minute. Not surprisingly, many develop cracks, which if left untended would lead to rupture or freezing of the pumps, which in turn could result in engine overheating or cause a substantial hydrogen leak. Although a new set of turbine blades costs only $12,000, engine removals and launch delays consume thousands, perhaps millions, of dollars more.

"The agency has essentially reached so far into the state of the art that the engines have very narrow margins," Hawkins concludes. Jerry Johnson, vice president for flight engines at the Rocketdyne Division of Rockwell International, agrees. "We all worry ourselves to death when we fly at [the standard rated power level]. It's a lot like flying at the emergency power level in a jet. You don't want to run a 20-year program with that margin."

In the program's defense, Johnson notes that the shuttle's engines are by far the most complex ever constructed. Similarly, McIlwain points out that the need to work with high-pressure hydrogen in extremely high temperatures forced the agency to invent a lot of new machinery. An additional hurdle was created by use of a unique staged-combustion cycle, in which the fuel is, in effect, burned a second time for improved efficiency. In an article published last year, McIlwain and Walter Dankhoff, NASA's director of shuttle propulsion, called it "the greatest challenge ever imposed on rocket-engine designers." It has taken roughly a thousand people up to 2 years to produce each of the 27 engines completed thus far.

Judged by its overall budget, the engine research and development program stands merely at its midpoint. Since 197X, it has cost $919 million. Between 1984 and 1989, it will cost another $900 million. Roughly a quarter of its 70,000 parts have been substantially modified to date. The agency's primary focus at present is on the turbomachinery. One goal is to reduce its operating temperature; another is to toughen several key components. By 1986, Johnson says, turbine blade replacement will be required every ten flights; by 1990, every 40 flights. Although annual maintenance costs will double over the next 4 years, to $97 million, they are then expected to decline.

Ultimately, additional engine components will be redesigned to boost power by roughly 5 percent. "The number of problems we've encountered is not unusual," Johnson says. "Some of them have simply proven harder to solve than we anticipated."—**R. Jeffrey Smith**

The Secret Recipe of GE's Reactor Safety Study

Risk estimates, like elixirs, are often brewed in obscurity and sold without labeling of the ingredients. Studies that find very high or very low risks are particularly suspect if they are put forward by the promoter of a special cause or a moneymaking venture. For this reason, Susan Niemczayk, a physicist at the Union of Concerned Scientists, would like to have the General Electric (GE) Company publish the details of a risk analysis that makes GE's latest nuclear reactor look like the safest ever conceived.

GE turned down Niemczayk's request. Instead, it labeled a probabilistic risk assessment of the "Mark III" boiling water reactor confidential, putting it off limits to the public. The study indicates that the new reactor would run a tiny risk of having a core melt accident—something like one chance in 5 million per year of reactor operation. On the basis of this and other GE assertions, Niemczayk claims, federal regulators are whisking the new design through an accelerated safety review, aiming for completion this August. The goal is to award a formal seal of approval by autumn to aid GE in marketing the plant abroad.

This review is important as the first use of new rules at the Nuclear Regulatory Commission (NRC) that encourage standardized plant design. The NRC is to use its "rule-making" authority to examine new designs, certify them as safe, and protect them from technical challenge for 10 years. This is supposed to speed up paperwork and discourage nitpicking. The public is meant to have a chance to comment on the design once, during the rule-making, but not afterward. Subsequent hearings will deal with construction licenses at specific sites.

The GE reactor will be the first to go through this new system, making this a groundbreaking case. However, Niemczayk argues that the NRC may be setting a bad precedent, for it is backing GE's claim that the risk analysis should be kept private. She says she knows of no other risk assessment that has been kept confidential, and finds it irksome in this case because the study plays an important part in NRC decision-making. For example, it may be used to help the NRC decide whether or not over 80 staff-recommended design changes are necessary. Having read an unauthorized copy of the risk study, Niemczayk says it is "not a state-of-the-art analysis." She worked on such studies herself in her former job at the Oak Ridge National Laboratory. Some of the calculations are in error, she believes.

GE official Joseph Quirk disagrees and explains that his company wants to keep the study secret because "there is a lot of competition for [probabilistic risk] analysis." If GE's raw data were published, he argues, another company could steal it and provide the same service to purchasers of the GE reactor at a cheaper rate.

GE has published a nonproprietary version that "includes the bottom line on the core melt probability and the consequences," Quirk says. "Because of that, we believe we are not withholding information that is crucial to the public. The actual methods and data to support that have been withheld because of the commercial value."—**Eliot Marshall**

Baby Doe Compromise Imminent

A resolution of the long-running Baby Doe controversy may be close at hand in the form of an amendment to the Child Abuse Prevention and Treatment Act, which is up for reauthorization this year.

The measure was crafted by six senators, including right-to-life advocate Orrin G. Hatch (R–Utah), after intensive consultation with interested parties. It is a meticulously worded statement which appears to satisfy everyone while at the same time affirming prevailing medical and ethical practices.

It would redefine child abuse to include "withholding of medically indicated treatment from disabled infants with life-threatening conditions." Such treatment, however, is not required where it would be "virtually futile" in prolonging an infant's life, or when it

would be ineffective "in ameliorating or correcting all of the infant's life-threatening conditions. . . ."

The amendment will probably be adopted when Congress reconvenes on 23 July. Surgeon General C. Everett Koop has approved it as "reasonable and practical," and it has been endorsed by handicapped, right-to-life, medical, and hospital organizations. The only dissenter is the American Medical Association, which has resisted all Baby Doe–related proposals on the grounds that they intrude on medical decision-making.

—CONSTANCE HOLDEN

Dioxin Trial Pits Workers Against Monsanto

The dioxin issue is back in court. A trial began last month between a group of Monsanto employees and the company. The group alleges that the company's negligence, dating from an accident in 1949 that exposed some of them to dioxin, is responsible for many of their medical problems. The trial is being held in federal court in Charleston, West Virginia, near the town of Nitro where the chemical company has been operating a manufacturing plant since 1929.

Although the plaintiffs' group includes more than 170 members, the first trial involves seven retired chemical workers who are seeking $2.5 million each in damages from the company, according to their attorney W. Stuart Calwell. The trial is expected to last several months. Depending on its outcome, the other plaintiffs' cases could be heard in a series of trials, he notes.

Calwell will try to convince a jury that the chemical causes specific medical problems in man. In doing so, he will raise issues similar to those in the Agent Orange case, which Vietnam veterans brought against eight chemical companies including Monsanto. The veterans alleged that the dioxin-contaminated herbicide, Agent Orange, to which they were exposed in Vietnam, caused numerous health problems. A tentative settlement between the veterans and the chemical companies was reached out of court shortly before the trial was scheduled to begin (*Science*, 25 May, p. 849).

Between 1949 and 1965, the company's Nitro plant was used for making the herbicide 2,4,5-trichlorophenol, or 2,4,5-T, which usually is contaminated with dioxin (specifically, tetrachlorodibenzodioxin). Calwell says that documents obtained from Monsanto dating back to the early 1950's refer to "some substance" being present in the manufacturing process that affected the liver, kidney, and other organ systems of workers. Soon thereafter the company identified dioxin as the "offending agent." Thus, despite the fact that "Monsanto knew of the toxicology of this [manufacturing] process . . . they continued to use it," he claims. He plans to call expert witnesses to testify that dioxin is responsible for liver disorders, nervous system disorders, and abnormalities in lipid metabolism among the Monsanto workers.

Monsanto says that chloracne, a skin rash, is the only long-term health effect that might result from the levels of exposure at the Nitro plant. "We do acknowledge other short-term health effects due to exposure to high levels of dioxin," a company spokesman says. They include respiratory tract irritation; headache, dizziness, and nausea; muscle discomfort; and liver disorders. A recent study also indicates an "association" connecting dioxin exposure to gastrointestinal ulcer incidence among those workers, the spokesman notes. "Contrary to what the plaintiff alleges, [Monsanto] was conscientious in its effort to decrease worker exposure to dioxin. We have behaved responsibly in protecting workers from hazards based on our knowledge and the scientific capabilities available."

Exposure to chemicals besides dioxin will likely also be an issue during the trial. For example, until 1955, Monsanto made para-aminobiphenyl at the Nitro plant, a chemical used in making rubber and now widely recognized for inducing bladder tumors in man. Monsanto says it monitors workers exposed to this chemical and continues to pay their medical expenses. Plaintiffs' attorney Calwell says that he will try to show there is synergism between dioxin and other substances causing health problems among the chemical workers.—JEFFREY L. FOX

EPA Failed to Catch Missing Data on Larvadex

When the Environmental Protection Agency (EPA) proposed to register a new pesticide called Larvadex last spring, it braced for controversy on claims that the compound might be carcinogenic. The pesticide will be fed to chickens to control flies that breed in their manure, and a residue will remain in the chickens and their eggs. This residue (melamine) has been linked with tumors in male rats (*Science*, 25 May, p. 851).

However, the agency ran into an entirely unexpected problem, one that its toxicology checkers simply missed in earlier reviews. Although the safety studies submitted by the manufacturer, Ciba-Geigy, were sound on carcinogenic risks, they failed to take full measure of the chemical's fetotoxic (embryo-damaging) effects.

This fact came to light after EPA officials began sorting through the more than 100 comments they received on Larvadex. Two letters from California state agencies and one from the Natural Resources Defense Council pointed to the same problem. In running tests on reproduction, researchers had recorded fetotoxic effects (such as a high rate of abortion or low birth weight) for all dose levels at which the chemical was fed. But they failed to ascertain one essential parameter—the dose at which no effect is seen. The EPA requires that this bottom end of the spectrum be clearly identified.

Ciba-Geigy has been told to redo one reproductive study, a task that will take at least 6 months. The company called the decision "disappointing" and "inappropriate," noting that the EPA has had the data on fetotoxicity in its files for almost 2 years.

The decision has been awkward for the agency as well. The data on Larvadex have been under intense scrutiny since August of 1983, when the EPA ended an "emergency use" waiver under which Larvadex was being used in 28 states. Farmers were told that the pesticide would be back on the market very soon. "When you do 7000 reviews a year," an official said, "you're going to miss on some."

—ELIOT MARSHALL