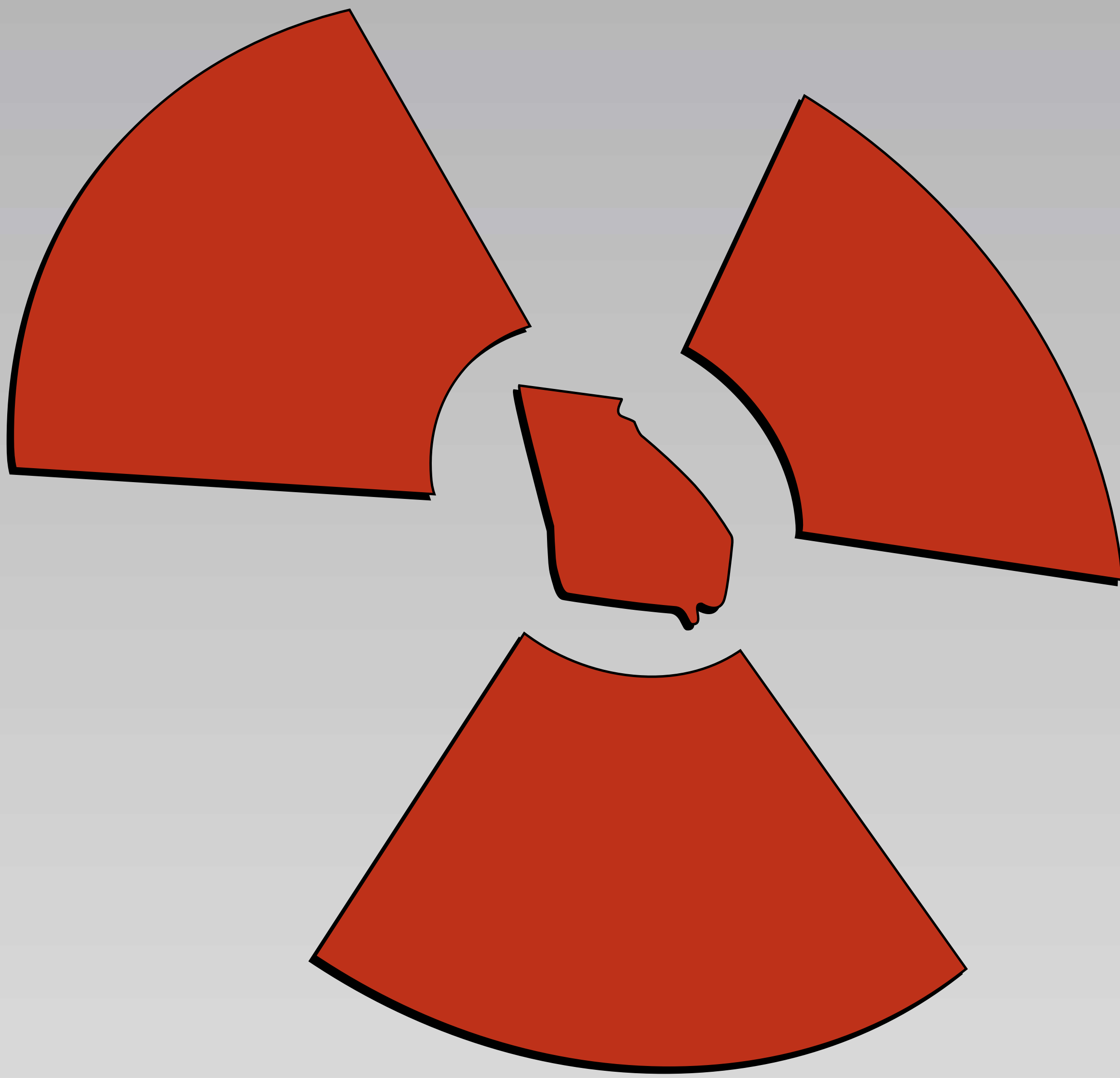
CODE RED ALERT

CONFRONTING NUCLEAR POWER IN GEORGIA



Southern Alliance For Clean Energy
www.cleanenergy.org

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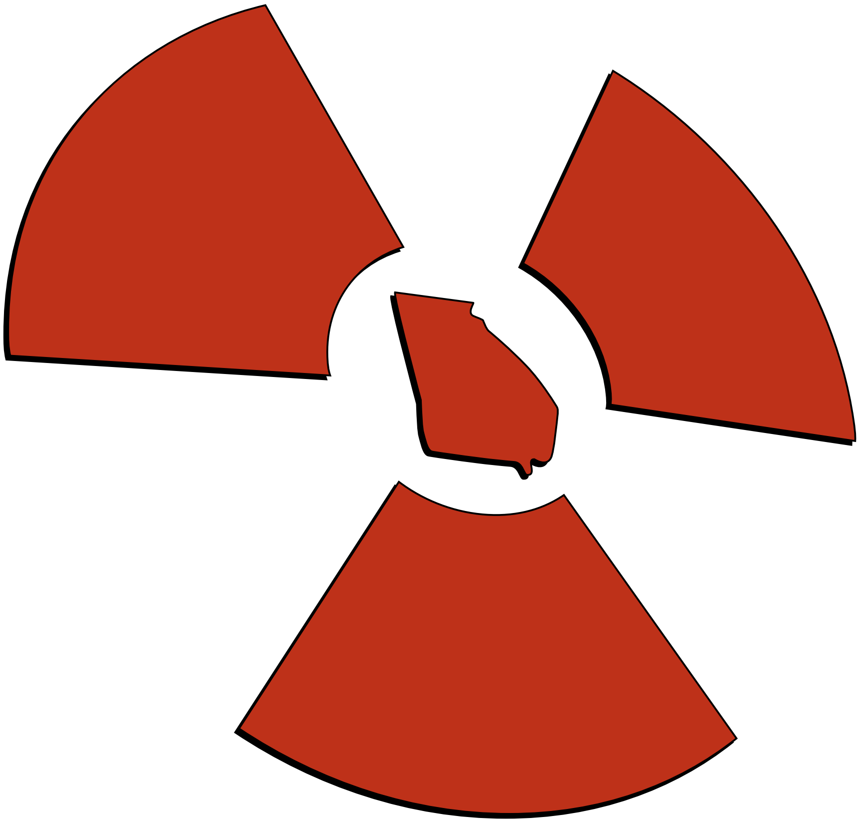

ACKNOWLEDGEMENTS

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Executive Summary

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Our 21st century world is complex, interconnected, and often unpredictable. The bitter lesson of just how unpredictable was brought home on September 11, 2001. We have power our ancestors never dreamed of, but we can also be overwhelmed by our own creations in ways we never imagined.

Americans now live with the color-coded alerts related to the probability of terrorist attacks. If we were to apply that system to real, if unacknowledged, dangers, we would find ourselves confronting a Code Red alert over growing stockpiles of unstable nuclear waste from nuclear power plants and weapons development that threaten our own health and safety, and those of future generations here in Georgia.

The dangers of atomic or nuclear power were not always acknowledged or widely known. The Atomic Age was once portrayed as the gateway to a prosperous future fueled by electricity "too cheap to meter," generated by nuclear power. It never got that cheap, and public enthusiasm for nuclear power cooled considerably after accidents at Three Mile Island and Chernobyl. The old plants continued to run, but no new reactors were licensed to be built in the United States. The energy industry had a huge investment that was going nowhere. They also had a serious marketing problem: how to sell nuclear power in a world more aware of environmental dangers. In recent years, though, two factors have increased interest in nuclear energy: recognition of the harm of burning coal and the terrorist attacks of September 11th.

We are increasingly aware of the air and climate problems created by coal-fired power plants. The shortcomings of fossil fuels prompted the nuclear power industry to market itself as an alternative. Nuclear power does not produce the ugly, smelly emissions that come from burning coal, gas, and oil; instead, it produces invisible radioactive emissions and deadly nuclear waste. In theory, switching to nuclear power might reduce greenhouse gases. But even if such a scenario were practical, it is a fool's bargain because the public loses more than it gains.

The terrorist attacks of September 11, 2001, raised the level of concern that the United States is dependent on oil from countries that may be harboring or financing terrorists or that may be taken over by regimes sympathetic to terrorists. Nuclear power is being marketed as an alternative to oil for the production of electricity and therefore as a way to make America less dependent on Middle Eastern oil. While less dependence on oil might indeed be a good thing, switching to nuclear power would arguably make the country less secure, not safer, in this post-superpower era of highly mobile terrorist cells.

This report explains why nuclear power is no bargain in terms of improving the environment, public health, or national security. This report details the nuclear dangers in Georgia from power generation and weapons development, both of which are taking a toll on the state's economy and natural resources. This report proposes ways to avert disasters that could emanate from these nuclear activities.

From nuclear bomb research testing in the late 1950s near Dawsonville to nuclear power generation on the Altamaha River, nuclear power and weapons industries have made an indelible mark on the state. Georgia relies on nuclear energy for 27% of its electricity and is home to four nuclear power reactors, and seven more reactors are within 15 miles of the state line.[1] With several nuclear weapons operations inside and near its borders, Georgia is the nation's second largest host of nuclear warheads.[2] Second in the country would be laudable if it were education, health, income, or football—but not for nuclear warheads.

All nuclear power plants and nuclear weapons production facilities release radioactive contaminants into the air, water, and soil during normal operations, raising the level of radiation exposure to the general population. Radiation is very disruptive to the chemical processes in living organisms, causing cancer and birth defects. There is no safe dose of radiation; increased radiation in our environment from nuclear facilities poses a hazard. Someone, somewhere is going to develop the extra case of cancer. Someone's child will suffer a birth defect.

All nuclear power plants produce highly radioactive waste in the form of spent fuel. Standing near an unshielded spent fuel assembly would be quickly fatal. Nothing renders this waste harmless except the passage of time—eons of time, thousands of years. Meanwhile, the waste must be stored completely shielded from humans and the environment. Thousands of tons of waste are stored at both closed and operating nuclear power plants all over the country, but they will run out of room—some already have. Long-term storage remains a very contentious issue. For obvious reasons, no one wants to be near it. There is the additional problem of transporting the waste from current storage sites to any long-term site.

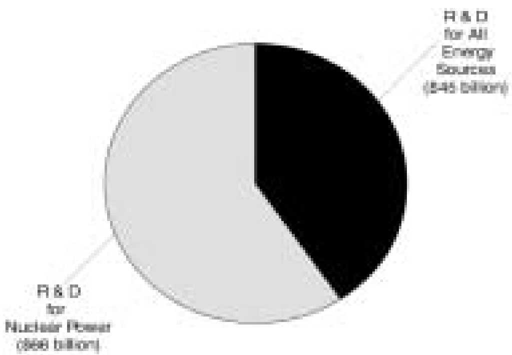
Nuclear power plants are as vulnerable to Murphy's law as anything else designed, built, and managed by humans. The consequences of an accident can span generations. The accidents at Three Mile Island and Chernobyl are well known. The increased rates of cancer and birth defects from the radiation at Chernobyl are horrible enough, but the accident will affect unborn generations because of the lingering radiation and genetic damage. Even if we consider only the economic effects, Chernobyl was a disaster. The economic losses due to Chernobyl were greater than three times the economic benefit accrued from the operation of every other Soviet nuclear power plant combined between 1954 and 1990.[3]

Nuclear power plants are prime terrorist targets. The Nuclear Regulatory Commission has long recognized this and designed exercises to test the ability of the staff at nuclear power plants to defend against an attack. These exercises do not inspire confidence. Even though the power plant operators are told months in advance when the attack will take place and what tactics will be used, almost half of the plants have been unable to prevent "terrorists" from simulating an action that would lead to reactor core damage. Ironically, these mock attacks have not been re-established since September 11th due to the higher security status for nuclear facilities.[4] Spent fuel storage casks stored near reactors are even more vulnerable. If plants keep operating, the highly radioactive spent fuel will have to be transported to long-term storage sites, giving terrorists additional opportunities and raising the possibility of the most disastrous of traffic accidents.

Nuclear power is a terribly expensive way to boil water that becomes the steam to spin turbines that generate electricity. It costs more to operate and maintain a nuclear power plant per unit of electricity produced than it does a coal or natural gas plant.[4a] And nuclear power uses an enormous amount of water to produce steam and to cool the reactor. (Georgia's nuclear power plants use more water daily than most of its cities.) Using so much water to produce electricity in a hot climate subject to periods of drought sets up some very difficult choices. Deciding between generating electricity for cooling offices and homes versus irrigating crops or maintaining lake water levels for recreation

It costs more to operate and maintain a nuclear power plant per unit of electricity produced than it does a coal or natural gas plant.[4a]

Total U.S. Federal Government Spending for Energy Research & Development (R & D) for Energy Sources 1948-1998



Source: National Council for Science and the Environment, "Congressional Research Service Issue Brief for Congress, IB10041, Renewable Energy Tax Credit, Budget, and Electricity Restructuring Issues," March 8, 2001.

and healthy water flows to our estuaries will become less a matter of reason and more a matter of political power. Even if the reactor is not generating electricity, it must be kept cool with circulating water. The cooling water is released back into Georgia's waterways at a higher temperature, creating thermal plumes that threaten aquatic life and Georgia's commercial fishing and seafood industries.

The "panacea" of nuclear power has diverted money and talent from the development of more benign but powerful forms of energy production. As a nation from 1948 to 1998 we spent more than $111 billion on total energy research and development. A whopping 59% was spent on nuclear power,[5] an industry that provides only 20% of total energy generation to the country.[6]

Nuclear power has associated costs that far exceed those of other kinds of power generation. These include:

- Production of nuclear fuel, including mining, uranium conversion, enrichment, and fuel fabrication (see Appendix C)
- Cost of transporting, storing, and safeguarding radioactive waste
- Regulatory costs, including support for the Nuclear Regulatory Commission
- State and federal radiation monitoring programs
- Economic damage from radioactive and other toxic contaminants
- Decommissioning (shutting down and dismantling the plant)
- Property value declines linked to contaminated sites and their surroundings
- Loss of economic development opportunities for surrounding communities, linked in part to water supplies diverted for Georgia's nuclear facilities

Despite documented economic, health, and environmental threats, the nuclear industry has launched a campaign to revive and expand in Georgia and the Southeast. Expansion plans include: production of commercial nuclear reactor fuel from surplus weapons plutonium; extension of operating licenses and lengthening of operating cycles so that aged, existing plants are allowed to run longer and harder; development of supposedly "new" nuclear plant designs; production of hydrogen from nuclear power plants; and consolidation of companies that own nuclear facilities. In addition, increased foreign ownership and more "industry friendly" regulatory treatment leave Georgians increasingly vulnerable and poorly positioned to determine the future of nuclear power in their own state.

Southern Alliance for Clean Energy recommends that Georgia and the region phase out the area's nuclear power plants and replace them with safe, clean, and economical energy supplies that would provide secure jobs to the region.

Southern Alliance for Clean Energy recommends that Georgia and the region phase out nuclear power plants, replacing them with safe, clean, and economical energy supplies that would provide secure jobs to the region. Specific policy steps include:

➤ Conduct comprehensive statewide energy planning that addresses future energy needs, removes long-term dependency on nuclear power, and sets goals for the systematic adoption of safe replacement power
➤ Establish economic incentives for businesses to develop efficient, clean, renewable energy resources
➤ Stop the ongoing, long-term production of dangerous nuclear waste and

unsafe, temporary storage of that waste in containers outdoors

- ➤ Protect taxpayers and utility ratepayers from expensive radioactive cleanup costs by removing corporate nuclear liability shields and instituting effective, long-term radioactive monitoring measures by the state
- ➤ Establish better regulations to protect the public and the environment from radiation, including adequate monitoring of air, water, and soil for contamination by nuclear activities
- ➤ Prevent the development of hydrogen-based nuclear fuel, plutonium bomb fuel, and other tactics that expand unsafe nuclear power
- ➤ Disallow nuclear power from being eligible for a federal or state renewable energy portfolio standard[7] requirement or eligible for "greenhouse gas" or "carbon emissions" credits[8]

Studies show that a clean energy generation mix can meet the region's power demands and reduce pollution by developing energy efficiency programs, employing cleaner conventional sources, and phasing in renewable energy as nuclear sources are phased out over time. For example, based on the technical potential identified in the Renewable Energy Policy Project's 2001 report *Powering the South: A Clean and Affordable Energy Plan for the Southern United States*, investments in energy efficiency initiatives alone over the next 20 years in Georgia would eliminate the need for 20 new power plants (300 MW each), a total of 6,000 MW, and potentially save 41 million megawatt hours (MWh). More specifically, energy efficiency measures such as efficient commercial lighting, efficient building shells, and improved industrial energy recovery systems, among many other energy efficiency options, can replace the need for six nuclear power reactors that are approximately the size of Georgia's 1,000 MW plants.[9]

To date, some of Georgia's officials and power companies have chosen to promote a dangerous and costly nuclear path to provide expensive energy. Nuclear power is a dinosaur of the Cold War era. Misguided support for nuclear technologies must give way to safe energy options that bolster the state's economy and protect both the public and valuable natural resources. A first essential step will be to discontinue nuclear power expansion with its costly nuclear fuel chain. This will require Georgia—from the Governor to U.S. and State legislators to Public Service Commissioners, local officials, and environmental regulators—to actively protect citizens and taxpayers by developing strategies for a safe, clean energy future. Local, state, and federal officials, including Georgia's Congressional delegation, must oppose nuclear expansion ventures to protect the health and prosperity of Georgia's citizens. Georgians increasingly understand the reason for a Code Red alert—unbalanced, uncontrolled, unsafe nuclear power—and they are increasingly determined that this threat be eliminated.

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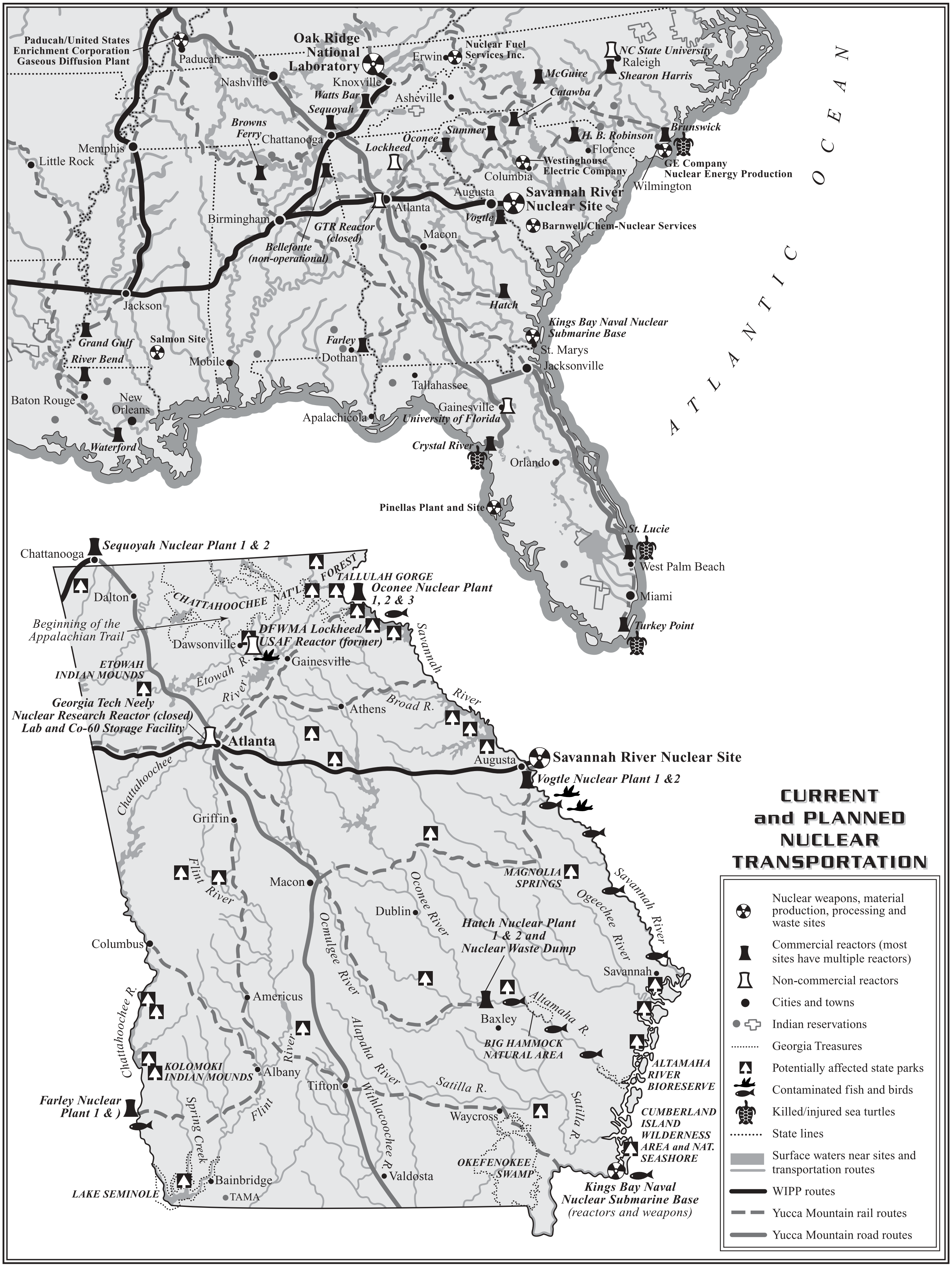
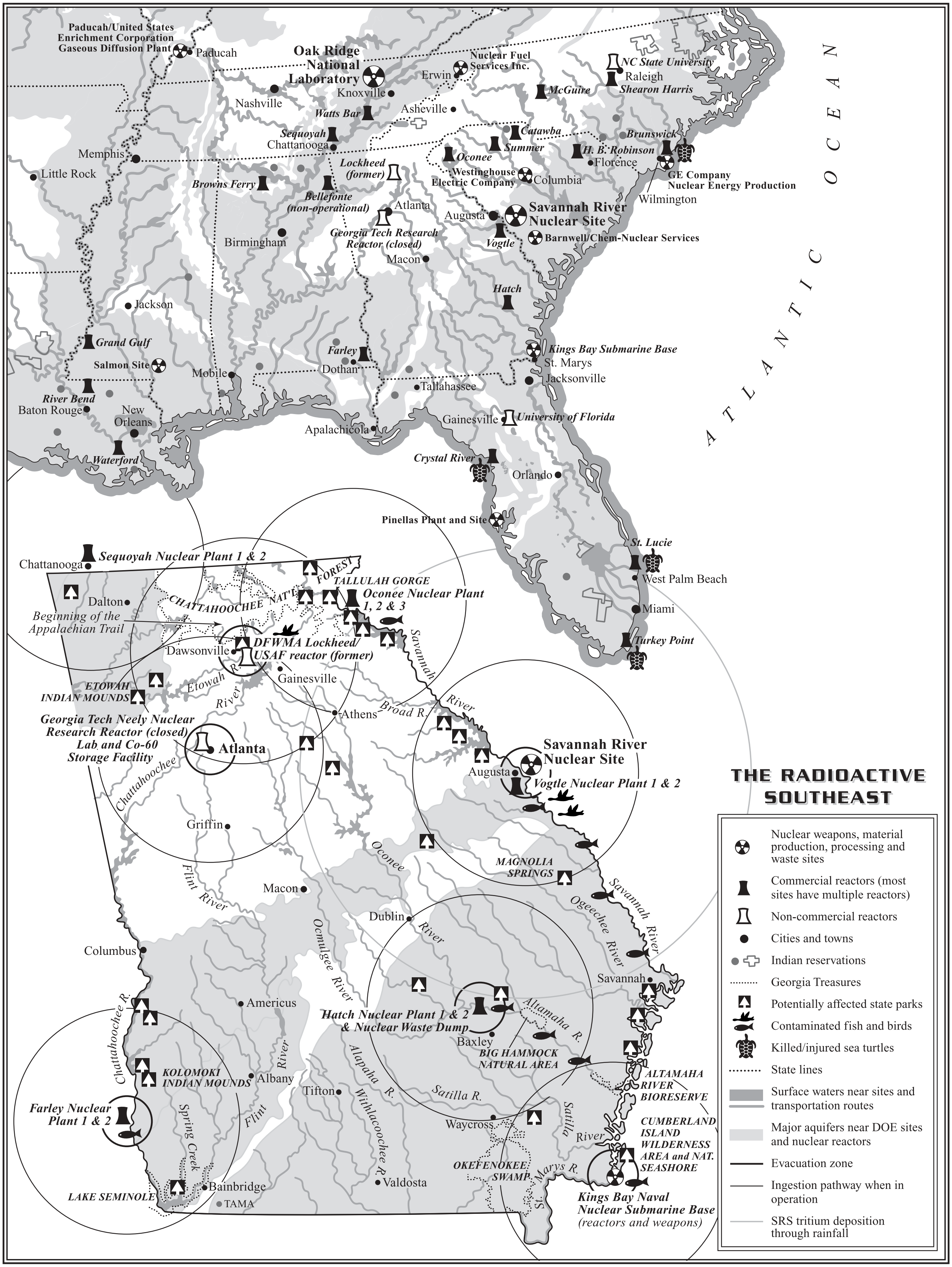

CURRENT
and PLANNED
NUCLEAR
TRANSPORTATION
Nuclear weapons, material production, processing and waste sites
Commercial reactors (most sites have multiple reactors)
Non-commercial reactors
Cities and towns
Indian reservations
Georgia Treasures
Potentially affected state parks
Contaminated fish and birds
Killed/injured sea turtles
State lines
Surface waters near sites and transportation routes
WIPP routes
Yucca Mountain rail routes
Yucca Mountain road routes
ATLANTIC OCEAN
Paducah/United States
Enrichment Corporation
Gaseous Diffusion Plant
Paducah
Oak Ridge
National
Laboratory
Nashville
Knoxville
Watts Bar
Sequoyah
Erwin
Nuclear Fuel
Services Inc.
Asheville
NC State University
Raleigh
Shearon Harris
McGuire
Catawba
Memphis
Little Rock
Browns
Ferry
Chattanooga
Oconee
Lockheed
Summer
H. B. Robinson
Florence
Brunswick
Westinghouse
Electric Company
GE Company
Nuclear Energy Production
Columbia
Wilmington
Birmingham
Atlanta
Augusta
Savannah River
Nuclear Site
Vogtle
Barnwell/Chem-Nuclear Services
GTR Reactor
(closed)
Bellefonte
(non-operational)
Macon
Jackson
Hatch
Kings Bay Naval Nuclear
Submarine Base
St. Marys
Jacksonville
Grand Gulf
Salmon Site
River Bend
Mobile
Farley
Dothan
Tallahassee
Baton Rouge
New
Orleans
Apalachicola
Gainesville
University of Florida
Waterford
Crystal River
Orlando
Pinellas Plant and Site
St. Lucie
West Palm Beach
Miami
Turkey Point
Chattanooga
Sequoyah Nuclear Plant 1 & 2
Dalton
CHATTAHOOCHEE NAT'L FOREST
TALLULAH GORGE
Oconee Nuclear Plant
1, 2 & 3
Beginning of the
Appalachian Trail
Dawsonville
DFWMA Lockheed/
USAF Reactor (former)
Gainesville
Savannah
River
ETOWAH
INDIAN MOUNDS
Etowah R.
River
Georgia Tech Neely
Nuclear Research Reactor (closed)
Lab and Co-60 Storage Facility
Athens
Broad R.
Atlanta
Augusta
Savannah River Nuclear Site
Vogtle Nuclear Plant 1 &2
Chattahoochee
Griffin
Macon
MAGNOLIA
SPRINGS
Flint
River
Dublin
Oconee River
Ogeechee
River
Savannah
River
Hatch Nuclear Plant
1 & 2 and
Nuclear Waste Dump
Columbus
Ocmulgee
River
Savannah
Americus
Baxley
Altamaha R.
Chattahoochee R.
BIG HAMMOCK
NATURAL AREA
KOLOMOKI
INDIAN MOUNDS
Albany
River
Alapaha River
ALTAMAHA
RIVER
BIORESERVE
Tifton
Satilla R.
Farley Nuclear
Plant 1 &)
Spring Creek
Flint
Withlacoochee R.
Waycross
Satilla R.
CUMBERLAND
ISLAND
WILDERNESS
AREA and NAT.
SEASHORE
OKEFENOKEE
SWAMP
Bainbridge
Valdosta
LAKE SEMINOLE
TAMA
Kings Bay Naval
Nuclear Submarine Base
(reactors and weapons)


THE RADIOACTIVE SOUTHEAST
Nuclear weapons, material production, processing and waste sites
Commercial reactors (most sites have multiple reactors)
Non-commercial reactors
Cities and towns
Indian reservations
Georgia Treasures
Potentially affected state parks
Contaminated fish and birds
Killed/injured sea turtles
State lines
Surface waters near sites and transportation routes
Major aquifers near DOE sites and nuclear reactors
Evacuation zone
Ingestion pathway when in operation
SRS tritium deposition through rainfall
ATLANTIC OCEAN
Paducah/United States Enrichment Corporation Gaseous Diffusion Plant
Paducah
Oak Ridge National Laboratory
Nuclear Fuel Services Inc.
Erwin
NC State University
Raleigh
Shearon Harris
McGuire
Nashville
Knoxville
Watts Bar
Asheville
Sequoyah
Chattanooga
Catawba
Summer
Brunswick
H. B. Robinson
Florence
Oconee
Memphis
Little Rock
Lockheed (former)
Westinghouse Electric Company
Columbia
GE Company Nuclear Energy Production
Wilmington
Browns Ferry
Bellefonte (non-operational)
Atlanta
Augusta
Savannah River Nuclear Site
Georgia Tech Research Reactor (closed)
Vogtle
Barnwell/Chem-Nuclear Services
Birmingham
Macon
Hatch
Jackson
Grand Gulf
Salmon Site
Farley
Dothan
Kings Bay Submarine Base
St. Marys
Mobile
Jacksonville
River Bend
Baton Rouge
New Orleans
Tallahassee
Gainesville
University of Florida
Apalachicola
Waterford
Crystal River
Orlando
Pinellas Plant and Site
St. Lucie
West Palm Beach
Miami
Turkey Point
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Oconee
MAGNOLIA SPRINGS
Flint River
Macon
Savannah River
Ogeechee River
Dublin
River
Ocmulgee River
Columbus
Savannah
Chattahoochee R.
Americus
Hatch Nuclear Plant 1 & 2 & Nuclear Waste Dump
Altamaha R.
Baxley
BIG HAMMOCK NATURAL AREA
KOLOMOKI INDIAN MOUNDS
Albany
River
ALTAMAHA RIVER BIORESERVE
Alapaha R.
Tifton
Satilla R.
Farley Nuclear Plant 1 & 2
Flint
Spring Creek
Withlacoochee R.
Waycross
Satilla River
CUMBERLAND ISLAND WILDERNESS AREA and NAT. SEASHORE
OKEFENOKEE SWAMP
St. Marys R.
Bainbridge
Valdosta
LAKE SEMINOLE
TAMA
Kings Bay Naval Nuclear Submarine Base (reactors and weapons)

Indelible Impacts and Threats

Impacts & Threats

NO PLACE TO HIDE

There are many problems associated with nuclear power, but to understand these, it will be helpful to review the way a typical nuclear reactor works. In a reactor, the nuclei of uranium (or plutonium) atoms are split—or fissioned—by hitting them with neutrons. A "neutron generator" is used to start the reaction. Think of a cluster of billiard balls being hit by the cue ball. When the uranium or plutonium nucleus fissions, it releases neutrons that can split other nuclei in a self-sustaining chain reaction. This creates an incredible amount of energy (heat), which can then be used to boil water to create steam to spin turbines to generate electricity. But heat is not the only thing that is produced. With each fissioning, dangerous radiation is formed. Also, radioactive activation and fission products are created *(see Appendix B, List of Terms)*, and these continue to emit dangerous radiation even after they are removed from the reactor. The nuclear chain reaction is the same in an atomic bomb as it is in a nuclear power plant or research reactor, but in a reactor it is "controlled" by using control rods to slow or stop the chain reaction.

Many industrial processes generate dangerous toxic waste, but radiation is a unique kind of danger. Most elements have forms or isotopes that can emit radiation. Very low levels of "background" radiation are part of the natural world. However, what is used in and created by nuclear power plants is called "ionizing radiation" and is far more intensely radioactive *(see List of Terms).* Ionizing radiation carries a powerful electrical charge that is very disruptive to the normal chemical processes in living organisms, like the replication of DNA. A National Academy of Sciences report states it bluntly, "Ionizing radiation damages genetic material in reproductive cells and results in mutations that are transmitted from generation to generation."[10] Another source further describes the cellular malfunctions created by nuclear activity this way:

> "Among the observed consequences of the action of ionizing radiations on cells are the breaking of the chromosomes, swelling of the nucleus and of the entire cell, increase in the viscosity of the cell fluid, increased permeability of the cell membrane, and destruction of cells. In addition, the process of cell division (or 'mitosis') is delayed by exposure to radiation. Frequently, cells are unable to undergo mitosis so that the normal cell replacement occurring in the living organism is inhibited."[11]

The cells that are the most vulnerable are those that are dividing most rapidly, such as those of a developing fetus. As far as scientists can determine, there is no safe level of radiation.[12]

Early in the development of nuclear power, atomic researchers conducted studies on animals to learn about the effects of radiation on living tissues and genetic mutations.[13] Radiation damage in the survivors of Hiroshima and Nagasaki were also studied. Radiation can cause cancer and damage reproductive cells, which can lead to mutations that are passed from generation to generation.[14] The greater the exposure to radiation, the greater the risk of genetic mutations and cancer.[15] As the World Health Organization observed, "Overexposure to ionizing radiation can have serious effects, including cancers, birth deformities, and mental anguish."[16] Radiation can also damage the immune system.[17] As radiation increases so does the risk of spontaneous abortion and birth defects such as mental retardation and spina bifida. The risk of heart disease, leukemia, and other diseases also increases.[18]

Dr. John Gofman, a medical doctor, atomic scientist, and the first director and founder of the biomedical division at Lawrence Livermore Laboratory, who led the "Plutonium Group" that managed to isolate the first milligram of plutonium from irradiated uranium stated, "By any reasonable standard of biomedical proof, there is no safe dose, which means that just one decaying radioactive atom can produce permanent mutation in a cell's genetic molecules."[19]

All nuclear power plants release radioactive contaminants such as Cesium–137, Strontium–90, Tritium, and radioactive Iodine into the air, soil, and water during normal, daily operations.[20] Airborne radioactive contaminants pollute nearby crops and vegetation. Farm animals that feed on the crops and vegetation concentrate these contaminants in their meat and milk. Current regulatory guidelines set limits on these emissions. However, the aggregate of radiation epidemiological evidence suggests that current radiation health standards that guide emissions are inadequate to protect public health.[21] Those living closest to a nuclear power plant have a greater risk of exposure, and these are often low-income and minority communities. The people who are actually at the highest risk are the workers at these plants. Regulations allow higher exposures to higher levels of radiation for nuclear workers than to the general public.[22] The 2003 European Committee on Radiation Risk (ECRR) issued an extensive report that criticized the health risk model of the International Commission on Radiological Protection (ICRP), which provides the basis for current radiation risk standards. The report stated that the ICRP seriously underestimated health risks resulting from nuclear energy and nuclear weapons activity.[23]

In Georgia, radioactive emissions released into the air and water have been measured in rain, soil, crops, vegetation, river sediment, surface water, groundwater, and in fish and seafood samples.[24] Cesium-137, which collects in muscle tissue, has been found in elevated levels in river sediment more than 80 miles downstream from Georgia's nuclear plants. In their fish consumption guideline publications, South Carolina and Georgia mention that some fish in the Savannah River contain both Cesium-137 and Strontium-90.[25] Strontium-90 collects in the bones. Non-cancer effects from exposure to Strontium-90 include higher infant mortality rates and more early fetal deaths associated with heart and circulatory defects.[26] Tritium, a radioactive isotope of hydrogen that is produced at all nuclear reactors, acts like water in the body and can pass through the placenta to harm a developing fetus.[27]

Currently, the Georgia Environmental Protection Division's Environmental Radiation Program works with the U.S. Department of Energy (DOE), the Savannah River Site (SRS), Georgia Power/Southern Nuclear, and the City of Savannah to monitor routine releases of tritium from SRS and nuclear Plant Vogtle. This is especially problematic when the facilities perform batch releases into the Savannah River during times of drought or low river flow.[28]

The Savannah River is used as a drinking water supply source for many downstream locations, including the City of Savannah Industrial and Domestic (I&D) Water Supply Plant in Port Wentworth and the Beaufort-Jasper Water Treatment Plant (which supplies Hilton Head, SC).[29] In 2002, the Augusta Radiation Lab tested more than 500 samples from the Savannah River and the City of Savannah's I&D plant. Most samples complied with the EPA drinking water limit of 20,000 picoCuries/liter. However, some samples taken from SRS outfalls, which discharge tritium from high-level waste tank processing, were

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Standing near unshielded spent fuel would be quickly fatal.

tested at more than 35,000 picoCuries/liter.[30] In contrast, prior to 1945, North American rivers measured less than 10 picoCuries of tritium per liter.[31]

NUCLEAR WASTE—THE ULTIMATE GARBAGE PROBLEM

The nuclear chain reaction going on in the reactor core occurs in the uranium fuel pellets encased in metal fuel rods. In order to provide a "steady state" of power, the fuel rods are removed before all of the fissionable material is used up. Thus, once a certain percentage of the fissionable material has been split, the material is off-loaded from the reactor and fresh fuel is added. When removed, generally after six years, the fuel rods contain about one-fifth of the original amount of Uranium-235.[32] While it would seem that these rods should be less radioactive, they are in fact thousands of times more radioactive than when they were originally placed in the reactor, due to the creation of various fission and activation products along with plutonium.

Standing near unshielded spent fuel would be quickly fatal. According to the federal government's Nuclear Regulatory Commission (NRC), 10 years after spent fuel is removed from a reactor, the radiation dose at one meter from a normal spent fuel assembly exceeds 20,000 rems per hour.[33] Immediate incapacitation and death is estimated to occur at 450-600 rems.[34] These rods will remain radioactive for well over 250,000 years.[35]

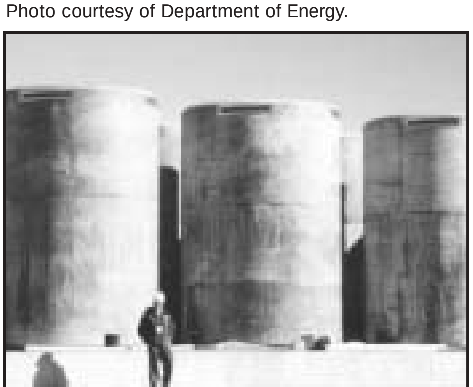
After being removed from the reactor, the spent fuel rods are placed underwater in an on-site, radioactive spent fuel storage pool. Water must be continuously circulated around them to prevent heat and radioactivity from rising to dangerous levels and causing a meltdown. Spent fuel pools provide limited storage space and must be managed carefully because individual fuel rods must not be placed too close to each other in order to prevent initiation of a nuclear reaction.[36]

To render this radioactive waste harmless would essentially require changing the laws of the universe, so we are left with the worst waste "disposal" problem in history. Scientists and government officials have been studying what to do with this deadly waste for more than five decades. A satisfactory solution is not in sight.

According to the NRC, U.S. nuclear power plants were not designed to have storage capacity for all the spent fuel produced by their reactors.[37] Consequently, utilities and the NRC undertook other procedures to continue generating energy along with nuclear waste. Part of the "solution" was to build outdoor nuclear waste storage dumps, known as Independent Spent Fuel Storage Installations (ISFSI), typically on the same site as the nuclear power plant.

At Georgia's Plant Hatch near the Altamaha River, Southern Company built an outdoor nuclear waste storage dump to avoid shutting the plant down after its indoor fuel storage pool was full. The outside dump consists of a concrete pad on which huge casks containing the spent fuel are stored. These concrete and steel cylindrical dry casks are each about 19 feet high, 12 feet wide, and weigh about 120 tons.[38] The Hatch site is currently built to hold up to 48 casks. Dry cask storage poses many health, environmental, and security concerns due

An example of an empty dry cask.
Photo courtesy of Department of Energy.



in part to the radiation the casks emit.[39] According to NRC Daily Event Reports, the first cask could not be properly sealed. Another cask loaded in 2002 also experienced difficulties—namely from problems with the large overhead crane that is used to move the heavy casks to and from the refueling floor, precariously located between the fourth and fifth floors.[40] A former nuclear auditor has raised serious questions about the design of casks used at Hatch.[41] As of March 2004, 17 casks have been filled at Hatch.[42]

Even by building storage installations on site, however problematic, nuclear power plants around the country face a common problem of running out of space. Because the waste from nuclear power plants will continue to emit dangerous levels of radiation for thousands of years,[43] there is no completely safe storage solution, which makes the debate over eventual long-term nuclear waste storage a contentious, unresolved issue.

Congress passed the Nuclear Waste Policy Act (NWPA) of 1982, which established methods for disposal of high-level radioactive waste, giving the Department of Energy (DOE) operational responsibility and the NRC regulatory responsibility for transportation, storage, and "geologic disposal" of the waste. In the 1987 Amendments to the NWPA, DOE was instructed to pursue just one potential high-level waste repository, located at Yucca Mountain, in Nye County, Nevada.[44] Yucca Mountain is located on Native American (Western Shoshone) land, next to the Nevada Nuclear Test Site (also Shoshone land), approximately 90 miles northwest of Las Vegas, one of the fastest growing cities in the nation.

Yucca Mountain is being presented as a solution to our nuclear waste problem. Yucca Mountain is licensed to store 70,000 metric tons of heavy metal (MTHM).[45] The bulk of this allotment, about 63,000 MTHM, would be for spent fuel assemblies from commercial nuclear power plants.[46] As of January 1998, there were 1,665 metric tons of this spent fuel stored in Georgia alone.[46a] If we commit to nuclear power, there is no end to the radioactive nuclear waste that will be generated. Perhaps DOE believes that future generations will invent a way to get around the laws of nature. Though the majority of the wastes slated for Yucca Mountain will need to be isolated from humans and the environment for hundreds of thousands of years, the DOE currently only requires containment for 10,000 years.[47]

Since the development of the nation's first high-level nuclear waste repository has taken many decades and still faces many daunting legal hurdles, utility companies have pursued other "disposal" tactics for their nuclear waste. Southern Company and other power companies have joined together in a consortium called Private Fuel Storage, LLC (PFS). PFS is working to establish a high-level nuclear waste dump on the impoverished Skull Valley Goshute Indian Reservation just 45 miles southwest of Salt Lake City in Utah, a state that does not even have a nuclear power plant. Though the companies claim that PFS will just be an "interim" storage facility for 20 years, 20-year license extensions are possible. If the PFS site were approved, the dry casks at Georgia's Plant Hatch, for example, would likely be shipped to Utah for storage. The jockeying of nuclear waste from one site to another throughout our

Southern Company and other power companies have joined together in a consortium called Private Fuel Storage...to establish a high-level nuclear waste dump on the impoverished Skull Valley Goshute Indian Reservation...

If we commit to nuclear power, there is no end to the radioactive nuclear waste that will be generated.

Yucca Mountain is located just 90 miles northwest of Las Vegas.

nation is the ultimate "shell game." It might also result in the ultimate traffic accident *(see Nuclear Transportation Map)*.

Politics is never far from any of these debates. In a shrewd lobbying move, six of the companies involved in PFS, including Southern Company, sent a letter to the U.S. Senators from Utah, Orrin Hatch and Robert Bennett, both of whom, in a high-level variation of NIMBY ("Not in my back yard!"), adamantly opposed PFS. In the letter, the companies pledged to drop financing PFS past the licensing process if Hatch and Bennett would vote for approval of Yucca Mountain.[48] The Senate approved Yucca Mountain the day after the above letter was sent. Both Utah Senators voted for it.[49]

Because of the long time frame, the costs of future nuclear waste storage and management are literally incalculable, but there are some estimates for the near future. Southern Company, for example, estimated start up for Plant Hatch's interim outdoor storage dump to be about $10 million, with the project estimated to cost $24 million through 2003.[50] Since 1983, Georgia electricity consumers alone have paid more than $715 million into the federal Nuclear Waste Fund to finance nuclear waste management.[51] Cleanup costs associated with the Department of Energy's nuclear weapons complex, of which the Savannah River Site is a part, are massive. Estimates from the DOE as of 1996 for clean up of the U.S. weapons complex are approximately $227 billion, with outside experts putting the range at $216-410 billion, and that does not take into account all cleanup problems.[52] The DOE has noted that even after DOE sites have been remediated to agreed upon levels, hazards will remain and that "in some cases, cleanup reduces risks, but may not be able to reduce contaminant concentrations to levels deemed safe for unrestricted use of the site."[53]

Low levels of radioactivity from daily operations and accumulations of very dangerous nuclear waste are just two things to be concerned about, even if everything goes right with nuclear power.

What if something goes wrong?

MURPHY'S LAW—DEADLY OUTCOME

Blackouts, Incidents, and Accidents

Ironically, nuclear power plants rely on electricity from the power grid to operate. The 2003 blackout in the Northeast, the largest in American history, shut down nine nuclear power plants in the United States. These plants, along with several more in Canada, could not come online for several days due to continued power grid instability.[54]

The 2003 blackout in the Northeast, the largest in American history, shut down nine nuclear power plants in the United States.

Power disruptions cause nuclear power plants to shutdown automatically. However, even when shutdown, the plant requires electricity to pump cooling water and to run the control room and other systems essential to keeping the reactor safe. You cannot simply turn off a nuclear power plant. To shut down a nuclear power plant, control rods are inserted into the nuclear reactor to stop the chain reaction. Furthermore, nuclear fuel inside the reactor and the used nuclear fuel stored in the spent fuel pools generate tremendous amounts of thermal radioactive decay heat and must be kept cool. Nuclear plants are required to have backup power (large, on-site diesel-powered generators) immediately available in order to maintain cool water flowing through the reactor core and spent fuel pools to prevent meltdown.[55]

Nuclear Plant Vogtle near Augusta, Georgia.

Nuclear power plants are as vulnerable to Murphy's law as anything else designed and managed by humans. During a routine refueling outage on March 20, 1990, at Georgia's Plant Vogtle, a fuel truck driver accidentally backed into an overhead transmission line that linked one of Vogtle's reactors to its off-site power source. The emergency diesel generators failed to provide backup power because one was undergoing routine maintenance and the other malfunctioned after little more than a minute of operation. This series of events caused Vogtle to experience a full blackout—a serious situation in which the plant was without power to maintain safe operations.[56]

The Vogtle incident eventually led to a senior manager coming forward to allege that falsification of emergency generator tests had occurred even after the above debacle. The manager was subsequently fired, leading to an investigation by the NRC, which determined that the firing violated federal regulations. A large fine was levied, but because the statute of limitations had expired the fine was never imposed.[57]

Other instances of poor management have surfaced at Plant Vogtle. According to NRC reports, licensed operators have been found under the influence of drugs and have failed breathalyzer tests, and control room areas have been inadequately attended, sometimes due to a "mental lapse" on the part of plant operators.[58]

In December 1996, Southern Nuclear received a $50,000 fine at Plant Farley in Alabama for failing to install fire barriers adequately, a situation that existed for an unknown period of time. This could have resulted in a failure "to achieve and maintain safe plant shutdown conditions." The NRC deemed that eventual improvements were not done in a timely manner.[59]

In 1986, then-NRC Commissioner James Asselstine testified to Congress that "given the level of safety being achieved by the operating nuclear power plants in this country, we can expect to see a core meltdown accident within the next 20 years, and it is possible that such an accident could result in off-site releases of radiation which are as large as, or larger than, the releases estimated to have occurred at Chernobyl."[60] We are nearing Asselstine's "deadline."

Flaws in construction raise concerns about possible catastrophic accidents. In August 2003, Plant Vogtle's Unit 2 reactor was shutdown due to a reactor coolant system leak.[61] The Davis-Besse nuclear reactor in Ohio experienced severe degradation of the reactor head, discovered only within the last few years, which led the NRC to acknowledge that serious problems could exist for a large portion of the U.S. pressurized water reactors such as Vogtle, Oconee, and others throughout the Southeast.[62] Design flaws are also a concern. All of Southern Company's plants, among many others, were designed with one of the large turbines rotating toward the reactor; pieces from the turbines, referred to as "turbine missiles," can break off and damage the reactor.[63] Plant Hatch has no traditional containment dome.[64]

Ultimately, ordinary wear and tear may be the biggest threat to the physical integrity of nuclear power plants...[65]

Ultimately, ordinary wear and tear may be the biggest threat to the physical integrity of nuclear power plants. Over time, aging effects reduce safety and

Many nuclear power plants are being run longer and harder than originally planned.

reliability as reactor parts and components such as pipes and valves become embrittled and fail due in part to the bombardment from radiation.[65] Many nuclear power plants are being run longer and harder than originally planned. Recently, both Plant Hatch and Plant Farley had their operating cycle extended from 18 months to 24 months; six months longer than originally planned before shutting down to refuel.[66] This also extends the time between surveillances that test, check, or repair various systems.

Health and Economic Effects of Accidents

The health effects from accidents at nuclear power plants can extend for decades. Land, water, and crop damage mirrors the long-lived nature of the radioactive contaminants; it lasts literally for generations. Since many of the effects on human health are not immediate, such as the increased rate of various cancers and birth defects, it is difficult to measure exactly the true impact of an accident.

The devastating nuclear accident at one of the four nuclear reactors at the Chernobyl plant in the former Soviet Union on April 26, 1986, caused immediate deaths and sent radioactive fallout around the globe, touching nearly 3 billion people.[67] Initially 130,000 people were evacuated and 175,000 acres of agricultural lands were abandoned. A long-term 30-kilometer “exclusion zone” around Chernobyl was eventually established.[68] The accident resulted in tremendous increases in thyroid cancer, particularly in children,[69] with the majority of cases being particularly invasive and aggressive.[70] One region of Belarus has incidences of thyroid cancers 100 times higher than prior to the accident.[71]

The American Thyroid Association recommends the distribution of potassium iodide (KI) to the public within a 200-mile radius of nuclear power plants and facilities due to its effectiveness in preventing the thyroid from absorbing radioactive iodine.[72] Exposure to radioactive iodine, which is released in the event of an accident at a nuclear power plant, is concretely linked to thyroid cancer, especially in those under the age of 18. Potassium iodide only protects the thyroid from radioactive iodine. In December 2001, the U.S. NRC offered states the option to receive, at no cost, two KI pills for each citizen living within a 10-mile radius of a nuclear power plant. As of March 2003, 18 states requested or received potassium iodide tablets including: Alabama, Florida, Mississippi, North Carolina, and South Carolina.[73] Georgia officials have not accepted KI due to concerns that people may be less likely to evacuate in case of an accident.[74]

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Scientists studying the effects of Chernobyl presented three main areas of concern at the 1995 World Health Organization conference in Geneva: “the large increase in psychological disorders, especially among accident recovery workers and people living in the highly contaminated areas; the health impact of the thyroid cancer incidence among children; and, future cancers which could occur in people, particularly leukemia, breast cancer, bladder cancer, and kidney diseases.”[75] Further, rescue workers known in the region as “liquidators,” who heroically prevented the accident from worsening,[76] experienced extremely high levels of radiation. A sevenfold increase in genetic damage was found in the children born to the Chernobyl liquidators after the accident.[77]

In response to the concerns raised over the Three Mile Island accident, the possible results of a severe accident at a nuclear power plant were compiled by DOE's Sandia National Laboratory and the NRC, and then evaluated by special Congressional experts. The study estimated that 700 fatalities (at a smaller reactor in a low population area) to 100,000 fatalities (at a larger reactor in a more densely populated area) would occur within the first year due to radiation exposure.[78] Predicting the outcome of an accident at a nuclear power plant is extremely difficult because of the large number of variables, including the weather. A release of radioactive material from an explosion might have little effect on people a few miles upwind from the reactor, but be lethal to people many miles downwind. It is equally difficult to predict economic losses and liabilities, especially since lawsuits would be inevitable. According to American Nuclear Insurers (ANI), the Three Mile Island accident in 1979 was a full-limit $300 million loss for the firm, which wrote the property insurance. Additionally, ANI paid out more than $70 million in claims from the accident.[79]

According to the Congressional report, a severe accident at one of Plant Hatch's reactors could result in 700 early fatalities and one of Plant Vogtle's reactors could experience 200 early fatalities based on 1980 Census figures. Scaled costs in 1982 dollars were in excess of $50 billion for each reactor at each plant. These calculated accident consequence estimates are shown in Figures 1 and 2.[80]

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The federal government and the nuclear power companies recognized the possibility of staggering financial losses in the event of a major accident. In 1957, the Price-Anderson Act was passed to encourage the commercial development of nuclear energy. It limits the financial losses of the companies that own nuclear power reactors in case of a major accident. Congress encouraged creation of the American Nuclear Insurers (ANI), the only company that provides liability insurance for private U.S. nuclear reactors.[81] However, it is unlikely that the insurance would cover the losses from a serious accident. For example, according to the 1982 Congressional report, a severe accident at one reactor at Plant Hatch could result in losses in excess of $50 billion (in 1982 dollars and 1980 population figures).[82] Yet the Price-Anderson Act currently limits the liability of nuclear power plant operators collectively to slightly more than $10 billion. In Georgia, this means that if a severe accident of the scale mentioned above were to occur at one of Plant Hatch's nuclear reactors, federal law would exempt the nuclear power industry from paying approximately $40 billion of the damages.[83] Given the inadequate coverage provided by the Price-Anderson Act, if a severe accident were to occur, it is highly unlikely that victims would ever receive full compensation for their losses. Additionally, in light of the terrorist attacks of September 11, 2001, it should be noted that, like most insurance policies, there is no coverage for damage resulting from "acts of war."[84] The private insurance industry recognized the potentially enormous losses from any nuclear accident long ago. Property insurance policies generally have a clause that excludes coverage for any losses from "nuclear hazards."

Example of an individual insurance policy clause excluding loss from "nuclear action."

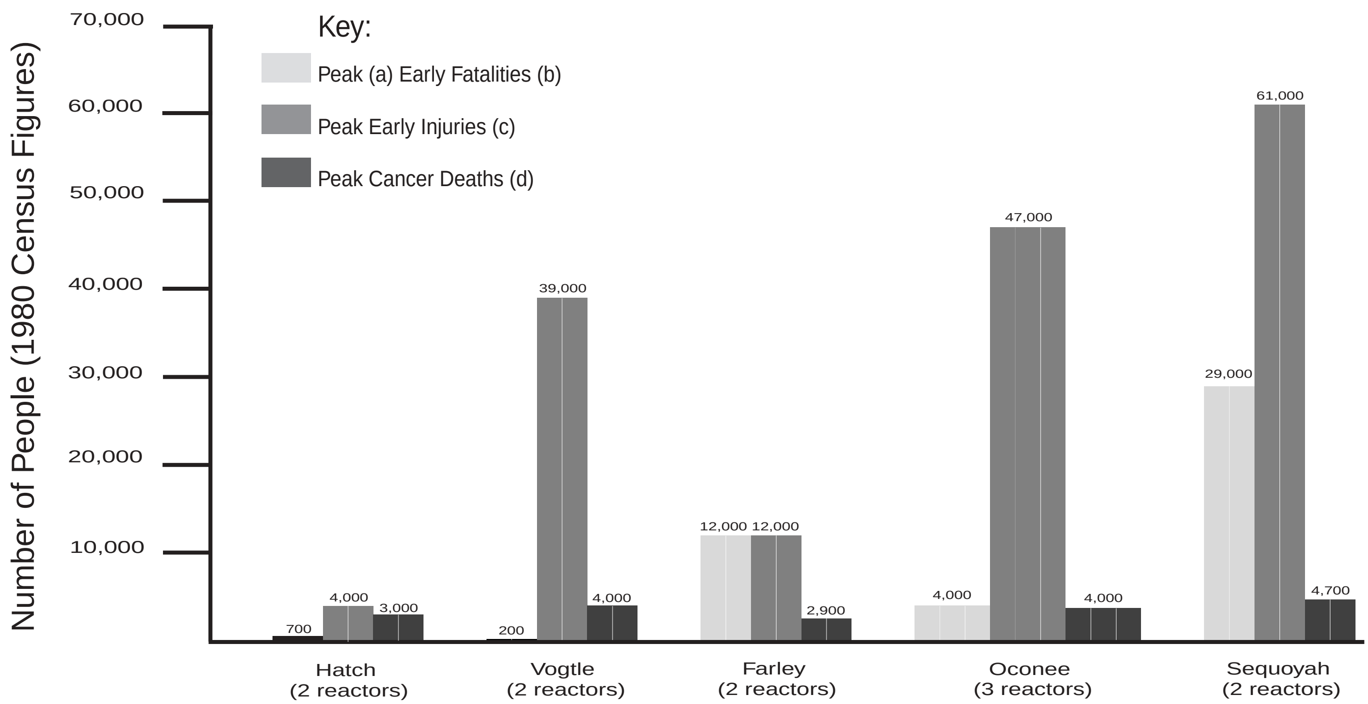
10. Nuclear action, meaning nuclear reaction, discharge, radiation or radioactive contamination or any consequence of any of these. Loss caused by nuclear action is not considered loss by fire, explosion or smoke.

    We do cover sudden and accidental direct physical loss by fire resulting from nuclear action.

11. War or warlike acts, including but not limited to, insurrection, rebellion or revolution.

Figure 1.

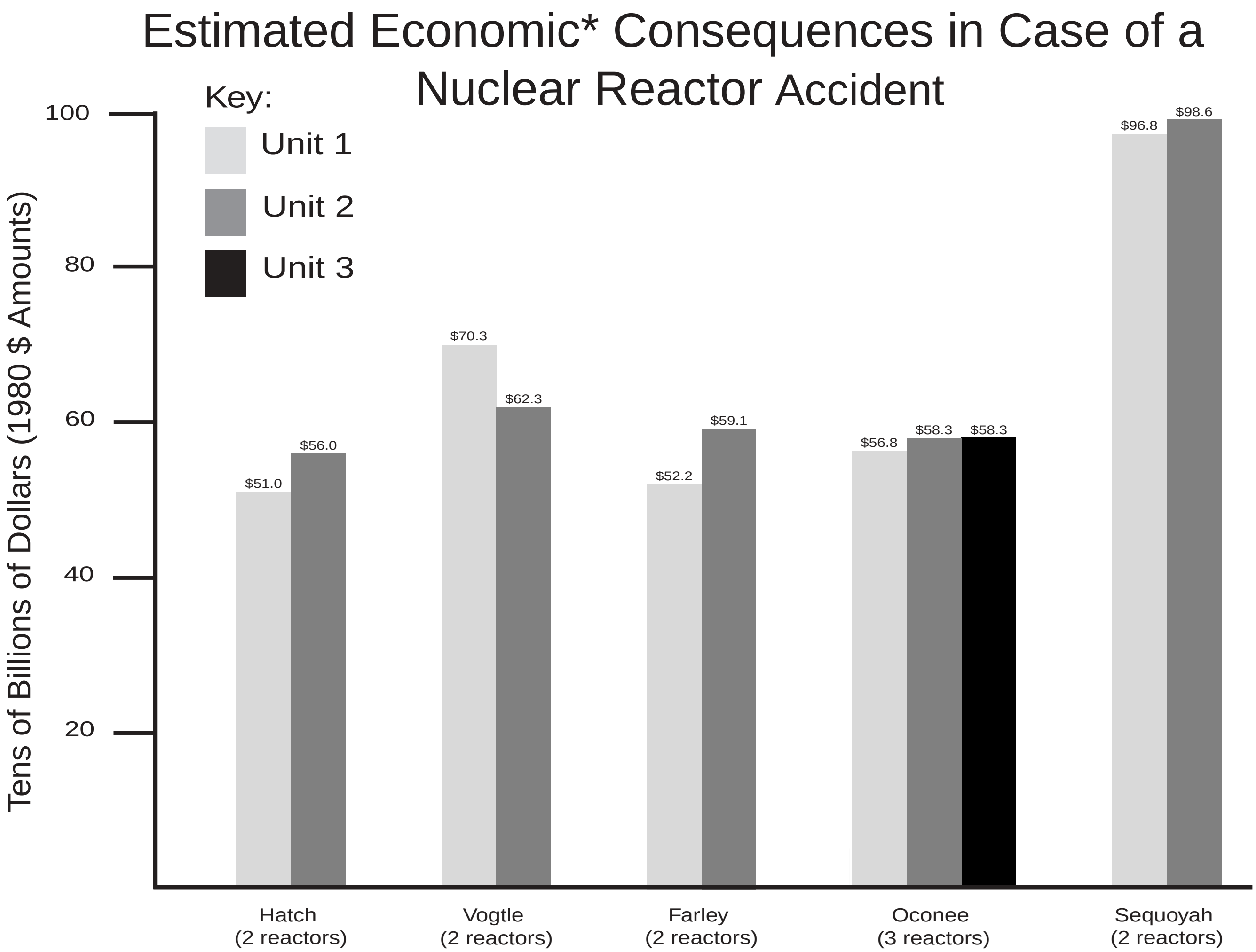
Estimated Health Consequences in Case of a Nuclear Reactor Accident



Notes:
(a) "Peak" means highest calculated value from the CRAC2 computer printouts for Sandia studies. Peak does not necessarily mean worst-case results.
(b)Early fatalities are deaths due to radiation exposure from causes other than cancer occurring within one year of the accident. For a number of plants, the estimate of early fatilities may be significally understated.
(c) Early injuries are radiation-related injuries occuring within one year of the accident, which require hospital treatment or medical attention, including temporary sterility, thyroid nodules, prodromal vomiting, and cataracts.
(d) Cancer deaths are predicted to occur over the lifetime of the exposed population, with the exception of leukemia, which is assumed to have occurred by 30 years after the accident.

Source: U.S. House of Representatives, Committee on Interior and Insular Affairs: Subcommittee on Oversight & Investigations, *Calculation of Reactor Accident Consequences (CRAC2) for U.S. Nuclear Power Plants (Health Effects & Costs),* November 1, 1982.

Figure 2.



*Scaled costs do not include cost of providing health care to those affected, all on-site costs, litigation costs, direct costs of health effects, and indirect costs.

Source: U.S. House of Representatives, Committee on Interior and Insular Affairs: Subcommittee on Oversight & Investigations, *Calculation of Reactor Accident Consequences for U.S. Nuclear Power Plants (Health Effects & Costs),* November 1, 1982.

> *Even with the advance notice and the generic quality of the simulated attacks, from 1991-2001 the NRC determined that 46% of the plants had a significant weakness in their response.*

The Price-Anderson Act is one of the ways in which nuclear power is favored over other forms of power generation, both traditional, e.g. coal, gas, and oil, and innovative, e.g. solar, wind, and biomass. Without this favored treatment by the government, the market might be able to set a more realistic price on nuclear energy in relation to the other forms of energy generation. This in turn would make the investment in development of alternative and innovative forms of energy more attractive.

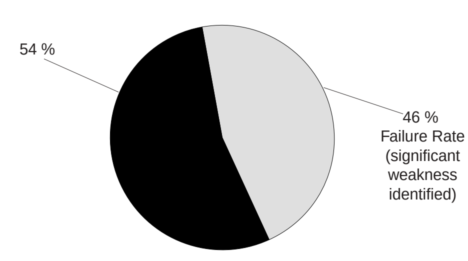
To put the possible economic losses into perspective, the accident at the Chernobyl nuclear power plant in 1986 cost the former Soviet Union more than three times the economical benefits accrued from the operation of every other Soviet nuclear power plant combined that operated between 1954 and 1990.[85]

Acts of Terrorism

President George W. Bush in his State of the Union Address on January 29, 2002, commented on terrorists and their targets, stating, "We have found diagrams of American nuclear power plants and public water facilities, detailed instructions for making chemical weapons, surveillance maps of American cities, and thorough descriptions of landmarks in America and throughout the world."[86] Although the Administration has since stated that diagrams of nuclear power plants were not found in the hideouts of terrorists, the location of nuclear power plants is hardly secret and it does not take a diagram to locate the reactor or the spent fuel storage casks—they are in plain sight.

In 1991, in response to the terrorist attacks in the 1980s, the NRC introduced exercises known as Operational Safeguards Response Evaluations (OSRE). These exercises were designed by NRC staff to test the ability of a nuclear plant to defend itself from a terrorist attack. However, the way they are carried out makes them poor replicas of real attacks. An OSRE is scheduled 6-10 months in advance. The NRC informs the company that owns the nuclear power plant what tactics will be used. Even with the advance notice and the generic quality of the simulated attacks, from 1991-2001 the NRC determined that 46% of the plants had a significant weakness in their response. A weakness was defined as the attack team being able to simulate an action that would lead to reactor core damage, with a probable radioactive release.[87]

Figure 3. U.S. Nuclear Power Plant Preparedness for Mock Terrorist Attacks 1991-2001



Source: Mr. David N. Orrik, U.S. NRC, Reactor Security Specialist, Office of Nuclear Security and Incident Response, Congressional Witness Testimony to the Committee on Energy and Commerce, Subcommittee on Oversight and Investigations, "A Review of Enhanced Security Requirements at NRC Licensed Facilities," April 11, 2002. http://energycommerce.house.gov/107/hearings/04112002Hearing532/Orrik908print.htm.

In July 2000, even though advance notice was given to Southern Nuclear Operating Company, it failed to defend Plant Farley from a mock assault, and the "terrorists" gained access to restricted areas of the plant. Preliminary NRC inspections listed this as an issue with "substantial importance to safety" and required a more detailed review. Yet, the NRC downgraded its level of concern after hearing from company officials who complained "that tactics used during one of the exercises are not included in the current model for conducting such exercises."[88] OSREs were suspended following the 9/11 attack and Farley's scheduled "retry" for Fall 2001 never occurred. The OSREs have not yet been re-established due, according to the NRC, to the higher-alert security status the facilities are under.[89] That many nuclear plants routinely failed a generic, advanced-warning mock terrorist assault is appalling. In response to increased concerns over nuclear security, the NRC established the Office of Nuclear Security and Incident Response in April 2002 though the benefits have not been clearly determined.[90]

In July 2000, even though advance notice was given to Southern Nuclear Operating Company, it failed to defend Plant Farley from a mock assault, and the "terrorists" gained access to restricted areas of the plant.

The nuclear reactor itself is not the only possible target of an assault. Spent fuel pools are of particular concern due to the high levels of radioactivity in the spent fuel and the large amount of fuel stored in the pool. Spent fuel is actually more radioactive than "fresh," unused fuel. These pools can also be more structurally vulnerable as some nuclear power plants have spent nuclear fuel storage in separate buildings that are not as structurally sound as the reactor building. Other designs, such as the G.E. boiling water reactor model at Plant Hatch, have the spent fuel pool precariously placed several stories above ground, even above the nuclear reactor.

The NRC is also concerned about the security of the dry casks of nuclear waste that are stored at nuclear power plants, especially since they are usually in plain sight and contain tremendous amounts of radioactivity. Only a chain link fence surrounds storage casks at Plant Hatch. In early 2003 the NRC requested from Plant Hatch personal information about individuals who were granted unescorted access to the outdoor storage site or who have access to sensitive security information.[91]

Whether Georgia receives enough funding to properly ensure safety and security of our nuclear facilities or nuclear materials is another concern. In August 2003, Georgia Senator Zell Miller questioned Homeland Security Secretary Tom Ridge about why Georgia ranked near the bottom in per capita spending of federal homeland security grants. "Georgia is home to the Center for Disease Control, the world's busiest airport, the nation's fifth largest port system, and two nuclear facilities," Miller said. "Taking this into consideration, it is inconceivable that Georgia did not receive any Homeland Security Funding under the Urban Area Security Initiative."[92]

Another security concern is the transport of casks of spent fuel from nuclear power plants to storage facilities, such as those proposed in Utah or Nevada. Trains or trucks carrying nuclear waste would be attractive and vulnerable targets for those who wanted to terrorize the American public. Even if an attack on a truck or train car transporting radioactive waste did not result in the release of radioactive material, it could cause widespread panic. The *Nuclear*

The nuclear reactor itself is not the only possible target of an assault.

“Nontraditional” attacks can also come in the form of computer viruses...”

Transportation Map shows projected nuclear waste transport routes through Georgia and the Southeast.

Though public awareness of nuclear security has increased since September 11, 2001, concerns over securing nuclear facilities are not new. Prior to the 1996 Olympics, the Georgia Tech research reactor in Atlanta was in the process of removing and replacing some of its nuclear fuel. Due to security concerns, it was suggested that the new fuel shipments be deferred—leaving the reactor without nuclear fuel during the games. Additionally, questions were raised about the security of the highly radioactive Cobalt-60 used at the university, and measures were implemented to increase security at the site throughout the Olympics.[93]

“Nontraditional” attacks can also come in the form of computer viruses, as was demonstrated at the Davis-Besse nuclear power plant in Ohio in January 2003. The plant’s Safety Parameter Display System and plant process computer were unavailable for several hours, during which the safety status of the plant was unknown. According to the NRC, the safe operation of the plant was ensured. Yet, this infiltration did lead the NRC to issue an Information Notice to other power plant operators about the vulnerability of nuclear power plant computer systems to infection and penetration.[94]

Emergency Procedures

In case of either accidents or attacks at nuclear power plants, implementation of emergency evacuation procedures is essential. Measures such as establishing evacuation routes and promptly notifying the public in a way that minimizes panic can reduce individuals’ exposure to radioactive materials that could be released. On the Radioactive Southeast nuclear facilities map, 10-mile evacuation zones are designated along with the 50-mile “ingestion/breathing” pathway. In cases of accidents, the 10-mile zone must be evacuated, although the 1982 Congressional report on accident consequences studied a 20-mile fatal radius and did not account for actual site conditions that could occur, such as traffic bottlenecks.[95] The 50-mile ingestion zone delineates the area in which vegetation, crops, and livestock may be impounded if a major release of radioactive contaminants occurred.[96] The Savannah River Site nuclear weapons facility also has defined a 100-mile tritium deposition-in-rain zone, which is an ongoing monitoring radius, not associated with the results of accidents. Of course, weather patterns during the time of release would play a role in how the radioactive materials were dispersed, so a strictly defined regulatory zone is not necessarily protective of the areas that may ultimately be affected.

Hurricanes bring fierce rain and wind to Coastal Georgia and South Carolina. The hurricane evacuation route for the Hilton Head and Beaufort, South Carolina region directs traffic toward Augusta, Georgia along SC Route 125, which runs through the security-restricted Savannah River Site. Other hurricane evacuation routes in Georgia direct traffic in Brunswick to head towards nuclear Plant Hatch.[97] Hurricanes can come far enough inland to threaten both of these nuclear facilities. Prior to Hurricane Isabel’s approach to

In case of either accidents or attacks at nuclear power plants, implementation of emergency evacuation procedures is essential.

the Atlantic coastline in 2003, the NRC Region II office in Atlanta implemented its hurricane response procedure since several nuclear power plants and fuel facilities could have been affected.[98]

Plant Hatch provides tone alert radios to citizens surrounding the plant as a means of ensuring prompt notification of a serious emergency at the plant, and it also provides early warning of severe weather using the National Oceanic Atmospheric Administration warning system.[99] Unfortunately, this method is not always reliable. According to an NRC Daily Event Report, Hatch lost its off-site notification system on July 31, 2003.[100]

As a nation, from 1948 to 1998, we spent more than $111 billion on total energy research and development. Sixty-six billion dollars, or 59% of that total, was spent on nuclear power...

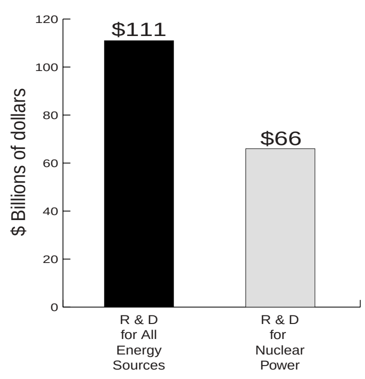
Economics

> *"The economics of atomic power are not attractive at present, nor are they likely to be for a long period of time in the future. This is expensive power, not cheap power as the public has been led to believe."*
>
> —1950 speech by C.G. Suits, Vice-President and Director of Research of General Electric[101]

Historically, the nuclear industry and its oversight agencies have projected levels of growth and job creation far beyond those that it has delivered. In 1974, the International Atomic Energy Agency predicted that nuclear power would provide 4.5 million megawatts of capacity by the year 2000. Nuclear power achieved less than eight percent of that goal.[102] As a nation, from 1948 to 1998, we spent more than $111 billion on total energy research and development. Sixty-six billion dollars, or 59% of that total, was spent on nuclear power,[103] an industry that provides only 20% of the total generated in the country[104] and is projected to provide less than 20% in the future.[105]

Figure 4.

Total U.S. Federal Government Spending for Energy Research & Development (R & D) for Energy Sources 1948-1998



Source: National Council for Science and the Environment, "Congressional Research Service Issue Brief for Congress, IB10041, Renewable Energy: Tax Credit, Budget, and Electricity Restructuring Issues,"March 9, 2001.

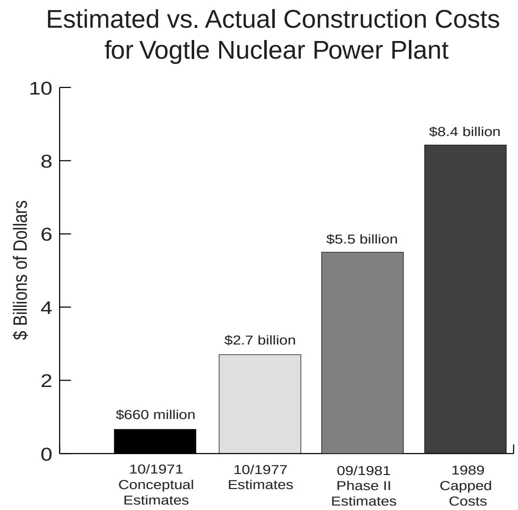
In 1953, Bechtel, Monsanto, Dow Chemical, Pacific Gas and Electric, Detroit Edison, and Commonwealth Edison concluded in an industry-funded report that "no reactor could be constructed in the very near future which would be economic on the basis of power generation alone."[108]

Nuclear power is a very expensive way to boil water. Nuclear power plants

Georgia's nuclear plant Vogtle was one of the last and most costly nuclear plants built in the country... resulting in the largest rate hike in Georgia's history.[110]

that came on line in the United States after 1983 typically cost about $4000 per kilowatt in capital costs.[109] By comparison, new gas-fired power plants cost $400-600 per kilowatt and new wind turbines cost about $800 per kilowatt and require no fuel.[109a] Georgia's nuclear plant Vogtle was one of the last and most costly nuclear plants built in the country. Original conceptual estimates for the 2-reactor plant were expected to cost approximately $660 million and over a decade later the estimates for construction costs escalated more than twelve-fold, to more than $8 billion, eventually resulting in the largest rate hike in Georgia's history.[110] The construction cost has to be built into future rates. Dalton Utilities has lower rates than other small utilities in Georgia due partly to the fact that they did not invest significantly in nuclear Plant Vogtle. According to a recent JEA (Jacksonville Electric Authority) survey, Dalton Utilities' rates were the lowest in the nation and 33% lower than the closest provider in the Southeast.[111]

Figure 5.



Source: Georgia Public Service Commission, *Order 3673-U*, April 2, 1987, & *Order 3840-U*, April 1989.

Nuclear power has higher overall lifetime costs compared to natural gas (with combined cycle turbine technology) and coal.[112] A recent Massachusetts Institute of Technology (MIT) study compared the real "levelized" cost of electricity among various technologies. Nuclear power had the highest cost at 6.7 cents per kWe-hr versus pulverized coal at 4.2 cents per kWe-hr and natural gas combined cycle plants (with moderate gas prices), at 4.4 cents per kWe-hr.[113] Even allowing for various cost improvement assumptions for nuclear power plants, such as reducing construction costs by 25% or reducing construction time from 5 to 4 years, nuclear power was still more costly than coal or natural gas.[114]

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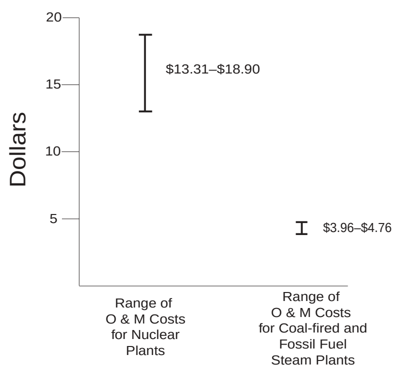
The operation and maintenance costs associated with nuclear power plants are much greater than at coal and fossil fuel plants. According to the NRC, from 1990 to 2000 operation and maintenance costs at nuclear power plants ranged from $13.34 to $18.90 per megawatt hour (MWh) compared to coal-fired and fossil fuel steam plants, which ranged from $3.96 to $4.76 per MWh.[115] Total production expenses, which include operation, maintenance, and fuel cost, during the same time frame were always less for coal plants. However, beginning in 1998, it appeared that nuclear production expenses were slightly less than coal. This was due in part to a change in how data was reported and compiled—the production costs of coal and other fossil fuel plants (such as natural gas whose fuel costs greatly increased since 1998) were combined into the same category.[116]

Figure 6.

Operation & Maintenance (O & M) Costs for Traditional Fuel Sources (1990-2000)



Source: United States Nuclear Regulatory Commission, NUREG-1350, vol. 14, *Information Digest 2002*, pp. 20-21.

In addition to the costs of construction, operations, maintenance, and fuel, nuclear power plants have associated costs that are either not present for other kinds of power generation or are much less. Policy-makers often ignore these costs. Some are fairly obvious:

- costs of transporting, storing, and safeguarding radioactive wastes
- regulatory costs *(see Table in Appendix A)* (e.g., financial support for the NRC)
- state and federal radiation monitoring programs

Some are not as obvious:

- costs of producing nuclear fuel, such as uranium conversion and enrichment
- economic damage from radioactive and other toxic contaminants
- decommissioning costs
- loss of property value linked to contaminated sites and their surroundings
- loss of economic development opportunities for surrounding communities, linked in part to water supplies having to be diverted for Georgia's nuclear facilities
- costs accrued from major accidents, or the "meltdown potential"

An example of the kinds of economic damage that can occur happened over Christmas 1991. A large radioactive spill from a nuclear reactor at SRS into the Savannah River resulted in the closure of the industrial water supply in Savannah and surrounding areas for several days.[117] Harvesting in two local

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Unfortunately, federal and state budget allocations for the state radiation monitoring program in Georgia are continually in peril.

shellfish beds was suspended; the Beaufort, South Carolina water intake system was closed; and two Savannah food-processing industries had to shutdown.[118] Although Savannah is more than 90 miles downriver from SRS, the tritium (a radioactive form of hydrogen) levels measured in Savannah were double the maximum drinking water limits allowed by the EPA and remained above drinking water standards for days.[119] DOE failed to notify Savannah in a timely manner to prevent economic losses to local industrial water users. Prompted by the spill and decades of past releases at the site, it was decided that a tritium monitoring and advanced notification system for Savannah was needed. Unfortunately, federal and state budget allocations for the state radiation monitoring program in Georgia are continually in peril. Savannah and other downstream communities should be guaranteed a safe water supply as ongoing releases of tritium and other radioactive contaminants continue. If the monitoring and notification programs are lost or further reduced, both citizens and businesses are at risk, jeopardizing the health and prosperity of Georgia's citizens.

Another problem with water discharged from nuclear power plants is its temperature. This water is warmer than the water into which it is discharged, and the resulting "thermal plumes" cause stress on the aquatic life, including commercially important fish and shellfish. Warmer water temperatures proximate to a nuclear power plant result in conditions that effect the feeding and breeding patterns of various species. For instance, nuclear power plants aggravate the problem of low dissolved oxygen levels through its heated discharge to lakes and rivers. The state of Tennessee voiced concerns to the NRC about this impact on mussel beds downstream from the Sequoyah nuclear plant, which suffered from even lower oxygen levels as it is also downstream from the Watts Bar nuclear plant.[120] Further, when shutdowns occur, large and rapid fluctuations in the water temperature can harm or kill aquatic species.[121]

Warmer water temperatures resulting from nuclear power plant operations can pose serious threats to human health by creating favorable environments for unhealthy levels of bacteria. Fatal cases of Legionnaires' disease contracted by workers cleaning cooling towers have been reported.[122] The long-term presence of a nuclear power plant can also increase the natural level of *N.fowlerli* in waterways; a bacteria whose infection can result in a rapidly fatal form of encephalitis. Primary amoebic meningoenchephalitis poses a risk to swimmers and the NRC has stated that heavily-used lakes and fresh bodies of water may merit special, routine monitoring.[123] Human illnesses resulting from changes in proximate water ecosystems need to be more fully studied.

Hazardous chemicals and heavy metals discharged to the Altamaha, Savannah, and Chattahoochee Rivers during routine operations of nuclear power plants are also harmful to fish and shellfish. Permit guidelines allow discharges of boric acid, lithium hydroxide, sulfuric acid, hydrazine, sodium hydroxide, phosphates, biocides, copper, zinc, and chromium.[124] Chlorine is widely used as a biocide and is the largest source of chemically toxic releases to the aquatic environment.[125] Southern Company's Plant Farley in Alabama uses an oxidizing biocide and other treatment chemicals in part to control Asiatic

Savannah River.
Photo courtesy of Department of Energy.

clams at the intake structure along the Chattahoochee.[126]

Besides thermal plumes and toxic chemicals, nuclear power plants damage aquatic life in other ways. According to the NRC, the entrapment and impingement of fish, crabs, shrimp, jellyfish, turtles, manatees, seals, and alligators has occurred at nuclear power plants throughout the nation. This essentially means they have been trapped against an intake screen or actually pulled through the entire condenser cooling system.[127] In many cases, the species affected are endangered or threatened—most notably sea turtles. Numerous endangered sea turtle species have been maimed or killed at the St. Lucie nuclear power plant in Florida. There were 5,420 instances recorded from 1976 to 1997, with 190 of those being lethal.[128] The EPA estimated that the Brunswick nuclear power plant in North Carolina destroyed 66% of juvenile fish in the Cape Fear Estuary.[129]

With Georgia's large economic reliance on the seafood industry, particularly along the coast through fishing, shrimping, and crabbing, and the tourism associated with a thriving, healthy coastal economy, it is imperative that its natural environment be better protected.

The dangers and liabilities associated with nuclear power do not end once a plant shuts down. Decommissioning of nuclear power plants poses a major economic and environmental health hurdle. The decommissioning of a nuclear power plant is complicated by radioactivity. Structural materials such as concrete and steel beams that have become radioactively contaminated over the years have to be dismantled as safely as possible and disposed of in low level radioactive waste dumps. Local communities will ultimately be stuck with a largely contaminated industrial use only land area.

Current decommissioning experiences in areas of the country where nuclear power plants have shut down offer grim examples of the financial ramifications that continue long after a plant stops generating electricity. The industry has little experience overall with decommissioning—of the 125 nuclear power plants licensed to operate since 1959, only three have been completely decommissioned.[130]

Estimates of $500 million to demolish and ship contaminated materials at Maine Yankee, a closed nuclear plant with only a single reactor in coastal Maine, are nearly double the cost of building the plant.[131] The U.S. General Accounting Office (GAO) estimates approximately $33 billion will be needed for decommissioning costs for the nation's nuclear power plants—not including costs for cleaning up nonradiological hazards or storing spent nuclear fuel.[132] The 1997 NRC minimum decommissioning funding requirements are $1.1 billion for Hatch and $1.3 billion for Vogtle.[133] An October 2003 analysis by the GAO shows serious deficiencies in the accumulation of adequate decommissioning funds by 33 owners at 42 nuclear power plants across the nation along with an ineffective effort by the NRC to ensure proper funding.[134] Locally, Oglethorpe Power, which owns approximately 30% of Plant Vogtle Units 1 & 2, was found to be 51-100% below the benchmark of sufficiency for trust fund balances and/or contribution rates for decommissioning.[135]

Georgia has had some recent experience decommissioning a small

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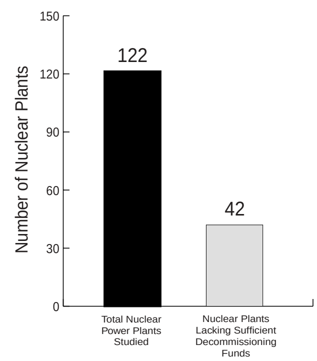
Nuclear power plants require very large quantities of water even in comparison to many traditional power plants, and in marked contrast to renewable energy.

installation. In 1999 the Georgia Tech nuclear research reactor began decommissioning associated with its shutdown.[136] As of late 2002, the nuclear reactor and some support systems had been dismantled and the facility was decommissioned, meaning all radioactive material licensed by the NRC had been removed and sent to waste disposal.[137] Nearly $10 million was spent on decommissioning. Approximately $7.5 million of that money came from the state of Georgia.[138] Essentially, Georgia taxpayers paid for the bulk of the "disposal" costs, and dangerous nuclear materials still remain on-site, in the heart of Atlanta.

Figure 7.

U.S. Nuclear Power Plants Lacking Adequate Decomissioning Funds



Source: United States Government Accounting Office (GAO), *NRC Needs More Effective Analysis to Ensure Accumulation of Funds to Decommission Nuclear Power Plants*, GAO-04-32, Appendix II, October 2003, p. 4.

Excessive Water Consumption

Both water and energy needs are increasing as the population in the Southeast grows. Georgia, Florida, and Alabama are deep in a continuing political and legal struggle over the allocation of water. According to state statistics, Georgia's energy industry is the largest water user outside the agricultural sector.[139] This is consistent with the national pattern: the electric industry follows closely on the heels of irrigation as the largest water user in the United States. Nuclear power plants require very large quantities of water even in comparison to many traditional power plants, and in marked contrast to renewable energy.

All nuclear power reactors must be located next to large bodies of water. This is so that significant water resources can be continuously and readily available to create steam to power the turbines and to constantly cool the nuclear fuel rods in the reactor core and nearby spent fuel pools to prevent meltdown. Consequently, in times of drought, it is not even negotiable as to whether a nuclear plant will get water or not; it is vital to the safe operation of the plant.[140] Past severe droughts serve as a wake up call for energy planning and water policy planning in the state.

The area's voracious appetite for energy, together with its antiquated, water-dependent power system, has at times led to desperate tactics to channel scarce water resources to generate electricity. For example, in late 2000, Southern

Sequoyah Nuclear Plant, like all nuclear plants, must be located next to large bodies of water.

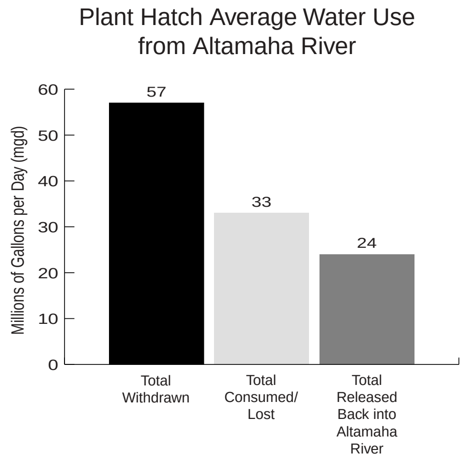
Company's nuclear Plant Farley persuaded the Army Corps of Engineers, despite public outcry, to release billions of gallons of water from reservoirs already at historically low levels (due to prolonged drought) to raise water levels in the Lower Chattahoochee River. The river levels needed to rise in order to enable a barge to deliver three enormous replacement steam generators to Farley. Southern Company claimed that brownouts during the peak summer season could happen if the shipment did not occur before February 2001.[141]

Georgia's nuclear power plants withdraw water from both surface and groundwater sources—water resources that are increasingly sought after for agricultural, fishing, and other competing needs. Groundwater use for these power plants is entirely consumptive, according to the Georgia Environmental Protection Division, as the water withdrawn is not returned to the originating source, as is also the case for municipal wastewater. In addition to having large surface water withdrawals from the Savannah River, nuclear Plant Vogtle has the largest groundwater permit of any electric power plant in the state. Vogtle is permitted to use a monthly average of 6 million gallons per day from the Cretaceous Sand aquifer.[142] Plant Hatch is also a large water user—having the largest surface water use permit on the Altamaha River while also having a permit to use more than 1 million gallons per day from the pristine Floridian aquifer.[143] Water withdrawn from aquifers is not inexhaustible and ultimately lowers the water in aboveground rivers and lakes.

Some water withdrawn by nuclear power plants is transformed into steam, and is therefore lost to the supply sources from which it was withdrawn. According to the U.S. Nuclear Regulatory Commission, nuclear Plant Hatch withdraws an average of 57 million gallons per day from the Altamaha River and actually "consumes" 33 million gallons of water per day that is lost as water vapor.[144] Plant Farley, which withdraws from the Chattahoochee at a rate of more than 87 million gallons per day, discharges back to the river at a rate of 46 million gallons per day—returning only approximately half of what it withdrew.[145] Further, Farley has a 5-year average daily groundwater use of more than 168,000 gallons per day from a deep major aquifer.[146]

Georgia's nuclear power plants withdraw water from both surface and groundwater sources—water resources that are increasingly sought after for agricultural, fishing, and other competing needs.

Figure 8.



Source: United States Nuclear Regulatory Commission (NRC), Generic Environmental Impact Statement for License of Nuclear Plants, NUREG-1437, Supplement 4, Regarding the Edwin I. Hatch Nuclear Plant, units 1 & 2, Final Report, may 2001, pp. 2-20.

Altamaha River.
Photo by Robert Overman.

Placing nuclear power plants' high water usage into perspective, Table 1 compares various water users, such as the average Georgian, and a typical Georgia city, to the state's nuclear power plants.

Table 1.

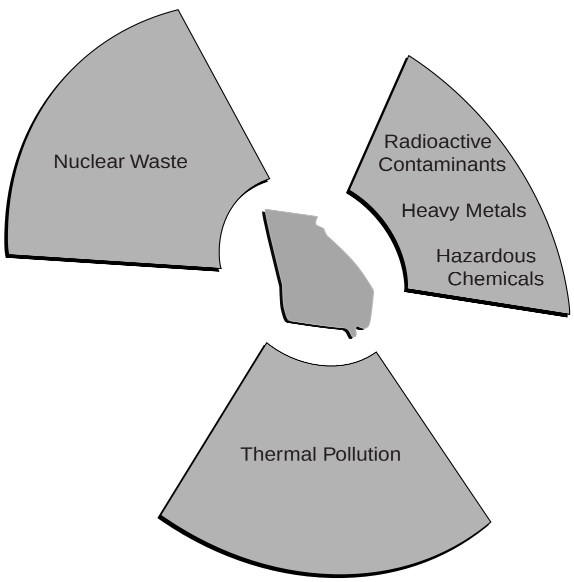
Plant (type)	Size–Generator Nameplate Capacity (megawatts)	Surface Water Source	Permitted Surface Water Monthly Average (gallons per day)	Reported Surface Water Monthly Average (gallons per day)
Average Georgian[147]	N/A	Varies (could be from groundwater)	N/A	168 gallons per day
Augusta-Richmond County	N/A	Savanah River	37,000,000	N/A
International Paper Corp.[148]	N/A	Savannah River	50,000,000	N/A
Plant Vogtle/ Nuclear (2 Reactors)	2,320	Savannah River	85,000,000	68,670,000
Plant Hatch/ Nuclear (2 Reactors)	1,721.8	Altamaha River	85,000,000	62,500,000[149]

Nuclear Power Keeps Bad Company

NEITHER CLEAN NOR PEACEFUL

In the last few years, the nuclear power industry has attempted to exploit the concern over air quality by promoting nuclear power as a "cleaner" alternative to coal-fired power plants. While once thought of as "clean energy," nuclear power is now known to cause a wide range of environmental pollution: radioactive contaminants, nuclear waste, thermal pollution, and hazardous chemicals, among others. In 1998, the Better Business Bureau ruled that advertisements placed by the Nuclear Energy Institute on behalf of the nuclear industry were misleading and that the industry must stop calling itself "environmentally clean."[150] The Better Business Bureau and conservation groups took their complaint to the Federal Trade Commission. The FTC ruled in 1999 that the Nuclear Energy Institute "failed to substantiate its general environmental benefit claim" not only because the discharge of hot water from cooling towers is known to harm the environment but also because of the "unresolved issues surrounding disposal of radioactive waste."[151] Even Southern Nuclear acknowledges that all working nuclear power plants emit radiation.[152]

Pollutants Produced at Operating Nuclear Power Plant During Routine Use

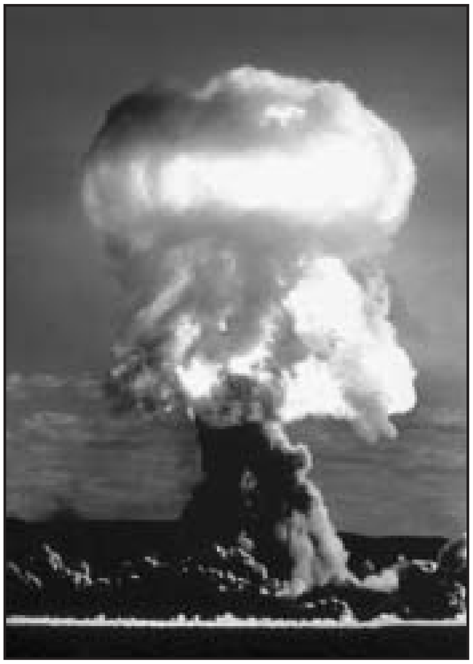


Further debunking the "clean energy" label for nuclear power are the environmental and health consequences from the production of uranium fuel, which is highly energy and waste intensive, requiring uranium mining, milling, conversion, enrichment, and fabrication. Though these fuel operations do not occur in Georgia, several facilities in the Southeast support these activities. *(See Radioactive Southeast Map and Appendix C).*

As early as 1944, Enrico Fermi, Noble Prize winner for physics and member of the "Manhattan Project," which developed the atomic bomb, said, "It is not clear that the public will accept an energy source that produces this much radioactivity and that can be subject to diversion of materials for bombs."[153]

Any atom that can be split ("fissioned") to provide commercial nuclear power can also be split in a nuclear bomb. The United States proved that a nuclear bomb could be made from reactor-grade plutonium when it tested and detonated such a bomb at the Nevada Test Site in 1962.[154] The nuclear power industry is the civilian arm of the nuclear weapons industry. Since the passage of

Bad Company



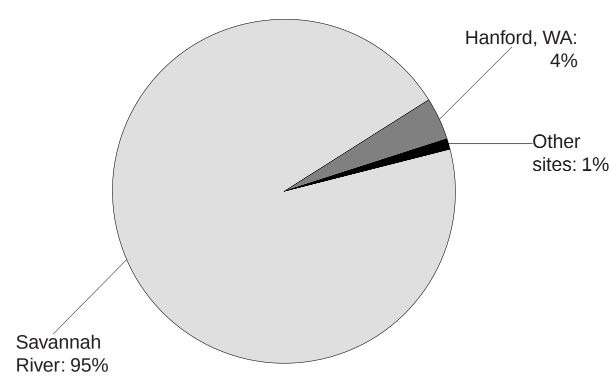
the federal Atomic Energy Act in 1946, nuclear power has developed in tandem with the nuclear weapons industry, sharing expertise, technology, dumping grounds, waste transportation routes, and special regulatory treatment by federal and state governments.

In the early days of nuclear power development, concerns were raised over the inherent dangers in the proliferation of atomic power and weapons. In 1953 President Eisenhower proclaimed that nuclear material "must be put into the hands of those who will know how to strip its military casing and adapt it to the arts of peace," a goal that is proving particularly illusive.[155] It is not surprising that the spread of nuclear power internationally has resulted in the spread of nuclear weapons. Plutonium is created in the fuel rods in commercial nuclear power plants and research reactors while they operate. Civilian nuclear power programs provide the potential for developing nuclear weapons in Iran[156] and North Korea, as well as an escalation of their use in military conflict between India and Pakistan.[157] These nations were given nuclear energy technology, in many cases with nuclear fuel, by a host of Western countries. Recipient countries used these materials to further their pursuit of nuclear weapons as much as to expand energy production.[158] The U.S. nuclear power industry has played a major role in global nuclear expansion.

Several troubling nuclear and plutonium expansion proposals threaten to firmly block the development of a safe, healthy future in the Southeast. These proposals, coupled with the current Administration's pursuit to revitalize nuclear power through controversial energy legislation, could further brand the Georgia region "Plutonium Alley." The Savannah River Site already is plagued by tremendous amounts of dangerous, high level radioactive waste. According to the DOE's nuclear waste generation projections within the entire nuclear waste complex from 2000-2070, 95% of the waste will be produced at SRS, nearly doubling existing volumes (see Figure 9).[159]

Figure 9. High Level Waste Expected Future Generation (2000 to 2070)

Total High Level Waste Future Generation Volume: 334,000 m^3



Original Source: James Werner, Director, Office of Long Term Stewardship, U.S. Department of Energy Environmental Management Program, "Presentation to the Institute for Energy and Environmental Research," June 23, 2000.

Several troubling nuclear and plutonium expansion proposals threaten to firmly block the development of a safe, healthy future in the Southeast.

Plutonium Bomb Fuel Initiative

Both the United States and Russia have supplies of weapons-grade plutonium left over from the Cold War. As part of the U.S. government's effort to make the two nations' "surplus" plutonium difficult to steal or reuse, two paths were to be taken: 1) immobilization and 2) conversion into fuel for commercial nuclear power plants, which were to be done concurrently with Russia with support from other G8 nations. The budget for immobilization has since been "zeroed" out, leaving only funding for producing the plutonium bomb fuel, called mixed-oxide fuel or "MOX," even though the costs have soared. The Bush Administration has endorsed the plutonium fuel program, proposed through a joint international agreement between the Clinton Administration and Russian officials.

In 1999, the Savannah River Site was designated as the nation's site to produce MOX for nuclear power reactors and the contract was awarded to DCS (Duke, Cogema, Stone & Webster), an international consortium of companies in the United States and France. MOX is made from a blend of uranium and plutonium. The plutonium fuel now in use in countries such as France and Belgium contains reactor-grade plutonium, which is found in spent nuclear fuel from commercial nuclear power plants. Mixed-oxide fuel containing weapons-grade plutonium has never been produced on a large scale or used as fuel in commercial nuclear power plants. Few nuclear power reactors were actually designed to use it.[160] There are significant differences between the two grades of plutonium that could have an impact on safety, both during fuel fabrication and during reactor operation.[161] The plutonium bomb fuel program would increase the Savannah River Site's radioactivity and waste levels. Furthermore, the program is incredibly expensive, costing billions of dollars for the U.S. taxpayer to shoulder.

Initially the companies in other southern states expressed interest but they have all dropped out except for one, Duke Energy Corporation, which is opting to use MOX fuel in their nuclear reactors at McGuire near Charlotte, NC, and Catawba near Rock Hill, SC. It should be noted here that the design of these reactors is considered less than optimum, even for a nuclear reactor.[162] Operators of the Duke reactors slated for plutonium bomb fuel use applied to extend the reactors' operating license during the summer of 2001.

In 1996, Southern Company's Georgia Power added Plant Vogtle to the list of interested nuclear reactors in the MOX fuel program, citing its convenient location near the Savannah River Site. The company, however, commented that major public policy issues needed to be considered, such as the possible "breached wall between the nation's commercial nuclear reactors and its nuclear weapons establishment that has kept weapons-grade plutonium out of the civilian side to reduce the risk of loss or theft."[163] Recently, indicating reasons for not participating, a Vogtle spokesperson was reported to have expressed concerns about the costs of retrofitting the plant in order to use the plutonium fuel.[164]

Transporting plutonium is a contentious issue because it is so dangerous.[165] A portion of the plutonium required for the MOX project was located at another Department of Energy facility undergoing closure in Rocky Flats, Colorado,

In 1996, Southern Company's Georgia Power added Plant Vogtle to the list of interested nuclear reactors in the MOX fuel program, citing its convenient location near the Savannah River Site.

Transporting plutonium is a contentious issue because it is so dangerous.[165]

Photo courtesy of Department of Energy.

Bellefonte Nuclear Power Plant Plant (cancelled) in northern Alabama is a possible site of a new nuclear reactor.

which required shipping the dangerous material across the country. Former South Carolina Governor Jim Hodges actually threatened to lie in the road to prevent the shipment from entering South Carolina but eventually lost the federal lawsuit against the Department of Energy.[166] More weapons plutonium shipments are anticipated from several DOE sites, including the bulk of the plutonium needed for MOX that is currently located at Pantex in Texas.

There are ongoing legal challenges brought by public interest organizations to the plutonium bomb fuel project at SRS and the associated Duke reactors.[167] The environmental, health, and safety risks as well as the enormous cost have left many questions unresolved, including the extent to which plutonium fuel is intended to be part of a broader effort to expand both countries' nuclear infrastructure. The plan for a plutonium bomb fuel program in Russia has made other nations understandably nervous.

Plans to Build More Nuclear Reactors

The nuclear energy industry has been trying to stage a comeback as memories of Chernobyl and Three Mile Island fade. Many lobbying efforts are underway to bring new nuclear missions of all types to the Southeast. Vice President Cheney's National Energy Policy Development group (often referred to as the energy task force) issued a National Energy Policy in May 2001 that serves as the cornerstone of the current national energy bill (The Energy Policy Act of 2003). This initiative recommended that President Bush support expansion of nuclear energy as "a major component of national energy policy," claiming that nuclear power offers a low-cost, safe, and environmentally clean source of energy. The Nuclear Energy Institute, the lobbying arm for the nuclear industry, was in contact with Cheney's energy task force early and often, more than any other organization or corporation.[168]

The Bush Administration's Nuclear Power 2010 program advocates an expedited nuclear renaissance. Efforts to promote public-private partnerships to place new nuclear reactors at DOE sites have been introduced into national energy legislation. Even catchy, if Orwellian, phrases like "Freedom Reactors" have been coined.

One proposal is to establish a "Southeast Energy Park" on federally-owned land at SRS. This would require the construction of a new "fleet" of nuclear power plants, including new generation designs, through a public-private partnership with interested private electric utilities, such as Dominion Energy.[169] Some of these new nuclear reactor designs could use plutonium-based nuclear fuel or be modified to do so in the future. Professional presentations have been made to bodies of elected officials, such as the South Carolina Governor's Nuclear Advisory Council in February 2003 and the May 2003 "Community Leaders Breakfast" sponsored by Westinghouse-Savannah River Company in Savannah. When asked, "Why an energy park?" the response was that it "supports national energy policy and Department of Energy/Congressional initiatives."[170]

The Administration's Nuclear Power 2010 program poses implications beyond SRS. In fact, two other companies besides Dominion Generation have applied for early site permits for new nuclear plants: Exelon Generation Co. at

Many lobbying efforts are underway to bring new nuclear missions of all types to the Southeast.

its Clinton, Illinois site and Entergy Operations, Inc. at its Grand Gulf, Mississippi site.[171] Despite keeping a low profile on nuclear expansion, Southern Company has also been identified as having interest in building new nuclear reactors, including at existing nuclear sites.[172] Georgia's Plant Vogtle directly across the Savannah River from SRS has existing construction permits for two reactors that were never built.[173] Given Vogtle's proximity to SRS and the stated need by DOE for more reactors to use MOX fuel in order to complete the program, the area could be targeted for this and other dangerous schemes.

Southern Company has also been identified as having interest in building new nuclear reactors, some perhaps at existing nuclear sites.[172]

The NRC has a new streamlined licensing process that allows the issuance of a combined construction permit and a conditional operating license for a nuclear power plant.[174] The NRC has already provided certifications for three new reactors designs (GE Nuclear Energy's Advanced Boiling Water Reactor, Westinghouse's Systems 80+, and AP600) and is reviewing Westinghouse's AP1000 passive advanced light-water reactor design.[175] If these designs are truly new, they are untested in the real world. They can be expected to have the same environmental, economic, and safety problems as existing nuclear reactors due to the nature of radioactivity.

Scheme to Hijack the Hydrogen Promise

Hydrogen fuel offers the possibility, if produced from safe methods, of moving us toward a cleaner energy future. The promise of a hydrogen fuel era could be compromised if nuclear power is the energy source used to produce it. President Bush and other national leaders have stated strong support for promoting research into the development of a hydrogen economy with the involvement of nuclear power. World leaders have also become involved, with the first meeting of the newly formed International Partnership for the Hydrogen Economy (IPHE) held in November 2003 in Washington, DC. In fact, plans for the emerging "hydrogen fuel economy" have been introduced in national energy legislation and have been lobbied for by nuclear supporters at forums in the Southeast. SRS, in particular, is considered a world leader in hydrogen storage and handling due to its extensive work with handling tritium,[176] a radioactive form of hydrogen, which is used to boost the yield of the hydrogen bomb.

SRS's expertise, derived from nuclear weapons development, is likely to put SRS at the forefront of new hydrogen technologies. This "expertise" is dubious at best, since large releases of tritium have occurred for more than 50 years, impacting several states. According to Westinghouse Savannah River Company reports, "since site startup in 1952 through 1991, 25 million curies of tritium (94%) have left the plant site through the atmosphere and 1.6 million curies (6%) have left through the Savannah River."[177] If nuclear power becomes an integral part of hydrogen production, attaining a truly clean energy future and a future free of nuclear weapons would become impossible.

If nuclear power becomes an integral part of hydrogen production, attaining a truly clean energy future and a future free of nuclear weapons would become impossible.

Attempt to Resurrect the Bomb

Efforts to restore the old "Bomb Plant" function at SRS are emerging through recent efforts by the DOE's National Nuclear Security Administration

(NNSA) to establish a “Modern Pit Facility” within the nation’s nuclear weapons complex. A “pit” is the plutonium core of a nuclear weapon.[178] A draft environmental impact statement (EIS) was released in May 2003, with several DOE sites under evaluation, including SRS. If SRS is chosen, the Modern Pit facility is certain to sideline necessary cleanup measures and put workers, surrounding communities, and the environment at further risk. The DOE estimates a 1 in 5 chance for the worker population to experience a fatal cancer per year of operations for a 450 pit per year production rate.[179] The reestablishment of a large-scale plutonium pit production center would add a new generation of Southeastern-made weapons of mass destruction to our nation’s already large stockpile. Further, with design and construction estimates at $2-4 billion and projected operating costs of $200-300 million per year, it would drain federal financial resources on a program that will ensure more contamination, perhaps trigger a new nuclear arms race, and provide for the build up of a costly infrastructure that had begun to be dismantled.

Nuclear Sites in and Around Georgia

Today Georgia is home to four nuclear power reactors at two power plants that supply 27% of the state's electricity.[180] Southern Company's nuclear division—Southern Nuclear Operating Company—holds the license to operate these plants. The plants are jointly owned by Southern Company's affiliate Georgia Power, MEAG Power, and the state's electric membership cooperatives. Table 2 provides plant ownership, generating capacity, and details on nuclear waste storage at nuclear power plants in and near Georgia.

Table 2.

Name & Location	# of Reactors	Operating Utility	Operating License Issued	Original Closure Date	New Closure Date (if allowed to operate)	Ownership	Nuclear Waste Storage
Edwin I. Hatch- 11 miles North of Baxley, GA	2	Southern Nuclear Operating Company	1974 (Unit 1) 1978 (Unit 2)	2014 (Unit 1) 2018 (Unit 2)	2034 (Unit 1) 2038 (Unit 2)	Georgia Power (50.1%) Oglethorpe Power Corporation (30%), MEAG Power (17.7%) and Dalton Utilities (2.2%)	Outdoor dry cask storage (ISFSI) approved July 2001, 17 dry casks (as of March 2004)[2]
Vogtle- 26 miles SE of Augusta, GA	2	Southern Nuclear Operating Company	1987 (Unit 1) 1989 (Unit 2)	2027 (Unit 1) 2029 (Unit 2)	Has not officially applied for relicensing	Georgia Power (45.7%), Oglethorpe Power Corporation (30%), MEAG Power (22.7%) and Dalton Utilities (1.6%)	Spent fuel pool storage
Joseph M. Farley- 18 miles SE of Dothan, AL	2	Southern Nuclear Operating Company	1977 (Unit 1) 1981 (Unit 2)	2017 (Unit 1) 2021 (Unit 2)	Applied for relicensing September 2003	Alabama Power	Spent fuel pool storage
Oconee 30 miles West of Greenville, SC	3	Duke Energy Corporation	1973 (Unit 1,2) 1974 (Unit 3)	2013 (Unit 1,2) 2014 (Unit 3)	2033 (Unit 1,2) 2034 (Unit 3)	Duke Energy	Outdoor dry cask storage (ISFSI), approved January 1990, 58 dry casks (as of June 2001)

Sources:
U.S. Nuclear Regulatory Commission Information Digest. NUREG-1350, Vol. 14,2002 Edition. pp.54-55, 105-106, 108, 130-131.
Oconee was the second nuclear plant in the United States to be relicensed and the first in the Southeast. U.S. Nuclear Regulatory Commission Information Digest, NUREG-1350, Vol. 14, 2002 Edition, p. 52.

Georgia has significant nuclear power and nuclear weapons facilities inside or close to its borders. *(See Radioactive Southeast Map for more details.)* Since these facilities add man-made radioactive materials to the environment, Georgia has operated outdoor radiation monitoring networks at nine nuclear facilities within and bordering the state.[181] Even after a reactor has closed, it needs to be closely monitored as it poses an ongoing security and health threat to a surrounding community, heightened when dangerous radioactive materials are left on site. This report focuses primarily on the two nuclear power plants within Georgia, but also provides information on the other monitored nuclear facilities that deal with nuclear weapons, nuclear research, and nuclear power.

Edwin I. Hatch Nuclear Power Plant

The state's oldest nuclear power reactors are part of Plant Hatch, two General Electric Mark I boiling water reactors, near Baxley in South Georgia.[182] They are owned by Southern Company affiliate Georgia Power (50.1%), Oglethorpe Power Corporation (30%), MEAG Power (17.7%), and Dalton Utilities (2.2%).[183] Plant Hatch's two reactors came online in 1974 and 1978 and were originally licensed to operate until 2014 and 2018 respectively, listed also in Table 2.

Several major problems at Plant Hatch have been brought to regulators' attention.

Aerial photo of Hatch Nuclear Power Plant along the Altahama River.

These include:

- reactors that have reached their maximum radioactive waste storage capacity
- ongoing worker safety violations[184]
- both water contamination and excessive water consumption that place the Altamaha River at risk[185]
- damaged components when a bolt weighing several hundred pounds was dropped into the spent fuel pool and tore the liner[186]
- lack of a traditional containment dome (Chernobyl lacked a containment dome)
- early reactor damage (cracked core shroud) poses an ongoing safety risk

Alvin W. Vogtle Nuclear Power Plant

Nuclear Plant Vogtle in Burke County near Waynesboro and Augusta has two reactors that are licensed to operate until 2027 and 2029 and are owned by Southern Company affiliate Georgia Power (45.7%), Oglethorpe Power Corporation (30%), MEAG Power (22.7%), and Dalton Utilities (1.6%), as described in Table 2.[187]

Public concerns about nuclear Plant Vogtle include:

- water contamination and excessive water consumption that places the Savannah River at risk, resulting in fish contaminated with radioactive materials and tritium in drinking water supplies[188]
- Southern Company's initial interest to use the facility for a federally proposed plutonium bomb fuel program, crossing the line from "peaceful" nuclear power to weapons applications
- worker safety violations that point to management problems such as security breaches and failed drug and alcohol tests[189]
- poor management practices that led to $350,000 in fines and penalties for issues and violations involving failure to properly secure information, actions which could have led to a criticality accident, and attempts at cover-up[190]
- misjudgment of construction and startup costs by company resulting in massive rate increase
- insufficient decommissioning funds[191]

Water contamination threatens fishing and tourism industries in Georgia.
Photo courtesy of U.S. Fish and Wildlife Service.

"Primary construction has begun on the Georgia Power Company nuclear [reactor] plant near Waynesboro and natural resources and the environment will not be harmed, officials say."

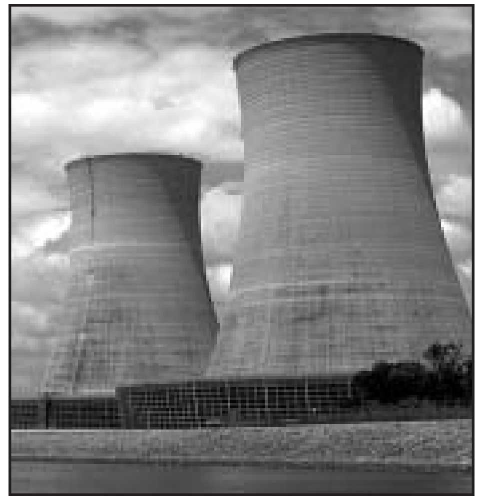
—Augusta Chronicle, reprint of original article from March 14, 1972[192]

"Elevated tritium (H-3) was detected in Savannah River water at all SRS [Savannah River Site] outfalls and at the Vogtle outfall…Enhanced tritium monitoring by Georgia, South Carolina, the City of Savannah, and DOE, has resulted in detection of periodic, low-level tritium pulses in downstream water. These pulses are attributed to routine (normal) batch discharges from SRS and Vogtle operations."

— Georgia Department of Natural Resources Environmental Protection Division, Environmental Radiation Surveillance Report, 1997-1999[193]

Joseph M. Farley Nuclear Power Plant

The Joseph M. Farley plant houses two nuclear reactors and is located approximately 16 miles from Dothan, Alabama in the southeastern part of the state near the Lower Chattahoochee River[194] that forms the Alabama/Georgia state border, adjacent to Early County, Georgia. It is owned by the Southern Company affiliate Alabama Power.[195] In late 2003 it applied to the NRC to operate an additional 20 years beyond its original license that requires shutdown no later than 2017 and 2021.[196]



Sequoyah Nuclear Power Plant near the Tennessee-Georgia border.

Oconee and Sequoyah Nuclear Power Plants

The Oconee nuclear plant and the Sequoyah nuclear plant are also located near Georgia and directly affect surrounding areas in the state. Duke Power Company operates the three-reactor Oconee nuclear power plant located near Seneca, South Carolina, about 20 miles northeast of Toccoa, Georgia. It draws water from Lake Keowee, which flows into the Savannah River. The Tennessee Valley Authority (TVA) operates the two Sequoyah Westinghouse Electric ice condenser reactors near Chattanooga, along the banks of the Tennessee River, approximately 20 miles northeast of Rossville, Georgia. Sequoyah is a nuclear power plant[197] slated as a back-up facility to produce tritium required to recharge U.S. nuclear weapons, another example of the increasing, dangerous crossovers between military and civilian nuclear operations.[198]

Georgia Tech Neely Nuclear Reactor

In downtown Atlanta on the Georgia Institute of Technology campus, a 5 Megawatt, highly-enriched, heavy water moderated research reactor was operating along with other nuclear installations up until 1996. The reactor came to the campus in 1964 as a smaller, 1 Megawatt reactor. In November 1995, in spite of the NRC approval for the reactor's license renewal, the reactor was shut down. Its fuel was removed in the spring of 1996 in advance of the Olympics.[199] Although officials stated that the shutdown was due in large part to the university's financial concerns about the reactor and a lack of utilization,[200] concerns about terrorism were raised by coordinators of the Olympics,[201] and there had been extensive legal proceedings brought by public interest advocates on grounds of serious public safety and contamination concerns.[202]

Extensive safety problems were present well before the reactor was shut down. In a Memorandum to Georgia Tech's Nuclear Safeguards Committee in 1988, the manager from Georgia Tech's Office of Radiation Safety (ORS) stated: "As many of you may know, I am extremely concerned about the safe use of the Hot Cell/Storage Pool complex at Georgia Tech. Because of the seriousness of this operation, that involves the transfer of up to 600,000 Curies of Cobalt-60 [a radioactive isotope of cobalt] from one place to another, and because of the current confusion and hostility surrounding the ORS, I recommend that the Hot Cell operations be terminated."[203]

Ongoing concerns about the Neely nuclear reactor building and complex include:

- The "hot cells," associated facilities, and Cobalt-60 pool were not part of

Although officials stated that the shutdown was due in large part to the university's financial concerns about the reactor and a lack of utilization,[200] concerns about terrorism were raised by coordinators of the Olympics...

According to the GAEPD's November 2001 inspection, the Georgia Institute of Technology still has a large inventory of 93,900 Curies of Cobalt-60 on site.[205]

decommissioning activities. In fact, they are still in active use under the regulatory oversight of the Georgia Environmental Protection Division (GAEPD) for academic research and to fulfill contracts with private companies and federal agencies.[204] According to the GAEPD's November 2001 inspection, the Georgia Institute of Technology still has a large inventory of 93,900 Curies of Cobalt-60 on site.[205]

- Radiation was measured outside of the facility and radioactive wastewater from the site was detected, including Cobalt-60 and tritium.[206] For example, on January 31, 1983, Cobalt-60 was released into Atlanta's city sewer system[207] and elevated levels of tritium in waste water began in June 1998.[208] Extensive documentation exists showing past and existing contamination of the campus.[209]

Kings Bay Naval Nuclear Submarine Base

Kings Bay Naval Nuclear Submarine Base is located on Kings Bay and Cumberland Sound near St. Marys, Georgia and near the Cumberland Island National Seashore Wilderness Area. Operating as a Trident base since 1978, the site supports the Trident Nuclear Submarines and their associated nuclear weapons systems.[210] The fleet consists of eight nuclear-powered ballistic missile submarines armed with 24 Trident II submarine-launched ballistic missiles with each missile containing eight W76 or four W88 nuclear warheads.[211] Additional W76 warheads are stored along with 160 W80 warheads for the Tomahawk sea-launched cruise missile. This brings the total of nuclear warheads in Georgia to approximately 1,960, making the state of Georgia the second largest holder of nuclear warheads in the United States.[212]

In addition to the large number of nuclear weapons at Kings Bay, concerns exist over the nuclear fuel needed to power the submarines, the subsequent needs to transport and store the used naval nuclear reactor fuel, and the eventual decommissioning required for the nuclear submarines and their onboard reactors. The average annual operational cost per submarine is estimated to be $4.3 million with the operating costs of the naval base increasing to more than $285 million.[213]

Dawson Forest Wildlife Management Area

Lockheed Aircraft Corporation operated the Georgia Nuclear Aircraft Laboratory, near Dawsonville, Georgia, for the Air Force. It was decommissioned in 1971. Beginning in 1959, the site was originally used to study a nuclear propulsion system for aircraft but was later used for material and biological effects research and radioactive materials sources encapsulation (e.g. sealed Cobalt-60 sources).[214] The 10,000-acre site in Dawson County, approximately 40 miles north of Atlanta, included an open "air-shielded" 10-Megawatt test reactor, a hot cell building, seepage basins, and a temporary "cooling-off" storage area where high levels of short-lived radioactive materials were kept.[215] The area drains to the Etowah River. Nearly three decades later, access to the hot-cell area and "cooling off" area is still restricted to minimize exposure to radioactive contamination.

"Experience with the unshielded reactor at Dawsonville, Georgia provides a good example [of the effects of radiation]. After one of the high energy runs the entire population of marked cotton rats living in the adjacent field was exterminated… Small birds entering the radiation field were also undoubtedly killed…"

—Eugene P. Odum, University of Georgia, 1965[216]

This area was the site of extensive animal research by scientists at the University of Georgia and Emory University to determine what levels of immediate radioactive contamination would kill birds and animals.[217] These studies were supported by contracts between the Atomic Energy Commission and Emory University and the University of Georgia. Dr. Jay Schnell acknowledged assistance from Eugene P. Odum, a well-recognized pioneer in ecological studies, who also conducted research on the effects of radiation.[218] Further, studies were done using nuclear reactor energy levels" giving 'radiation doses up to supralethal'…to simulate nuclear war without 'the heat and blast associated with bomb tests.'"[219] The forest area was irradiated in two acute exposures in June 1959 and August 1960 and it was recommended that the "area be called a 'radiation subclimax' as the 'radiation disturbed community is not in the normal successional pattern.' "[220] A forest develops in an established pattern. In this case, that pattern was severely altered due to the high levels of radiation.

Savannah River Site Nuclear Facility

The Department of Energy's (DOE) 310-square mile Savannah River Site nuclear facility (SRS), originally known as the "Savannah River Plant," is located near Aiken, South Carolina, along the state border with Georgia formed by the Savannah River, 15 miles from Augusta, Georgia and bordering Richmond, Burke, and Screven counties. Locally referred to as the "bomb plant," it was initially built in the early 1950s to produce materials such as plutonium-239 and tritium used in the production of nuclear weapons. The federal government signed a contract with E.I. du Pont de Nemours Corporation to design, construct, and operate nuclear production facilities on the site. Currently, SRS is operated for the DOE by a team from Westinghouse Savannah River Company; Bechtel Savannah River Inc. (parent company, Bechtel National, Inc.); BWXT Savannah River Company (parent company, BWX Technologies); and British Nuclear Fuels, Limited, Savannah River Company (parent company, British Nuclear Fuels, Limited, Inc.).[221] Five nuclear reactors producing nuclear weapons materials, not electricity, were built along with numerous support facilities including two chemical separations plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, a tritium extractions facility and waste management facilities which included 51 high level radioactive waste tanks, which ranged in size from 750,000 gallons to nearly 1.3 million gallons, and several radioactive waste burial grounds.[222]

Savannah River Site.
Photo courtesy of Department of Energy.

"…We'll study war right here they said, the little town must go."

—From "Death of Ellenton," by The Johnson Family Singers, 1978

In 1951 to secure such a large tract of land, thousands of residents, mostly poor white or African-American families, along with small businesses and local cemeteries, were uprooted from several small towns, such as Ellenton, South Carolina. The site had global implications in the nuclear arms race. From 1953 to 1988, SRS produced approximately 36 metric tons of plutonium, nearly 80,000 pounds.[223] A nuclear weapon requires only about 2.2 to 13.2 pounds of weapons plutonium.[224]

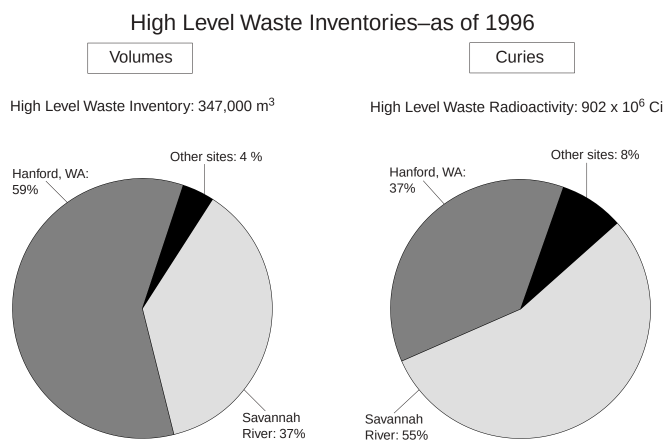
In 1989, SRS was added to the National Priority List as a federal Superfund site with levels of contamination that were deemed by the EPA to pose risk to human health and the environment.[225] This categorization, which remains in effect today, requires implementation of mandated cleanup measures. For more than 50 years, contamination has occurred, threatening the quality of drinking water in nearby counties and the quality of the Savannah River. The operations at SRS generate a variety of radioactive, non-radioactive, and mixed (radioactive and non-radioactive) hazardous wastes that contaminate ground water and aquifers and on-site creeks and streams that discharge to the Savannah River with volatile organic compounds (degreasing solvents), heavy metals (lead, chromium, mercury, and cadmium), radionuclides (uranium, tritium, fission products, and plutonium),[226] and numerous other hazardous chemicals[227] including PCBs, vinyl chloride, and trichloroethylene.[228]

More than 30 million gallons of high level radioactive liquid waste are currently stored on site in waste tanks, some more than 50 years old and still in operation; more than half of those original tanks experienced leaks.[229] SRS stores 37% of the nation's high-level radioactive waste, second only to the DOE's Hanford site in Washington; however, SRS houses the greatest amount of radioactivity (in the hundreds of millions of Curies) in the entire U.S. nuclear weapons complex, approximately 55%, as shown in Figure 10.[230]

For more than 50 years, contamination has occurred, threatening the quality of drinking water in nearby counties and the quality of the Savannah River.

The DOE has identified SRS as one of 103 sites that will require active, long-term stewardship.[231] Long-term stewardship is defined as "all activities required to protect human health and the environment from hazards remaining after clean up is complete."[232] Paradoxically, the DOE has said that there are no complete remediation technologies to deal with the high level radioactive waste tanks at SRS.[233] It is sometimes difficult to decide if it is more dangerous to try to remove radioactive waste or leave it alone. For example, concern over risks to remediation workers led to the decision not to excavate and remove 28,000 cubic meters of radioactive waste that was buried at SRS from 1952-1974.[234]

Figure 10.



Original Source: James Werner, Director, Office of Long Term Stewardship, U.S. Department of Energy Environmental Management Program, "Presentation to the Institute for Energy and Environmental Research," June 23, 2000.

Policy Recommendations

Policy Recommendations for a Safer, Cleaner Energy Future

The harmful health effects of nuclear power, its detrimental impact on Georgia's economic wellbeing, and the irreversible damage to ecosystems require thoughtful and expeditious action by public policy-makers.

Southern Alliance for Clean Energy recommends the following:

➤ Conduct comprehensive statewide energy planning to address future energy needs, remove long-term dependency on nuclear power, and set goals for the systematic adoption of safe replacement power

➤ Establish economic incentives for businesses to develop energy efficiency programs and clean, renewable energy resources

➤ Stop the ongoing, long-term production of dangerous, nuclear waste and the unsafe, temporary storage of that waste in containers outdoors

➤ Protect taxpayers and utility ratepayers from having to pay for radioactive cleanup by removing corporate nuclear liability shields and instituting effective, long-term radioactive monitoring measures by the state

➤ Establish better regulations to protect the public and the environment from damaging radiation exposure including adequate monitoring of air, water, and soil for contamination by nuclear activities

➤ Prevent the development of hydrogen-based nuclear fuel, plutonium bomb fuel, and other tactics that expand unsafe nuclear power

➤ Disallow nuclear power from being eligible for a federal or state renewable energy portfolio standard[235] requirement or eligible for "greenhouse gas" or "carbon emissions" credits

Conduct Comprehensive Statewide Energy Planning

Georgia is a fast growing state and its infrastructure needs to expand rapidly to accommodate this growth. Yet, the state's current electricity system faces a range of vulnerabilities and is ill prepared to handle this growth. Except for hydropower, the existing electric system relies on fuel that is not indigenous to the region. Georgia is vulnerable to being cut off from essential power, supply lines, or reduced availability of fuel due to terrorism, war, or dramatic price fluctuations. The state needs broader, safer, more diverse fuel resources to offer greater security.

Most of Georgia's baseload power plants (those that run all of the time) are coal or nuclear powered. Almost no electricity has been generated on the grid in Georgia from non-hydro, renewable energy sources such as solar, wind, switch grass, and other biomass fuel sources. Key elements of a secure energy system include reliance on clean, renewable energy sources and development of cost-effective energy efficiency and conservation resources—all of which are important to identify in a state energy planning process.

Statewide energy policies need to support a shift toward affordable and safe energy practices. The best way to devise these policies is through the development of a comprehensive state energy plan that identifies the future energy needs for the state, the degree to which energy efficiency and conservation can meet those future energy needs, which safe (non-nuclear), existing supplies are needed to meet those energy needs, and what additional energy supplies will be needed to meet future energy demand. Currently, the state has no mechanism to provide forecasts of statewide electricity supply and demand so that sound decisions can be made on the necessity and timing of new power supplies from both regulated and non-regulated sources. Nor does it have a power plant siting process to ensure suitable power plant selection and location for all electric suppliers—investor-owned utilities, cooperatives, municipalities, and merchant power companies. A state energy plan, combined with effective legislation, can address these and other serious planning and policy gaps.

Establish Economic Incentives for Safe Replacement Power

Georgia's economy would benefit by recruiting clean energy industries to locate in the state. Renewable energy technologies produce substantially more temporary and long-term jobs than traditional energy supplies.[236] Wind and solar energy are likely to provide one of the largest sources of new manufacturing jobs worldwide during the 21st century.[237] Georgia's rural communities, especially its plentiful undeveloped farmland, as well as coastal areas could greatly benefit from incentives to develop solar and wind farms, and to advance clean biomass technologies.[238]

Georgia's rural communities, especially its plentiful undeveloped farmland, as well as coastal areas could greatly benefit from incentives to develop solar and wind farms, and to advance clean biomass technologies.[238]

Clean, safe energy technologies have reduced their costs significantly over the past few decades while improving their technologies. For example, in the early 1980s, when the first utility-scale turbines were installed, wind-generated electricity cost as much as 30 cents per kilowatt-hour. Now, many state-of-the-art wind power plants in the United States can generate electricity for less than 5 cents per kilowatt-hour, a price that is in a competitive range with many conventional energy technologies.[239] When adjusted for total power production, nuclear power has been 18 times more expensive than wind power in terms of subsidies received over the first 25 years of either technology development.[240]

Studies show that energy efficiency investments and renewable energy options together with non-nuclear conventional sources have the potential to supply the state's future energy needs without any long-term dependence on nuclear power. Based on the technical potential identified under the Clean Energy Plan in the 2001 Renewable Energy Policy Project report *Powering the South: A Clean Affordable Energy Plan for the Southern United States*, investments in energy efficiency measures alone over the next 20 years in Georgia would eliminate the need for 20 new power plants of the size of 300 MW each (or 6,000MW total) and potentially save 41 million megawatt hours (MWh). Energy efficiency could replace six nuclear power reactors that are approximately the size of Georgia's plants.[241]

In the *Powering the South* report, the Clean Energy Plan for Georgia does not rely on building any new nuclear power plants and assumes that all nuclear plants in the region will retire according to their initial licensed closure date. The plan highlights the positive results that energy efficiency measures and technologies would:[242]

- Save 41 million megawatt hours of electricity by 2020 (approximately 6 nuclear reactors of 1,000 MW each)
- Reduce electricity demand nearly 14% by 2010 and 23% by 2020
- Cost significantly less than generating, transmitting, and distributing electricity—with an average cost of 2.6 cents per kilowatt hour
- Reduce net electricity costs by $744 million by 2020

Clean, renewable energy generating sources such as solar, wind, and certain forms of biomass energy do not require water for cooling the generators.

Energy efficiency could replace six nuclear power reactors that are approximately the size of Georgia's plants.[241]

The state should incorporate water efficiency, water quantity, and water quality criteria into its energy planning so that water conserving energy supply choices and energy efficiency investments are made.

Development of these resources, together with increased investment in energy conservation and efficiency, would reduce the state's dependency on water-intensive nuclear power.[243]

The state should incorporate water efficiency, water quantity, and water quality criteria into its energy planning so that water conserving energy supply choices and energy efficiency investments are made. As illustrated in Table 3, renewable sources require significantly less water than conventional sources such as coal and nuclear power.[244]

Table 3.

Technology	Gallons per kilowatt hour (g/kWh)
CONVENTIAL SOURCES	
Nuclear	0.62
Coal	0.49
Oil	0.43
Combined Cycle Natural Gas	0.25
RENEWABLE SOURCES	
Solar	0.030
Wind	0.001

Biomass energy, which has significant potential in Georgia if implemented with proper environmental guidelines, can be used to produce electricity, heat, or liquid fuels from organic matter such as wood, crops, and animal waste. Studies by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy show that substantially less water would be required by various biomass operations than current conventional power plants (though more than other renewable sources such as solar and wind). The most likely technology to be used in the near-term, biomass co-firing, was shown to produce negligible increases in water consumption when compared to coal-only operation.[245]

The cost of regulation of different fuel types is an important consideration, too. Due to security and safety problems, nuclear power plants require significant federal and state oversight at every stage of development including decommissioning. Clean and safe energy supplies do not require extensive security oversight or involvement. The trend of "hands-off" government regulation that is popular today further heightens the public risks and liabilities surrounding nuclear power.

The construction of a power plant has substantial long-term consequences, especially when its typical lifetime exceeds 40 years. Expensive long-term purchase agreements, such as the one that Georgia's small utilities entered into with nuclear Plant Vogtle, can financially burden a utility for many years and create a distorted incentive to push increased power sales rather than partner with customers to curb their demand. The construction of a nuclear power plant also forces the surrounding region to handle the pollution and other adverse impacts of that plant for countless generations. Much greater effort should be made to minimize the need for additional power generation in Georgia by

Solar system at a private residence on Tybee Island, Georgia.

increasing the use of energy efficiency and implementing clean energy technologies.

Stop Ongoing, Long-Term Production of Dangerous of Nuclear Waste

As long as nuclear power plants are allowed to operate, nuclear waste will continue to be generated. Phasing out nuclear power and discontinuing operations is the only guarantee preventing the production of these dangerous wastes. As mentioned earlier, the licensing of outdoor spent fuel storage is problematic as it poses security concerns along with environmental and health risks. Though Plant Hatch already has an outdoor nuclear waste storage site, further expansion should be prevented. Plants like Vogtle that currently lack outdoor storage should not be granted permission to create such outdoor nuclear waste dumps, or to ship its nuclear waste to sites with outdoor storage, such as Plant Hatch. Since spent fuel pools have also been identified as a security risk, measures must be taken to determine what can be done to more safely store the fuel.

In January 2002, although public opposition was high, the Nuclear Regulatory Commission approved a request made by Southern Nuclear Operating Company to extend the license of Plant Hatch for an additional 20 years. Despite NRC license renewal, the state of Georgia, along with the respective owners of the plants in Georgia, has the authority to prevent the extended operation of Hatch and other nuclear facilities. In its license extension document, the NRC stated:

> *If the operating licenses are renewed, Federal (other than NRC) agencies, State regulatory agencies, and the owners of the plant will ultimately decide whether the plant will continue to operate. This decision will be based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners.*[246]

No nuclear reactor in the United States has been able to operate the full length of its 40-year operating cycle, while some have permanently closed before the original 40 years of operation due to equipment failures or financial reasons, among others. Some European countries have adopted policies for systematic phase-out of nuclear power that would be useful models for Georgia to emulate.

Protect Taxpayers and Utility Ratepayers from Having to Pay for Radioactive Cleanup

Federal subsidies to protect nuclear utilities from the liability costs that would accrue from severe accidents, such as the Price-Anderson Act, should not be renewed or extended by Congress. The nuclear industry should be required to provide funding assurance independently, as other industries are required. Further, Department of Energy contractors should also be held financially liable in cases of accidents or negligence.

Georgia regulatory agencies should institute economic requirements on nuclear industries operating in Georgia as a mechanism to protect taxpayers and utility ratepayers from having to pay for radioactive cleanup. A down

As long as nuclear power plants are allowed to operate, nuclear waste will continue to be generated.

No nuclear reactor in the United States has been able to operate the full length of its 40-year operating cycle...

Due to the long-lived, dangerous nature of many radioactive contaminants, Georgia will continue to be threatened by current facilities well into the future...

payment of sorts should be collected at the border for trucks or trains that transport any form of nuclear waste through the state so that in the event of accident, hauling companies are liable.

The Georgia Public Service Commission that regulates Georgia Power's electricity rates should assist in establishing better methods to protect ratepayers. For example, this regulatory body is responsible for ensuring that adequate funds are collected for decommissioning expenses for nuclear power plant closure. The projected costs for permanently closing a plant need to be re-examined in light of higher-than-expected decommissioning costs experienced at other plant closures in the country.

The Georgia Assembly should support state funding for thorough radioactive monitoring programs. Additionally, federal funding to properly and independently monitor federal weapons sites such as SRS should also be required for the protection of Georgia's citizens, economy, and environment.

State radiation monitoring is seriously deficient. Current radiation monitoring programs conducted by the Georgia EPD have already undergone serious budget cuts that have resulted in less frequent sampling and monitoring. Funding from federal agencies such at the Department of Energy are at risk. Though budget constraints will continue to impact Georgia in the near future, policy-makers should not support decreasing important radiation monitoring programs even further. Due to the long-lived, dangerous nature of many radioactive contaminants, Georgia will continue to be threatened by current facilities well into the future, even those that have closed or are slated for eventual decommissioning. Georgia's policy-makers should secure means to provide adequate funding for decades into the future in order to ensure proper monitoring of these nuclear facilities for future generations.

Since the NRC's process for handling licensing and other issues of concern is inadequate in protecting the public from economic, safety, and environmental deterioration, the state of Georgia should develop its own regulations to address the gaps left by poor federal regulations governing construction and operation of nuclear power plants, nuclear waste storage, and transport issues.

These types of precautionary measures are warranted given the high threat that nuclear power plants pose to our region's security, economy, human health, and environment.

Establish Regulations to Better Protect the Public and Environment from Damaging Radiation Exposure

Basic public protections concerning the nuclear industry are sorely needed not only for the current population but to provide intergenerational equity over many years and well into the future.

Basic public protections concerning the nuclear industry are sorely needed not only for the current population but to provide intergenerational equity over many years and well into the future.

Under the precautionary principle, an industrial process should not be allowed to proceed until it can be determined that it will not endanger the public health or safety. As identified in the 2003 report by the European Committee on Radiation Risk, the precautionary principle has never been applied to the nuclear power industry. The primary reason for the lack of precaution was that in spite of the novelty of the technology they were engaged in, nuclear physicists, who were not medical doctors, were convinced that nuclear energy posed little risk to public health, and they convinced policy-makers of this false safety. Certain areas of scientific discovery, particularly cell biology and the study of the immune system, have made tremendous progress since the inception of the nuclear power program. The risk model within which the nuclear program currently operates was drawn up before the discovery of DNA. In setting any protective health standards, clearly the most recent physiological, biological, and environmental discoveries should be taken into consideration.[247]

A recent analysis of public view indicated that the majority of the public is not supportive of building new nuclear power plants.[251]

State regulations need to be rewritten to incorporate the latest knowledge on the health and environmental affects of radiation.

Prevent Development of Plutonium Bomb Fuel and Further Expansion of the Nuclear Industry

Serious health, security, and economic problems are linked with plutonium and the development of plutonium bomb fuel (MOX). Therefore, plutonium should be handled as a deadly waste product and a security concern and should be taken entirely out of human circulation in order to avoid these problems rather than be developed as plutonium fuel for use in commercial nuclear facilities.

In a 2003 study done by the Massachusetts Institute of Technology (MIT) on the future of nuclear power, proliferation concerns were cited as a major obstacle in the expansion of the industry. Specifically, the "possible misuse of commercial or associated nuclear facilities and operations to acquire technology or materials as a precursor to the acquisition of a nuclear weapons capability."[248] Objections to the use of closed fuel cycles were also raised, such as the MOX process used in Europe and Japan and proposed here in the United States, center around proliferation concerns—the technologies can promote the spread of nuclear weapons usable materials.[249]

Government and industry initiatives supporting the expansion of the nuclear power and weapons industry, especially the pursuit of producing hydrogen from nuclear power reactors, should be dropped. Instead, funding for vital clean up needs at sites such as SRS should be enhanced along with providing research opportunities to pursue clean, safer energy production technologies. Support of destructive energy development in national energy legislation should be disallowed. Instead, Congress should support federal energy policies that offer safer, affordable, and less environmentally damaging energy technologies, such as renewable energy forms and aggressive energy efficiency and energy conservation programs.

Historically, polling has shown that the public favors government investment in energy efficiency and renewable sources of energy over investments in fossil and nuclear fuels.[250] A recent analysis of public view indicated that the majority of the public is not supportive of building new nuclear power plants.[251]

Government and industry initiatives supporting the expansion of the nuclear power and weapons industry, especially the pursuit of producing hydrogen from nuclear power reactors, should be dropped.

Disallow Nuclear Power Emission Credits and Related Incentives

The United States is the world's largest emitter of carbon dioxide, a major

Nuclear power is not a renewable energy technology, and should not be regarded or rewarded as such.

global warming pollutant. As effective policies to reduce carbon dioxide are being debated, the nuclear industry is pushing for nuclear power to be eligible for policies such as carbon emission "credits" where carbon-free energy resources receive financial incentives to operate.[252] Such credit mechanisms for nuclear power could be included in state or federal renewable portfolio standards and should be prevented. A renewable energy portfolio standard (RPS) would require all retail electricity suppliers to include renewable energy as a specified portion of the overall power mix.[253] Nuclear power is not a renewable energy technology, and should not be regarded or rewarded as such. While nuclear power does not directly produce carbon dioxide,[254] providing emission credits to an energy technology that poses security, terrorist, and nuclear proliferation risks will only exacerbate these existing problems. Carbon dioxide emissions are a byproduct of the production, processing, and handling operations for nuclear power.[255] *(See Appendix C—Uranium Fuel Chain.)* The nuclear power industry has relied heavily on financial subsidies since its inception more than five decades ago, and continues to aggressively seek new handouts. A 2003 MIT study identified such carbon incentive programs as one of very few ways that nuclear power could change its position as one of the most expensive means of energy to becoming competitive in the future.[256]

Conclusion

As local, state, and federal policy-makers work to develop a stronger, safer Georgia, it is imperative to confront the economic, health, safety, and environmental threats of nuclear power. For decades, the true costs of this dangerous energy supply have not been taken into account in corporate or governmental decision-making. In today's complex world, "safe communities" means far more than preventing burglaries and vandalism. We face insidious, fundamental societal threats to our personal and family safety. Nuclear power is one of those threats.

Fortunately, the solution to the nuclear power threat is within our reach. We have the tools to implement safe replacement power solutions, achieve greater energy efficiency, and reduce dependence on oil. As Georgians, we are responsible for our future and our family's futures. The "downstream" effects of generating electricity by nuclear power plants are not limited to the water flowing from their processes into our communities, "downstream" generations are also at risk—financial, health, and catastrophic. Georgia must refuse to be an unsafe, continual repository for nuclear waste and prevent the expansion of nuclear power. It must set a discerning course for phased shutdown, decommissioning, and dismantling of nuclear power plants at a pace that is humanly possible and with a focus on adopting energy technologies that are truly safe to live around.

Conclusion

Appendix A

Appendix

THE ROLE OF RELEVANT REGULATORY AGENCIES AND ASSOCIATED INSTITUTIONS

Atomic Energy Commission (AEC)

The Atomic Energy Act, originally passed in 1946 and later amended in 1954, along with the Energy Reorganization Act of 1974, provided the foundation for regulation of the U.S. commercial nuclear power industry.[257] In 1946, Congress established the Atomic Energy Commission (AEC), a civilian body to primarily oversee nuclear weapons development and production. Tremendous growth occurred under the AEC in the late 1940s and early 1950s and the bulk of our current large, centralized nuclear weapons complex was created.[258] The AEC also promoted and regulated civilian nuclear power. These broad responsibilities produced a conflict of interest that gained scrutiny as environmental awareness increased over the safety issues linked to nuclear reactors, which led to separating the regulatory needs of nuclear power from the weapons-related functions.[259] Congress reorganized the AEC in the mid-1970s and its functions were reassigned to several newly-created government agencies, currently the Department of Energy (DOE) and the Nuclear Regulatory Commission (NRC).

U.S. Nuclear Regulatory Commission (NRC)

The Nuclear Regulatory Commission (NRC) was created in 1974 to perform the regulatory function for the civilian nuclear power program of the dismantled Atomic Energy Commission. The NRC is responsible for regulating all of the following:

- commercial nuclear power plants
- research, test, and training reactors
- fuel cycle facilities
- medical, academic, and industrial uses of nuclear materials
- transport, storage, and disposal of nuclear materials and wastes[260]

The NRC's governing body consists of five members appointed by the President of the United States; they serve staggered, five-year terms. NRC headquarters are in Rockville, Maryland, and the country is divided into four NRC regions. Region II is based in Atlanta, Georgia, and is responsible for most of the southeastern United States.

Congress appropriated $584.9 million to the NRC for Fiscal Year (FY) 2003. Due to Congressional legislation passed in 1990 that continues today, the NRC is mandated to recover nearly all of its budget authority by assessing fees to its licensees.[261] The nuclear power companies the NRC regulates provide a large portion of the NRC's budget. Consequently, this money ultimately originates from utility ratepayers.

Table 4.[262]

Class of License	Range of Annual Fees
Operating Nuclear Power Reactor	$3,251,000*
Nuclear Fuel Facility	$559,000 to $5,836,000
Transportation Approval	$7,100 to $76,200

*includes Spent Fuel Storage/Reactor Deommissioning FY2003 annual fee of $319,000

For more information on the local power plant in your area, contact the NRC Public Document Room at 800-397-4209. Ask for a free docket print out for the plant which lists all accidents, violations, inspection reports, fires, and contamination events.

Department of Energy (DOE)

The Department of Energy (DOE) was created in 1977 by President Jimmy Carter to raise the profile and importance of energy issues to a cabinet level. DOE was given responsibility for all energy programs and the former AEC's mission of nuclear energy/weapons research and development. The DOE is also responsible for promoting energy efficiency and renewable energy, but the budget is largely consumed by nuclear energy/ weapons related activities.[263] The DOE was also one of the principle partners in the U.S. Human Genome Project, with an ultimate goal to discover all of the more than 30,000 human genes to make them accessible for further biological study.[264]

Savannah River Ecology Lab (SREL)

Savannah River Ecology Lab (SREL) is operated by the University of Georgia at Savannah River Site and has been funded by DOE (and its predecessors) since 1951 to conduct research on the impacts of the site on the environment.[265]

International Atomic Energy Agency (IAEA)

The International Atomic Energy Agency (IAEA) is the United Nations "Atoms for Peace" agency. According to their website, it is "the world center of nuclear cooperation and works for the safe, secure, and peaceful use of nuclear technologies." Essentially, IAEA promotes nuclear power and nuclear technologies. This should be kept in mind when considering some of the information from the UN about the effects of nuclear power on health. Since 1959 there has been an agreement between IAEA and the World Health Organization (WHO), the agency that provides international research work on the health effects of ionizing radiation. The following are quotes from the 1959 agreement:[266]

- "They (WHO and IAEA) will act in close cooperation with each other and will consult each other regularly in regard to matters of common interest" Article 1, Par. 1
- "…It is recognized by the WHO that the IAEA has the primary responsibility for encouraging, assisting and coordinating research on, and development and practical application of, atomic energy for peaceful uses throughout the world…" Art. 1, Par. 2
- "Whenever either organization proposes to initiate a program or activity on a subject which the other organization has or may have a substantial interest, the first party shall consult the other with a view to adjusting the matter by mutual agreement." Art. 1, Par. 3
- "The IAEA and WHO recognize that they may find it necessary to apply certain limitations for the safeguarding of confidential information

> furnished to them. They therefore agree that nothing in this agreement shall be construed as requiring either of them to furnish such information as would, in the judgment of the party possessing the information, constitute a violation of the confidence of any of its Members or anyone from whom it has received such information or otherwise interfere with the orderly conduct of its operations." Article 3, Par. 1

This agreement raises questions about whether objective, scientifically based information can be obtained from either of these two agencies regarding nuclear power's effects on public health. This is especially true since the actual goal of IAEA, the development of nuclear power, has an enormous potential for profit, while WHO's mission, the protection of public health, does not.

Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA), like the NRC and DOE, is a federal agency. The EPA's Radiation Protection Program responds to emergencies, assesses risk, sets certain limits on some emissions, such as drinking water standards, for some radionuclides like tritium, and provides information on radiation hazards.[267] Georgia is in EPA's Region IV. Conflicts exist in standards set by federal agencies. For example, the EPA sets radiation doses allowed to the public at nuclear power plants of 25 millirem (mrem) per year while the NRC has a limit of 100 mrem a year. Where the Clean Water Act is concerned, radioactive materials are often ignored. Under the Clean Water Act as implemented by the EPA, the EPA refined the definition of "pollutant" to exclude radioactive materials regulated under the Atomic Energy Act of 1954 (AEA). This means that implementing regulations in the Clean Water Act do not apply to "source, byproduct, or special nuclear materials as defined by the AEA."[268]

Federal Emergency Management Agency (FEMA)

Along with the NRC, Federal Emergency Management Agency (FEMA) is one of two federal agencies responsible for emergency preparedness at and around nuclear power plants. FEMA's role includes assessing the adequacy of off-site emergency planning, which the NRC relies on as a determination that there is "reasonable assurance that adequate planning measures can and will be taken in the event of a radiological emergency."[269]

Georgia Environmental Protection Division (GAEPD)

In 1964 the Georgia Legislature passed the Radiation Control Act, which allowed Georgia to become an "agreement state" with the former Atomic Energy Commission (now NRC). GAEPD became responsible for monitoring of radiation and radioactive materials in the environment when the Act was amended in 1976. GAEPD now has two programs that relate to nuclear materials and facilities, the Environmental Radiation Program and the Radioactive Materials Program.

The Environmental Radiation Program monitors the release of radioactive materials into the environment with specific focus on nine commercial and defense nuclear facilities in or bordering Georgia. The various samples collected, from soil, milk, crops, water, among others, are analyzed at the Environmental Radiation Laboratory at Georgia Tech through contracts with the State.[270] The Environmental Radiation Program leads state emergency response in Georgia with support as needed from the Radioactive Materials Program.[271]

The Radioactive Materials Program is responsible for regulating radioactive material in the state, other than at nuclear reactors, which includes issuing licenses, performing inspections, among other duties. Currently the Program has 478 active licenses in the state: 31% medical, 33% industrial type gauges, and 36% other industrial uses. The Program performs about 150 inspections a year. The X-Ray Control Program is with the Diagnostic Services Unit in the GA Department of Human Resources. None of the programs have medical doctors or radiation ecologists on staff.

Similar to the NRC, the Radioactive Materials Program is supported by a fee system, in which users of radioactive materials have to pay fees for licenses, compliance inspections, etc. The Environmental Radiation Program receives state appropriated funds along with a grant from the U.S. DOE for environmental monitoring and emergency preparedness around SRS.[272]

Georgia Public Service Commission (GAPSC)

As it relates to nuclear energy regulation, the Georgia Public Service Commission (GAPSC) mission is “to ensure that consumers receive the best possible value in…electric services and to improve utility facility protection...”.[273] The PSC is composed of five publicly elected officials. The Commissioners deal with nuclear issues in various proceedings, including electric rate cases, approval of long term utility plans, and overseeing economic concerns related to nuclear power plants in Georgia, owned or co-owned by Georgia Power Company and run by Southern Nuclear Operating Company. The GAPSC has very limited jurisdiction over electric municipal companies and electric membership cooperatives.

Appendix B

Appendix B

LIST OF TERMS

Activation product: The violent chain reaction resulting from splitting (fissioning) the atom that causes chemicals in air, water, or other materials to absorb energy, change structure slightly, and become radioactive. About 300 different radioactive chemicals are created with each chain reaction, which takes up to thousands or millions of years to return to their normal "stable" state, emitting radiation until "stable."[274]

Background radiation (natural): Environmental radiation due to naturally occurring radioactive elements and cosmic rays. In general, it is about 100 millirem per year.[275]

Criticality: A nuclear reaction has achieved criticality if it is generating enough neutrons to maintain the reaction at the same level that it is currently operating at. Creating too many neutrons makes the reaction super-critical, and too few neutrons makes the reaction sub-critical. An operating nuclear power plant is intentionally critical but can also have an uncontrolled nuclear reaction (e.g. Chernobyl). Spent fuel pools can also achieve criticality unless certain precautions are taken.[275a]

Curie: Traditional unit of radiation equal to the radioactivity of 1 gram of pure radium. One Curie gives off 37 billion nuclear disintegrations (mini-explosions) per second.[276]

Fission: From the Latin "to cleave or split" i.e. the splitting of the nucleus of the atom, particularly the uranium or plutonium atom, releasing incredible amounts of energy.[277]

Fission product: A general term for the mixture of substances resulting from nuclear fission. A distinction should be made between these and the *direct fission products or fission fragments* which are formed by the actual splitting of the heavy-element nuclei. Something like 80 different fission fragments result from roughly 40 different modes of fission of a given nuclear species, e.g. uranium-235 or plutonium-239. These radioactive fission fragments decay forming additional *daughter products* with the result that the complex mixture of fission products so formed contains about 200 different isotopes of 36 elements.[278]

Fusion: In nuclear fusion, a pair of light nuclei unite (or fuse) together to form a nucleus of a heavier atom, which can only occur with temperatures of the order of several million degrees. Such temperatures can only be achieved on earth by means of fission explosion (atomic bomb). By combining a quantity of deuterium or tritium (or a mixture) with a fission device a thermonuclear fusion reaction can be initiated. This is the process that produces the hydrogen bomb, which is even more powerful than the atomic bomb.[279]

Genetic effect: The effect of nuclear radiation in particular of producing changes (mutations) in genes and in the hereditary components (genes) in germ cells in reproductive organs (gonads). A mutant gene causes changes in the next generation.[280]

Ionizing radiation: Electromagnetic radiation (gamma rays or X-rays) or particulate radiation (alpha particles, beta particles, neutrons, etc.) capable of producing ions, i.e., electrically charged particles, directly or indirectly, in its passage through matter.[281] It causes genetic damage and mutations transmitted through generations.[282]

Isotope: Forms of the same element having identical chemical properties but differing in their atomic masses, and in their nuclear properties.[283]

MEV (million electron volt): A unit of energy commonly used in nuclear physics. Approximately 200 Mev of energy are produced for every nucleus that undergoes *fission*.[284]

REM (roentgen equivalent man): The dose of any ionizing radiation that produces the same biological effect as that produced by one roentgen of high voltage X-radiation. It is a measure of biological damage. One rem equals 1000 millirem (mrem).[285]

Tritium: A radioactive isotope of hydrogen, having a mass of 3 units; it is produced in nuclear reactors by the action of neutrons on lithium nuclei.[286]

Appendix C

Appendix C

THE URANIUM FUEL CHAIN

The production of uranium fuel is highly energy and waste intensive, requiring uranium mining, milling, conversion, enrichment and fabrication. In fact, uranium enrichment has been the largest contributor of wastes to the DOE's materials inventory.[287] Though these fuel operations do not occur in Georgia, several facilities in the southeast do engage in these activities *(see Radioactive Southeast Map)*. Uranium fuel production impacts broad geographic areas of the nation—negatively impacting states such as Utah that do not even have nuclear power plants. The production of energy at the nuclear reactor generates dangerous, highly radioactive, long-lived waste. This "spent" nuclear fuel is a dangerous residue that threatens local communities.

Types of waste created by a one-year operation of a typical 1000 MW nuclear reactor—of comparable size to the nuclear power plants in Georgia—include 179,728 tons of uranium mill tailings, .2 metric tons of plutonium waste, 159 tons of reactor fuels as well as weapons grade plutonium. [288]

Mining of Uranium

Uranium ore has to be mined, like coal, to be used as a fuel source. Uranium is both radioactive and a chemical toxin. Additionally, numerous heavy metals present in uranium ore can have adverse health effects. Many uranium mines in the United States are on Native American lands. Nearly one third of these mines are located within the Navajo nation.[289] The mines have had a negative effect on the quality of life of Native Americans living near the mines.[290] Even though lung cancer was considered rare in Navajo Indians, a report by Dr. Gerald Buker stated, "the risk of lung cancer had increased by a factor of at least 85 percent among Navajo uranium miners."[291]

Uranium mines are found around the globe and both the mining and milling processes disproportionately affect indigenous populations. Africa has long served as a source of uranium for the nuclear industry. Describing an observation during a visit to a French-run uranium mine in the early 1980s, a BBC commentary described the injustice and abuse perpetrated at mines as, "Some of the poorest people on earth labor in one of the deadliest environments to power the electric train sets and fuel the bombs of the world's richest nations."[292]

Milling of Uranium

Milling consists of chemically separating uranium from other ore components. A thousand tons of ore must be processed to get just 2 tons of uranium.[293] The waste produced is known as "mill tailings," which are often left near the land surrounding the mine, creating another dangerous legacy of the mining process. For typical uranium concentrations, the tailings contain 85 percent of the radioactivity in the original ore along with toxic chemicals and heavy metals. Furthermore, the volume of mill tailings is enormous and the majority of the radioactive components are extremely long-lived. Unfortunately, a large portion of mill tailings in the United States were "grandfathered" when more protective standards began to be implemented in the late 1970s, leaving behind more than 100 million tons of uranium waste with limited regulatory oversight.[294]

The mill tailings can infiltrate surrounding waterways. In 1979, near Churchrock, New Mexico, a United Nuclear uranium mill tailings dam broke, dumping nearly 100 million gallons of liquid radioactive tailings and 1000 tons of solid tailings into a surrounding area, spreading nearly 60 miles from the facility. The Rio Puerco River was contaminated and the local Native American tribe was devastated since their water source was forever rendered toxic by the tailings.[295]

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Conversion & Enrichment

After the uranium ore is milled, it is converted to uranium hexafluoride at Honeywell International, Inc. (formerly Allied Signal, Inc.[296]) in Metropolis, Illinois.[297] It is then further enriched at Paducah, Kentucky through a chemical process known as gaseous diffusion. Enrichment is required to increase the percentage of Uranium-235, the isotope of uranium needed for nuclear power or nuclear weapons. In natural uranium, U-235 concentration is too low, even after milling and conversion. The end results of gaseous diffusion are called a) the "product," in which the percentage of U-235 has been increased and b) the "tails," which is predominantly U-238, also known as depleted uranium, in which the percentage of U-235 has been decreased.[298] Uranium enrichment has been the largest contributor of wastes to the DOE's materials inventory.[299]

Union Carbide operated two of the three U.S. conversion and uranium enrichment plants, at Paducah, Kentucky and at Oak Ridge, Tennessee. The Goodyear Atomic Corporation, a subsidiary of the Bechtel Company, originally ran the third plant, at the Portsmouth facility in Ohio.[300] In the early 1990s, the U.S. Enrichment Corporation (USEC), a wholly owned government company, was formed to operate the nation's enrichment plants. On July 28, 1998, USEC, Inc. was privatized, resulting in one of the largest privatizations of a federal government enterprise in American history and making the company the leading global marketer and producer of uranium enrichment services.[301]

Different end uses require different degrees of enrichment. Some enriched uranium can be used for commercial nuclear power plants while some nuclear weapons needs, or naval and research reactors, require further enrichment. Several by products are created. Depleted uranium (DU), for example, which is produced at a larger ratio than the desired enriched uranium, is a heavy metal poison and is radioactive.[302] Depleted uranium is frequently used in armor piercing munitions.

Gaseous diffusion plants, such as Paducah, require an enormous amount of electricity produced largely from coal-fired power plants in the areas surrounding the plant along with large amounts of cooling water for the processing equipment.[303] In order to support the United States' defense effort, the Atomic Energy Commission needed to construct a uranium enrichment plant. Since the Portsmouth plant required electricity amounts that were not available so the Ohio Valley Electric Corporation (OVEC) and its subsidiary, Indiana Kentucky Electric Corporation (IKEC), were organized in 1952 by

Uranium enrichment has been the largest contributor of wastes to the DOE's materials inventory.[299]

fifteen investor-owned utilities in the region. In 1955 two coal-fired power plants, Kyger Creek in Ohio (OVEC's) and Clifty Creek in Madison, Indiana (IKEC's) were built and began supplying electricity to the Portsmouth plant.[304] In 1998, energy sold to the Department of Energy for use by USEC was 9.2 billion kilowatt hours (kWh) with costs of over $180 million.[305] These two old coal plants were also extremely polluting. According to the Environmental Protection Agency, in 1998 Clifty Creek emitted over 9 million tons of carbon dioxide, a greenhouse gas associated with global warming.[306] Additionally, in 1999 both plants rated in the top 100 for coal plants emitting hazardous air pollutants such as mercury, nitrogen oxides, and sulfur dioxides.[307]

During the gaseous diffusion process, though the uranium hexafluoride gas produced is highly corrosive and radioactive, the safety precautions around these facilities were questionable at best. Drums full of trichloroethylene-contaminated uranium along with large amounts of other uranium wastes were buried on site at Paducah, with most of the drum contents having leaked away by 1984, and large releases of uranium to surface waters also occurred.[308]

Portsmouth originally produced highly enriched uranium for naval nuclear reactors and nuclear weapons and now provides enrichment only for commercial nuclear power. It is also a federal Superfund site as the aquifer beneath it is contaminated. Department of Energy estimates for clean up were approximately $163 million.[309]

Eventually, the resulting enriched uranium is converted into a metallic form and then made into tiny pellets. This is done at seven uranium fuel fabrication facilities in the country, with six located in the Southeast, such as Nuclear Fuel Services, Inc. in Erwin, TN, Westinghouse Electric Company, LLC (formerly a Division of CBS) in Columbia, SC, and Global Nuclear Fuel Americas, LLC (formerly GE Company Nuclear Energy Production) in Wilmington, NC.[310] These pellets are stacked end-to-end like tiny poker chips and encased with a zirconium/aluminum cladding known as Zircalloy in approximately twelve-foot long fuel rods that look like very long pencils. These fuel rods are then shipped to reactors and inserted into the reactor core in groups known as "assemblies" or "bundles," approximately 60 per assembly. The reactor cores contain thousands of fuel rods in a large nuclear reactor.[311]

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