LOCKHEED-GEORGIA COMPANY

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

MARIETTA, GEORGIA 30060

January 29, 1971

LGD/303992

United States Atomic Energy Commission
Division of Reactor Licensing
Washington, D.C. 20545

Regulatory File Cy

Subject: Technical Specifications for Radiation Effects Reactor, Docket 50-172

Gentlemen:

Our letter of August, 14, 1970 (LGD/299741, Subject, Radiation Effects Reactor, Docket 50-172), advised the Commission that operation of the Radiation Effects Reactor (RER) had been terminated. We also enclosed a set of proposed technical specifications for the RER facility pending development of a reactor decommissioning plan. During the intervening period, representatives of the Division of Reactor Licensing and of Lockheed have had several conferences regarding the adequacy of the proposed technical specifications. Lockheed has, as a consequence, modified its proposed technical specifications in several areas to incorporate several additional restrictions which the Division of Reactor Licensing considers necessary to enhance the safety of the RER prior to the start of decommissioning. Accordingly, Lockheed now requests that the proposed technical specifications contained with our letter of August 14, 1970, be withdrawn, and that the proposed technical specifications and supporting analyses enclosed with this letter be substituted. Addendum 1 to our letter of August 14, 1970, listing the incumbent membership of the Procedure Review Committee at that time, is still valid and should be considered a part of the new proposed technical specifications.

We wish to advise that Lockheed is also continuing its plans for decommissioning the reactor facility, and expects to submit a proposed decommissioning plan to the Commission in the very near future.

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United States Atomic Energy Commission LGD/303992

If you have any questions about the above or attached information, please contact M. A. Dewar, Department 72-14, Zone 401, Lockheed-Georgia Company, Marietta, Georgia 30060, phone Area Code 404, 424-8367. Your early consideration of this request will be appreciated.

Very truly yours,

LOCKHEED-AIRCRAFT CORPORATION

H L Poore

H. L. Poore
Vice President

HLP:pb

Enclosures

H. L. Poore, under oath, states that the above and attached statements are true to the best of his knowledge and belief.

Subscribed and sworn to before me this 29th day of January, 1971, at Marietta, Georgia.

Gertrude B. Rachels

Notary Public

My Commission expires: March 1, 1971

HAZARDS ANALYSIS

[illegible] 1.29.71

Regulatory File Cy.

In conjunction with its application for permission to own but not operate the Radiation Effects Reactor under Facility License Number R-86, Lockheed is enclosing a set of revised technical specification. Changes are identified in the specifications as -r- (revisions), -d- (deletions), and -a- (additions). Following are the basis for the indicated changes:

A. SITE

A-2. As indicated in our annual report dated September 26, 1968, security of LGNL is subcontracted to a professional security agency. The subcontractor security personnel operate under the same rules and regulations as Lockheed Plant Protection, and there is no degradation in the level of security afforded.

A-3. Inasmuch as there will be no further operation of the reactor, those portions of A-3 which refer to access control during reactor operation are no longer necessary. Appropriate access control requirements have been moved to Section L.2.1. and will be covered in the discussion of Section L

B. BUILDINGS

B-2. Inasmuch as there will be no further operation of the reactor, those portions of B-2 which refer to conditions during reactor operations are no longer necessary. None of the reactor system controls will be operated. Certain portions of the primary cooling system valving may be altered, but only at the direction of and with the cognizance of, the Reactor Supervisor. The reactor lift controls may be operated, but only at the direction of and with the cognizance of, the Reactor Supervisor. The reactor lift position indication system is only operable when the reactor upper closure and equipment tanks are assembled on the present vessel. Hence in present shutdown configuration there is no reactor lift position indication system. When the reactor lift is in the fully raised position and there is no shielding water in the shield tanks, the dose rate outside the reactor building is not greater than 100 mr/hr. Hence we visualize no circumstance by which operation of the lift controls would be detrimental to the health and safety of the general public. The electrically operated doors controlled from the operations building prevented inadvertent departure of personnel from the operations building during reactor operation. Since the reactor will no longer be operated, the requirement for electrically locking the doors no longer exists. The ventilation system kept the operations building at a positive pressure with respect to the reactor building during reactor operation to prevent reactor-activated argon-41 and airborne particulate contamination from entering the operations building. Hence operation of the ventilation system is no longer required.

A-31a

C. RADIATION MONITORING

C-1. The gaseous and particulate monitoring systems in the existing specifications are pertinent only during reactor operation and hence are no longer necessary.

C-2. The continuous fission products monitoring system described in the current technical specifications constitutes an operational requirement only. Since the primary loop is no longer operating, and since the reactor fuel is no longer stored in the primary cooling system, operation of the fission products monitor would not reveal a fuel element cladding rupture. Analysis of the grab samples as specified in the proposed technical specifications is no less restrictive, however, than the monitoring method prescribed in the last sentence of Paragraph 4 of Change No. 7 to the RER Technical Specifications. Furthermore, once the fuel has been removed from the facility, the requirement for monitoring for inadvertent release of fission products ceases to exist, justifying the proposed reduction of sampling frequency.

C-3. This section is deleted since use of the operations building monitors is required only during periods of reactor operation.

C-4. This section is deleted since use of the remote area monitoring system is required only during periods of reactor operation.

C-5. The paragraph describing the water samplers has been changed to clarify the mode of operation of the samplers. The river samplers are continuously drawing a small water sample into a large container in which the sample is homogenized. A sample is withdrawn from the large container at the indicated sampling frequency.

The number of air sampling locations has been reduced to the indicated level inasmuch as a sampling program of this magnitude is deemed adequate to document a fission product release.

The change in wording in the paragraph on the soil and vegetation sampling program is for clarification only.

C-6. Specification of a criticality alarm system is deemed necessary to satisfy the monitoring requirements for special nuclear materials not being stored in a reactor. Alarm set points for the monitoring device are fixed by the Code of Federal Regulations. The conditions and criteria set forth for portable monitoring during periods of non-operability of the criticality alarm system are intended to recognize the fact that a system can break down, and to encourage expeditious repair of the system by Lockheed.

E. EMERGENCY SYSTEMS

The cooling requirements for the fuel have been calculated, and it has been ascertained that using air convection cooling only, the maximum fuel plate temperature will not exceed 413°F. The calculation assumes no conduction of heat to the fuel element storage rack, which weighs 363 lbs, and which represents a very significant heat sink by conduction.

The current power generation in the two RER cores has been calculated based on the Way-Wigner equation:

$$P = 0.0622 P_o \left[t^{-0.2} - (t + T)^{-0.2} \right]$$

Where

P = Present power

P_o = Operational power level

t = Shutdown time, seconds

T = Operating time, seconds

The first core was operated for total of 3828.28 MWH between December 14, 1958, and February 28, 1964. The following table gives the number of megawatt hours generated in each year, the last date of operation in each year, and the maximum power of operation during that year:

Year	Date of last operation in that year	Maximum Power Level	Megawatt hours in year
1959	Dec. 30	10 MW	793.88
1960	Dec. 1	10 MW	2655.55
1961	June 27	10 MW	33.32
1962	Dec. 28	1 MW	45.91
1963	Dec. 31	1 MW	287.65
1964	Feb. 28	1 MW	11.97

For conservatism, all operation was assumed to be continuous at the maximum power level, ending on the last indicated date of operation. In actuality, operation occurred in almost every month of each year and at varying power levels up to the authorized level. Hence lumping each year's operation into one continuous period at the end of the year increases the conservatism of the calculation. The power generation from the first core, based on these assumptions, was 2.503 KW on December 31, 1970.

A similar set of assumptions was made for the second core based on the following data:

Year	Date of last operation in that year	Maximum Power Level	Megawatt hours in year
1964	Dec. 23	3 MW	882.86
1965	Dec. 30	3 MW	953.82
1966	Dec. 28	3 MW	1092.92
1967	Dec. 19	3 MW	457.53
1968	Dec. [illegible]	3 MW	422.22
1969	Dec. 11	3 MW	157.88
1970	Jul. 16	3 MW	115.10

The power generation from the second core on December 31, 1970, is 9.497 KW.

The fuel elements are assumed to be cooled by natural convection of air. A fuel element storage rack with 20 elements, rather than the actual core loading of 26 elements, was conservatively estimated to have a total shutdown power of 9.497 KW. The hottest coolant channel is estimated to dissipate about 120 BTU/hr, or about 1/3 more power than the average channel. The temperature rise of the air in passing through a channel is:

$$\Delta T = \frac{q}{\dot{m}\, c_p}$$

where q is the heat flow into the channel, c_p is the specific heat (a value of .243 BTU/lb°F is assumed) and $\dot{m}$ is the mass flow rate. $\dot{m} = VA\rho$ where V is the velocity of the air, A is the cross sectional area of the channel (.0018 ft^2) and ρ is the density of the air in lb/ft^3. $\rho = \rho_0 (T_0/T)$ where the zero subscript refers to initial conditions (that is, upon entering the channel); T is the absolute temperature: ρ_0 = .0711 lb/ft^3 for an assumed T_0 of 560°R. The velocity which the air reaches in traversing this channel is thus

$$V = \left(\frac{1.91T}{T-560}\right) \frac{ft}{sec} \qquad (1)$$

The acceleration due to the buoyant force resulting from heating the air is given by $a = g\,\beta\,\Delta T$ where g is the acceleration due to gravity (32.17 ft/sec^2); β is the volumetric expansion coefficient (0.002033/°F); ΔT is the increase in temperature in °F of the air. The average acceleration of the air in passing through the fuel element may be taken as a/2. Hence:

$$\bar{a} = (32.17)\ (.002033)\ \frac{\Delta T}{2} = (.0327\,\Delta T)\ \frac{ft}{sec^2}$$

With an initial velocity of zero, the distance the air stream traverses in time t is given by $z = \frac{1}{2}\,\bar{a}\,t^2$; with z = 2 ft, $t = (4/\bar{a})^{\frac{1}{2}}$.

The velocity after time t is: $V = \bar{a}t = .362\,(\Delta T)^{\frac{1}{2}}$ ft/sec (2)

Combining equations (1) and (2) provides an exit temperature for the air of 827°R (367°F). The maximum temperature differential between the air and the fuel plates is estimated by $\Delta T = \frac{q\,\lambda}{k\,A}$ where q is the heat flow rate (a value of 90 BTU/hr or about twice the average value is assumed to approximate the maximum conditions) from one face of the fuel plate; A is the surface area of one face of the fuel plate (.2 ft x 2 ft); λ is the distance from the fuel plate surface to mid channel (0.0045 ft) k is the conductivity of air (.022 BTU/ft hr°F). Hence ΔT = 46°F. The maximum heat flow rate will occur near the midplate of the fuel. It is thus conservative to consider the maximum temperature differential between the air and the fuel plate at the top of the fuel. The maximum fuel plate temperature would thus be 413°F which is far below the melting point of about 1220°F.

The temperature differential across the .02 inch aluminum cladding and across the fuel itself (.02 inch thickness) was found to be on the order of milli degrees.

Loss of power at the REF will activate the criticality monitoring system alarm. Hence from the standpoint of criticality monitoring, no need exists for emergency power. To inhibit corrosion of the fuel cladding, the pool in which the RER fuel is stored is maintained at a high degree of purity by the pool circulating system. It has been determined that the quality of the pool water remained within acceptable limits when the pool circulating system was shut down for a period of two weeks. Hence it is concluded that temporary loss of power at the REF will not lead to a condition detrimental to the cladding on the reactor fuel, and thus no need for emergency power exists.

On the basis of the above observations, no description of the operational emergency systems is considered necessary in the Technical Specification.

F. CORE COMPONENT STORAGE

F.1 The changes in this section have included reidentification of the title to include the reactor start-up source; description of the current core component inventory; and establishment of that inventory as the upper limit.

Lockheed has on hand at LGNL (but not at the REF) 38 new fuel elements and 5 new control rods which have not been irradiated and which are still stored in their original criticality-safe shipping containers. At the time shipping casks arrive at LGNL for removing the irradiated fuel, it may be desirable to ship some of the new elements along with the irradiated fuel. Inasmuch as there are no Lockheed facilities outside the REF for opening the shipping cask after irradiated fuel has been placed in the cask, it will be necessary either to load the new elements into the cask

before the cask is taken to the REF, or to take the new elements to the REF and load them into the cask while the cask is in the storage pool. Written procedures for accomplishing the handling and loading of the new elements will be subject to the approval of the Procedure Review Committee. The procedures will incorporate the criteria that no more than one fuel assembly will be out of a criticality-safe container at any one time; and that all fuel handling will be conducted under the direct surveillance of the Reactor Supervisor.

F-3. A question has been raised by the United States Atomic Energy Commission as to the possibility of spilling fuel elements into a critical array during handling of the fuel element storage racks. Spilling fuel from the storage rack is precluded by the storage rack design. The lifting bail on the rack will not operate unless the rack lid is closed and mechanically locked. As long as there is pressure on the lid in either direction, the spring-loaded latch cannot be released. Hence spilling of the fuel is assumed to be incredible.

F-4. At the time the reactor facility was designed and built, the anticipated turnover of reactor fuel was expected to be a core loading approximately every three months. A criticality-safe fuel element shipping cask meeting Bureau of Explosives requirements was provided with the reactor, and an underwater cutting tool was also provided to remove excess metal (end boxes; lifting bails) from the fuel assemblies. The shipping cask was sized to accommodate the fuel assemblies only when the excess metal had been removed. Lockheed will not attempt to get its shipping cask approved for shipment of the irradiated fuel, but will instead plan shipment of the fuel in licensed fuel shipping casks. Depending upon the economics involved, however, Lockheed may elect to remove the excess metal, using the underwater cutting tool, before the fuel is shipped. The tool carriage contains guides for positioning the fuel assemblies as necessary to assure that no cut will be made into a fuel plate. If it is determined that the excess metal will be cut off prior to shipment, written procedures for utilizing the cutting tool will be prepared, and will be subject to review and approval by the Procedure Review Committee. The previously stated conditions on administrative control (no more than one fuel assembly being handled at one time; all handling under direct surveillance of Reactor Supervisor) will also apply.

G. REACTOR SHIELD TANKS

The basic purposes for the reactor shield tanks were (1) to serve as a housing for the reactor system nuclear detectors; and (2) to attenuate the neutron flux (and thus minimize neutron activation) in all directions except toward the test article being irradiated. Since the fuel is no longer in the reactor and the reactor will not be loaded and operated any more, the above functions are no longer necessary.

H. REACTOR DESIGN

H-2. Shutdown procedures exist which provide that, during non-operational periods, the reactor lift may be immobilized at any desired level by means of hand-operated bleed line valves. Procedures also exist which provide that a specific storage rack will be used for storing the upper closure whenever the upper closure is removed from the pressure vessel. There is no degradation in the level of safety involved in the changes which have been made in this section, and the only purpose of the changes is to document the above practices.

H-3. The only changes to the description of the internal components are to exclude fuel from being reloaded into the reactor and to specify the manner of storage of the other components. Neither of the above changes represents a degradation of reactor safety, and both actions are permitted by current operating and/or maintenance procedures.

H-4. The changes to subparagraph b. of this section are to specify the actual inventory of drive mechanisms and to indicate approved areas for storage. These changes represent approved procedural practices, and do not represent a degradation of reactor safety. The deletion of the operating limitations (subparagraph c.) applies only to operation of the reactor and hence does not degrade safety in the shutdown facility.

H-5. The change to subparagraph c. of this section deleted authorization to use a plutonium-beryllium source and prohibit reactivation of the antimony-124 source. The above changes and the changes to subparagraph d. all apply to operating conditions; since there will be no further operation of the RER, none of these changes will affect reactor safety.

I. NUCLEAR AND PROCESS INSTRUMENTATION

In previous discussions it has been shown that the only requirements for continuous instrumentation consist of monitoring for criticality and monitoring the level of water in the storage pool. The sections of the operational technical specifications applied only to conditions during facility operation, and none of the conditions of the operational specifications could, in our opinion, be considered mandatory to assure the safety of the facility in its present configuration.

J. EXPERIMENTAL FACILITIES

Inasmuch as there will be no further operation of the RER, and since the reactor core has been unloaded and stored in the storage pool, the limitations imposed on experiments by this section are no longer pertinent. The one exception is the lithium hydride shield which is currently stored in the

reactor building basement, and negotiations are underway to dispose of the shield to a licensed waste disposal firm as radioactive waste. A pressure check of the shield is performed weekly and the proposed technical specifications request that the interval be changed to monthly. There has been no indicated change in pressure for over two years.

The restrictions on operation of the locomotive and on the presence of railway cars were imposed because of the potential of damaging the reactor and possibly crushing the fuel in the reactor. Since the fuel is now located in the storage pool at a horizontal distance of more than 20 feet from car position 3/4, it is considered unlikely that a car or locomotive could obtain enough kinetic energy to leave the tracks and impact on the fuel. Cars or locomotives on tracks 1 and 2 or on car position 5/6 would have kinetic energy only in a direction 90° from the direction to the stored fuel and at a minimum horizontal distance of 10 feet from the fuel. Hence it is considered unlikely that the fuel could be damaged from those directions. Therefore, it is considered that there is no need for restrictions on the use of railroad rolling stock. For the same reason, the requirement for the derail at the exclusion fence gate was also imposed to assure that a runaway locomotive could not reach the reactor, and this requirement also no longer exists. Use of the derails in the indicated configurations will as a matter of course be continued, but we propose that there be no requirement for reporting and logging the derail configuration.

K. REACTOR COOLANT SYSTEM

As previously discussed in Section E, there is no requirement, under either normal or emergency conditions, to provide a cooling system in the present configuration. Periodically circulating the pool water through the pool and/or bypass demineralizer has been shown to maintain the pool water purity at a level adequate to retard corrosion of the fuel cladding. Limits for the water quality are stated in Section I, and the pool water will be circulated through portions of the primary coolant system and the demineralizers when necessary to maintain water quality within these limits.

L. ADMINISTRATIVE AND PROCEDURAL SAFEGUARDS

L-1. With the shutdown of LGNL, the emphasis has shifted from operational safety to that of maintaining a safe configuration during the planning and conduct of decommissioning of the reactor facility. The individual responsible for maintaining the safe configuration has not changed, but the methods by which we intend to assure this continuity of safety are reflected in the proposed technical specifications. The responsibilities assigned the Reactor Supervisor are the same responsibilities assigned to the senior operator and his team in the operational technical specifications.

The Reactor Safety Committee, which was responsible for experimental safety, is replaced by the Procedure Review Committee, three of whose four incumbent members are also members of the Reactor Safety Committee. The job titles which were specified for the membership of the Reactor Safety Committee have been abolished, but the last incumbents in those positions or their alternates are continuing as members of the Reactor Safety Committee until adoption of these proposed technical specifications. Except for the fact that the Procedure Review Committee does not encounter problems involving safety of reactor experiments, the functions of the Reactor Safety Committee and of the Procedure Review Committee are essentially identical.

[illegible]. The provisions for control of access to the exclusion area are essentially identical to those contained in the operational technical specifications, and procedurally have been moved to this section of the specifications because they are now administrative procedures not affecting reactor safety.

A. SITE

1. PHYSICAL LOCATION

The reactor facility is located in Dawson County, Georgia, on a site which is nominally described by the parallels 34°, 2[illegible].6 minutes north latitude and 34° 24 minutes north latitude, and the meridians 84° 08 minutes west longitude and 84° 12 minutes west longitude.

-r- ### 2. DESCRIPTION OF CONTROLLED AREA

The reactor is located within the Georgia Nuclear Laboratories, a controlled area of roughly 10,000 acres. The nearest uncontrolled areas are the south perimeter fence (8240 feet south), the east perimeter fence (9820 feet east) and the west perimeter fence [illegible]20 feet west). The minimum distance to the north perimeter fenc[illegible] [illegible]285 feet [illegible] All land within that area is controlled by Plant Security, and the nearest routinely occupied above-ground work area is about 8845 feet from the reactor. A chain link exclusion fence surrounds the reactor generally at a radius of 3600 feet. A segment of the fence North East of the reactor is slightly closer than 3600 feet.

-d- ### 3. EXCLUSION AREA ACCESS CONTROL

B. BUILDING

1. REACTOR BUILDING

The reactor building is of conventional construction with steel I-beam columns and built-up truss work. Siding and roofing are corrugated aluminum. The building is not heated; however, during periods when the ambient temperature is below freezing, the reactor will not be raised from the pool unless heat is provided to prevent auxiliary piping (e.g. shield tank plumbing system) from freezing. Roof mounted fans are provided to ventilate the building as necessary.

-r- 2. OPERATIONS BUILDING

The operations building is an underground concrete structure with approximately 2 feet of concrete and 5 feet of earth on the roof to provide shielding.

C. RADIATION MONITORING

-d- 1. GASEOUS AND PARTICULATE MONITOR

-r- 2. RER STORAGE POOL

While reactor fuel is stored in the RER storage pool, grab samples of the storage pool water shall be collected at least weekly and analyzed for gross beta-gamma and gross alpha activity. If the pool pump is not operable at the time the sample is to be taken, the sample shall be taken from within 3 feet of one of the baskets containing stored fuel elements. If a sample has a radioactivity concentration in excess of $1x10^{-2}$ μc/cc, an investigation shall be made as to the cause. If it is found that a fuel element is leaking, action shall then be taken to identify the leaking element and seal it in a leak-proof container.

-d- 3. BUILDING MONITORS

-d- 4. REMOTE AREA MONITORING SYSTEM

-r- 5. ENVIRONMENTAL SAMPLING

A minimum of two continuous water samplers shall be located in the Etowah River, at least one being located 3600 feet or more upstream from the reactor and at least one 3600 feet or more downstream from the reactor. Samples shall be collected and analyzed at least twice monthly; the collection interval shall be approximately two weeks except when weather conditions make the sample collecting points inaccessible. Samples shall be analyzed for gross beta-gamma and gross alpha activity.

A continuous particulate air sampler at the RER demineralizer building entrance shall be operated. Filter samples from the particulate air sampler shall be collected and analyzed weekly for gross beta-gamma and gross alpha activity. Operation of the air sampling system may be discontinued after the fuel is removed from the RER storage pool.

Soil and vegetation samples shall be collected and analyzed for gross beta-gamma and gross alpha activity at least quarterly.

-a- 6. CRITICALITY ALARM

While reactor fuel is stored in the RER storage pool, a criticality alarm system shall be operable. The location, sensitivity, and alarm set point of the monitoring device for the criticality alarm system shall comply with the requirements set forth in the Code of Federal Regulations, Title 10, Part 70, Paragraph 70.24 (a) (1) as amended. The system shall alarm in Plant Security Headquarters. Response to alarms shall be made by Plant Security personnel in accordance with procedures approved by the Procedure Review Committee. The alarm system shall be checkeu for operability at least weekly. If the criticality alarm system is non-operable, the radiation level in the RER storage pool shall, during the first 72 hours of such non-operable periods, be monitored at least once every 24 hours by an individual authorized by Health Physics utilizing an operable currently-calibrated portable survey meter. After 72 hours, the monitoring frequency shall be increased to at least once every 8 hours until the criticality alarm system is operable. No activity involving fuel handling nor pool water transfer other than normal circulation shall be conducted while the criticality alarm system is inoperable.

D. WASTE DISPOSAL SYSTEM

The REF waste disposal system is designed to handle activation products generated by RER operation. Features incorporated in the design include demineralizer resin beds with decontamination factors of 10^3 to 10^4; two 5000 gallon waste decay tanks for retention of waste water with high radioactivity concentrations; and one 150,000 gallon hold and drain tank which may be used for decay and dilution of activity prior to release to the seepage basin.

The activity levels of radioactive waste released to the seepage basin will not exceed limits specified in 10 CFR 20 for restricted areas. The total annual release will not exceed 1 curie.

Radioactive waste materials will not be permanently disposed of by burial at the site except as provided by 10 CFR 20.304.

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E. EMERGENCY SYSTEMS

There shall be no requirement at the REP for emergency cooling or emergency power.

F. CORE COMPONENT STORAGE

1. INVENTORY

The number of irradiated fuel elements on hand at the REF is 56. The number of irradiated control rod fuel assemblies on hand at the REF is 8. There are elsewhere at LRNL 38 new fuel elements and 5 new control rods. When being prepared for shipment off-site, these fuel elements and control rods may be brought to the REF only in accordance with procedures approved by the Procedure Review Committee. Other identifiable radioactive material (i.e., licensed byproduct material as distinguished from activated reactor components and activated tools and experimental equipment) consists of the antimony-124 reactor startup source (currently less than 10 curies) and about 10,000 curies of encapsulated cobalt-60. All core components and byproduct material may be disposed of by authorized means.

2. STORAGE

Irradiated fuel elements shall be stored in fuel element storage racks at the bottom of the storage pool. Irradiated control rods shall be stored either in control rod storage racks along the pool wall; or in control rod storage positions, two of which are available in each fuel element storage rack. Antimony-124 shall be stored in the pool or in the pressure vessel. Any cobalt-60 in storage at the REF shall be stored in the pool. Fuel shall not be transferred to, nor stored in, the reactor.

3. FUEL ELEMENT STORAGE RACKS

Fuel element storage racks are constructed of aluminum, and contain layers of aluminum-clad cadmium around the outside of the fuel plate region and between each tier of four fuel elements. Each rack shall hold a maximum of 20 fuel elements in a 4 x 5 array. The 4 x 5 array has accommodations for storing two control rods in fuel element positions. The calculated U-235 loading required for the fuel elements in one fuel element storage rack to achieve criticality, assuming no leakage, is 211 gms per element. When leakage is assumed from the sides only, a full rack of 211 gm elements would have a calculated multiplication constant of 0.78.

4. PREPARATION FOR SHIPMENT

When fuel is being prepared for shipment off-site, fuel element end boxes may be removed from the fuel assemblies before the fuel is loaded into the cask. The poison sections and lifting bails may be removed from the control

rods before the control rod fuel sections are loaded into the cask. Such removal shall be accomplished only in accordance with detailed procedures approved by the Procedure Review Committee. Casks used for removal and shipment of fuel shall have been duly licensed for such usage in accordance with appropriate AEC & DOT regulations. Procedural control shall be used to assure that no more than one fuel assembly at a time is out of a storage rack or a shipping cask. Individual fuel assemblies shall be handled only under the direct personal surveillance of the Reactor Supervisor.

G. REACTOR SHIELD TANKS

The reactor vessel is surrounded by segmented shield tanks. The shield tanks in the quadrant 180° away from car position 3/4 shall be approximately 20 inches thick. The shield tanks in any of the other three quadrants may be either 8 inches or 20 inches thick. The tanks may be either filled or drained. The shield tanks may be removed from the reactor.

H. REACTOR DESIGN

1. LOCATION

The vertical center line of the reactor is located approximately 4'6" from the NE end of the reactor pool. The pool is rectangular and is 11-1/2' by 10' by 36-1/2' deep. There is also a storage pool which joins the reactor pool at the SW end. An aluminum gate is provided for separation of the pools. In plan view, the storage section resembles an un-symmetrical letter T. Rough dimensions are stem, 17' by 8'; cross, 24' by 6'. The depth of both of these parts is 21' below the finished reactor building floor. Curbing for both pools is continuous and extends one foot above the finished floor.

-r- 2. MECHANICAL DESIGN OF THE RER PRESSURE VESSEL

The RER stainless steel pressure vessel is designed for 150 psig at 200°F. The minimum design and construction requirements of the vessel conform to the ASME Boiler and Pressure Vessel Code, Section VIII, 1956 Edition, and the vessel bears the official code stamp. The pressure vessel is supported by two steel bands welded to four equally spaced vertical members which rest on bearing plates bolted to the platform, which in turn rests on top of the hydraulic lift. The reactor support system has been designed to support a one-fourth G side load on the reactor and shield tank.

The design loading of the hydraulic lift is 42,000 pounds, and it is designed for a total moment of [illegible]6,500 foot-pounds from eccentric loading and other causes. The lift has a stroke of 30 feet and is capable of raising the reactor at a maximum speed of 10 feet per minute. Shoes which slide on T-rails fastened to the pool walls guide the upper end of the ram through its full travel and restrain the top of the reactor to within one inch of its nominal path.

Two parallel bleed lines, controlled by individual solenoids which fail open on loss of power or on improper operation of the safety doors in the operations building, are used to lower the reactor. The bleed lines may be valved off so that the reactor may be kept in any desired position regardless of the status of electric power and other automatic interrupt devices.

The reactor upper closure is a flat, circular, forged plate 3 feet 9 inches in diameter and 5 inches thick. This closure is equipped with holes to accommodate the control rods, the regulating rod, and the fission chamber. It can be removed to provide access to the internals of the pressure vessel. The upper closure may be located either on the reactor or off the reactor. A stand at one end of the storage pool may be used for storage of the upper closure.

In addition to the opening closed by the reactor upper closure, the pressure vessel has four penetrations above the core, consisting of 6-inch instrument ports. Below the top of the core, only four penetrations exist. These are

four 8-inch pipes which serve as two primary coolant inlets and two primary coolant outlets. No new penetration shall be added to the pressure vessel or reactor closure.

-r- 3. RER VESSEL INTERNAL STRUCTURE

Internally the vessel consists principally of the inner tank, the hold-down plate, and the core support structure. The inner tank, which is open at the bottom and top, and otherwise has no penetration, serves as a flow guide. The hold-down plate, located above the core, covers the entire core section. Since flow through the core is down, the hydraulic loading of the hold-down plate is not a factor. If the reactor should ' inverted, the maximum loading on the hold-down plate would be less than 10,000 psi. The yield stress for the holo-down plate is 32,000 psi at 200°F.

The core support structure consists of a grid plate to position the various core components, a support plate which retains fuel elements, reflector elements and the start-up source within the core and a control rod shock damper which consists of a main cone, individual shock absorber tubes, and associated structural members. Its function is to transmit the shock load which the control rods impart subsequent to scram to the pressure vessel wall. As a backup to the shock damper, a mechanical stop is welded to the bottom of the pressure vessel.

The entire core structure is supported by a ring welded to the pressure vessel wall. The design criteria on stress for these structures are a maximum stress of 7200 psi on the core support bracket, 2440 psi maximum stress on the support plate, 14,500 psi maximum stress on the grid plate, and 5600 psi on the cone. The yield stress for all of these components is in excess of 25,000 psi.

Fuel elements and control rods shall not be loaded into the RER vessel. The hold-down plate, inner tank, and grid and scram damper assembly may be in the RER vesse or may be stored in the reactor building or storage pool. The start-up source, dummy fuel elements, reflector assemblies and flow baffles may be left in the RER vessel or may be removed from the vessel.

-r- 4. CONTROL SYSTEM AND OPERATING LIMITATIONS

a. Control Rod Design

The control rods are fuel and poison sections enclosed by aluminum tubes approximately 3" square by 85" long. Each has a grapple head at the top and a spring-loaded tip plunger at the bottom. The fuel section contains an aluminum strap extension at the top which extends the length of the poison section. The poison section, a square aluminum tube, slides onto the strap

and fits flush against the top of the fuel element assembly. The entire fuel-poison assembly fits into the control rod tube. A mechanical attachment on the fuel-poison section prevents assembly of the control rod if the fuel-poison section is inverted. The control rod is guided and supported within the core by means of four rollers above the core and four rollers below the core. The lower end of the control rod fits within a scram guide tube, which also acts as the hydraulic damper during scram. The poison section is a square cadmium tube, 0.02 inch thick and 32-1/4 inches long. It is clad with a 0.02-inch layer of aluminum on each side so that all edges are sealed. The length provides approximately 4-1/2 inches overlap at each end of the active fuel plates in the reactor core.

The fuel section, which contains about 111 grams of highly enriched U-235, is similar to a standard fuel element; however, it is smaller and contains 14 plates. A mechanical stop at the bottom, and the affixed poison, position the fuel section within the control rod.

The upper end of the control rod tube is fitted with a lifting knob, with which the control drive grapple engages by electro-magnet actuation, for lifting the control rod.

The core regulating rod is located near the periphery of the core. The regulating rod poison is a 30-70 cadmium silver alloy material. The tubular poison section, which has a nominal thickness of 0.09 inch, is enclosed in a tubular aluminum sheath approximately 1-1/4 inches in diameter.

b. Drive Mechanisms

The four control rods are actuated by separate mechanisms, mounted to the top head of the pressure vessel. Each control rod drive mechanism consists of an electric motor, reduction unit, a rack and pinion, limit switches, an electro-magnet and grapple, a spring loaded scram tube which provides an initial 5-g accelerating force to the rods when the grapple is released. The maximum drive speed is 4.5 inches per minute.

Magnets in the control rod and a limit switch in the hold-down plate indiate by an electric signal the position of the rod when fully scrammed as well as engagement of the rod by the mechanism. A selsyn, mounted on the gear reduction casting, gives a continuous position indication of the drive and also an indication of rod position during normal reactor operations.

The regulating rod drive mechanism, mounted to the top head of the vessel, serves to drive the regulating rod. The mechanism and rod are bolted together so that the combination is an integral unit. The regulating rod drive mechanism is very similar to the control rod drive mechanism, but no scram attachment is provided. The drive motor is designed to operate with a servo control system or under manual control.

Including spares, there are 9 control rod drive mechanisms, 3 regulating rod drive mechanisms, and 2 fission chamber drive mechanisms. The drive mechanisms may be stored either on the upper closure or elsewhere.

-r- 5. CORE OPERATING LIMITATIONS

a. The core, which has an active height of 24 inches, is designed on a 3-inch modulus in a 6 x 7 array with the four corner positions omitted. The moderator and coolant are light water. The reflector may be light water, or may be solid or canned aluminum or beryllium designed to conform to the unused spaces in the grid and external to the grid but within the inner tank.

b. Fuel material is uranium-alumin alloy. The enrichment of the fuel is nominally 93% U-235. Cladding metallurgically bonded 1100 aluminum. The fuel elements are flat plate, m.fied MTR type, aluminum, uranium assemblies. Each element contains 18 fuel plates having the approximate dimensions 0.060 inch thick, 2.75 inches wide, and 24.5 inches long. Each fuel plate consists of a nominal 0.020 inch thickness of uranium-aluminum alloy in a picture fram clad with a nominal 0.020 inch thick layer of 1100 aluminum. The plates are positioned in the element by aluminum side plates so that a nominal 0.108 inch wide coolant passage is provided between fuel plates. Each element is loaded with approximately 176 gms U-235. The top end of each element has a handling device. The bottom of each element is equipped with a positioning box about 3 inches square which fits into the grid. The overall length of fuel element is nominally 38.5 inches.

c. The start-up source is an antimony gamma emitter, placed in the center of a beryllium dummy fuel element, and is positioned in one of the available spare fuel element positions in the grid plate. For operation, the source provided a neutron flux of at least 15 nv at the fission chamber location. There will be no minimum source strength requirement at present. The source shall not be reactivated.

d. Fuel content verification and other core parameter determinations will normally be conducted at the CER. The following limitations will apply, however:

(1) The maximum number of fuel elements in the core shall not exceed 33.
(2) The maximum U-235 content of the core shall not exceed 6.2 kg.

I. NUCLEAR AND PROCESS INSTRUMENTATION

1. NUCLEAR INSTRUMENTATION

The criticality alarm system described in Section C.6 shall alarm in Plant Security headquarters. Response to alarms shall be made by Plant Security personnel in accordance with procedures approved by the Procedure Review Committee. After the reactor fuel has been removed from the pool, use of the criticality alarm system may be discontinued.

2. PROCESS INSTRUMENTATION

The reactor storage pool water shall be monitored for pH and conductivity at least weekly while reactor fuel is stored in the pool. Conductivity and pH shall be measured utilizing either portable or fixed instrumentation. If the pump is not operating at the time the sample is to be taken, the sample shall be taken from within 3 feet of one of the baskets containing stored fuel elements. Pool water resistivity shall be maintained greater than 250,000 ohm-cm, and pool water pH shall be maintained between 6 and 7.5. A pool level monitor shall sound an alarm in Plant Security headquarters if the pool water level drops below 18 feet. The pool level monitor shall be checked weekly for operability. If the pool level monitoring system is inoperable, the pool level shall be checked visually at least once every 24 hours. After the reactor fuel has been removed, operation of the pool circulation system and monitoring of pH, conductivity and water level may be discontinued.

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J. EXPERIMENTAL FACILITIES

1. GENERAL

Except for the lithium hydride shield, no experiments or equipment having significant kinetic energy shall be operated in the reactor building. No experiments or equipment involving energetic fluids or materials having a potential of sudden release of chemical energy in excess of 0.1 lb of TNT shall be stored or used closer than one foot to the reactor pressure vessel. All amounts at other distances may be determined on the basis of R^2 geometric attenuation subject to the further limitation that the total potential lateral loading of the pressure vessel support structure shall not exceed the allowable design loading. There shall be no restriction on use of the locomotive.

2. LITHIUM HYDRIDE SHIELD

A helium environment shall be maintained on the lithium hydride at all times. When installed in the facility and not in use the shield shall be stored at a positive internal pressure. Monthly checks on pressure shall be performed in order to determine the leakage rate from the shield. Gases vented from the shield will be monitored for tritium content during release to the environment. Tritium released to the environment, when averaged monthly, shall not exceed 1% of the applicable limit of the Code of Federal Regulations, Title 10, Part 20, at the site boundaries. The lithium hydride shield may be disposed of in accordance with the Code of Federal Regulations, Title 10, Part 30.

K. REACTOR COOLANT SYSTEM

There is no further need for a reactor primary cooling system. As long as reactor fuel is stored in the storage pool, the primary cooling system valving shall be set to permit the storage pool water to be circulated through the pool and/or bypass demineralizer.

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L. ADMINISTRATIVE AND PROCEDURAL SAFEGUARDS

1. ADMINISTRATIVE ORGANIZATION AND STAFFING

a. Organization

The Reactor Supervisor, appointed by the Lockheed-Georgia Company Chief Engineer - Experimental and Avionics - shall be responsible for, and shall maintain surveillance over, all activities within the RER exclusion fence. He shall have responsibility for maintenance and removal of equipment, maintaining the integrity of the fuel elements, and precluding the release of radioactivity. A qualified Health Physicist, appointed by the Chief Engineer - Experimental and Avionics - shall be an advisor to the Reactor Supervisor.

b. Procedure Review Committee

A Procedure Review Committee, appointed by the Chief Engineer - Experimental and Avionics - shall monitor activities arising as a result of activities within the RER exclusion fence. As a minimum, the Procedure Review Committee shall consist of the Reactor Supervisor, the Health Physicist, and two additional scientists/engineers, one of whom shall be chairman. Each scientist/engineer on the Procedure Review Committee shall have at least 5 years of experimental, design, or operational experience with a test or power reactor. Addendum 1 lists the names and qualifications of the incumbents. When any changes are made in the Procedure Review Committee membership, Lockheed shall advise the Commission within 30 days of the nature of the changes and the names and qualifications of new members. All procedures pertaining to activities within the RER exclusion fence shall be subject to the approval of the Procedure Review Committee. Actions of the Committee shall require unanimous agreement. The Committee shall meet at least monthly.

2. PROCEDURAL SAFEGUARDS

a. Exclusion Area Access Control

Plant Security shall control access to the RER exclusion fence by controlling keys to the gates. Personnel may enter the area within the 3600-foot fence provided that each such entry is governed by the provisions of administrative procedures approved by the Procedure Review Committee. Access to the Reactor Building shall be under the control of the Reactor Supervisor. The roll doors on the RER building shall be immobilized whenever the facility is not manned. All other doors into areas of the RER where radioactive materials or radiation areas are present shall be kept locked except when authorized personnel are in the area. Areas within the exclusion fence which constitute radiation areas shall be roped off and posted with appropriate radiation warning signs in accordance with the Code of Federal Regulations, Title 10, Part 20. While the reactor fuel, start-up source, and ORNL-owned Cobalt-60 are in the facility, Plant Security shall

patrol the exclusion fence at least once per week. After the reactor fuel, start-up source and Cobalt-60 have been removed, Plant Security shall patrol the exclusion fence at least once every six months. The Radiation Effects Facility shall be patrolled at least daily by Plant Security or operating personnel.

b. Emergency Procedures
Detailed emergency plans and procedures, covering all classes of potential REF incidents, shall be prepared and published in the GNL Emergency Manual. That portion of the LGNL Emergency Manual pertaining to the REF shall be reviewed and approved by the Procedure Review Committee.

c. Fuel Element Manipulation
All fuel handling operations shall be conducted in accordance with written procedures under the direct personal supervision of the Reactor Supervisor.

d. Health Physics Surveillance
Health Physics personnel shall maintain surveillance over activity involving handling of radioactive materials. The Reactor Supervisor may act as a self monitor and may provide routine health physics services for daily activities involving routine facility surveillance only.

Health Physics personnel shall specifically establish the radiation protection requirements involving the handling of radioactive material, and shall be in attendance for such activities as deemed appropriate by the Health Physicist.

e. Maintenance
Routine maintenance shall be required only on those items and systems which these specifications state must be maintained in operable condition.