

of New York. The other reviewers, performing independently to avoid the public meetings required of an advisory committee, were Miles C. Leverett, a consultant with 25 years of experience with the N-Reactor; Harold Lewis, a physicist at the University of California at Santa Barbara with a long record of advising the government about nuclear safety; Thomas A. Pigford, chairman of the nuclear engineering department at the University of California at Berkeley, who has experience in nuclear plant studies for the National Research Council; Gerald F. Tape, a physicist who was once deputy director of Brookhaven National Laboratory, served on the Atomic Energy Commission and headed Associated Universities Inc, which functions as a board of directors for Fermilab; and retired Admiral Eugene P. Wilkinson, former president of the industry's Institute for Nuclear Power Operations.

Roddiss begins his report by quoting the last independent report on the N-Reactor, completed in 1966 by the Advisory Committee on Reactor Safeguards. In the unlikely event of severe accident, the committee said, the N-Reactor would release more radioactivity than a commercial power reactor. Writing only three years after the plant's start-up, ACRS warned that operating the N-Reactor was riskier than running a civilian reactor and that it was justified only by military requirements for plutonium.

Two decades later Roddis recommends that DOE "shut down the N-Reactor unless a positive judgment is made that the requirements for defense material warrant accepting public hazards exceeding those of commercial reactors." Lewis agrees. Prudent policy, he asserts, requires DOE to close the plant in "the very near future... concomitantly forcing a decision on a new production facility." The other reviewers call for remedial work but do not believe it is dangerous to continue running the reactor for another three to five years.

In his review, Lewis attempts to answer those who defend the N-Reactor because it operated for 23 years without mishap and is likely to run safely for many more years. This was the argument used to defeat an amendment put before the House of Representatives last July by James Weaver, an

Oregon Democrat, who sought to shut down the plant until the safety reviews were completed. Some members of Congress praised the reactor's redundant safety systems and reinforced concrete structure, which would minimize the risk of a radioactive release. DOE and the White House opposed the amendment on the grounds that the reactor had a superb safety record and that its plutonium output was necessary to meet current goals for nuclear weapons.

Lewis, however, regards what many see as virtues to be defects. He notes that the statistical record of the N-Reactor is specious and irrelevant. "The probability of a major accident can simply not be inferred from such short operating experience. TMI-2 happened after several hundred reactor-years of US commercial experience and Chernobyl after thousands of reactor-years of worldwide experience." He also recalls, somewhat sadly, that NASA boasted that 24 successful shuttle flights could justify another mission no matter what objections were raised (PHYSICS TODAY, August, page 41). In addition, because the reactor is unique, "it benefits only in part from operating experience, and I found little in the way of systematic effort to derive even those benefits." The problem, according to Lewis, is that management of the reactor "resembles a family operation" within DOE, with "no external peer pressure encouraging excellence of the entire structure," unlike what prevails in the commercial domain of reactors. All six outside reviews agreed that the facility's management was somewhat lax and that workers were unmindful of safety rules.

Complacency. Some problems, say Hanford's critics, involve what they call "widespread complacency" at the plant, which led to no less than 2800 pounds of plutonium unaccounted for more than a decade ago. Hanford's antagonists say it is already the world's biggest radioactive waste dump, and DOE would like to make it the permanent graveyard for 77 000 tons of waste with a half-life longer than human history on the planet.

According to a report issued last August by Congress's General Accounting Office, the N-Reactor's continued operation beyond the 1990s would require spending at least \$1.2 billion for

changes and repairs. One trouble is that equipment used to sample water in the plant for levels of radioactivity is inoperable, so that manual sampling of high-pressure and high-temperature steam is required, causing delays in obtaining readings. Another involves the primary coolant pumps, designed to function five years between major overhauls. These are so old that the work must be done every two years. What's more, electrical wiring often fails, causing reactor outages, and motors for running various valves often burn out but such motors are no longer made.

Operators of the plant say the N-Reactor encounters 20 to 25 "trips," or unplanned outages, each year. Commercial reactors average about seven trips per year, and the Nuclear Regulatory Commission wants to lower the number as a way of reducing wear and tear on operating parts and safety equipment.

Even routine operation is becoming more difficult. The N-Reactor building was designed to withstand only 5 psi above atmospheric pressure, compared with about 50 psi for a modern US nuclear plant and 26 at Chernobyl. Examinations reveal that neutrons are loosening the structure of the graphite blocks at the heart of the reactor with the result that the pile of blocks has been expanding vertically and is almost certain to "hit the roof" of shielding by 1990 or 1991, Roddis asserts, causing a shutdown. In addition, neutrons from the fission reaction bombard the metal tubes that isolate the fuel rods and high-pressure hot water from the graphite, causing them to become so brittle they are prone to rupture. If that were to happen, steam would strike the hot graphite, resulting in a catastrophic accident.

After Salgado announced DOE's plan to repair the N-Reactor, attorneys for the Natural Resources Defense Council asked for a delay in all work until a full environmental impact statement is completed. If the government is unwilling to do this, NRDC threatens to take the issue to court. Meanwhile, Washington's Governor Booth Gardner, a frequent critic of the Hanford nuclear facility, commended DOE for its action, while observing that the various reviews "read like a script from a disaster movie."

—IRWIN GOODWIN

Supreme Court hears arguments on teaching 'creation science'

The case argued before the US Supreme Court on 10 December had its genesis one evening in 1978 when Bill Keith arrived home in Shreveport,

Louisiana, to find his wife in tears. Their teenage son's science teacher, she explained, had ridiculed the youth for saying he did not believe "we all came

from monkeys." Keith commended his son for insisting that humans were created in the image of God. Three years later Keith, then a state senator,

sponsored a law requiring that whenever Louisiana schools teach the theory of evolution they must also teach "creation science."

A year later, in 1982, a suit challenging the Louisiana law was brought against Governor Edwin W. Edwards by parents, schoolteachers and clergymen before a US District Court judge in Baton Rouge. After listening to the arguments, the judge struck down the Louisiana law, holding that the legislature had no secular purpose in passing it and therefore it was a clear violation of the First Amendment's Establishment clause that separates church and state. While doing this, however, the judge refused to resolve the public brouhaha over the state's position that "creationism" is a true science and not, as some citizens claimed, a tenet of religious belief.

Scopes. The US Court of Appeals for the Fifth Circuit upheld the decision. A three-judge panel observed that the Louisiana law "continues the battle William Jennings Bryan carried to his grave" in arguing for the prosecution in the 1925 trial of John T. Scopes.

Soon afterward the full 15-member Fifth Circuit rejected the state's petition that it rehear the case by a narrow margin of 8 to 7. In an impassioned opinion for the seven dissenters, Judge Thomas G. Gee wrote that "evolution is not established scientific fact" and that the law had a legitimate intent: "to prevent the closing of children's minds to religious doctrine by misrepresenting it as in conflict with established scientific laws." Though the Louisiana law had been championed by avowed anti-evolutionists, Judge Gee argued, "they did not seek to further their aim by requiring that religious doctrine be taught in public school." Instead, he claimed, the legislature had chosen "a more modest tactic"—the promotion of "academic freedom" through a "balanced treatment" of scientific information and ideas. The dissenting judges, citing affidavits from "highly qualified scientists," insisted that "there are two bona fide views of human origins." The minority opinion is the heart of the argument the creationists put before the Supreme Court in *Edwards v. Aguillard* (Case No. 85-1513).

Anticlimax. The Fifth Circuit dissent is the first heartening judicial response that fundamentalists have received since the Scopes "monkey trial" more than 60 years ago. Bryan, a commanding orator who had been defeated in three runs for the Presidency, succeeded in keeping evolution out of Tennessee classrooms. But the issue in the case was limited and ended in anticlimax: Scopes was fined \$50 for teaching "any theory that denies the story of



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Divine Creation of man as taught in the Bible" by teaching instead "that man descended from a lower order of animals."

It was a Pyrrhic victory. Most historians agree that the Scopes trial was the beginning of the end for religion in the classroom. Though fundamentalism appeared to be laughed out of court at the time, many textbook publishers and schoolteachers avoided entering the evolution vs creation debate for almost two generations. Not until the 1960s, after the Soviet sputnik shocked the US into upgrading its science courses and updating its texts, was the controversy renewed in the law courts. In 1968 the US Supreme Court seemed to settle the issue by dismissing an Arkansas anti-evolution law as a "quixotic" and "anachronistic" violation of the Constitution's First Amendment, which guarantees free speech and forbids the establishment of religion. Two years later Mississippi's anti-evolutionary teaching law was killed in a court case.

The war wasn't over, however. With the defeat of one series of assaults the creationists simply devised a new strategy. The battleground shifted from state to local levels, where school boards and administrators took up the creationist banner. The victories were sporadic, though the legacy of skirmishes over school prayer and textbook censorship persists to this day.

During the 1970s the creationist controversy increased. One law in Tennessee was ruled unconstitutional on the ground that it established religion in schools. The practice of reading from the Bible and reciting the Lord's Prayer in a Pennsylvania school district was invalidated. A Kentucky law requiring the Ten Commandments to hang in every classroom was struck down, with the court holding that although each poster carried a disclaimer about the Decalogue being part of the "fundamental legal code" of

Western civilization and US common law, "the posting of religious texts on the wall serves no such educational function." In 1964 the Supreme Court overturned an Alabama law requiring "a moment of silence for voluntary prayer" at the start of each school day. In this case, the court said, the bill's legislative backers had unabashedly proclaimed their sole purpose was to institute prayer in Alabama's public schools—a transparent violation of the First Amendment.

Ussher. In most of these cases the majority opinions invoked no less an American than Thomas Jefferson, who once said the First Amendment's establishment clause erected "a wall of separation" between church and state. There is no longer consensus about Jefferson's meaning in the courts. In one of the most recent rulings, Federal District Judge Thomas Gray Hull held last December that children could not be suspended from Hawkins County schools in Tennessee for refusing to read assigned texts that, their parents argued, subjected them to anti-Christian influences—listed in the complaint as including stories about Cinderella and Macbeth because these speak of such supernatural things as fairies and ghosts, Anne Frank's *Diary of a Young Girl* because it concluded that all religions are equal, and a chapter on plate tectonics and accounts of dinosaurs because these call attention to phenomena that took place before the world was created, according to 17th-century Irish Archbishop James Ussher's reckoning, in 4004 BC.

The parents were awarded \$50,521 for their out-of-pocket expenses in bringing the suit. They had not sought damages for "pain and suffering," their lawyer explained, but they were entitled to payment for their "mental anguish." He said: "They stood for something they believed in. It's a principle that's worth more than money. We can't put a price on freedom of

belief."

In other decisions, such as the Alabama case, the Court expressed its trouble with Jefferson's aphorism using such terms as "blurred," "indistinct" and "incomplete." In his dissent, Associate Justice William H. Rehnquist called for abandoning Jefferson's "misleading metaphor." It is these latest rulings as well as the current makeup of the Court, with Rehnquist now Chief Justice, that make *Edwards v. Aguillard* so crucial. The decision could affect the intense national debate over the place of religion in society, including the way public schools and textbooks deal with scientific knowledge, processes and emerging issues.

The strategy used by creationists in the Louisiana act, which the state legislature passed by a large majority, sought to avoid "the inescapable religiosity" that had been exposed in other actions that have come before the courts. Because the Supreme Court may decide whether creationism is science, many scientists have entered the fray with *amicus curiae* briefs. In one such brief, the National Academy of Sciences declared that creationists place themselves beyond reach by asserting that creation "requires the direct involvement of a supernatural intelligence and thus cannot be directly tested by scientific method." To this assertion the academy retorted, "If no test can be conceived that could prove a proposition wrong, it is not a proposition of science."

Nobelists. Among the other 15 *amicus curiae* briefs, most coming from scientific and educational groups, is one filed by 72 Nobel laureates and 17 state academies of science. The organizer was Caltech's Murray Gell-Mann, who began gathering support after the Supreme Court decided to take the case last spring. According to Gell-Mann, Louisiana's concept of creation science is essentially religious beliefs promoted as pseudoscientific doctrine. At a news conference last August in Washington, held to coincide with the filing of the Nobelists' brief, Stephen Jay Gould, a paleontologist at Harvard University, called creation science an oxymoron—"a self-contradictory and meaningless phrase, a whitewash for a specific, particular and minority religious view in America: Biblical literalism."

When the case reached the Supreme Court for an hour of oral arguments, Wendell R. Bird, attorney for the state, conceded that while "some legislators had a desire to teach religious doctrine in the classroom," the purpose of the Louisiana law was "primarily secular." Responding to Associate Justice Sandra Day O'Connor's question whether

National Academy: Creationism is religion, not science

"Scientists, like many others, are touched with awe at the order and complexity of nature. Religion provides one way for human beings to be comfortable with these marvels. However, the goal of science is to seek naturalistic explanations for phenomena—and the origins of life, the Earth and the universe are, to scientists, such phenomena—within the framework of natural laws and principles and the operational rule of testability.

"It is, therefore, our unequivocal conclusion that creationism, with its account of the origin of life by supernatural means, is not science. It subordinates evidence to statements based on authority and revelation. Its documentation is almost entirely limited to the special publications of its advocates. And its central hypothesis is not subject to change in light of new data or demonstration of error. Moreover, when the evidence for creationism has been subjected to the tests of the scientific method, it has been found invalid.

"No body of beliefs that has its origin in doctrinal material rather than scientific observation should be admissible as science in any science course. Incorporating the teaching of such doctrines into a science curriculum stifles the development of critical thinking patterns in the developing mind and seriously compromises the best interests of public education. This could eventually hamper the advancement of science and technology as students take their places as leaders of future generations."

—*Science and Creationism: A View from the National Academy of Sciences.*
NAS Committee on Science and Creationism,
James D. Ebert, Chairman, 1984

it is valid to teach religious belief in order to balance nonreligious teaching, Bird acknowledged that "teaching religious doctrine is unconstitutional." The Louisiana statute, he added, does not call for religious instruction but for balancing the teaching of evolution by exposing students to "scientific evidences supporting creation" and to scientific doubts about evolution. This would include discussion of the "mathematical improbability" that life forms in their riotous diversity could have evolved from one-celled organisms over billions of years.

Associate Justice Antonin Scalia, the newest appointee to the Court, challenged many of the arguments put forward by Jay Topkis, representing the American Civil Liberties Union, which opposes the act. Could the Big

Bang be considered an act of theistic creation, Scalia asked, with evolution following afterward? "What about Aristotle's idea of a first cause—an unmoved mover? Would that be a creationist view? Would that make Aristotelian philosophy a religion?" posed Justice Scalia. Topkis said it would not and parried with references to St. Thomas Aquinas and Baruch Spinoza, but stressed that such concepts were not the moving force of the Louisiana law, which had little to do with philosophical subtleties or secular purposes. For instance, said Topkis, what the act's advocates mean by academic freedom is, "simply put, 'We've got to give God equal time.'"

The Court is expected to hand down a ruling by July.

—IRWIN GOODWIN

Education

NSF undergrad programs upset scientists

Among the most dismaying accusations in *College—The Undergraduate Experience in America*, a critical examination of baccalaureate education published last November (Harper and Row), are that students remain unchallenged intellectually and that their major specialties lack enrichment. The report, written by Ernest L. Boyer, president of The Carnegie Foundation for the Advancement of Teaching, and based on studies of students, faculty and administrators at 29 public and private four-year schools in various parts of the country, is still another low grade for American academe.

Until recently all the bad marks were given in the pre-college years. The Carnegie report on colleges can be

read as a cheerless companion to its earlier study, *High School*, and to an even more sobering inquiry of pre-college schooling, *A Nation at Risk*, in which the National Commission on Excellence in Education cited a "rising tide of mediocrity that threatens our very future as a nation and a people" (PHYSICS TODAY, June 1983, page 44).

The outpouring of reports carrying more or less the same message is contributing to a wave of school reforms now sweeping through state legislatures and local school boards. Teacher pay scales are going up, often on the basis of merit reviews, and student graduation standards are being raised to meet the demands of concerned parents and prospective em-