HAZARDS ANALYSIS BY THE TEST & POWER REACTOR SAFETY BRANCH

DIVISION OF LICENSING AND REGULATION 6-27-62

LOCKHEED AIRCRAFT CORPORATION

DOCKET NO. 50-172

By application filed on April 4, 1962 the Lockheed Aircraft Corporation requested a facility license to operate the Radiation Effects Reactor (RER) located in Dawson County, Georgia. This reactor is owned by the U. S. Air Force and has previously been operated by Lockheed for the Air Force under a Presidential authorization. Use of the facility is not presently needed in connection with Air Force programs for which it was built. It is proposed by Lockheed, therefore, with Air Force Agreement, to operate the reactor at a maximum power level of 1 Mw(thermal) in connection with commercial irradiation work. Under licensed operation Lockheed would assume sole responsibility for indemnification and for safety, although the Air Force would continue to own the reactor.

SITE

The RER is located on a 10,000 acre site in Dawson County, Georgia about 45 miles north-northeast of Atlanta. The reactor is situated near the center of the site in a shallow valley running generally east and west through the site. The minimum distance to the nearest boundary is 1.55 miles.

The area within a five mile radius of the reactor is sparsely populated, and population is largely concentrated in three small communities. The closest dwelling is 1.8 miles south of the RER in the community of Barrettsville (pop. 26). Further to the south, about 4½ miles from RER, is Matt Community (pop. 300), while to the southeast 3½ miles is Silver City Community (pop. 450). Dawsonville (pop. 318) lies about 4½ miles to the northeast of the RER. These communities and the rural population comprise a total of 2575 people resident within a five mile radius of the reactor. There are no cities or towns within a ten mile radius with populations in excess of 500 people.

Generally speaking the site is favorable for operation of a reactor because of its large size and the comparatively low population density in the surrounding area. There are no indications of geological, hydrological or seismological conditions in the area that would require special attention in reactor design or operation.

RER FACILITY

The RER is a heterogeneous, pressurized water reactor utilizing MTR-type flat plate fuel elements containing highly enriched U-235. Control is accomplished through four fuel-poison control rods and a servo controlled regulating rod. The four poison-fuel rods are magnetically latched to drive mechanisms during operation; any scram signal that interrupts magnet current allows these rods

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to be forced into the core by springs and gravity to shut the reactor down. The regulating rod does not scram.

The reactor pressure vessel is mounted on a hydraulic lift in a 26½ foot deep pool of water. The reactor can be stored, maintained, or operated at low power in the pool with biological shielding provided by pool water. In normal use, the reactor is raised out of the pool on the lift so that leakage fluxes of neutrons and gamma rays can be utilized in irradiation of experiments external to the reactor. Swivel jointed piping permits coolant water to circulate through the core while the reactor is in any position.

Shield tanks mounted external to the pressure vessel can be filled to varying degrees with water to provide control over the neutron to gamma ratio in experimental areas.

A 6 ft. chain link security type fence within the Air Force plant completely surrounds the reactor at a distance of 3600 ft. to prevent entry of persons or animals to the reactor area. The minimum distance from the reactor to the Air Force plant boundary fence is 8340 feet. Access to areas within the Air Force plant is strictly controlled and limited to authorized personnel only.

DISCUSSION

The RER is similar to several other reactors that have operated successfully and reliably, and its characteristics are well understood. Except for operation in an unshielded manner, the RER does not depart significantly from well established reactor technology. The reactor was initially operated in December 1958, and as of June 27, 1961 had accumulated about 3500 Mw hours of operation. A good portion of this total operating time was accumulated during check out of systems and components and calibration of nuclear instrumentation. Modifications have been made to improve reliability of instrumentation and safety systems wherever experience gained through operation has indicated the need. The reactor has operated satisfactorily and without incident, and there has been no indication of conditions that could be construed to be potentially unsafe.

Information submitted in support of the application indicates that an adequate staff of experienced personnel will be available to operate the reactor and provide supporting activities. Over-all surveillance of RER operations is provided through a Reactor Safety Committee on a regularly scheduled basis. This committee, in addition to general surveillance, specifically considers each experimental system from the standpoint of reactor safety. In our opinion the Lockheed operating staff is technically qualified to operate the reactor.

During normal operation of the reactor radiation intensities in close proximity to the reactor are very high. However the intensity decreases with distance due to air shielding and geometric attenuation. In occupied areas of the site radiation levels are below those allowed by the Commission's regulations, and off-site they are negligible.

Operating personnel within the exclusion area are protected in an underground operations building during reactor operation. Radiation surveys which had been conducted during previous operation show that all occupied areas within the operations building are sufficiently shielded to keep personnel exposures below tolerance. With one exception egress from the operations building during reactor operation is prohibited by procedural control and interlocked doors. The applicant proposes to permit shift change under certain conditions while the reactor continues to operate at low power in its fully raised position. The possibility exists that personnel in transit between the exclusion fence and the operations building could be exposed to excessive radiation levels if the reactor power level were raised. We believe therefore that during any shift change the reactor should be lowered into the pool in order to take advantage of the protection afforded by the pool water.

The RER was designed expressly for the irradiation of large experiments which could not be accommodated in the irradiation facilities of conventionally designed research and test reactors. Experiments to be irradiated can be mounted on flat cars at a support facility, rolled into position adjacent to the reactor, irradiated, and then removed to the support facility for examination. It is now proposed that some experiments be placed in the core, reflector and shield tank regions of the reactor, in the reactor pool, and in the general area both inside and outside the reactor building.

Lockheed has outlined the general classes of irradiation experiments that may be performed and has outlined the review and approval procedures that must be followed prior to irradiation of each particular experiment. We believe the safeguards considerations of this review are sufficient to assure that damage to the reactor due to failure of most types of experiments is an extremely remote possibility.

There is ample experimental and theoretical evidence to support the conclusion that fuel melting would not likely occur in the event of sudden complete loss of coolant following prolonged operation at 1 Mwt. Thus in the event of severe damage to the reactor and consequent complete loss of cooling capability, the dispersion of large amounts of radioactivity to the environment is unlikely. Nevertheless, we note that cryogenic equipment utilizing relatively large amounts of non-inert gases has been considered for some experiments. Since such experiments might have an associated possibility of explosive hazard that could lead to damage to the reactor, we recommend that such experiments not be permitted until more explicit and definitive information relative to explosion hazards of this kind has been submitted and evaluated by the Commission.

The applicant considers that the maximum credible accident will occur as a result of inadvertent withdrawal of control rods during removal of the reactor vessel head in connection with refueling or core modification. We concur in Lockheed's choice of this particular event as establishing an upper limit to the hazards attending operation of the RER. Inasmuch as 3.3% excess reactivity will be available in the cold clean core, such an event could lead to an

excursion that would destroy a large fraction of the core.

The postulated event is a remote possibility, however, since specific measures are taken prior to removal of the head to assure that control rods are delatched prior to lifting of the head. Further, procedures require that the vessel be at the bottom of the pool when the head is removed. This provides a depth of 20 feet of water over the vessel, and in the event of an excursion a large fraction of any fission products released would be absorbed in the pool water.

If one were to assume that the maximum credible accident event were to occur while the vessel were elevated above the surface of the pool, a substantial fraction of the fis ion product inventory could escape to the environment. Using the pessimistic assumption that 100% of the noble fission gases and 25% of the halogens escape from the reactor, we have estimated that the maximum radiation exposures at the site boundary would be 15 rem whole body and 75 rem to the thyroid. These values represent a maximum dose that could be received at the perimeter fence in the direction of the valley to the southwest under typical nighttime meteorological weather conditions. The probable maximum exposure from the postulated release in directions other than up or down the valley would in our opinion be less than one-tenth those estimated here because of the influence of the terrain in enhancing dispersion of a fission product release.

In our opinion the foregoing establishes an upper limit to the hazard to the public attending operation of the RER. The dose values are within acceptable criteria set forth by the Commission in Proposed Regulation 10 CFR 100 for accidents with a low probability of occurrence.

CONCLUSION

To minimize the possibility of over exposure to personnel we recommend that the reactor be lowered below the surface of the pool during shift change. We also recommend that cryogenic experiments utilizing non-inert gases not be performed until such time as information relative to evaluation of attending explosion hazards has been submitted. Subject to this recommendation we believe the RER can be operated as proposed without undue risk to the health and safety of operating personnel or the public.

FOR THE ATOMIC ENERGY COMMISSION

Saul Levine, Chief
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