...ARDS ANALYSIS BY THE TEST & POWER REACTOR SAFETY BRANCH

DIVISION OF LICENSING AND REGULATION 12/12/63

LOCKHEED AIRCRAFT CORPORATION

DOCKET NO. 50-172

Licensed operation at 1 Mwt by the Lockheed Aircraft Corporation of the Radiation Effects Reactor (RER), located at Air Force Plant No. 67 in Dawson County, Georgia, was previously evaluated by the Division of Licensing and Regulation in a staff hazards analysis dated June 29, 1962. Lockheed subsequently requested authority to operate the RER at 3 Mwt, and has also requested several other minor amendments to Facility License R-86. Certain of the amendments requested will not be discussed explicitly in this analysis since they represent only minor changes, or are items related intimately to the requests which will be covered in the following discussion.

The principal amendments sought by Lockheed are as follows:

1. Permission to operate the RER at a maximum power level of 3 Mwt.
2. Relocation of a test car position.
3. Relaxation of air traffic restrictions at the RER site.
4. Removal of weather restrictions on reactor operation.
5. Deactivation of certain remote area monitors.

Insufficient information has been submitted by Lockheed with respect to the last item; therefore the amendment requested is not being considered at this time.

The Advisory Committee on Reactor Safeguards has reviewed Lockheed's request to operate at 3 Mwt and commented as follows in its report of July 18, 1963 to the Chairman, AEC:

". . . The Committee suggests that due attention be given to the reliability and adequacy of coolant supply to the core under all conditions of operation. In addition, the Committee suggests that the available excess reactivity be limited to that required for three megawatt operation and that continuing attention be given to procedural safeguards and environmental surveillance.

With proper consideration given to the comments above, the Committee believes that the licensee can operate the facility at powers up to three megawatts thermal as proposed without undue risk to the health and safety of the general public."

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...ration at Three Mwt- The RER is currently licensed for operation at a maximum power level of 1 Mwt, or one-tenth of its design rating of 10 Mwt. During previous operations for military purposes, the reactor and its auxiliary systems were checked out up to the full design power of 10 Mwt. Accordingly the capability of the reactor to operate satisfactorily at the requested maximum power level of 3 Mwt has been established.

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Lockheed is presently authorized to load the reactor to a cold-clean excess reactivity of 3.3% with a minimum shutdown margin of 14%. Operation at 3 Mwt will require that the reactor be loaded to 5% excess reactivity with a corresponding decrease in specified shutdown margin to 12% k. This margin is adequate, however, since the reactor can be made well subcritical under all temperature conditions even if one of the four control rods sticks in the fully withdrawn position. The additional excess reactivity will have negligible effect on the course of possible transients during operation of the reactor since the presently authorized 3.3% excess is already sufficient to govern the course of most transients. Nevertheless, 5% is substantially short of the 11% that was required for 10 Mwt operation. The limitation to 5% is important in controlling the possibility of incidents during fuel manipulation or maintenance.

A potential safety problem which could exist at 3 Mwt operation is the possibility of melting a fraction of the reactor core due to decay heat following a rapid total loss of coolant. During 1 Mwt operation, the likelihood of melting is extremely remote even if the coolant were to be lost instantaneously. Extrapolation of experimental evidence to 3 Mwt, however, indicates that a small fraction of the core might melt due to after-heat under the same circumstances. Because provisions have been made for the injection of emergency cooling water and the fact that pool water can adequately cool the core if the reactor is lowered into the pool, the likelihood of melting due to after-heat is very remote even after 3 Mwt operation. It is our opinion that the only likely mechanisms for initiating an accident in which after-heat melting is possible would be violent explosion of an experiment or ramming of the reactor vessel by the locomotive used to move the flat cars containing experiments. Such incidents could conceivably cause penetration of both the inner and outer reactor vessels, shear off the inlet coolant lines, and render the reactor hydraulic lift incapable of lowering the reactor into the pool. In order to limit such possibilities, use of the locomotive in the vicinity of reactor building is prohibited unless the reactor is lowered into the pool. Also irradiation of experiments which have the potential to rupture or dislocate the reactor vessel will be permitted only after Commission review has established that particular experiments are designed in such a manner that they can be performed with adequate margins of safety. Such experiments are not proposed as part of the present review.

Lockheed notified the Commission by letter dated August 12, 1963, that a leak had developed in one of the flow chutes within the reactor vessel. Subsequent investigation indicated that the leak had been caused by mechanical deformation of the chute during fabrication of the reactor vessel. The leak has been repaired by welding, and exploratory examination of the interior of the vessel indicates that no other similar conditions now exist. It is our opinion, through evaluation of data obtained during investigation into the cause of the leak and its subsequent repair, that the vessel is now sound and that a similar condition which could cause loss of coolant is unlikely to develop.

In view of the foregoing restrictions, and in view of the various means by which water can be made available to cool the reactor core under various

emergency conditions, it is our opinion that the meltdown of a substantial part of the core due to the postulated total rapid loss of coolant may be deemed to be an incredible circumstance.

The applicant has postulated a maximum credible accident which could potentially lead to dispersion of relatively large amounts of radioactivity to the environment. The same maximum credible accident was postulated for previous 1 Mwt operations; however, in the present case, the fission product inventory would be larger. The accident is created by the inadvertent withdrawal of the control rods when the vessel head is removed in preparation for work on the core. However, this accident is considered to be a remote possibility since visible and audible annunication is provided in the control room should a rod become unseated. Furthermore, removal of the vessel head will only be performed with the top of the reactor core immersed in the pool to a depth of 20 feet. This will, in the event of an excursion, minimize the amount of fission products released to the environment. Based on the conservative assumption that 100% of the noble fission gases and 2.5% of the halogens would be released to the environment, it is estimated that the maximum doses received at the site boundary under strong inversion conditions would be approximately 10 rem whole-body and 180 rem to the thyroid. These doses are within the guide-line emergency doses set forth in 10 CFR 100. In our opinion this accident represents an upper limit to the potential hazard attending 3 Mwt operation.

Since the RER is operated in an unshielded configuration for the most part, it is important to follow neutron-induced activity in the soil in the vicinity of the reactor. Review of the results of Lockheed's surveillance program to monitor such activity reveals that there is at present no potential for off-site transport of induced activity in excess of 10 CFR 20 limitations. Nevertheless periodic review of surveillance records will be necessary to establish whether or not the activity trend over a long period of reactor operation will require remedial action. It is our intention to require submission of an annual report by Lockheed outlining the significant results of the surveillance program for Commission review.

In view of the fact that the RER is designed for operation in excess of 3 Mwt, that suitable limitations are in existence to govern experimental utilization, that consequences of the maximum credible accident is within Commission criteria, and that environmental-induced activity is negligible at present and surveillance is continuing, we have concluded that the RER can be operated as proposed at 3 Mwt without undue risk to the health and safety of the public.

Relocation of Test Car Position- Lockheed proposed to lay one new set of tracks over and parallel with two pairs of currently existing tracks (thus making the original tracks unusuable) in order to facilitate location of irradiation experiments closer to the reactor. No provision will be made to install a test car ejection system such as is installed at existing test car positions. No experiment which presents a potential hazard to the reactor will be placed in this test car position without appropriate provisions for remote removal.

The test car has an extension which overhangs the edge of the reactor pool; therefore, we have considered the possibility of contact between the reactor shield structure and the underside of the test car extension if the reactor

is overdriven upward on its hydraulic lift. To prevent such contact, reliance will be placed upon instrumentation which remotely indicates the vertical position of the reactor lift and upon two limit switches which will actuate indicating lights to alert the operator to the fact that the shield structure is near the car extension 18 inches and 3 inches before contact is possible. It is our opinion that the administrative controls over lift operation and limit switches are adequately developed; however, in order to avoid complete reliance on administrative control, we have recommended, and the applicant has agreed, that the upper limit switch be interlocked to stop the reactor lift automatically.

When the reactor is in its fully elevated position during irradiation of an experiment, it is conceivable that a relative shift in position of the test car and/or the reactor might create an interference which would impede subsequent efforts to lower the reactor into the pool. The new tracks and their associated stops will be constructed in such a manner that the test car will be firmly supported in a fixed position. Guide rails on the reactor lift will preclude undesirable lateral motion of the reactor vessel and associated structure. Assurance that the test car is properly positioned so that adequate initial clearance exists will be provided by a visual check prior to raising the reactor vessel. Having considered the positioning of the test car relative to the reactor vessel and the reasonable dimensional tolerances involved, it is our opinion that the minimum two inches clearance, provided for the present test car extension, should be sufficient to preclude the possibility of interference with vertical movement of the reactor vessel.

In view of the facts that no experiment which is potentially hazardous will be placed in this test car position without provision for remote removal, that adequate clearance between the present test car extension and the reactor can be maintained with reasonable precision, that procedures have been developed to assure that adequate clearances are provided for any test car extension configuration, and that adequate protective measures exist which preclude a collision between the reactor shield tank and the underside of the test car extension, we believe that no significant hazards will arise from operating with the proposed modifications.

Relaxed Air Traffic Restrictions - At the present time aircraft are restricted from flying within a radius of 2.5 miles of the reactor at an altitude under 5000 feet. It is proposed that the radial restriction be reduced to 1.5 miles and that the present altitude restriction remain in effect. The limiting distance is determined by the altitude restriction which had previously been established as an altitude at which persons in aircraft would receive negligible radiation exposure from normal reactor operation at 10 Mwt. Radiation levels at a horizontal distance of 1.5 miles from the reactor would be even less than predicted in connection with the altitude restriction. Furthermore, radiation level measurements made during reactor operation confirm that the radiation exposure to individuals in aircraft flying within a horizontal distance of 1.5 miles of the reactor would be completely negligible at 3 Mwt reactor operation. Accordingly, we believe the airspace restriction can be modified as proposed without raising any possibility that persons in aircraft could receive radiation exposure approaching the allowable exposures set forth in 10 CFR 20 for

unrestricted areas. It is noted that the Commission does not regulate air traffic as such; Lockheed has a procedure for shutting down the reactor and reporting to FAA the passage of aircraft that are detected within the unrestricted zone defined above.

Weather Restrictions of Reactor Operation - At the present time the RSR is restricted from operating under strong inversion conditions in combination with wind speeds less than 1 mile per hour. These criteria were developed during previous 10 Mwt operations to insure that diffusion conditions would be adequate to keep A-41 concentrations below allowable levels at the 3600 ft exclusion fence. This fence is wholly within the controlled site, and the nearest public property is over 4000 feet beyond the exclusion fence.

Lockheed has requested that the meteorological restrictions be removed, since at a power level of 3 Mwt there is little likelihood that A-41 concentrations would exceed allowable concentrations set forth in 10 CFR 20 when averaged as permitted by the regulations. Our independent calculations in general corroborate those presented by Lockheed and indicate that under extremely poor diffusion conditions Part 20 concentrations may be exceeded at the 3600 ft fence for short periods of time. Our calculations also show that concentrations in uncontrolled areas (beyond the perimeter fence) should not be exceeded at any time. Consideration of the frequency and persistence of meteorological conditions under which Part 20 concentrations could be exceeded for short periods at the 3600 ft fence indicates that average annual concentrations would be well within Part 20 limits at the exclusion fence which is itself in a controlled area. We believe that the present weather restrictions on reactor operation can be removed without raising any possibility of exposure of personnel to excessive A-41 concentrations. Compliance with the provisions of 10 CFR 20 will be established by the applicant on a continuing basis by maintaining meteorological records during periods of reactor operation and computing average A-41 concentrations at the 3600 ft fence.

Technical Specifications

Proposed Technical Specifications submitted by Lockheed on September 26, 1963, were developed jointly by Lockheed and the Commission. Our review of these Technical Specifications indicates that they are consistant with the application, as amended, and with the terms mutually agreed upon except for one omission. With the concurrence of Lockheed, we have added a new paragraph, J.2.b.(3). to correct this oversight, which reads as follows:

> "Test cars will not be moved in the vicinity of the reactor building by means of a locomotive unless the reactor is lowered into the pool. Test cars and experiments that overhang the reactor structure will be equipped with an interlock to stop elevation of the lift prior to contact."

CONCLUSION

As a result of the above analysis we have concluded that there is reasonable assurance that the health and safety of the public will not be endangered

by operation of the RER in the manner described and in accordance with the proposed technical specifications as modified above.

FOR THE ATOMIC ENERGY COMMISSION

Original Signed By
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Date: DEC 14 1960