The devastation being wrought by the fusion cuts is being nonlinearly amplified by the effects of the explosion of the Space Shuttle Challenger. For example, many proposed basic plasma and directed-energy experiments have now been postponed by several years, as a direct result of the loss of one Shuttle and the delay in the launch of the others. These basic science experiments will now have to compete with full-scale hardware demonstrations of the Shuttle in the outlying years. Given the priority of the Strategic Defense Initiative, program managers are being forced to cancel these smaller experiments and cut them completely out of the SDI program.

The effects of the Shuttle disaster extend even to space-based experimental astrophysics. The net result is that there is nowhere for these basic plasma physics scientists to go, for work in their field.

Although it would appear that the Confinement Systems portion of magnetic fusion R&D—which has consisted of two main lines of approach, the linear tandem mirror and toroidal systems like the tokamak—is at least being maintained near previous levels, the actual budget proposal states that "to accommodate present fiscal constraints, further research on tandem mirrors is being deferred."

The result is that the world's largest fusion experiment,

What is fusion power?

Fusion, the fusing together of atomic nuclei, is the energy source that powers the Sun and the other stars, and will be the energy source of the 21st century. Unlike nuclear fission, which splits heavier elements like uranium up into lighter ones and makes use of the energy released, fusion fuses lighter elements into heavier ones. Fusion's basic fuels, deuterium and tritium, are found in sea water. Deuterium is sufficiently abundant that there is enough in sea water to fuel fusion reactors for millions of years.

When it fuses, a fusion fuel releases one million times more energy than burning a comparable weight of coal or oil, so it is a very efficient producer of energy. A single gallon of sea water can fuel as much fusion energy as five barrels of oil can fuel conventional energy. The fusion fuel produces about eight times more energy than a fission reactor produces from a comparable weight of uranium.

The electromagentic energy in the fusion-energized plasma will make it possible to build fusion reactors with a closed cycle of materials and energy flows that will have no waste and no radioactivity. Further, fusion would permit man to redefine his earthly supply of raw materials, through the use of plasma processing.

How will the reactors work? The key element in a fusion reactor is a fusion plasma, a very high-temperature gaslike mixture of ions and electrons. The gas is at such a high temperature that when the nuclei of the atoms in it collide, they fuse together and form new elements. Heat is released, which heats up a moderator; a coolant circulating around the moderator produces steam, which can be used to produce electric power.

The requirement for a "break-even" fusion reactor is to make a fusion plasma that has high temperatures, like those on the Sun, but very low density, so that it does not melt the materials with which it comes in contact. If the fusion plasma were to come in contact with the reactor wall, the wall would cool the plasma, stopping the fusion reaction.

The fusion reaction requires an energy investment to create the high-temperature plasma and a confining force to keep the plasma under control. In order to achieve net energy output, the following conditions are required: 1) the temperature must reach 50-100 million degrees C; 2) the density of the fusion fuel times the length of time it is confined—a measure of the energy output—must reach about 10^{14} particles per cubic centimeters times seconds (100,000 times less dense than the density of air in an ordinary room).

There are two basic approaches to confining the fusion plasma, magnetic confinement and inertial confinement.

For magnetic fusion, magnetic fields are generated either by external electric circuits, such as sets of copper coil magnets, or by electrical currents induced within the confined plasma itself. The magnetic field acts as a countervailing force to the gas pressure of expansion exerted by a hot plasma. There are two types of magnetic confinement devices: an open system or magnetic mirror, and a doughnut-shaped system (e.g., the tokamak).

Inertial confinement, on the other hand, makes it possible to eliminate the magnetic coils. Only the inertia of the fuel itself is utilized to confine it to a specific density while it is heated to fusion ignition temperatures. In inertial confinement fusion (also called laser fusion), a tiny hollow pellet is filled with deuterium and tritium fuel, then irradiated with a laser beam, ion beam, or electron beam. This force heats and compresses the pellet to produce a burst of energy, before the pellet flies apart. It is essentially a miniature explosion, the same process that goes on in the hydrogen bomb. But the pellets are so small that the microexplosions don't damage the reactor vessel.