UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 38 TO FACILITY OPERATING LICENSE NO. R-67

GA TECHNOLOGIES, INC.

DOCKET NO. 50-163

1.0 INTRODUCTION

In a letter dated April 30, 1987, GA Technologies, Inc. (GA) requested a change in the Technical Specifications of Operating License No. R-67 for the TRIGA Mark F non-power reactor. This request relates to the use of experimental fueled in-core thermionic direct conversion devices. The requested change would authorize irradiation time not to exceed 40,000 hours for any one thermionic device. The previous irradiation time limit was 20,000 hours for any one thermionic device.

2.0 BACKGROUND

GA initially designed and remains the sole vendor for the TRIGA family of non-power research reactors. In addition, they have installed several such reactors and operated them in their facilities under Nuclear Regulatory Commission operating licenses. One of these, a Mark III, was devoted primarily to tests of thermionic direct conversion devices for the production of electricity for specialized purposes. That Mark III was operated under Operating License No. R-100, Docket 50-227, from approximately 1966 to 1973, when it was decommissioned. In recent years, the continued development of these direct conversion devices has been resumed, using a very similar Mark F reactor, which has been in operation since the early 1960s. During the years of experimentation on the direct conversion devices, there have been no significant malfunctions or deviations from their predicted operations that raised unreviewed safety questions.

A goal of the Department of Energy (DOE) test program for thermionic devices is to evaluate the dimensional stability of the emitter, which is heated by the nuclear fuel contained in the thermionic device. The gap between the emitter and the collector is dependent on the emitter stability. Understanding gap behavior will allow thermionic device designs with increased efficiency and longer lifetimes.

The thermionic devices under test do not produce electric power but are designed to evaluate emitter stability. The test program is at the point where an increase in allowable irradiation time to 40,000 hours is requested to acquire the data needed to continue the comparison between the actual emitter growth and the emitter growth predicted by theory.

3.0 EVALUATION

The licensee has analyzed the change in fission product inventory and the neutron damage effect on the critical components of the thermionic devices that will occur with increased irradiation time.

The methodology followed by GA in the current calculations is essentially the same as that followed in GA-9622 ("Direct Conversion Device Description and Safety Evaluation", December 1970), which was previously reviewed by the staff and found to be acceptable. The staff's review of the current amendment request indicates that all relevant operating conditions of the Mark F reactor, Mark III reactor, and the thermionic devices are sufficiently similar to support the use of GA-9622. The assumptions made for the current amendment are either the same as those made in GA-9622 or are more conservative in nature.

The fission product inventory of a thermionic device is directly related to the total thermal power due to fissioning of the U-235 fuel contained within the thermionic device. The only fission products that escape the thermionic device in the event of failure are gaseous. At the currently authorized irradiation time of 20,000 hours, all of the gaseous fission products, with the exception of Kr-85, are at saturation. Thus, any increase in irradiation time will only increase the fission product inventory of Kr-85. GA calculates that the fraction of unrestricted MPC at the site boundary for a 20,000 hour irradiation of a thermionic device containing 100 grams of U-235 operated at a thermal output of 3.75 KW is 0.1888 (Table 1). This thermal output is based upon exposure in the maximum neutron flux that the reactor can achieve. The inventory of Kr-85 will double as the irradiation time increases from 20,000 to 40,000 hours. Kr-85 is a minor contributor to the total fission product inventory and GA calculates that the fraction of unrestricted MPC at the site boundary for a 40,000 hour irradiation is 0.1889. Thus, the increase in potential release is negligible at the site boundary. The staff agrees with this analysis.

The licensee has considered the potential for neutron damage that the increased irradiation time will have on the thermionic device containment. The materials of interest are the Type 304 stainless-steel of the primary and secondary containment, the associated stainless-steel welds, and the ceramic-to-metal (Al_2O_3) hard vacuum seal. The change in material properties due to the increased fast neutron fluence is small and the increase in potential for containment failure is negligible. The stresses under any condition of operation or handling continue to be less than 10% of the yield stress of the stainless-steel. Damage to the ceramic-to-metal seal consists of inconsequential swelling, resulting in a volume increase of much less than 1%. Therefore, the operating conditions and planned handling of the thermionic devices are such that there are no credible means of failure. However, in the event that the containment were to fail, the fission product release analysis above shows that the concentration of isotopes released is less than unrestricted MPC at the site boundary.

TABLE 1. Gaseous Fission Products Released to Reactor Room and to Site Boundary at 350 m. after 20,000 Hr Irradiation (3.75 KW Operation) with Stated Assumptions.*

Nuclide	Curies Inventory	$T_{1/2}$	Curies* Releasable From Reactor Room	MPC** μc/ml	Fraction of MPC at Site Boundary, f_i
I-131	91.4	8.04d	4.6	1×10^{-10}	0.1617
132	151.6	2.29hr	7.6	3×10^{-9}	0.00025
133	204.7	20.8hr	10.2	4×10^{-10}	0.01953
134	237.5	52.6m	11.9	6×10^{-9}	0.00008
135	184.4	6.58hr	9.2	1×10^{-9}	0.00242
Br-82	3.9	35.3hr	3.9	4×10^{-8}	0.0012
Kr-85	47.7	10.72y	47.7	1×10^{-7}	0.00009
87	85.2	76 min	85.2	2×10^{-8}	0.00023
88	115.4	2.84hr	116.4	2×10^{-8}	0.00066
Xe-131m	0.8	11.92d	0.8	4×10^{-7}	0.000008
133m	4.7	2.19d	4.7	3×10^{-7}	0.000027
133	204.7	5.25d	204.7	3×10^{-7}	0.0020
135	171.9	9.09hr	171.9	1×10^{-7}	0.000624
					$\Sigma_i f_i = F = 0.1888$

* I-5% release; Br-100% release; Kr-100% release; Xe-100% release.

** 10CFR20 (1/24/84), 168 hour week, unrestricted area.

4.0 ENVIRONMENTAL CONSIDERATION

This amendment involves a change in the installation and use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes in inspection and surveillance requirements. The staff has determined that the amendment involves no significant hazards consideration (as discussed below), there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and there is no significant increase in individual or cumulative occupational radiation exposure. Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no Environmental Impact Statement or Environmental Assessment need be prepared in connection with the issuance of this amendment.

5.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously evaluated, or create the possibility of a new or different kind of accident from any accident previously evaluated, and does not involve a significant reduction in a margin of safety, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed activities, and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or the health and safety of the public.

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Dated: