5.0 ENVIRONMENTAL AND SAFETY ASSESSMENT

5.1 INTRODUCTION

A strong emphasis has been given to the environment and safety issues in both the SOMBRERO and Osiris reactor designs. Carbon/carbon composite has been used as the chamber material to avoid a high level of induced radioactivity in both reactor structures. Similarly, the use of Li_2O in SOMBRERO and Flibe in Osiris as coolant and breeder materials eliminates the hazard posed by the energy-producing chemical reactions usually associated with the use of lithium and, hence, reduces the risk of mobilizing the radioactive inventory present in both reactors.

A detailed activation analysis was performed in order to calculate all possible radioactive inventories for each of the two reactor designs. Results of the radioactivity calculations were used to evaluate the following:

1) The biological dose rate at different locations inside the reactor building following shutdown to assess the feasibility of hands-on maintenance
2) The radwaste classification for each region of the reactor
3) The maximum public dose from routine operational effluents
4) The off-site doses from accidental release of the radioactive inventories present in the reactor building, target factory, and fuel reprocessing facility.

5.2 SAFETY DESIGN GOALS

The main safety goals for both the SOMBRERO and Osiris reactor designs are:

1) Limiting the need for remote maintenance and allowing for hands-on maintenance by reducing the biological dose rate following shutdown below 2.5 mrem/hr by increasing the biological shield where it is possible.
2) Disposing the reactor structure and coolant as either Class A or Class C low-level wastes as regulated by the Nuclear Regulatory Commission's (NRC) 10CFR61 guide lines.
3) Limiting the public dose to the maximally exposed individual (MEI) from routine operational effluents to less than 5 mrem/yr.
4) Limiting the whole-body (WB) early dose during a conservative accident scenario to 25 rem, which was recommended for this study by the study guidelines. The low off-site dose will allow for the avoidance of early fatalities in case of an accidental release of radioactivity.
5) Eliminating the need for the use of N-Stamp nuclear grade components.

5.3 RESULTS

The key results of the environmental and safety assessment are summarized in Table 5.1. The SOMBRERO and Osiris reactor designs have distinct favorable safety characteristics. Because of the double wall layout used in SOMBRERO, the biological dose rate behind the steel-reinforced concrete shield is low enough to allow hands-on maintenance inside the IHX enclosures within a day after shutdown. The dose rate after shutdown behind the 3 meter biological shield of Osiris is only 0.1 mrem/hr allowing for hands-on maintenance. However, only remote maintenance is allowed in the space between the chamber and shield of both reactors. The chamber and shield of both reactor designs qualify for near surface burial as Class A low level waste. Using the NRC waste disposal limits for solid waste, both the Li_2O solid breeder and Flibe could qualify for shallow land burial as Class C and Class A low level wastes, respectively. However, Flibe has to be in solid form before such disposal can take place and the feasibility/practicality of such a process has to be determined.

Some tritium does reach the off-site environment during normal operation. The reactor system, the reactor building, the fuel reprocessing facility, and the target factory are the major sources of routine release of tritium. Assuming a barrier factor of 10^6, the doses from the atmospheric routine release of tritium from SOMBRERO and Osiris to the maximally exposed individual are 0.93 and 2.43 mrem/yr, respectively. Both values are far below the 10 mrem/yr EPA current effluent limit. The site boundary is assumed to be at 1 km from the point of release. The off-site doses caused by an accidental release of radioactivity from both reactor designs are dominated by the dose resulting from the off-normal release of tritium. During an accident, the maximum vulnerable inventory of tritium in SOMBRERO is 183 g. Most of the tritium (162 g) is contributed by the Li_2O granules. On the other hand, due to the small tritium inventory in Flibe salt (1 g), the maximum vulnerable inventory of tritium in Osiris is only 13 g. The estimated off-site whole body (WB) early dose released from SOMBRERO due to a highly unlikely sequence of simultaneous accident scenarios involving, the reactor chamber, biological shield, breeder, and tritium is 2.22 rem. This dose is below the 5 rem level where evacuation plans are needed and far below the 25 rem value recommended for this study by the oversight committee as a threshold for avoidance of early fatalities. Assuming similar accident scenarios, the Osiris design would result in a WB early dose of only 0.13 rem.

An accident analysis involving the target factory facility showed that a 100% release of the 300 g of tritium expected to be present inside the facility at any moment would result in a WB early dose at the site boundary of only 2.70 rem, which again is below the limits required for public evacuation. Finally, an accident resulting in the release of the total inventory of tritium existing in the fuel reprocessing facilities of SOMBRERO and Osiris would produce off-site doses of only 0.68 and 0.48 rem, respectively. The very low off-site dose for either reactor designs

eliminates the need for N-Stamp nuclear grade reactor components, which are only required if the dose exceeds the 25 rem limit.

Table 5.1. Comparison of Environmental and Safety Results

	Osiris	**SOMBRERO**
Maintenance of Chamber Components	Remote	Remote
Maintenance of Power Cycle Components	Hands-on	Hands-on
Chamber Radwaste Classification	A	A
Shield Radwaste Classification	A	A
Breeder Radwaste Classification	A	C
Routine T_2 Release (Ci/d)	92	93
Maximum Dose to Exposed Individual from Routine Release (mrem/y)	2.43	0.93
Total T_2 Inventory (g)		
Reactor	13	183
Fuel Processing	54	74
Target Factory	300	300
Accidental WB Early Off-Site Dose at 1 km (rem)		
Reactor	0.13	2.22
Fuel Processing	0.48	0.68
Target Factory	2.70	2.70