wide, 120 feet long, extending 40 feet above the general floor level and yielding a free volume of about 230,000 cubic feet. At the beam hole end, the floor is dropped 20 feet to provide access to the beam tubes as they emerge from the pool wall. The walls of the bay area are constructed of corrugated aluminum panels fastened to the structural steel frame-work and insulated by a 1 inch layer of Fiberglass. The roof consists of a metal deck, 3/4 inch Fiberglass insulation, and four ply roofing. There are no windows in the bay and only two doors opening directly to the outside. The estimated leakage rate with doors closed and ventilation off is one air-change per 32 hours under normal atmospheric pressure and temperature conditions.

Heat and ventilation for the reactor bay are supplied by a single overhead space heater. This oil fired unit provides a minimum of 20 per cent outside air and at least 6 air changes per hour. The supply fan is suspended from the ceiling of the reactor bay and draws its air from above roof level. Associated with the supply fan is an oil fired space heater which is actuated by a thermostat in the reactor bay. There are two exhaust vents located at the opposite end of the roof from the supply unit. A system of recirculation is normally used whereby a portion of the exhaust air is recirculated to the intake of the supply fan. An air sampler located in the reactor bay will provide a continuous record of the amount of radioactive air contamination. In the event of high activity in the bay air, the ventilation fan can be stopped manually and all dampers closed, thus confining the contaminated air to the stated normal leakage rate.

The reactor is of the light water-moderated and -cooled, solid fuel type, often referred to as a swimming pool reactor. The aluminum-uranium alloy fuel plates are similar in construction to those used in the Bulk Shielding Reactor at Oak Ridge, Tennessee, the Battelle Memorial Institute Reactor at Columbus, Ohio and the Materials Testing Reactor at Arco, Idaho. Cooling water is circulated through the core by natural convection at power levels up to 100 kilowatts; cooling is to be by forced circulation of water above 100 kilowatts. The core is immersed in a pool 20 feet wide by 40 feet long by 26 feet deep with a minimum of 19½ feet of water covering the core. The reinforced concrete pool is separated into two sections. One is a three-sided end section penetrated by three beam tubes for experimentation purposes. The other section, 20 feet by 24 feet, will be used for bulk shielding studies. The larger pool volume is about 93,600 gallons, while the smaller contains 53,800 gallons. The reinforced concrete pool walls are 18 inches thick, except at the beam hole end where the thickness is increased to 5½ feet. The outer four feet contains a high density ferrophosphorus aggregate which extends to 9½ feet above the floor level in the beam room.

The reactor core will be made up of eighteen or more Curtiss-Wright-designed, MTR-type fuel elements. The standard elements will contain ten fuel bearing plates. Each fuel plate contains a uranium-aluminum alloy "meat" 0.020 inch thick surrounded by 0.020 inch thick aluminum cladding. The uranium in the meat is enriched to greater than 90 per cent in U-235. The dimensions of the finished plate are approximately 3 inches wide, 24 inches long and 0.060 inch thick. Ten fuel plates are fitted into an aluminum box (3 inches by 3 inches) to make up a standard fuel element. At one end of the element, a male guide piece of circular cross-section is attached, bringing the over-all length of an element to about 3 feet. This guide piece is inserted into a hole in the grid plate which supports the entire fuel element array. Both ends of the elements are open so that cooling water may flow between the fuel plates. The outer surfaces of the elements are cooled by water which passes through a funnel formed at the intersection of four elements and through auxiliary coolant holes in the grid plate. Partial fuel elements identical in size to the standard element are available in which solid aluminum plates have replaced some of the fuel bearing plates. Thirty graphite reflector elements and eight beryllium oxide reflector elements also will be available for use in the reactor. These will be canned in aluminum and tested with helium to insure leak-tightness. Reflector elements will be clearly distinguishable from the fuel elements under the full depth of water in the pool. Moreover, each reflector element will have a large identification number engraved on two sides in order to positively distinguish these elements from the fuel elements. Both the fuel and reflector elements will be supported in a grid plate which has 54 holes, in a 9 by 6 array. The grid plate is positioned so that the fuel is at least 4 feet above the pool floor.

The pool water supply is softened and deionized prior to being supplied to the pool. There is also a continuous pool water repurification system which makes use of additional ion-exchange columns. Special lead shielded containers are available in case the resin should become contaminated.

When the reactor is operating at powers in excess of 100 kilowatts, convective cooling will not be relied upon. Instead, water will be pumped downward through the core. This will not only cool the fuel plates, but will reduce the quantity of radioactive N^{16} rising to the pool surface.

A pneumatic rabbit is provided for short term irradiations. Three beam tubes are provided primarily to obtain collimated beams of neutrons for experimental purposes, and to provide dry irradiation chambers. Each beam tube contains a boral 8 inch internal diameter section which extends from the beam hole room through the concrete shield and then tapers to a 6.06 inch internal diameter aluminum beam tube extender section (four feet long) which reaches to the face of the core and is sealed at its reactor end. Concrete shielding plugs are available for each hole when not in use. The plugs are contained in a 1/4 inch thick aluminum outer casing. There are 1 inch drains leading from the beam hole liner to the contaminated waste system. These beam hole drains will carry away any water which might leak into the beam tubes.

Three safety-shim rods and one regulating rod are used in controlling the reactor. Each of the three safety rods, made of boron carbide and cadmium, provides a delta k/k of 2.7 per cent for a light water reflector, and a delta k/k of 4.0 per cent for a graphite reflector. There are insufficient BeO reflector elements to completely surround the core, although a calculation by the applicant indicated that a 3 inch layer of BeO backed by water would provide about the same reflector savings as would a 3 inch graphite layer backed by water. Therefore, the applicant considers that each of the shim safety rods would be worth about 4.0 per cent for a BeO partial reflector. The safety rods are magnetically coupled to their respective drive mechanisms, and during a scram the rods fall freely under gravity. The maximum rate of withdrawal of the safety rods is 6¼ inches per minute. At their most effective position (about 50 per cent withdrawn) this speed corresponds to a rate of change of reactivity for any one rod of about 0.021 per cent per second for a water reflector, and 0.031 per cent per second for a graphite reflector. The safety rods may be withdrawn individually, or any combination of the three rods may be withdrawn simultaneously as desired. Since the migration length for light water is so small, there will be little "rod shadowing" and hence the maximum rate of reactivity insertion corresponding to the simultaneous withdrawal of all three rods would be 0.063 per cent per second for a water reflector and 0.093 per cent per second for a graphite reflector.

One stainless steel regulating rod is used in the control system. This rod provides a delta k/k of 0.7 per cent for a light water reflector and delta k/k of 1.2 per cent for a graphite reflector. The maximum withdrawal rate for this rod is 25 inches per minute. In its most effective position, the maximum rate of change of reactivity of the regulating rod is 0.018 per cent per second for a water reflector and 0.029 per cent per second for a graphite reflector. An interlock requires 2 counts per second signal before rod withdrawal is permitted.

The position of all control rods is continuously indicated to within plus or minus 0.05 inch at the reactor control console. A servo amplifier system is used to automatically control the power level at the desired operating level. This system is interlocked so that it cannot be energized unless the actual power level is greater than 90 per cent of the desired operating value. Four gamma compensated ionization chambers and a fission chamber serve as the flux level detecting devices. One of the ion chambers is connected to the Log N period amplifier system which furnishes a period signal to the safety amplifiers.

There are three types of automatic shutdown which provide protection against nuclear excursions. They are:

1. Slow shutdown
2. Slow scram
3. Fast scram

The slow shutdown is initiated by a microswitch in the Log N recorder whenever the flux level exceeds 120 per cent of the desired operating level or the period is less than 20 seconds. This action drives all control rods to their lower limit at full speed. The slow shutdown feature is designed to be the first line of defense against any incipiently dangerous condition such as a relatively slow rate of increase in flux level above the desired operating value.

The slow scram action is initiated by a disruption of power to the safety amplifiers, which results in a somewhat longer rod release time (about 50 milliseconds) than would result from a fast scram brought on by a current interruption to the safety rod coupling magnets. Both scram actions result in all rods falling by force of gravity. The slow scram is brought on by movement of the reactor bridge during reactor operation or by manually pushing the scram button. The fast scram is brought on when the neutron flux increases to 140 per cent of the desired operating level or when the reactor period is 5 seconds or less.

Gamma radiation detectors are located in the beam room and on the reactor bridge. The bridge monitor is interlocked with the reactor safety system to cause an automatic slow shutdown in the event that radiation levels become greater than during normal operation. A coolant activity monitor which detects delayed neutrons will cause an automatic slow shutdown upon the release of fresh fission products.

Part III - Hazards Analysis

There is an extensive body of relevant knowledge and successful operating experience for swimming pool type reactors. Further, the BORAX and SPERT experiments have provided information relating to reactivity restrictions necessary in this type reactor.

The applicant has reviewed the available BORAX and SPERT data and, coupled with the results of calculations, has concluded that the Curtiss-Wright reactor can withstand a step function increase in reactivity of as much as 1.5 per cent and a ramp addition of about 2.5 per cent at a rate of 0.09 per cent per second without mechanically damaging the fuel elements or approaching the melting point of the fuel elements. This appears to be a reasonable conclusion.

Based on these observations, the applicant has designed the control and regulating rod drives to prevent withdrawal of the rods at an excessive rate. Also, based on the above conclusions, the applicant has limited the total reactivity worth of small experiments of the type which could conceivably be rapidly removed to 0.2 per cent. Further, under no circumstances will an experiment be installed which has a reactivity worth greater than 1.5 per cent. Any experiment having a reactivity worth between 0.2 per cent and 1.5 per cent would be designed so that its removal could not be effected except while the reactor is shut down. In addition, the total worth of all such "fixed-type" experiments will be restricted to a reactivity worth of 3 per cent.

Two desirable characteristics in any reactor are a negative temperature and a negative void coefficient of reactivity. Curtiss-Wright has stated that it expects its reactor to have a temperature coefficient of $- 1.5 \times 10^{-5}$ delta k/k per ^{o}F. at about 100^{o}F. and an average void coefficient of approximately $- 5 \times 10^{-6}$ delta k/k per cubic centimeter. Battelle Memorial Institute has conducted a number of experiments to determine the void and temperature coefficients in a reactor employing fuel elements of the same plate spacing and thickness as Curtiss-Wright. The results indicate that the values quoted by Curtiss-Wright are of the magnitude to be expected. We feel there is reasonable assurance that this facility will have both a negative void and temperature coefficient; however, Curtiss-Wright will measure these coefficients during critical experiments prior to full power operation.

The applicant has considered a number of mechanisms which would unintentionally introduce excess reactivity into the core. The applicant concludes that none of these accidents would result in the release of fission products. In view of the aforementioned reactivity limitations placed on the control rods and experiments and the expected negative temperature and void coefficients, we concur in this conclusion.

Although there does not appear to be a credible accident which would release fission products, the applicant has calculated the radiation dose which would result should such a release occur. The dose at the nearest site boundary following the release of 10 per cent of the fission products in the reactor would be less than 1 rad from internal or external radiation. Assuming an RBE (relative biological effect) from beta radiation,as is specified in the Commission's regulation "Standards for Protection Against Radiation", 10 CFR, Part 20, this is equivalent to one (1) rem of exposure in one week and compares with .9 rem permitted persons working in radiation areas in a single week under Part 20. Due to the remoteness of the reactor site and the relatively low dosages which would result in public areas even from the release of fission products by some accident which does not appear credible the construction of a containment vessel does not appear to be necessary.

Part IV - Technical and Financial Qualifications

At the time consideration was given to the issuance of a construction permit covering this facility the Commission reviewed Curtiss-Wright's technical and Financial qualifications and determined that the applicant was technically and financially qualified to construct and operate the facility in accordance with the regulations contained in Title 10, Chapter 1, CFR. There is no additional information to suggest any change in those determinations.

Part V - Financial Protection

Curtiss-Wright has filed with the Commission, as proof of financial protection, pursuant to 10 CFR Part 140, copies of Binder No. 13, issued by the Mutual Atomic Energy Liability Underwriters, covering this facility, in the amount of $250,000.

Part VI - Conclusion

Based on the above considerations, it is concluded that:

a. There is reasonable assurance that the health and safety of the public will not be endangered by the operation of the facility.

b. Curtiss-Wright is technically and financially qualified to engage in the proposed activities.

FOR THE DIVISION OF LICENSING AND REGULATION

H. L. Price
Director

Date: [illegible]