Fusion Technology

Objective:
Show that it is possible to create the unique components and subsystems required to perform required experiments and to develop a fusion power reactor.

For magnetic fusion to become a practical energy source, scientific insights must be developed through technology and engineering into laboratory achievements and then into a safe and economical fusion reactor. Scientific efforts to improve plasma behavior as a fusion fuel have fostered the development of a wealth of technologies and concepts for power reactors that are steadily bringing MFE to reality. Consider the unique technological needs of a magnetic fusion reactor (see Figure 2):

- ***Confinement Technologies*** - High-intensity, large-volume electromagnets to create the magnetic fields for confining the plasma, and vacuum systems that approach the low pressures found in outer space to maintain an impurity free environment for the confined plasma fuel.

- ***Auxiliary Plasma Heating Technologies*** - High-intensity, high-energy neutral beam particle injectors and radiofrequency heating systems to heat the plasma.

- ***Materials Technologies*** - Materials that can withstand intense neutron bombardment, especially in the wall of the vacuum (plasma) chamber and in the energy-absorbing and fuel-producing "blanket" which surrounds the wall.

- ***Fueling Technologies*** - Continuous plasma fueling by extremely rapid injection of frozen pellets of deuterium supercooled to -269 degrees Celsius.

Conceptual reactor designs based on these evolving technologies provide a means for measuring progress against the program's technology development objectives. They also provide a framework for considering tradeoffs among technological options, economic objectives, and environmental and safety requirements.

Confinement Technologies

To construct a fusion reactor, fusion engineers must learn how best to confine an adequate amount of the reacting plasma sufficiently long that enough fusion reactions occur to produce a net power output. This involves two key confinement technologies—magnets, which create the force to confine the plasma fuel and vacuum systems, which evacuate the spent fuel and keep the fusion chamber free of impurities and spent fuel.

Large Volume Magnets - Plasma fuel, the energy source in a fusion device, is a collection of electrically charged particles which must operate at temperatures far too high for any ordinary vessel. As a solution, magnetic fields are used to confine the plasma and shape it into the forms required by the various fusion devices.

The magnetic fields required to do this are tens of thousands of times stronger than the earth's magnetic field, and they must encompass confinement chambers of large volume. Magnetic fields of this dimension are generated by complex