7.0 TECHNOLOGY ASSESSMENTS

7.1 INTRODUCTION

Many assumptions have been made during this study about materials capabilities, component availability and performance, and cost. In Chapter 7 we attempt to put all this in perspective and assess the technical issues, development needs, and level of urgency. A semi-quantitative approach was taken with issues weighted on a scale from zero (low) to 100 (high) in increments of 25. The issues and weighting factors are given in Table 7.1.

Table 7.1. Technical Issues and Weights

Technical Immaturity	10%
Critical Technology	30%
High Development Cost	30%
Long Lead Time	20%
% Cost in Experiments	10%

Note that they are defined in terms of concerns (e.g., technical immaturity rather than maturity) so that a high score always indicates a problem. The weightings are obviously judgmental. Technical immaturity is far less important than critical technology (i.e., no alternative technologies or approaches exist) or development cost. These last two are considered the most important. Long lead time is also an issue. An example of an issue with a long lead time would be materials development. Some account is also made of the greater developmental uncertainty when many experiments are required.

The areas covered for Osiris and SOMBRERO are reactor chamber, shielding, final beam transport, coolant and ducting, IHX, steam generator, power conversion, driver, and target fabrication and injection. Other areas generic to IFE regardless of the specifics of the reactor chamber and driver include target design and innovations, systems modeling, low-activation materials, and remote maintenance.

7.2 SUMMARY OF DEVELOPMENT PRIORITIES FOR OSIRIS

Table 7.2 summarizes the results of the technology assessment for Osiris listing current technical credibility (i.e., the current state of the art) for each item, as well as development needs for reactor applications. It also shows a ranking of the development priorities for each major

subsystem. The development needs are not necessarily the inverse of technical credibility, because, in many cases, rather simple experiments can resolve major issues. The level of expense and difficulty has been included, as has the impact of the issue on reactor performance and cost.

Not surprisingly, the driver ranks first in development priority. Part of this is due to the enormous potential expense and part because of the limited development paths: RF or induction and once-through or recirculating.

The target factory ranks second because so little is known about economic, automatic fabrication of cryogenic targets. Hopefully, the ongoing research on target fabrication will help. Nevertheless, a concerted effort must be undertaken to scope out a reactor-relevant target factory in some detail.

While one might expect the reactor chamber to top the list, it is preceded by the two above partly because the development needs can probably be met with less expense, and there are many other reactor concepts to fall back on. This is not true with the driver and target factory.

Target injection and tracking doesn't rank as high as expected in development priority partly because of the relatively modest scale experiments that are required and because of related technology existing in the MFE and SDI programs.

The remaining items lie some distance down the development priority scale although there are certainly numerous design issues that must be addressed.

Table 7.2. Osiris Development Priorities

Item	Current Technical Credibility	Development Needs	Devel. Priority
Driver	Low	High	1
Target Fabrication	Low	High	2
Reactor Chamber	Low	Moderate	3
Target Injection	Moderate	Moderate	4
IHX	Moderate	Low	5
Steam Generator	Moderate	Low	6
Flibe Pumps/Ducts	High	Low	7
Shielding	High	Low	8
Reactor Building	High	Low	9
Power Conversion	High	Low	10

7.3 SUMMARY OF DEVELOPMENT PRIORITIES FOR SOMBRERO

Table 7.3 gives a summary of the technology assessment for SOMBRERO, listing technical credibility of the current state of the art for each item, as well as development needs for reactor applications. It also shows a ranking of the development priorities for each major subsystem.

As with the Osiris reactor, the driver ranks first in development priority. The key issue is cost, which translates into technical issues like material selection, fabrication techniques, and tolerances. Reliability and component lifetime are related to cost, of course, but they have been separated out here as an issue that will require considerable development. The remaining driver issues have moderate to low development needs.

Target fabrication and injection rank second and fourth, respectively, primarily because of the newness of the technology. Being simpler than hohlraum targets, direct drive targets should be somewhat easier to fabricate.

The reactor chamber appears to have fewer development problems than the driver/target systems. The key issues here are sustained leak tightness and erosion. The first depends on the allowable helium density in the target chamber, which will certainly be much higher than the allowable xenon density, and on the pumping capacity of the vacuum system.

The final optics concerns rank fifth in development priority. Final optics problems center around pointing stability and neutron damage. The last could be a serious problem if lifetimes are much less than our estimates.

The reactor building, although very large, is technically fairly credible. Key issues are cost, vacuum maintenance, dimensional stability, and activation from scattered neutrons.

The remaining issues (i.e., Li_2O transport, IHX, steam generator, shielding, and power conversion) are all quite credible today and require little costly development.

7.3 GENERIC IFE ISSUES

The four generic issues were also evaluated using the criteria in Table 7.1, but were not ranked in priority as the power plant issues listed in Tables 7.2 and 7.3. All of the generic issues are critical in that they impact all elements of IFE power plant development. Innovations in targets, or discoveries from reactor modeling, for example, could move the program in totally unexpected directions. For this reason, lead times are considered long so that results can impact the program before long-term commitments or premature down-selections are made.

Table 7.3. SOMBRERO Development Priorities

Item	Current Technical Credibility	Development Needs	Devel. Priority
Driver	Low	High	1
Target Fabrication	Low	High	2
Reactor Chamber	Moderate	Moderate	3
Target Injection	Moderate	Moderate	4
Final Optics	Moderate	Moderate	5
Reactor Building	Moderate	Moderate	6
Li_2O Transport	High	Low	7
IHX	High	Low	8
Steam Generator	High	Low	9
Shielding	High	Low	10
Power Conversion	High	Low	11

Some interesting conclusions can be reached by examining the detailed entries in Chapter 7. For example, while the overall urgency is fairly low for reactor modeling, criticality is high and lead time is long. Development cost, however, is very low compared to other items. This suggests that an on-going, low-level effort in reactor modeling is warranted so that results can influence the IFE development program.

Low-activity, neutron-resistant materials must be vigorously pursued without delay at a fairly high level unless a commitment is made to reactor designs that have thick "healable" flowing liquid or granule blankets like HYLIFE,[2] HYLIFE-II,[5] Cascade[11] or LIFE.[17] A main attraction for fusion is the ability to design reactors with low radioactivity and little radioactive waste.

Remote maintenance, while critical, can borrow from other programs. Effort is required, however, to tailor it to the IFE program.