S. HRG. 107–666

PRICE-ANDERSON ACT REAUTHORIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, INFRASTRUCTURE, AND NUCLEAR SAFETY

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

ON

JANUARY 23, 2002

Printed for the use of the Committee on Environment and Public Works

U.S. GOVERNMENT PRINTING OFFICE

81–721 PDF WASHINGTON : 2003

For sale by the Superintendent of Documents, U.S. Government Printing Office
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ONE HUNDRED SEVENTH CONGRESS
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C O N T E N T S

PRICE–ANDERSON ACT REAUTHORIZATION

WEDNESDAY, JANUARY 23, 2002

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON TRANSPORTATION, INFRASTRUCTURE AND NUCLEAR SAFETY,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:08 a.m. in Room 406, Dirksen Senate Building, Hon. Harry Reid [chairman of the subcommittee] presiding.

Present: Senators Reid, Jeffords, Inhofe and Voinovich.

OPENING STATEMENT OF HON. JAMES M. JEFFORDS, U.S. SENATOR FROM THE STATE OF VERMONT

Senator JEFFORDS [assuming the chair]. The committee will come to order.

Senator Reid is on his way from the White House and will be here shortly. I will give my statement so we can have that out of the way while we await his arrival.

I am pleased to be here this morning to hear testimony regarding reauthorization of the Price-Anderson provisions of the Atomic Energy Act. My good friend, Senator Reid, who is the subcommittee chair, has called this hearing and as I said, he will be slightly delayed.

Price-Anderson was enacted in 1957 as an amendment to the Atomic Energy Act. Its purpose was to ensure that adequate funds would be available to compensate victims of nuclear accidents and to remove the threat of unlimited liability that would deter private companies from engaging in nuclear activities.

Price-Anderson is due to expire August 1, 2002. However, existing Price-Anderson coverage for already licensed power plants will not expire since under the law existing power plants are covered for the lifetime of the facility. The Price-Anderson coverage we are talking about is that which will apply to any new facilities licensed after August.

Nuclear power supplies are a very important part of our energy mix. In Vermont, nuclear power from the Vermont Yankee plant provides almost 30 percent of our electricity as well as providing electricity to other New England States. Nationwide, nuclear power produces 20 percent of the electricity used. As an emissions free energy source, it has many benefits.

However, nuclear energy is also burdened with serious concerns over waste disposal and safety. Price-Anderson acts as a means of encouraging the development of nuclear power and also sets a

framework for providing financial coverage in the event of an accident at any of our Nation's nuclear power facilities. Price-Anderson provides several important public benefits including simplifying claims in the event of an accident and providing for immediate reimbursement in the case of an emergency.

There are, nonetheless, a number of very legitimate questions about the appropriateness and the adequacy of this legislation. For example, how do we best ensure that companies have sufficient financial resources to pay the deferred premiums which are not due until an accident occurs but which form the bulk of the coverage amounts? Also, while the approximately $9 billion coverage per nuclear accident that Price-Anderson would supply is high in terms of insurance coverage, is it sufficient to cover the actual public and private costs of a catastrophic nuclear accident?

Price-Anderson was initially contemplated as temporary coverage to help a fledgling industry. Should that coverage now be extended indefinitely as some would suggest? Does this kind of insulation from liability with the Federal Government bearing responsibility for anything above the $9 billion per accident coverage unfairly benefit the nuclear industry over all desirable energy forms such as wind and solar? Is existing Price-Anderson coverage sufficient to cover terrorist acts?

These are all very important issues and I thank today's witnesses for sharing their time and expertise with the committee and I look forward to their testimony.

Our first witness will be Mr. William Kane, Deputy Executive Director for Reactor Programs, U.S. Nuclear Regulatory Commission, testifying on behalf of the Administration. Mr. Kane, please proceed.

Senator INHOFE. I think it would be more appropriate to do our opening statements and wait for the chairman to arrive.

Senator JEFFORDS. Yes, please do.

OPENING STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. Thank you, Mr. Chairman.

Last September when I added the energy bill that passed the House, H.R. 4, as an amendment to the Defense Authorization bill, a lot of people started screaming and got quite upset. I was trying to make the point that our reliance upon foreign sources for our abilities to run a Nation, to fight a war, is a national security issue, not an energy issue. This is not a new concept with me because starting back in the 1980s when Don Hodell was the Secretary of Interior and then later Secretary of Energy, we went around at that time and said why it is so critical for the United States to get in a position where we are not dependent upon foreign sources for our ability to fight a war. At that time, we were 37 percent dependent upon foreign sources. Today, it is 57 percent. So times have changed and it has gotten worse.

I think we now realize we have to have the broadest possible based energy policy and that has to include nuclear, oil, gas, coal, sun, wind, conservation itself among others as a means of making these resources more available.

Currently, the 106 U.S. nuclear units supply about 20 percent of the electricity produced in the United States. Going forward into the future, nuclear energy must be a key component to any national energy policy and the first step would be to reauthorize Price-Anderson.

I would like to insert at this point in the record, the National Energy Policy Development Group's findings and key recommendations concerning nuclear energy.

Senator JEFFORDS. Without objection.

[The referenced document follows:]

CHAPTER ONE

Taking Stock

Energy Challenges Facing the United States

America's current energy challenges can be met with rapidly improving technology, dedicated leadership, and a comprehensive approach to our energy needs. Our challenge is clear—we must use technology to reduce demand for energy, repair and maintain our energy infrastructure, and increase energy supply. Today, the United States remains the world's undisputed technological leader; but recent events have demonstrated that we have yet to integrate 21st-century technology into an energy plan that is focused on wise energy use, production, efficiency, and conservation.

Prices today for gasoline, heating oil, and natural gas are dramatically higher than they were only a year ago. In California, homeowners, farmers, and businesses face soaring electricity prices, rolling blackouts, increasing financial turmoil, and an uncertain energy future. Our nation's dependence on foreign sources of oil is at an all-time high and is expected to grow. Current high energy prices and supply shortages are hurting U.S. consumers and businesses, as well as their prospects for continued economic growth.

Our national energy policy must be comprehensive in scope. It must protect our environment. It must also increase our supply of domestic oil, natural gas, coal, nuclear, and renewable energy sources. Our failure over the past several years to modernize our energy infrastructure—the network of transmission lines, gas pipelines, and oil refineries that transports our energy to consumers and converts raw materials into usable fuels—is a result of the lack of careful planning and lack of a comprehensive national energy plan. The United States faces serious energy challenges: electricity shortages and disruptions in California and elsewhere in the West, dramatic increases in gasoline prices due to record-low inventories, a strained supply system, and continued dependence on foreign suppliers. These challenges have developed from years of neglect and can only be addressed with the implementation of sound policy. There are no easy, short-term solutions.

Our increased dependence on foreign oil profoundly illustrates our nation's failure to establish an effective energy policy. Between 1991 and 2000, Americans used 17 percent more energy than in the previous decade, while during that same period, domestic energy production rose by only 2.3 percent. While U.S. production of coal, natural gas, nuclear energy, and renewable energy has increased somewhat in recent years, these increases have been largely offset by declines in domestic oil production. As a result, America has met almost all of its increased energy demand over the past ten years with increased imports.

U.S. energy consumption is projected to increase by about 32 percent by 2020. Unless a comprehensive national energy policy is adopted, Americans will continue to feel the effects of an inadequate electrical transmission grid, a pipeline system stretched to capacity, insufficient domestic energy supply, and a regional imbalance in supply sources. It is important that we meet these challenges with a comprehensive energy plan that takes a long-term approach to meeting our energy needs.

The U.S. economy depends on reliable and affordable energy. In the coming months, we face several serious long-term energy challenges: electricity shortages and disruptions in California and the West, dramatic increases in gasoline prices due to record-low inventories, a strained supply system, and continued dependence on foreign suppliers.

PHILADELPHIA CONVENTION & VISITORS BUREAU

California's Energy Challenge

Recent and looming electricity blackouts in California demonstrate the problem of neglecting energy supply. They also foretell the consequences of failing to implement a long-term energy plan for our nation as a whole. Though weather conditions and design flaws in California's electricity restructuring plan contributed, the California electricity crisis is at heart a supply crisis.

Since 1995, California's peak summer demand for electricity has risen by at least 5,500 megawatts (MW), while in-state generation has failed to keep pace. California's generation shortfall did not stem from a lack of interest in building capacity. Since 1997, power producers filed applications to build an additional 14,000 MW of new capacity in California.

In addition to a lack of new generation, a crucial transmission bottleneck in the middle of the state—called Path 15—prevents power in the south from being shipped to the north during emergencies.

This year, reduced hydropower availability due to low rainfall, higher than expected unplanned plant outages, and the financial problems of California's utilities exacerbated this growing supply–demand imbalance. As a result, California's supply problem turned into a crisis, resulting in soaring electricity bills for homes and businesses and rolling blackouts.

In part due to the interconnected nature of the western electricity grid, California's critical electricity shortages have helped to drive up electricity costs in the West.

Unfortunately, there are no short-term solutions to long-term neglect. It can take new power plants and transmission facilities years to site, permit, and construct. Despite expedited federal permitting, California's emergency efforts to increase new generation by 5,000 MW by July appear to be falling short. Less than 2,000 MW of new generation is expected to be in place by summer. Even with aggressive conservation measures, peak demand this summer is projected to outstrip supply by several thousand megawatts. The California grid operator expects more than 30 days of blackouts.

California officials have warned that the crisis may last several years. Though California's efforts to increase generation may not suffice to prevent blackouts this summer, if continued and strengthened, they promise to limit the duration of the crisis.

Recommendations:

★ The National Energy Policy Development (NEPD) Group recommends that the President issue an Executive Order to direct all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on (1) the energy impact of the proposed action, (2) any adverse energy effects that cannot be avoided should the proposal be implemented, and (3) alternatives to the proposed action. The agencies would be directed to include this statement in all submissions to the Office of Management and Budget of proposed regulations covered by Executive Order 12866, as well as in all notices of proposed regulations published in the Federal Register.

★ The NEPD Group recommends that the President direct the executive agencies to work closely with Congress to implement the legislative components of a national energy policy.

Conservation and Energy Efficiency

Conservation and energy efficiency are crucial components of a national energy plan. Energy efficiency is the ability to use less energy to produce the same amount of useful work or services. Conservation is closely related and is simply using less energy. Improved energy efficiency and conservation reduces energy consumption and energy costs, while maintaining equivalent service in our homes, offices, factories, and automobiles. Greater energy

efficiency helps the United States reduce energy imports, the likelihood of energy shortages, emissions, and the volatility of energy prices.

Over the last three decades, the United States has significantly improved its energy efficiency by developing and expanding the use of energy efficient technologies. Although our economy has grown by 126 percent since 1973, our energy use has increased by only 30 percent. Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus.

About a third to a half of these savings resulted from shifts in the economy, such as the growth of the service sector. The other half to two-thirds resulted from greater energy efficiency. Technological improvements in energy efficiency allow consumers to enjoy more energy services without commensurate increases in energy demand. The rate at which these efficiency improvements are made varies over time, depending on the extent to which factors—such as energy policies, research and development, prices, and market regulations—encourage the development of new, efficient products and consumer investment in these products. An increased rate of improvement in energy efficiency can have a large impact on energy supply and infrastructure needs, reducing the need for new power plants and other energy resources, along with reduced stress on the energy supply infrastructure.

Load management is the ability to adjust energy loads to reflect immediate supply conditions. In the very short term, direct appeals for conservation can ease strained energy supply markets for a time. Over the longer run, the ability to adjust demand on an as-needed basis can be an important source of energy reserves, resulting in lower energy bills for participating customers.

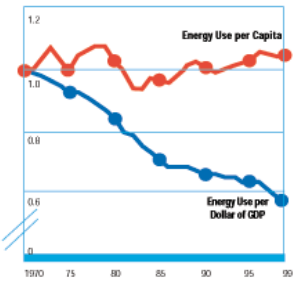
The impact that improvements in energy efficiency can have on energy supply markets grows over time. Electricity demand is projected to rise by 1.8 percent a year over the next 20 years, requiring the addition of some 393,000 MW of generation capacity. At the same time, energy efficiency is projected to continue to improve between 2000 and 2020. A decrease in demand from 1.8 percent to 1.5 percent would reduce the need for new generating capacity next year by about 2,000 MW. Extending that reduction over the next 20 years would reduce the need for new generation by 60,000 to 66,000 MW.

While this projection shows that conservation can help ensure the United States has adequate energy supplies for the future, it also shows that conservation alone is not the answer. Even with more conservation, the U.S. will need more energy supplies. Today, new technologies offer new opportunities to enhance our energy efficiency. As these technologies gain market acceptance, they will help ensure a reliable and affordable energy and electric power supply for the nation.

Energy Intensity

The energy intensity of the U.S. economy is measured by the amount of energy used to produce a dollar's worth of gross domestic product (GDP). It now takes only about 56 percent of the energy required in 1970 to produce a

Figure 1-1
U.S. Energy Use per Capita and per Dollar of GDP: 1970–1999
(Index: 1970 = 1)



The energy intensity of the U.S. economy is measured by the amount of energy used to produce a dollar's worth of gross domestic product (GDP). By that yardstick, U.S. energy intensity declined significantly between 1970 and 1985, and has continued to decline, albeit at a slower rate.

Source: U.S. Department of Energy, Energy Information Administration.

Measures of Electrical Power

A watt is a measure of the amount of energy that can be produced during a specific period of time.

1 kilowatt (KW)= 1,000 watts
1 megawatt (MW)=1million watts
1 gigawatt (GW)=1 billion watts
1 terawatt (TW)=1 trillion watts

U.S. Energy Efficiency Is Improving

- New home refrigerators now use about one-third less energy than they did in 1972.
- New commercial fluorescent lighting systems use less than half the energy they did during the 1980s.
- Federal buildings now use about 20 percent less energy per square foot since 1985.
- Industrial energy use per unit of output declined by 25 percent from 1980 to 1999.
- The chemical industry's energy use per unit of output has declined by roughly 40 percent in the past 25 years.
- The U.S. government has reduced its energy use in buildings by over 20 percent since 1985.
- The amount of energy required to generate 1 kilowatt-hour of electricity has declined by 10 percent since 1980.

What Causes Transmission Constraints?

When additional electricity flow from one area exceeds a circuit's capacity to carry that flow to another area, the overloaded circuit becomes congested and blocks a steady flow of power. To prevent transmission bottlenecks, system operators curtail transactions between areas or increase generation on the side of the constraint where the electricity is flowing and reduce generation on the opposite side. Transmission constraints result in price differences between regions that exceed differences due to line losses, because electricity can no longer flow freely to the affected area.

dollar of GDP today (Figure 1-1). This reduction is attributable to improved energy efficiency, as well as to structural changes in the economy, particularly the relative decline of energy-intensive industries.

The decline in the nation's energy intensity accelerated between 1999 and 2000, a period when nonenergy-intensive industries experienced rapid growth. Energy intensity is projected to continue to decline through 2020 at an average rate of 1.6 percent a year. This is a slower rate of decline than experienced in the 1970s and early 1980s, which was characterized by high energy prices and a shift to less energy-intensive industries, but is a more rapid rate of decline than experienced on average during the latter part of the 1980s and the 1990s.

Challenges Confronting Electricity Supply

Our nation's electricity supply has failed to keep pace with growing demand. This imbalance is projected to persist into the future. The adverse consequences have manifested themselves most severely in the West, where supply shortages have led to high prices and even blackouts. In other regions, inadequate supply threatens the reliability and affordability of electric power.

Large amounts of new generating capacity are slated for installation around the country from 2001 to 2004. However, there is a geographic mismatch between where we will generate energy and where it is needed. For example, little capacity is being added where it is most needed, such as in California and eastern New York.

A pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand.

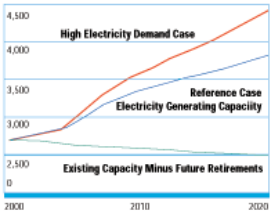
Electricity supply conditions in the Southeast are expected to be tight in the summer of 2001, much as they have been the previous two years. The Northeast may also face supply shortages. If the temperatures of the summer of 2000 had been normal rather than unseasonably cool, New York and New England would most likely have experienced electricity supply shortfalls and price spikes. Critical supply problems could arise if the weather in the summer of 2001 is unusually warm or if plant outages rise above average levels.

Our nation's most pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand. Across the country, we are seeing the same signs that California faced in the mid-1990s: significant economic regulatory uncertainty, which can result in inadequate supply. This level of uncertainty can vary across the country, depending on state and local regulations. Of the approximately 43,000 MW of new generating capacity that power companies planned in 1994 for construction from 1995 to 1999, only about 18,000 MW were actually built. Although plans have been announced to build more capacity than the country will need over the next five to seven years, this new construction assumes market and regulatory conditions that are not yet assured. Over the next twenty years, the United States will need 1,300 to 1,900 new power plants, which is the equivalent of 60 to 90 new power plants a year (Figure 1-2).

But even with adequate generating capacity, we do not have the infrastructure to ensure reliable supply of electricity. Investment in new transmission capacity has failed to keep pace with growth in demand and with changes in the industry's structure. Since 1989, electricity sales to consumers have increased by 2.1 percent annually, yet transmission capacity has increased by only 0.8 percent annually. As electricity markets become more regional, transmission constraints are impeding the movement of electricity both within and between regions.

The price spikes in the Midwest in the summer of 1998 were in part caused by trans-

Figure 1-2
The U.S. Needs More Power Plants



The nation is going to require significant new generation capacity in the next two decades. Depending on demand, the United States will need to build between 1,300 and 1,900 new power plants—or about one new power plant a week.

Source: U.S. Department of Energy, Energy Information Administration.

mission constraints, which limited the region's ability to import electricity from other regions at a time of high demand. Transmission bottlenecks contributed to the blackouts in California over the past year, and have been a persistent cause of price spikes in New York City during peak demand. Constraints on New England's ability to import low-cost power from Canada could raise electricity prices during periods of high demand.

Electricity is a secondary source of energy, generated through the consumption of primary sources (Figure 1-3). The largest source of U.S. electricity generation is coal, followed by nuclear energy, natural gas, hydropower, oil, and non-hydropower renewable energy.

Coal

Coal is America's most abundant fuel source. The United States has a 250-year supply of coal. Over 1 billion tons of coal were produced in 25 states in 2000. About 99.7 percent of U.S. coal production is consumed domestically, with electricity generation accounting for about 90 percent of coal consumption.

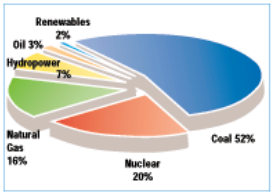
After peaking in 1982, coal prices have generally declined. This trend is projected to continue through 2020, reflecting an expanding shift into lower-cost western coal production and substantial increases in productivity. While coal is expected to remain the dominant fuel in meeting increasing U.S. electricity demand through 2020, energy policy goals must be carefully integrated with environmental policy goals. The Clean Air Act Amendments of 1990 and related state regulations require electricity generators to reduce emissions of sulfur dioxide and nitrogen oxide.

Nuclear Energy

Nuclear energy is the second-largest source (20 percent) of U.S. electricity generation. Nuclear power is used exclusively to generate electricity. Nuclear power has none of the emissions associated with coal and gas power plants, including nitrogen oxides, sulfur dioxide, mercury and carbon dioxide. Costs of electricity generation by nuclear plants compare favorably with the costs of generation by other sources.

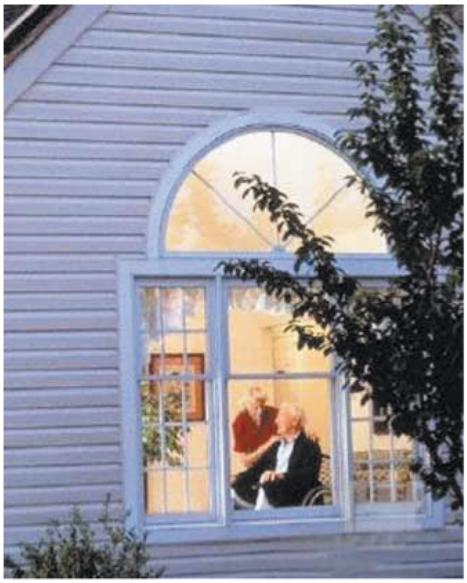
While the number of nuclear plants has declined due to retirements, nuclear electricity generation has steadily increased in recent years. Several factors have created a more favorable environment for nuclear energy: safe, standardized plant designs; an improved licensing process; effective safety oversight by the Nuclear Regulatory Commission (NRC); the advent of new technologies; and uncertain, volatile natural gas prices. This more favorable environment has resulted in increased re-licensing of nuclear plants and the consolidation of several plants in the hands of fewer, more experienced operators.

Figure 1-3
Fuel Sources for Electricity Generation in 2000



Electricity is a secondary source of energy, generated through the consumption of primary sources. Coal and nuclear energy account for over 70 percent of U.S. electricity generation.

Source: U.S. Department of Energy, Energy Information Administration.



Many Americans received high heating bills this winter as a result of sharp increases in natural gas prices.

The nuclear industry is closely regulated by the NRC, which provides oversight of the operation and maintenance of these plants. This oversight includes a comprehensive inspection program that focuses on the most significant potential risks of plant operations, and features full-time resident inspectors at each plant, as well as regional inspectors with specialized expertise. In addition to rigorous inspection criteria, the installation of new design features, improvements in operating experience, nuclear safety research, and operator training have all contributed to the nuclear industry's strong safety record.

An important challenge to the use of nuclear energy is the issue of safe and timely long-term storage of spent nuclear fuel and high- and low-level radioactive waste. Currently, no plans exist to construct any new nuclear plants. However, due to more favorable conditions, the decline in nuclear energy generation has not been as rapid as was predicted only a few years ago, as evidenced by increased re-licensing.

Natural Gas

Natural gas is the third-largest source of U.S. electricity generation, accounting for 16 percent of generation in 2000. Under existing policy, natural gas generating capacity is expected to constitute about 90 percent of the projected increase in electricity generation between 1999 and 2020. Electricity generated by natural gas is expected to grow to 33 percent in 2020—a growth driven by electricity restructuring and the economics of natural gas power plants. Lower capital costs, shorter construction lead times, higher efficiencies, and lower emissions give gas an advantage over coal and other fuels for new generation in most regions of the country.

However, natural gas is not just an electricity source. It is used in many different ways, including as vehicle fuel, as industrial fuel, and in our homes. In addition, natural gas is used as a feedstock during the manufacturing process of such products as chemicals, rubber, apparel, furniture, paper, clay, glass, and other petroleum and coal products. Overall, natural gas accounts for 24 percent of total U.S. energy consumed and for all purposes 27 percent of domestic energy produced.

Eighty-five percent of total U.S. natural gas consumption is produced domestically. The import share of consumption rose from 5 percent in 1987 to 15 percent in 2000, and net imports have comprised more than 50 percent of the growth in gas demand since 1990. Canada, with very large gas supplies and easy pipeline access to the lower 48 states, accounts for nearly all U.S. natural gas imports. Unlike oil, almost all natural gas is produced and sold within the same region. Therefore, prices are determined by regional, rather than global, markets.

In 2000, natural gas prices moved

sharply higher after fifteen years of generally flat prices. Futures prices surged by 320 percent in 2000 to an all-time high of $9.98 per million Btus in late December 2000—nearly five times higher than the $2.05 per million Btu average from 1991 to 1999. While prices have declined since the beginning of 2001, they remain much higher than recent levels.

Between 2000 and 2020, U.S. natural gas demand is projected by the Energy Information Administration to increse by more than 50 percent, from 22.8 to 34.7 trillion cubic feet. Others, such as Cambridge Energy Research Associates, expect gas consumption to increase by about 37 percent over that period. Growth is projected in all sectors—industrial, commercial, residential, transportation, and electric generation. More than half of the increase in overall gas consumption will result from rising demand for electricity generation.

Although high natural gas prices have negative effects on consumers, businesses, industries, and the economy as a whole, they also promote more rapid development and adoption of new energy efficient technologies, investment in distribution systems, and greater investment in exploration and development. Although these market responses do not occur rapidly enough to prevent near-term price spikes, over time, they help to hold down prices.

As a result of the sharp increase in natural gas prices, many consumers received historically high utility bills this winter. The price spike has had a particularly severe impact on low-income consumers who use natural gas for heating. In recent months, 5 million consumers have applied for federal and state assistance to pay their heating bills—an increase of 1 million consumers over last year.

The projected rise in domestic natural gas production—from 19.3 trillion cubic feet in 2000 to 29.0 trillion cubic feet in 2020—may not be high enough to meet projected demand. In the near term, incremental production of natural gas is expected to come primarily from unconventional sources in the Rocky Mountain, Gulf Coast, and mid-continent regions; the North Slope of Alaska; and the offshore Gulf of Mexico. Onshore federal lands currently contribute about 10 percent of U.S. production, and federal offshore production contributes about 26 percent.

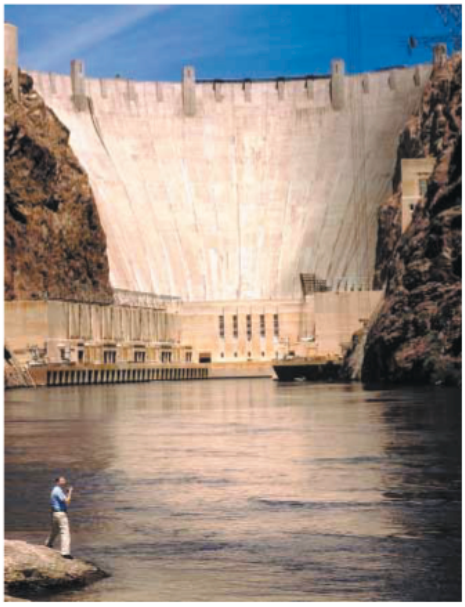
The most significant long-term challenge relating to natural gas is whether adequate supplies can be provided to meet sharply increased projected demand at reasonable prices. If supplies are not adequate, the high natural gas prices experienced over the past year could become a continuing problem, with consequent impacts on electricity prices, home heating bills, and the cost of industrial production. These concerns will redouble if policy decisions sharply reduce electricity generation by any other source, since it is doubtful that natural gas electricity generation could expand to the extent necessary to compensate for that loss of generation.

To meet this long-term challenge, the United States not only needs to boost production, but also must ensure that the natural gas pipeline network is expanded to the extent necessary. For example, although natural gas electricity generation in New England is projected to increase by 16,000 MW through 2000, bottlenecks may block the transmission of necessary supplies. Unless pipeline constraints are eliminated, they will contribute to supply shortages and high prices, and will impede growth in electricity generation.

Hydropower

Hydropower is the fourth-largest source of U.S. electricity generation, accounting for about 7 percent of total generation in 2000. In some regions of the country, such as the Northwest and New York, hydropower makes a much bigger contribution to electricity generation. Although the United States is second only to Canada in hydropower generation, hydropower generation has remained relatively flat in the United States for years.

Hydropower has significant environmental benefits. It is a form of low-cost electricity generation that produces no emissions, and it will continue to be an important source of U.S. energy for the future. Given the potential impacts on fish and wildlife, however, it is important to ef-



Hydropower is the fourth-largest source of U.S. electricity generation. The most significant challenge confronting this source of energy is regulatory uncertainty regarding the federal licensing process.

ficiently and effectively integrate national interests in both natural resource preservation and environmental protection with energy needs.

There are two categories of hydropower projects in the United States: (1) those operated by federal electric utilities, such as the federal power marketing administrations (Bonneville, Western, Southwestern, and Southeastern); and (2) the approximately 2,600 non-federal hydropower dams licensed or exempted by the Federal Energy Regulatory Commission (FERC). The federal utilities have large hydropower systems operated by the Bureau of Reclamation and Army Corps of Engineers, and play an important role meeting electricity demand, especially in the Northwest and the West. Hydropower projects operate with multiple purposes, such as electricity generation, flood control, navigation, and irrigation.

Although most potential for hydropower has already been developed, there is some undeveloped hydropower capacity in the United States. Much of this capacity could be expanded without constructing a new dam.

The most significant challenge confronting hydropower is regulatory uncertainty regarding the federal licensing process. The process is long and burdensome, and decision-making authority is spread across a range of federal and state agencies charged with promoting different public policy goals. Reforms can improve the hydropower licensing process, ensuring better public participation, ensuring that effective fish and wildlife conditions are adopted, and providing interagency resolution before conflicting mandatory license conditions are presented. The licensing process needs both administrative and legislative reforms. In addition, FERC should be encouraged to adopt appropriate deadlines for its own actions during the process.

Oil

Oil accounts for approximately 3 percent of electricity generation. Oil is used as a primary source to fire electricity generation plants in some regions. Specifically, oil is an important source of electricity in Hawaii, Florida, and some northeastern states. Oil can also be used an additional source of fuel for electricity generation in plants that can use either natural gas or oil. However, electricity generation from oil is projected to decline to about one-half of one percent of total electricity generation by 2020.

Renewable Energy: A Growing Resource

Renewable energy technologies tap natural flows of energy—such as water, wind, solar, geological, and biomass sources—to produce electricity, fuels, and heat. Non-hydropower renewable electricity generation is projected to grow at a faster rate

than all other generation sources, except natural gas. These sources of energy are continuously renewable, can be very clean, are domestically produced, and can generate income for farmers, landowners, and others. Although its production costs generally remain higher than other sources, renewable energy has not experienced the price volatility of other energy resources.

Non-hydropower renewable energy sources currently account for only about 4 percent of total energy consumption and 2 percent of total electricity generation. The sources of non-hydropower renewable electricity generation are biomass (the direct combustion of plant matter and organic residues, such as municipal solid waste use); geothermal (use of naturally occurring steam and hot water); wind; and solar. Biomass and geothermal account for most renewable electricity generation.

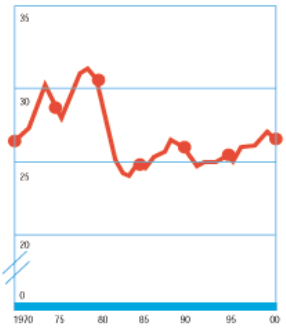
The most important long-term challenge facing renewable energy remains economic. Renewable energy costs are often greater than those of other energy sources. However, these costs have declined sharply in recent years, due to improved technology. If this trend continues, renewable energy growth will accelerate. By 2020, non-hydropower renewable energy is expected to account for 2.8 percent of total electricity generation.

Transportation Energy Needs

Oil is the nation's largest source of primary energy, serving almost 40 percent of U.S. energy needs. In 2000, the United States consumed an average of 19.5 million barrels of oil every day. Transportation fuels account for about two-thirds of our oil consumption, and the industrial sector for 25 percent. Residential and commercial uses, such as heating oil and propane—important fuels in the Northeast and Midwest—account for most of the rest.

The share of oil in U.S. energy supply has declined since the early 1970s, the result of growth in other fuels, particularly coal and nuclear. Per capita oil consumption, which reached a peak in 1978, has fallen by 20 percent from that level (Figure 1-4).

Figure 1-4
U.S. Per Capita Oil Consumption: 1970–2000

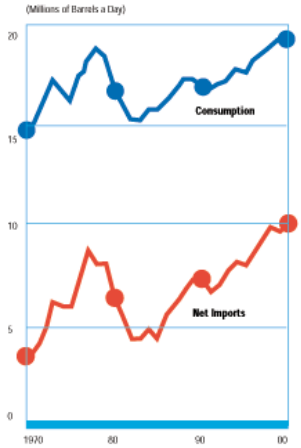


Per capita oil consumption reached a peak in 1978 of 31 barrels. It has fallen by 20 percent since then to 26 barrels per capita.

Source: U.S. Department of Energy, Energy Information Administration

Renewable energy technologies tap natural flows of energy to produce electricity, fuels, and heat.
U.S. Department of Energy, National Renewable Energy Laboratory

Figure 1-5
Dependence on Foreign Sources of Oil



U.S. dependence on oil imports is a serious long-term challenge. The economic security of our nation and our trading partners will remain closely tied to global oil market developments.

Source: U.S. Department of Energy, Energy Information Administration.

In 2020, oil is projected to account for roughly the same share of U.S. energy consumption as it does today.

The United States has been a net importer of energy since the 1950s, and U.S. dependence on imports has grown sharply since 1985 (Figure 1-5). Today, oil accounts for 89 percent of net U.S. energy imports. Net oil imports account for most of the rise in energy imports since the mid-1980s, and have grown from about 4.3 million barrels per day (bpd) in 1985 to 10 million bpd in 2000.

World oil prices have been marked by notable price volatility over the past several years. For example, the average initial purchase price of crude oil rose from $8.03 a barrel in December 1998 to $30.30 a barrel in November 2000. Spot prices rose even higher. This dramatic price swing was the product of several events. A series of production cuts by the Organization of Petroleum Exporting Countries (OPEC) in 1998 and 1999 sharply curtailed global oil supplies. At the same time, rebounding demand for oil in Asia following roughly two years of economic weakness, and rapid economic growth in the United States boosted oil consumption and squeezed supplies even further. By September 2000, oil prices peaked as markets faced limited supply of crude and petroleum products

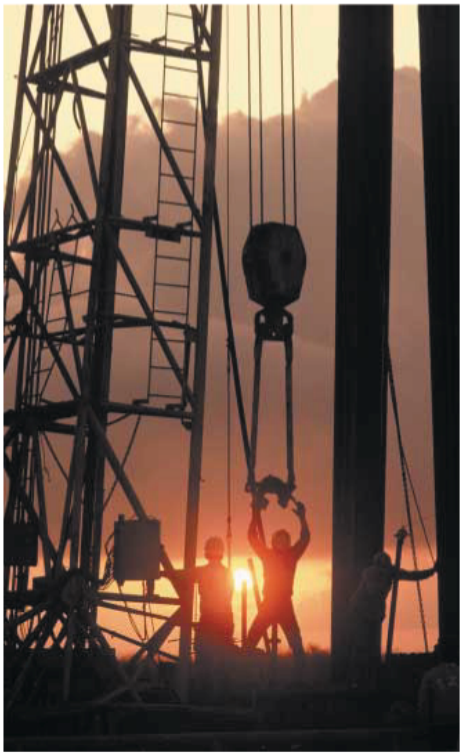
U.S. Department of Transportation

Domestic oil supply cannot be increased unless several access and infrastructure challenges are addressed. For example, U.S. refining and pipeline capacity has not kept pace with increasing demand for petroleum products.

ahead of the winter season, when demand is typically higher. In December 2000, oil prices fell after the market absorbed the impact of a series of OPEC production increases.

This recent price volatility illustrates the effect of intermittent market power exerted by cartel behavior in a global petroleum market. Moreover, prices are set in a market where supply is geographically concentrated. Almost two-thirds of world proven reserves are in the Middle East. Elsewhere, Central and South America account for 9 percent; Africa, 7 percent; North America, 5 percent; Eastern Europe and the former Soviet Union, 5 percent; the rest of Asia, 4 percent; and Western Europe, 2 percent. OPEC's huge oil reserves and production capacity and its periodic efforts to influence prices add to volatility in the market.

Oil prices are expected to remain high through 2002, affecting the cost of transportation, heating, electricity generation, and industrial production. High oil prices mean high prices for petroleum products, such as gasoline, diesel fuel, heating oil, propane, and jet fuel. The summer 2001 base case average gasoline price from the Department of Energy *Short-Term Energy Outlook* is $1.49 per gallon. However, prices have risen more rapidly than anticipated since the report's release, and a much higher summer average in the range of $1.50 to $1.65 per gallon is likely. Some areas have already experienced gasoline prices above $2.00 per gallon. Gasoline inventories going into the driving season are projected to be lower than last year, which could set the stage for regional supply problems that once again create significant price volatility in gasoline markets.



Because the United States is a mature oil-producing region, production costs are often higher than in foreign countries.

Price Volatility in Gasoline Markets

During the early summer of 2000, low inventories set the stage for a gasoline price run-up in the Midwest. Several pipeline and refinery problems sent marketers scrambling for limited supplies of both reformulated gasoline (RFG) and conventional gasoline, driving prices up rapidly. In Chicago, the spot price for blend stock for RFG, excluding ethanol, doubled in about six weeks, from 83 cents per gallon on April 25 to $1.65 on June 7. Spot prices then fell back over the next five weeks to 84 cents on July 12 as extra supply began arriving. Retail regular-grade RFG prices in the Midwest rose from $1.47 on April 24 to just over $2.00 per gallon on June 19, before falling back to $1.43 by July 24, showing the typical tendency of

retail prices to lag spot price changes.

Refiners face additional challenges as a result of various state and local clean fuel requirements for distinct gasoline blends ("boutique fuels"). These different requirements sometimes make it difficult, if not impossible, to draw on gasoline supplies from nearby areas or states to meet local needs when the normal supply is disrupted.

In 2000, very low inventories of gasoline and other refined products on the U.S. East and Gulf coasts increased the market's susceptibility to external shocks, such as operating problems in refineries or pipelines, or short-term surges in demand. Last winter, heating oil prices were at near-record levels. During 2000, the federal government reduced the vulnerability of the Northeast to heating oil shortages, such as those experienced in January 2000, by creating a 2-million-barrel heating oil reserve in New Jersey and Connecticut.

Because the United States is a mature oil-producing region, production costs are often higher than in foreign countries, particularly OPEC countries. In addition, access to promising domestic oil reserves is limited. U.S. oil production in the lower 48 states reached its peak in 1970 at 9.4 million bpd. A surge in Alaskan North Slope oil production beginning in the late 1970s helped postpone the decline in overall U.S. production, but Alaska's production peaked in 1988 at 2 million bpd, and fell to 1 million bpd by 2000. By then, U.S. total oil output had fallen to 5.8 million bpd, 39 percent below its peak.

By 2020, U.S. oil production is projected to decline from 5.8 to 5.1 million bpd under current policy. However, oil consumption is expected to rise to 25.8 million bpd by 2020, primarily due to growth in consumption of transportation fuels. Given existing law, production from offshore sources, particularly the Gulf of Mexico, is predicted to play an increasingly important role in the future, accounting for a projected high of 40 percent of domestic oil production by 2010, up from 27 percent today. Technological advances can mitigate the decline in U.S. oil production by enhancing recovery from domestic oil reserves and lowering production costs.

Our projected growing dependence on oil imports is a serious long-term challenge. U.S. economic security and that of our trading partners will remain closely tied to global oil market developments. Without a change in current policy, the share of U.S. oil demand met by net imports is projected to increase from 52 percent in 2000 to 64 percent in 2020. By 2020, the oil for nearly two of every three gallons of our gasoline and heating oil could come from foreign countries. The sources of this imported oil have changed considerably over the last thirty years, with more of our imports coming from the Western Hemisphere. Despite progress in diversifying our oil suppliers over the past two decades, the U.S. and global economies remain vulnerable to a major disruption of oil supplies.

The Strategic Petroleum Reserve (SPR), the federal government's major tool for responding to oil supply disruptions, has not kept pace with the growth in imports. The number of days of net oil import protection provided by the Reserve declined from 83 days of imports in 1992 to 54 days of imports today. Net domestic oil imports have increased significantly since 1992, while the SPR's oil inventory actually decreased.

Domestic oil supply cannot be increased unless several access and infrastructure challenges are addressed. U.S. refining and pipeline capacity has not kept pace with increasing demand for petroleum products. Unless changes take place, the net effect will likely be increased imports, regionally tight markets, and circumstances in which prices for gasoline, heating oil, and other products rise independently of oil prices.

Greater price volatility for gasoline, diesel fuel, heating oil, propane, and jet fuel is likely to become a larger problem over time, unless additional refining capacity and expanded distribution infrastructure can be developed at the same time cleaner products are required. Increasing domestic oil production and reducing demand, particularly for transportation fuels, will re-

quire adoption of a comprehensive national energy policy.

Alternative Transportation Fuels

Development of alternative fuels such as ethanol and other biofuels (liquid fuels derived from organic matter, such as crops), natural gas, and electricity, can help diversify the transportation sector that is so reliant on oil.

Ethanol, a biofuel based on starch crops such as corn, is already making a significant contribution to U.S. energy security, displacing more oil than any other alternative fuel. Other biofuels, such as biodiesel, which can be made from soybean, canola oils, animal fats, and vegetable oils, are making an increasingly important contribution

The success of the federal alternative fuels program has been limited, however. The program focuses on mandating that certain fleet operators purchase alternative fueled vehicles. The hope was that this vehicle purchase mandate would lead to expanded use of alternative fuels. That expectation has not been realized, since most fleet operators purchase dual-fueled vehicles that operate on petroleum motor fuels. Reforms to the federal alternative fuels program could promote alternative fuels use, such as expanding the development of an alternative fuels infrastructure.

Summary of Recommendations

Taking Stock: Energy Challenges Facing the United States

★ The NEPD Group recommends that the President issue an Executive Order to direct all federal agencies to include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on: (1) the energy impact of the proposed action, (2) any adverse energy effects that cannot be avoided should the proposal be implemented, and (3) alternatives to the proposed action. The agencies would be directed to include this statement in all submissions to the Office of Management and Budget of proposed regulations covered by Executive Order 12866, as well as in all notices of proposed regulations published in the Federal Register.

★ The NEPD Group recommends that the President direct the executive agencies to work closely with Congress to implement the legislative components of a national energy policy.

★ The NEPD Group recommends to the President that the NEPD Group continue to work and meet on the implementation of the National Energy Policy, and to explore other ways to advance dependable, affordable, and environmentally responsible production and distribution of energy.

Note: All recommendations in this report are subject to execution in accordance with applicable law. Legislation would be sought where needed. Also, any recommendations that involve foreign countries would be executed in accordance with the customs of international relations, including appropriate diplomatic consultation.

Senator INHOFE. I have also noticed attitudes changing. I can remember back when people were marking in protests at various nuclear opportunities they would see and now they realize all of a sudden that each year the U.S. nuclear powerplants prevent 5.1 million tons of sulfur dioxide, 2.4 million tons of nitrogen oxide, and 164 million metric tons of carbon from entering the Earth's atmosphere. Furthermore, as a former insurance executive, I think Price-Anderson as an insurance program is a good deal for the public. For over 45 years, we have seen this provide immediate and substantial private compensation to the public in the event of a nuclear accident, the case in point being Three Mile Island, how well that went in terms of compensation. It provides coverage for pre-

cautionary evacuations and out of pocket expenses, it has reduced delays often inherent in tort cases and I think we all understand that, it has consolidated all cases into a single Federal court.

Price-Anderson's renewal enjoys bipartisan support. This Administration is for it, the past Administration, the Clinton Administration, was supportive of it, the House has already passed it by voice vote, and we need to get something happening here in the Senate so that we can ensure we have that opportunity.

While I understand the chairman and others have concerns about Price-Anderson, I think it is really necessary that we do something and this is a good start, Mr. Chairman. For all the witnesses on the first and second panel, I am hoping you will be thinking about an answer to the question as to what is going to happen if we do not reauthorize Price-Anderson; what is going to happen to our Nation, who is now dependent upon nuclear energy for 20 percent of its energy if we don't have nuclear energy, and I think that would be the result; so I think these questions have to be answered by all the witnesses that come forth. We look forward to those answers.

Senator JEFFORDS. Senator Voinovich?

OPENING STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Senator VOINOVICH. Mr. Chairman, I am pleased we are having this hearing today on the reauthorization of the Price-Anderson legislation. As you know, I have introduced the bill to reauthorize Price-Anderson, Senate 1360, and that bill is cosponsored by Senators Smith and Inhofe, the Ranking Members of both the full and subcommittee. I really appreciate their support for that legislation.

Mr. Chairman, as you know, this law was first passed back in 1957 and has been renewed three times since. The current version expires on August 1 of this year and it is important that this legislation which provides the insurance program for commercial nuclear powerplants and the Department of Energy facilities be passed as soon as possible. I am pleased that the House of Representatives passed their version of the bill on November 27 and as I say, I hope we can move quickly to reauthorize it.

I think it's important to note that during the previous Administration, both the Department of Energy and the Nuclear Regulatory Commission issued reports to Congress recommending reauthorization of Price-Anderson, both Republicans and Democrats. The report also called for doubling of the annual premium paid by nuclear reactors from $10 million to $20 million. This recommendation was made prior to the relicensing process and at that time, the NRC projected that up to half of the nuclear energy reactor fleet would retire instead of being relicensed. However, thanks to the regulatory improvements made to the process largely due to the oversight of this subcommittee under the chairmanship of Senator Inhofe, the NRC believes that most of our nuclear reactors will be relicensed so that many they anticipated going out at one time are being relicensed.

As a result, the NRC issued a statement last year revising their projections and recommending that the annual premium not be in-

creased from $10 million to $20 million but rather, remain at $20 million.

Mr. Chairman, currently nuclear energy provides approximately, as you pointed out, 20 percent of our energy needs while fossil fuels such as coal and natural gas provide the bulk of the remainder. Coal and nuclear power have been, in my opinion, inappropriately demonized over the last few years but the fact of the matter is that they are both efficient and cost effective sources of energy. As you point out, they contribute substantially, particularly in the northeastern part of this country, to providing their energy needs. One thing we need to reiterate over and over again with nuclear power is that it is very friendly to the environment. In fact, in terms of emissions, it is zero.

Like many of my colleagues, I support investing in renewable energy. As a matter of fact, in the Murkowski energy bill, of which I am a cosponsor, the first title is "Energy Conservation," and the second is "Renewable Energy." We provide over $5 billion for energy efficiency activities and $1.3 billion for renewable fuels. I think we have to understand though that nevertheless, wind and solar currently provide less than one-tenth of one percent of our energy. I keep hearing over and over again that windmills and the sun are going to be able to take care of our current and future needs, when currently they only make up one-tenth of one percent of provision of our energy needs. Even with significant investments, these sources would not come close to meeting our growing energy demand or replace our current energy resources.

I think last night Senator Kerrey was on talking about his bill. He admitted before these renewables become a reality, it will be 10 to 15 years before they will make any kind of real dent in providing us energy. It is extremely important that we maintain and expand nuclear power if we are going to meet our current and future energy needs.

I think Senator Inhofe said it well, we need coal, we need nuclear, we need gas, all of these sources of energy and renewables if we are going to provide for our current needs and also our future needs. Mr. Chairman, this legislation is fundamental to our maintaining and expanding nuclear power; it's fundamental to providing insurance for the Department of Energy.

Mr. Chairman, now that you're here, I want to say I appreciate your holding this important hearing. I realize that you have issues regarding the status of Yucca Mountain which we are going to be hearing a lot more about during this year, but I appreciate your willingness to separate the renewal of this relatively noncontroversial program from the larger issue of waste storage.

Thank you.

OPENING STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

Senator Reid [assuming the chair]. I would like to express my appreciation to the full committee chair, Senator Jeffords, for starting this meeting. Senator Daschle and I were asked to come to the White House this morning and we just finished that meeting. I appreciate everyone's patience and being here.

I would just say to my friend, Senator Voinovich, that this hearing has nothing to do with Yucca Mountain but it has everything to do with some of the things about which you spoke, and that is the future of energy generation in this country. Even though the amount of energy produced by alternative forms is very small, one reason is we have really been no help to these alternative energy production units and hopefully, we can be more help in the immediate future to get that figure up where it's with geothermal, with wind, with the sun and some of the other alternative energy, and we can do a better job there than we have done as a Congress in helping those industries.

As many of you know, Price-Anderson has been with us for a long time. The Act was first established almost 50 years ago and I think it was for two purposes: first, to allow for commercial use of nuclear energy by providing liability certainty to a complex, untested technology; and second, to ensure compensation to the public in the event of an accident. We all agree it has performed the first function quite well, but that was easy. The second is the one we must address and it's a challenge. I don't think we can shrink from that responsibility.

The builders of the Titanic told people it was unsinkable. Only when the boat was in the water did its vulnerabilities appear apparent. Thankfully, Price-Anderson's ship has not been put to a test yet and I hope it never is, but we must prepare for that possibility. It is our job to make sure we don't skimp on the legislative lifeboats.

So what should we do? The nuclear power industry went through its troubled teenage years during the 1970s and maybe even during the 1960s, moved through adolescence and has now settled into a comfortable middle age. It no longer needs the Federal Government to nurture it.

Over the years, Price-Anderson has shifted more to fulfilling the second goal, providing the public with compensation in the event of a catastrophic nuclear accident. The law has become an upgraded Model T with original parts and newfangled additions that simply don't match. What we really need now is a brand new vehicle, one that is designed using today's understanding to secure tomorrow's energy industry. Generation and selling of electricity are very different than 50 years ago. That is for better or worse, but we now have unregulated electricity markets in some States where competition is keen and consumers are no longer captive to rate monarchies. A new electricity market demands a new Price-Anderson system. This isn't easy.

The basic problem appears to be that the cost of an accident would be just too big and how big, the General Accounting Office reported in 1986 that the cost could be in the tens of billions or even in the hundreds of billions of dollars, depending on which way the wind is blowing. There can be no doubt that without some form of insurance, no nuclear powerplant has the assets to cover the cost of a truly catastrophic accident. The utility would simply go bankrupt first.

Unfortunately, even after 50 years the private insurance industry still is only willing to insure a nuclear powerplant for a few hundred million dollars, much less than the likely cost of an acci-

dent. The bulk of the Price-Anderson insurance comes from the industry's promise to share the burden in cost, up to $9 billion, in the event of an accident. That's like promising to pay your health insurance premiums only after you've been diagnosed with a debilitating disease, a disease that will keep you bedridden for years, unable to work or otherwise take care of yourself. No insurance company would be willing to let you get away with that and we cannot allow nuclear powerplants to operate without adequate insurance. It's as simple as that.

The question we then have to ask is how can we fill the void left by the private insurance companies and insure nuclear powerplants for a reasonable sum in a way that is both fair to potential accident victims and guarantees payment in the event of an accident. Perhaps the first question is why we should do this when we don't do it for other industries? Maybe the market decision not to insure nuclear powerplants adequately means nuclear powerplants shouldn't be built, especially now that other safer, alternative energy sources are available. Today, our witnesses will address these and other issues.

I would say to my colleagues on the subcommittee that we have a vote right after noon. We're starting the second session of the 107th Congress and we will have a vote right after that which means we will have to finish here shortly after noon. So I say to all witnesses we have asked that you limit your statements to five minutes and I would ask my colleagues to be somewhat conservative, as you always are, but this time in your questions.

[The statement of Senator Smith follows:]

STATEMENT OF HON. BOB SMITH, U.S. SENATOR FROM THE STATE OF NEW HAMPSHIRE

Good morning, and thank you all for coming here today for a hearing on the reauthorization of Price-Anderson. As you all know, Price-Anderson first became law in 1957 in order to provide immediate compensation in the event of a nuclear accident.

After being reauthorized three times, the Act is set to expire this August. I have joined Senators Voinovich, Inhofe and Crapo in introducing a bill that will again, reauthorize the statute.

I am a strong supporter of Price-Anderson because I believe that it is the best mechanism for providing the highest level of compensation in the shortest period of time; without having to put victims through an arduous and protracted legal process.

On top of all of that, it is the best deal for the tax payer.

With Price-Anderson—if there were a major nuclear accident up to $9.5 billion, under current law, would be provided in compensation to the victims, not by the government, but by private insurers and the nuclear industry—without having a lengthy judicial process to determine liability or culpability.

The law requires the insured and the insurers to waive most standard legal defenses—fault does not need to be established.

Absent Price Anderson, victims would have to rely on the tort system—and damages would effectively be limited by the assets of a company. Bottom line is that there would be less money available and it would take years for the dollars to work their way through the courts and into the hands of those who need immediate assistance.

And when you do finally get out of the courts - check your pockets, because the lawyers will have gotten their share and probably a good chunk of your share. In all probability, while we are waiting for the courts to act, it is likely that the taxpayer, via Congress, would already have stepped in and provided whatever financial assistance was needed—the events of September 11, showed how quickly Congress can act in such a disaster situation.

To put the $9.5 billion into historical perspective:

• In the nearly 45 years of Price-Anderson, the most widely known payout under the law was with Three Mile Island - certainly a major event -
• That pay-out totaled $70 million—even when adjusted for inflation, it barely makes a dent in what funds are available

Certainly Price-Anderson is a good deal, both for the taxpayers and for anyone seeking damages.

I understand that there are those who simply do not like nuclear energy and will see the Price-Anderson debate as a means stop nuclear power. I do respect the rights and integrity of those who hold this view.

But, I believe that there are enormous benefits to nuclear power—the majority of energy generated in New Hampshire comes from nuclear.

Seabrook has proven to be a safe, reliable source of power - on top of that, it is emissions free.

I have spent the better part of two years working with a number of stakeholders to come up with a bipartisan plan for reducing our utility emissions without compromising our long-term energy security.

Nuclear power allows us to safely generate enormous amounts of energy at low cost and with zero emissions—it must be a part of any reasonable energy plan.

And that means that we should not be discouraging the development of new, safe nuclear technologies.

If we do not reauthorize Price-Anderson, we effectively kill those promising technologies that are the next generation of emissions-free power production.

As we do look at reauthorization, there are a number of questions that should be debated. For instance, looking forward, how do we treat new modular technologies that are not that far down the road? Should we adjust insurance coverage and the retrospective premiums?

Our witnesses have raised a number of questions, concerns and ideas as we look toward reauthorization—and I look forward to the discussion of those ideas this morning.

I want to thank you again for coming here today and I do look forward to hearing your testimony.

Senator REID. Our first witness is William F. Kane, Deputy Executive Director for Reactor Programs, United States Nuclear Regulatory Commission.

Senator Inhofe, the first vote will be a live quorum to my understanding.

Please proceed, Mr. Kane.

STATEMENT OF WILLIAM F. KANE, DEPUTY EXECUTIVE DIRECTOR FOR REACTOR PROGRAMS, UNITED STATES NUCLEAR REGULATORY COMMISSION

Mr. KANE. Mr. Chairman, members of the subcommittee, I am pleased to appear before you today to present the views of the Nuclear Regulatory Commission on extending and amending the Price-Anderson Act.

As requested by the committee, I have a short oral statement that I will present and ask that the Commission's prepared testimony be made a part of the hearing record.

Senator REID. That will be the order.

Mr. KANE. Seated with me at the table is Joseph Gray, Associate General Counsel for Licensing and Regulation.

I am here to deliver the strong and unanimous recommendation of the Commission that the Price-Anderson Act be renewed. However, I would like to point out that the Commission's primary concern is public health and safety. We are not a promotional agency. Our mission is to ensure the safe use of nuclear power and nuclear materials. Nonetheless, it remains important to assure that if an improbable accident should occur, the means are provided to care for the affected members of the public.

As you know, Congress first enacted the Price-Anderson Act in 1957 and its goals were then, as now, one, to ensure that adequate funds would be available to the public to satisfy liability claims in a catastrophic nuclear accident and two, to permit private sector participation in nuclear energy by removing the threat of a potentially large liability in the event of such an accident.

On original passage, the Congress provided the term during which the Commission could extend the Price-Anderson coverage to new licensees and facilities. When that term expired, the Congress then and repeatedly since decided that the Nation's energy policy would be served by extending the Price-Anderson Act so that the coverage would be available for newly licensed reactors. This action assured protection of the public and preserved the option of private sector nuclear power.

I would note that Price-Anderson coverage for currently licensed nuclear powerplants is granted for their lifetime and does not expire in 2002. Thus, Price-Anderson coverage will continue for liability claims resulting from an accident at those facilities.

While Congress has amended the Price-Anderson Act, it has done so cautiously so as to avoid upsetting the balance of obligations between operators of nuclear facilities and the United States Government. Perhaps the most significant amendments to date were those that effectively removed the United States Government from its obligation to indemnify reactors and instead place that burden on the nuclear power industry. Today, commercial insurance and the reactor retrospective premium pooled together would make available, as noted earlier, over $9 billion to cover any personal or property harm to the public caused by an accident.

In 1988, as mandated by Congress, the NRC issued a report on the Price-Anderson Act that included an update on legal developments and events pertaining to the nuclear insurance and indemnity in the last decade. In that report, the Commission recommended that Congress renew the Price-Anderson Act because it provides a valuable public benefit by establishing a system for the prompt and equitable settlement of public liability claims resulting from an accident. This remains the strong position of the Commission.

Also, having noted that substantial changes in the nuclear power industry had begun and could continue, the Commission recommended renewal of the Act for only 10 years so that any significant evolution in the industry could be considered when the effects of ongoing changes could be clear.

Finally, the Commission recommended that Congress consider doubling the annual retrospective premiums installment because it then appeared likely that in the coming decade a number of reactors would permanently shut down, thus reducing the amount of funds available to the retrospective premium pool.

Further developments in the electric generation industry since the report such as extending the operating life for most if not all of the currently operating reactors and the possibility that some companies may submit applications for new reactors or complete construction of reactors that have been deferred led the Commission to reassess this recommendation. As noted earlier, the Com-

mission does not now believe that there is a justification for raising this maximum annual retrospective premium.

In conclusion, I would note to date the United States Government has not paid a penny in claims against nuclear powerplant licensees. In the event a serious accident were to occur, over $9 billion would be available to pay compensation for any personal injury or off-site property damage. Money will come from insurance policies bought by the industry and from retrospective premiums. If those funds were inadequate, Congress would be called upon to decide what action is needed to provide assistance to those harmed. We believe the public is protected by this broad base of prompt funding.

The Price-Anderson Act further aids the public by channeling liability to the licensee establishing a single Federal form for all claims, eliminating the need to prove fault, requiring waivers of other significant defenses, making prompt settlements possible and if litigation is needed, establishing legal management processes to assure fairness and equity in distribution of damage awards.

The Commission reiterates its support for reauthorization of the Price-Anderson Act.

Thank you, Mr. Chairman. I welcome your comments and questions.

Senator REID. Mr. Kane, you work with reactors, that's your job. In your experience, have you known of any other businesses where the Federal Government, in effect, provides for the liability of any harm caused by the business?

Mr. KANE. The short answer is "no."

Senator REID. I don't either and that's the problem I have. I am not opposed to looking at further generation of nuclear power but I think we have to have a lot of questions answered before we do that, one of which would be why do we treat this industry different than any other that I am aware of. That is a question I thought you might have an answer for me.

Senator Inhofe?

Senator INHOFE. Thank you, Mr. Chairman.

Mr. Kane, I'd like to address a couple of the hysterical things that come up because I know there have been studies that have been conducted by the NRC responding to some of the accusations that talked about consequences such as some have recently referred to thousands of deaths and about $600 billion in damages projected from the 1982 Sandia National Lab study. That was 20 years ago and it's my understanding that there has been some evaluation of that. How would you react to that now, 20 years later, as to how authentic those estimates would be?

Mr. KANE. You have to appreciate what the report was designed to do at the time. It's a siting study report and it made a number of assumptions that were somewhat generic and applied them to all sites to get a comparison of various sites.

It didn't take into account some of the tools and technology that we use today in terms of evaluating risk such as new reg 1150 which has updated many of those assumptions including the source term which is a very significant contributor. At the time it was produced, it was useful in terms of comparison of sites but to get into looking at specific damage at a particular site, one would have to

take into account the operating features of the reactor at that site and also the off-site preparedness and the environment surrounding the site.

Senator INHOFE. So you don't think it's really appropriate today to use that 20-year-old study?

Mr. KANE. We do not.

Senator INHOFE. In recent months, there have been reports from the so-called Tooth Fairy Project that alleges finding levels of this Strontium 90 in teeth collected from people living around a nuclear reactor. There has been a study on this too, is that correct?

Mr. KANE. That's correct. We have looked at it and I can give you a high level response.

There are a number of concerns that we had with that study. We would not support the results of that study. The amount of Strontium 90 that is released from nuclear plants is very, very low compared with that which was associated with background as a result of atomic bombs or atmospheric testing, as I should more accurately describe it, elsewhere.

Senator INHOFE. Thank you, Mr. Kane.

Senator REID. Senator Voinovich?

Senator VOINOVICH. Mr. Kane, what if we don't reauthorize Price-Anderson? If it's not done this year, what impact will it have?

Mr. KANE. That's a somewhat difficult question for me to answer. Obviously as noted earlier, it would not impact those currently operating facilities. My sense is, and I have to put this in the context of we're not a promotional agency, but my sense is that it would have an impact on the future development of new powerplants.

Senator VOINOVICH. Senator Jeffords, when he was here, in his opening statement indicated that we never used Price-Anderson. Didn't we use Price-Anderson at Three Mile Island?

Mr. KANE. Yes. We have never used the retrospective payments portion of Price-Anderson but the insurance industry has paid claims. I think the witness from ANI can probably give you a better update but it's on the order of $200 million cumulative overall and, he can probably provide you better information than I could, I understand around $70 million at TMI.

Senator VOINOVICH. So the retrospective thing never came in, the insurance they had on those facilities took care of the damages?

Mr. KANE. That's correct, primary insurance.

Senator VOINOVICH. Thank you.

Senator INHOFE. Mr. Chairman, would it be all right if I interrupt at this point? Senator Smith he was not going to be able to be here unfortunately and asked that I ask unanimous consent that his statement be included in the record immediately following our opening statements.

Senator REID. That will be the order.

Mr. Kane, do you know of any future development planned for nuclear powerplants as we speak?

Mr. KANE. We have had a number of discussions as we do in terms of trying to prepare a budget for the Congress and there have been discussions.

Senator REID. With whom?

Mr. KANE. For example, the Pebble Bed reactor, which is a modular type.

Senator REID. Where is that?

Mr. KANE. It's not sited anywhere in this country. South Africa is looking at it, the Germans have looked at it and I believe the Chinese have looked at it.

Senator REID. Do we have any control over what they build in South Africa or China?

Mr. KANE. No, we do not.

Senator REID. Why are you having discussions on these plans?

Mr. KANE. It's with respect to potentially siting them in this country.

Senator REID. Do you know where?

Mr. KANE. At this point, no.

Senator REID. It's my understanding that the Nuclear Regulatory Commission recommended raising the retrospective premium to $20 million from $10 million and now you don't think that's appropriate. Why?

Mr. KANE. The logic in that was that as we made our recommendations in 1998, the status of the industry was such that they were forecasting plant shutdowns and decommissioning. In the intervening several years, that has turned around rather dramatically such that some of those facilities that were forecast to be shutdown are not at this point, but are going for license renewals for an additional 20 years beyond the 40-year license. The most recent projections that we have by assessing the industry is that most, if not all, of the current reactors will apply for plant life extension.

To complete the answer, the $20 million was in consideration of the fact that there may be a reduction in the pool.

Senator REID. Thank you very much for being here today. We appreciate it. You are excused now.

We are going to hear now from a panel that we are anxious to hear. We are going to hear first from Christie Brinkley, a member of the board of directors of the STAR Foundation, a group which opposes reauthorization of Price-Anderson. We will hear from Peter Bradford who teaches and consults in regulatory practices and procedures in the United States and abroad and was a member of the United States Nuclear Regulatory Commission. Dan Guttman will also appear before us, who teaches and is an attorney in private practice with substantial experience in the public and private management of the electric utility industry. John L. Quattrocchi is Senior Vice President, Underwriting, American Nuclear Insurers. Marvin Fertel is Senior Vice President, Nuclear Energy Institute, a professional association representing the nuclear power industry.

Ms. Brinkley, we are happy to have you here. Please proceed.

STATEMENT OF CHRISTIE BRINKLEY, BOARD MEMBER, STAR FOUNDATION

Ms. BRINKLEY. Mr. Chairman, members of the committee, I thank you for the opportunity to appear here today.

My name is Christie Brinkley and I am a member of the STAR Foundation based in East Hampton, New York. It's an environmental organization which my husband, Peter, and I joined after we learned we were raising our three children in the cross-hairs of several very old and troubled nuclear reactors. We decided we had

to learn everything we could about the Oyster Creek reactor to our south, the Indian Point Reactor to our west and the Millstone Reactor to our north. Millstone is just 11 miles off the shores of Long Island which we call home and that puts us just one mile too far away for an evacuation plan.

Amongst many things we learned was that a lot has changed since those reactors were built. For one thing, they are now over 24 million people living within the triangle defined by these three nuclear powerplants.

After the terrorist attacks on September 11, like many Americans, my husband and I became concerned about the safety of our family and our friends, and our country and we attended public meetings with local emergency officials where many questions were asked. How can we protect our children in the event of a nuclear emergency? What if it happens at night while we're sleeping? What if it happens while our kids are at school? How will we be notified to take shelter or should we evacuate? Is it even possible to evacuate densely populated areas like Long Island or New York City where there are few and highly congested roads and bridges and tunnels? No clear answers were provided. Unfortunately today these questions are no longer abstractions given that highly destructive acts of terror have become a reality in the United States.

Today, this Senate committee is addressing a law that deals with how Americans are going to be compensated after a major nuclear accident. Before I go any further, I just have to say what I think we all know in our hearts that no one could ever truly be compensated for the loss of a loved one, a birthplace or your health, your hometown, your way of life or peace of mind. This discussion today is really about an industry owning up to its responsibilities.

I am not an expert on the Price-Anderson Act but what I do know leaves me filled with questions and concerns. One half of all of Americans, 145 million people, live within a 50-mile radius of a nuclear powerplant. I'll bet they'd be interested to know if they took out their homeowners insurance policy, they would see in plain black and white—I have one right here—that their policy excludes them from coverage in the event of a nuclear accident. You can get coverage against a meteor hitting your home but not one private insurance company in America will cover you against a nuclear event.

Since you can't get private insurance coverage, we're supposed to be compensated under the Price-Anderson Act which arbitrarily sets a limit of $9.4 billion for compensation of damages in the event of a nuclear catastrophe. It's abundantly clear radiation from a nuclear accident does not follow arbitrary rules that say, dangerous contamination will just travel ten miles and then stop.

The STAR Foundation and numerous groups around the country have repeatedly asked the NRC for several years to expand its evacuation zone beyond 10 miles to protect Americans but to no avail. This arbitrary $9.4 billion limit doesn't even match with recent damage estimates done for the Nuclear Regulatory Commission.

A study developed for the NRC by Brookhaven National Laboratory in 1997 reported that a spent pool fuel fire could contaminate a large area, cause thousands of fatal cancers and could cost about

$59 billion in property and economic loss. With your permission I would like to place this study in the record of the hearing.

Senator REID. Without objection, that will be the order.

[The referenced document appears in the hearing appendix.]

Ms. BRINKLEY. I would also like to take this opportunity to remind you that the impetus for the Price-Anderson Act was WASH 740, a 1957 study more commonly referred to as the Brookhaven Report which established that a nuclear plant accident could incur up to $7 billion in property damage alone, aside from payments for loss of life and injuries. That's $7 billion 1957 dollars. Using the U.S. Government calculations for inflation, that $7 billion is equal to $45 billion in today's dollars and a lot has changed since 1957.

Unlike private insurance companies, reactor owners do not have to come up with over 95 percent of the $9.4 billion they are supposed to pay out until after a nuclear accident occurs. This means that the nuclear industry only has to show a source for less than 3 percent of that $9.4 billion. That's like taking out a million dollar insurance policy from an insurance company that can only show assets of $20,000. Why doesn't the Price-Anderson Act require the nuclear industry to keep the full $9.4 billion untouched, excuse the expression, in an ironclad lockbox.

After September 11, our world has unfortunately become a more dangerous place. Nuclear power stations are now frequently reported as being prime targets for terrorists. It is my understanding that the Price-Anderson Act excludes acts of war from coverage from nuclear accidents. Our President has declared that America is at war against terrorism. Does that mean that if there is a terrorist attack against a nuclear facility, Americans won't get anything, not even the paltry, arbitrary amount provided for in the Price-Anderson Act as currently written? Why is the limit on liability set by the Price-Anderson Act not based on official estimates of damage? What guarantees do we have that the nuclear industry will come up with the necessary funds if such a terrible event arises?

If the nuclear industry can't come up with the funds to compensate victims, the burden of payment falls on the American people, the taxpayer. Is it really fair or reasonable for the taxpayer to be stuck with the cost of a major nuclear accident? In this increasingly dangerous world, can we even afford to bear the cost of nuclear power stations and their potential consequences?

England, Germany and Sweden have decided they cannot and are phasing out nuclear power for safer, cleaner energy alternatives. I hope the committee will find the answers to these questions and seek reasonable solutions. I hope and trust that this committee will also help ensure that the risks and consequences of such terrible acts are minimized. For this reason, I extend my thanks to Senator Clinton from my home State of New York, Senator Reid and Senator Lieberman for introducing the Nuclear Security Act which strengthens safety protection and emergency response near nuclear powerplants. I would like to urge all the U.S. Senators to join them and support this important piece of legislation.

Once again, I wish to thank Senator Reid and the members of the committee for allowing me the privilege of appearing before you today.

Senator REID. We appreciate your testimony. If you would remain seated, we may have some questions for you when we finish.

Mr. Bradford?

STATEMENT OF PETER BRADFORD, VISITING LECTURER, YALE UNIVERSITY

Mr. BRADFORD. Thank you very much for the invitation to testify regarding the renewal of the Price-Anderson Act in the context of competitive electric markets.

Aspects of the law have provided for a system of self-insurance by the nuclear industry for 45 years. While these provisions can and should be strengthened to assure funding in the event of a serious nuclear accident, the underlying concept of that part of the law is sensible.

However, the electric industry has changed significantly since Congress last renewed Price-Anderson, since my own term on the NRC and since I last testified before this committee on that subject in 1985. These changes undermine the wisdom and the fairness of applying the liability limitation provisions to new nuclear units and perhaps also to units whose license life is extended beyond its original term.

One change of note in recent years is that virtually no imported oil is now burned to generate electricity in the United States. Consequently, nuclear energy, while still a hedge against air pollution, does nothing to reduce U.S. oil import dependence or vulnerability.

However, the most significant change is the opening of the electric power market to competition among all forms of power generation. A national policy requiring competitive electric power supply was achieved through the enactment of the Energy Policy Act of 1992 and through subsequent proceedings of the Federal Energy Regulatory Commission. Pursuant to this national policy, all powerplants should now have an equal opportunity to sell into the wholesale electric market based on their costs and other operating characteristics.

The basis for this policy was Congress's belief that marketplace competition will produce lower prices and greater customer satisfaction than did the powerplant selection process based on utility and governmental forecasts that prevailed when Price-Anderson was enacted and renewed.

In a competitive power generation market, capacity from nuclear plants must compete with capacity from fossil fuels and from renewable resources, none of which enjoy any type of federally mandated liability limitations. Under these circumstances, the liability limitation has two anticompetitive effects, first, new nuclear capacity appears cheaper than it really is relative to other sources or for that matter, relative to an investment in energy efficiency. This is because its cost of capital does not reflect the risk of having to pay for damages in excess of $9 billion when estimates of worst case accident or sabotage scenarios are much higher than that.

Second, any nuclear design that is truly inherently safe—op that is least incapable of doing more than $9 billion in damage does not

enjoy the benefit of its improved safety and competition with those nuclear plants that do benefit from the liability limitation. Indeed, the liability limitation ultimately is less a subsidy of nuclear power than of nuclear catastrophe. As such, it removes market incentives for remote siting, underground siting and inherently safe designs. Companies offering designs that have such advantages would be well advised to disavow the liability limitation and thereby avoid the public skepticism that it engenders.

The risk of an accident that exceeds $9 billion in damages is in no way diminished by the Price-Anderson Act. The Act merely requires that whatever that risk is, it will be borne either by those who suffer the damage or by the Nation's taxpayers.

In the wake of September 11, the possibility of a disaster involving nuclear energy and costing many times $9 billion is clearly not as low as we had thought. Rather than underwrite industry cost in the event of such an accident, it would seem far wiser for Congress to adopt a framework that encourages the deployment of energy sources conceivably including inherently safe nuclear sources that do not carry with them the potential for inflicting such large damages.

No connection exists between the upper limit on liability and the more desirable features of Price-Anderson. Removal of the limit coupled with the provision extending the retrospective annual premium until all damages had been paid would provide more assurance to the general public than the present law. Indeed, most of the witnesses who testified in favor of Price-Anderson renewal in the House last year made little or no mention of the liability limit for nuclear powerplants. Their testimony urged retention of the mutual insurance scheme and other aspects of the law. If they saw Price-Anderson as essential to future nuclear plants, to nuclear relicensing, to increasing the licensed output of existing nuclear plants, they did not say so. Even the two witnesses who endorsed the liability limit offered no proof that it is still needed to encourage future nuclear construction.

The most vehement claim that the liability limit is essential to the future of nuclear power was made by a witness opposing renewal of Price-Anderson. The fact is that other industries—marine oil transport comes to mind—are required to provide a mutual insurance framework independent of any liability limit that may exist and the Price-Anderson mutual insurance requirement need not be modified if the liability limit were removed.

The Price-Anderson limited liability principle was originally adopted as part of a clear congressional bargain that included detailed requirements for public participation in the nuclear licensing process. Over the years those protections have been substantially eroded, usually on the basis of arguments that nuclear technology had substantially matured and no longer required so great a set of intervenor protections.

Furthermore, probabalistic risk assessment has been introduced into many aspects of nuclear regulation. Again, based on the rationale that the technology and risk assessment methodology have matured to an extent now adequate to provide informed judgment about accident vulnerability.

What then are we to make of continued insistence on liability limits? Can it really be that all of this maturing, all of this increased database only counts when it is being used to reduce aspects of NRC safety oversight, that it counts for nothing in the context of reconsidering the liability limit?

Such a result is indefensible. If the technology is mature enough to cut public hearing and information rights to the vanishing point, if it is mature enough to circumscribe regulatory scrutiny with probabalistic risk assessment, then it is too mature to need a limitation on its liability for catastrophic accidents.

The justification for the limit dates from a time when other alternatives to fossil fuels did not exist. Now, however, at a time when competitive markets are actually providing as many or more renewable megawatts per year worldwide as new nuclear powerplant megawatts, this argument is out of date. If nuclear law is to be updated as industry witnesses urged, to take account of changes in the 1990s, then Congress should take all of those changes into account. Congress should let nuclear power compete within a framework that will reward its safest designs to the fullest. Congress should not continue a framework that encourages facilities with a remote potential for extreme catastrophe to substitute for facilities that can provide or conserve energy in safer ways.

At the very least, those who support renewal of the liability limitation can hardly oppose measures providing support for renewable energy and energy efficiency as part of electric industry restructuring legislation. The liability limitation is a specific override of an asserted free market outcome, the unwillingness of private insurers to cover the full potential cost of a nuclear accident.

If such a counter market subsidy is to be offered to one technology, then the least that can responsibly be done is to ascertain its value and offer a comparable subsidy to other technologies that offer the same advantages of domestic supply, reduced fossil fuel dependence and diminished air pollution, especially since these technologies really are in the start-up phase that was said to justify the Price-Anderson Act when it first became law 45 years ago.

Thank you for the opportunity to testify.

Senator REID. We will now hear from Dan Guttman.

STATEMENT OF DAN GUTTMAN, FELLOW, CENTER FOR STUDY OF AMERICAN GOVERNMENT, JOHNS HOPKINS UNIVERSITY

Mr. GUTTMAN. Thank you all for inviting me. I appear here today as a citizen, as my testimony states, privileged to have a variety of experience in the nuclear area, most recently privileged to work with the nuclear weapons workers who owe an extraordinary debt to you all and particularly to Senator Voinovich for the Compensation Act which is now being put into effect.

When I listened to some of the questions here about why we should care about hypothetical questions about a law that fortunately has never had to be tested, I think about some of the other folks I'm working with and I know Senator Voinovich is, of the Portsmouth of Piketon, Ohio workers. Three years ago, the workers were asking questions about the USEC Privatization Act saying what if this doesn't work, what if this, what if that, and the answer

was no problem, we've got the best and the brightest working on it.

The point is not that Price-Anderson shouldn't be reauthorized but that an ounce of prevention is worth a pound of cure because as we see in the case of USEC, the industry may now be strangling itself to the closure of our domestic uranium enrichment facilities which is one of the things I suspect Senator Inhofe is quite concerned with, as are the workers at these facilities.

So when I was asked by the subcommittee staff to testify about this as an expert, I said good news, bad news. The good news is I don't have a horse in this race, a dog in the show. The bad news, I don't know anything about the Act, fortunately because it hasn't been used.

I've had four or five months since the initial inquiry was six or seven months ago to read the case law, read what the GAO and NRC have been reporting. What surprises me as a citizen is that there are so many basic unanswered questions, some of which have just been addressed.

Briefly, to go down the unanswered questions, by which I don't mean to say the Act shouldn't be reauthorized but by which I mean Congress should think about these questions. If it doesn't want to do anything, that's okay.

Question one is kind of technical, inside, legal stuff but that's why I don't get paid much for testifying, is what does the Act cover? Much to my shock, it turns out what is covered by the Price-Anderson Act. There are three kinds of splits in the court decisions. A couple of cases recently said you have to have an indemnification agreement.

As we know only some folks, obviously the big reactors have indemnification agreements but there are lots of other, probably the vast majority, NRC licensees that don't have such agreement and one case having to do with a thorium plant that was in operation until 1956 said this is not Price-Anderson Act. It had nuclear materials but no indemnification agreement.

Another set of cases has to be an accident, it can't be intentional. This had to do with another Ohio case, the famous Cincinnati human radiation experiments, University of Cincinnati. The question was, did Price-Anderson apply to this radiation therapy which was clearly, admittedly related to the AEC NRC. The court said it wasn't an accident, the doctors intended to inject these folks. This was how this stuff was supposed to be used. So it's intentional. So you're sitting here after September 11 thinking this is what the terrorists intended to do.

A third question is how broadly does the Act apply. The most amusing case was a Swatch watch product liability case. Can you go under the Price-Anderson Act if you're complaining about the defects in the radioisotopes that illuminate the dial. The court said, it doesn't sound like you can but Congress didn't say anything about it, so I guess it covers Swatch watches.

So there are basic questions that have nothing to do with is this good or bad for the future, that should merit attention or the tort system that we are all concerned about may get bogged down in this kind of litigation.

The most obvious of these questions is the apparent exclusion, not clear, acts of terrorism. Public liability is the technical term that triggers the law. The definition of public liability excludes act of war, the point not be belabored.

What surprised me as a citizen, I would have thought that by now having gone this far in the Price-Anderson process with all the high powered people who know this stuff, this would have been ironed out. What do we do with acts of terrorism? Do we intend to cover it? If so, does the Act currently provide it? If not, where do folks go if a powerplant has caused damage as a result of an act of terrorism?

Another obvious question Peter Bradford addressed, the deregulation effect. Again, I'm surprised the NRC report to you in 1998 said we have concerns because when you have deregulation you can't guarantee that there is going to be a revenue base of ratepayer dollars to provide for the retrospective payments as Ms. Brinkley said, is the lion's share of what the public has to rely on. This concern was punctuated in December by a report to Congressman Markey from the GAO and that to me was a very disturbing bell ringing report because that looked at the NRC's review of whether the license transfer process, when folks are buying up these plants, the Excelons and the Dukes, whether the NRC looks to see if there are adequate decommissioning costs.

The GAO said the NRC, on paper, looks good but it isn't clear that they sharing decommissioning costs. The reason this is so important is that the NRC's new reg document on financial conditions has half the things on decommissioning costs. Price-Anderson isn't mentioned.

So if a citizen is saying, if they are not, according to the GAO, doing what has to be done on decommissioning, what about Price-Anderson, where is that money going to be? As an obvious concern, you can see in the old days where the utilities had mixes of powerplants, a shutdown would permit that utility continue to operate coal and gas and get some revenues to pay for Price-Anderson.

Now where you've got consolidation, if you have an accident on one facility and you've got Excelon with 5, 10 or 15 facilities, a design factor review may cause a cascading, the perfect storm that we all are familiar with light of Enron and everything else. The point is not that we don't need Price-Anderson, we need it, but you need to think about it.

The other things are identified in the testimony. One of the stunning as a citizen and believer in small government as in Ohio, is that one of the premises of Price-Anderson when you amended it in 1988 to bring everything before the Federal courts was that the Federal court apply State law decision. This was not an antistate thing, this was an efficiency thing.

It turns out while Federal courts generally do that, there is one area that they don't, and that's the duty that is owed by the licensees, and the Federal courts have said that it doesn't matter what the State law says, you can only apply the numerical dose standard that is the NRC or governing DOE standard.

As a citizen I'm saying, of course and I can understand the logic of Federal preemption for efficiency or conflict reasons, but then I'm reading a case with a poor individual working for Florida

Power and Light Company. He said he wasn't given protective equipment. The State of Florida would have required him to get protective equipment. The Court of Appeals said, too bad, we are only permitted to apply the Federal duty of care which is numerical. I'm saying it can't be that if there is a State protective standard that is not in conflict but supplemental that is still something you intended in your interest in protecting States, intended to have eliminated.

The final point is a small but very important point. The Court of Appeals in the New Mexico area said you inadvertently did an injustice by tagging recoveries to the State statute of limitations. There are some States, New Mexico apparently is one, where if you don't bring a case within three years if someone dies, you're out of luck.

As that court said, unfortunately in the case of radiation, as you know, you have latencies that may be more than three years, this may work an injustice. In essence, this court, and I cite the decision, said, gee, Congress can you fix this.

Senator Inhofe's point is extremely well taken. We have a need, as Senator Voinovich knows, in the case of USEC, we may be running out of fuel shortly. We have a need to keep the system going. The question is, in the window you have, to think about fixing it to make sure that if like USEC, for some perfect storm reason it comes apart, you've given the best thought you have to make sure it is the best system there can be.

Senator REID. Thank you.

I know this has never happened to you, your name being mispronounced, but to complicate things I was given a piece of paper that had it even spelled wrong. It is my understanding your name is Quattrocchi.

Mr. QUATTROCCHI. Actually, it's Quattrocchi but for obvious reasons, most people just refer to me as John Q.

Senator REID. These Irish names have always been hard to remember. Please proceed.

STATEMENT OF JOHN L. QUATTROCCHI, SENIOR VICE PRESIDENT, UNDERWRITING, AMERICAN NUCLEAR INSURERS

Mr. QUATTROCCHI. I am John Quattrocchi, Senior Vice President at the American Nuclear Insurers which I'll abbreviate as ANI.

I am here today representing the member companies of ANI which are some of the largest insurance and reinsurance companies in the country, if not the world. ANI is a joint underwriting association or pool of insurers that were formed for the special purpose of insuring the nuclear risk. We were created in 1956 in response to Congress's desire that the insurance industry find a way to insure what was then a very new technology.

We worked very closely with Congress in those early days to develop the Price-Anderson law which essentially is an insurance program. The law, as many have said, had several purposes in mind. The first was to encourage private development; the second was to establish a framework for handling potential claims and the third was to provide a ready source of funds to compensate injured victims of an accident.

My purpose today is to let you know that from our perspective as professional insurers, the Act has served the American public very well and should be renewed with little if any change. Let me quickly mention a couple of key provisions of the Act that have allowed us to provide this insurance market for more than 40 years without interruption.

The law requires reactor operators to maintain primary financial protection equal to the maximum amount of liability insurance available from private sources at reasonable terms. That requirement is satisfied under nuclear liability policies that we write. Over the years, the primary insurance limit has increased from $60 million in 1957 to $200 million today. Incidentally, that's $200 million per site. So when the limits are totaled, insurers have a cumulative risk of more than $15 billion. The primary limit was last increased in 1988 after time of last renewal of the Act.

In the event that loss exceeds the primary limit, the law requires reactor licensees to participate in what is called a secondary financial protection program which we at ANI administer. Under this program, each licensee is retrospectively assessable for any loss in excess of the primary limit up to a maximum assessment of $88.1 million per reactor, per accident. As I mentioned ANI writes the secondary contract and we administer the program but the second layer of protection is drawn from reactor operators' own funds. With 106 units in the program, the total level of financial protection available to the public is just over $9.5 billion.

There are a number of other key provisions in the law critical to the interest of insurers and to the public. Those are outlined in my testimony and I won't go through them now in the interest of time but give some other quick points.

I mentioned earlier that our primary limit has not been increased since 1988. Obviously inflation has taken a toll. In testimony I delivered in Congress in June of last year, I indicated a reasonable goal might be a primary limit in the range of $300 million, assuming a satisfactory renewal of the Act. That remains our goal but I have to qualify my remarks by stating what may be obvious at this point. The events of September 11 will make it much more difficult for us to achieve the goal.

On the terrorism issue, ANI has elected to continue to cover liability arising out of terrorist acts as has been the case since 1957 but up to one shared industry aggregate limit of $200 million. The aggregate is necessary to assure our member companies and reinsurers that their exposure to terrorism is quantified and capped.

I would add that the secondary program will continue to apply to loss in excess of any diminished primary limit, so the program remains seamless as to terrorism.

We have also increased premiums by 30 percent effective January 1. There is obviously a cost to generate insurance capacity and the cost after September 11 is higher than it was before. I might also mention that we have begun talking with the nuclear industry about their interest and a possible new coverage that would pay the retrospective assessment in the second layer for the reactor that has the accident. We think in the unlikely event of an accident that requires assessments, the utility that suffers the loss will be under the most severe financial pressure. This new coverage would

shift that pressure to insurers, at least for one full retro assessment.

I have to stress one point again. To introduce a new product that would pay one full retro premium, we would have to develop additional insurance capacity over and above whatever additional capacity is developed for the primary layer. My comments about a new product therefore have to be qualified again. The events of September 11 will make the development of this new product difficult to accomplish and our first priority after all for new capacity has to be on the primary side.

I'll sum up by saying the financial protection this law provides the public far surpasses any other system that we as professional insurers are aware of. The Act is clearly in the public interest regardless of one's point of view on the issue of nuclear power itself. In its first true test in 1979—and I heard from other witnesses the Act had not been tested but in fact it had.

After the Three Mile Island accident, the Act served the public well. We as insurers responded under the Act within 24 hours of the evacuation order. We made emergency assistance payments to some 3,100 families without requiring a liability waiver of any kind. I myself was part of that effort and I am proud that we able to help those affected by the accident.

There is a little amusing and short story I'd like to share with you about that difficult time.

Senator REID. I let the others finish their statement because they were close to the end. Your's is extremely long so you would have to wrap it up quickly if you could.

Mr. QUATTROCCHI. I have told the story before so for those who have heard it my apologies.

The insurance team was staying at a motel about 10 miles from the site and that motel was nearly deserted. At breakfast one morning, I spotted a young couple with two children. Mom and dad were clearly distraught. A waitress walked over to their table and tried to console them. She said, "Do you see those people over there? They're with the insurance company and there's no way they'd be here if we were in any real danger." Then she added, "But watch them very carefully because when they leave, we leave."

I don't expect that to happen again but if it does, the public needs the protection the Act provides. We therefore urge the members of the subcommittee to support renewal of the Act in its existing form.

Thank you for your time and for the opportunity to express the views of insurers on this important issue.

Senator REID. Mr. Guttman, your full statement will be made a part of the record as your's will be.

Mr. Fertel?

STATEMENT OF MARVIN S. FERTEL, SENIOR VICE PRESIDENT, NUCLEAR ENERGY INSTITUTE

Mr. FERTEL. Thank you for the opportunity for NEI to testify today. I request my statement be made a part of the record.

Senator REID. Hearing no objection, that is the order.

Mr. FERTEL. As you've heard, for 45 years now Price-Anderson Act has provided what we believe is the most effective third party liability protection in the world. Since the inception of Price-Anderson in 1957, the law has been extended three times for successive ten year periods and in 1988 for an extended 15 year period.

Over that period it really has evolved from one that provided some specific government indemnification to a law that imposes, and I've heard a lot today, that it limits. I think there is two sides to a limit. It's an imposition too. There is an imposed requirement of $9.5 billion for the industry to have available through insurance and self insurance in the event of an accident. I think that's the right public policy and it's a good outcome.

Unless Congress renews the Price-Anderson Act, it will expire on August 1 of this year. Given its proven record, Congress should renew the Act indefinitely without changing the current processes applicable to commercial nuclear powerplants.

The industry also recommends adding a provision to the law that would address new, smaller, highly efficient modular reactors as the chairman spoke with Mr. Kane about which are under consideration by companies in our country for deployment here. Price-Anderson Act renewal should recognize this development and include these reactors in its protocols. We would be pleased to provide the committee with appropriate language to do that.

The Price-Anderson Act insures the availability of more than $9.5 billion to appropriately compensate members of the public as a result of a nuclear incident. I should add and somewhat contrary to what I have been hearing, no other energy source or industry has such an obligation. What I've heard is only the nuclear industry has such a provision to protect us. Nobody else has the obligation. I think there are both sides of that coin that we need to talk about.

The Price-Anderson Act has two tiers of liability protection, the primary level of coverage. The law requires nuclear plant operators to buy all nuclear liability insurance available or provide for an equal amount of financial protection. Currently, as John Q said, there's $200 million available at each nuclear powerplant site.

For the second level, nuclear power operators are assessed up to $88 million for each incident that exceeds the primary level at a rate not to exceed $10 million per year per reactor which gets you to another $9.3 billion. I should indicate that the $9.5 billion aggregate is per site per reactor. It's a lot of money, not only per reactor but across our whole country.

I want to emphasize that the Act creates an industrywide obligation for providing insurance by spreading the liability for a major accident across the industry. It's a pooling arrangement and actually seems to make good sense from public policy. I don't declare bankruptcy, all my peers help me make this payment.

In addition, the law requires that Congress may establish more assessments on the industry if that is required, if the first two levels of coverage are not adequate to cover claims. The cost of Price-Anderson coverage is included in the cost of electricity; it is not a Federal subsidy.

To date, no taxpayer dollars have ever been paid out for commercial claims under Price-Anderson and of the approximately $200

million paid in claims since the Act went into effect, including the $70 million from the Three Mile Island accident, all have been paid by private insurers in the industry.

I should note that the $70 million for TMI is a real cost based on the worst accident in the history of the U.S. nuclear program and represents less than 1 percent of the liability coverage required by Price-Anderson. Since TMI, in our opinion, the safety of our plants has moved to a level that no other country even approaches and has set a standard for the rest of the world.

The NRC and DOE have recommended renewal of the Price-Anderson Act and the House of Representatives passed legislation renewing Price-Anderson in November of last year. We believe electricity is essential for both insuring our quality of life and driving our economic growth. The strength of our electricity system is diversity of fuel type and technology, coupled with a robust program for energy conservation and efficiency.

Nuclear energy as our second largest source of electricity and our only large expandable source of emission free electricity is a critical component of our supply system. Our powerplants continue to achieve record levels of safety and reliability and 2001 has proved no different from previous years. Preliminary data show the industry is on track to produce about 760 billion kilowatt hours of electricity. That is more electricity than produced by nuclear programs in France and Japan combined.

Also, our existing nuclear plants are proving to be the most cost effective source of electricity in our country. Nuclear energy has played a vital role in meeting increased demand while significantly contributing to meeting our clean air goals and reducing carbon emissions. As demand continues to rise, nuclear energy will be even more important.

The Price-Anderson Act has been an effective law for more than four decades. We recommend that Congress renew it this time as it has over the three last times.

Thank you and we welcome any questions.

Senator REID. I'll take five minutes and ask questions and then Senator Inhofe and then you. If we need more time, we can go after that.

First to Christie Brinkley, I appreciate your lending your "star" power to this hearing. Your presence has helped focus attention on this most important issue. Thank you very much for being here.

I do think you sum the concern a lot of people have. You are a mother with children. You live in an area that is densely populated and you have these power producing devices that could cause irreparable harm to lots of people. I think it is good you raise concern because you are speaking for a lot of people in America today.

Mr. Bradford, as I understood your testimony, you support an unlimited liability system for the industry, is that right?

Mr. BRADFORD. Yes. If it were up to me, I would remove the liability limitation on a going forward basis.

Senator REID. You laid out in your statement why. In short, would you repeat that for me?

Mr. BRADFORD. Because the liability limit is in effect anti-competitive now that we have a competitive wholesale generation market. It provides a subsidy of indeterminant value to the nuclear

powerplants who benefit from it, both in comparison to other sources of electricity generation be they fossil or renewable, and even between nuclear powerplant designs with the claims now being advanced to the effect that a new generation of nuclear powerplants potentially and inherently safe, potentially sited underground that would not have the potential to do these large kinds of damages, those plants don't need this subsidy. So to the extent that the price of power from the plants that do benefit from the subsidy is lower, those who don't need it are at a competitive disadvantage even there.

Senator REID. Mr. Guttman, in your testimony you raise concerns about the failure of Price-Anderson to require the powerplants to keep records of their accidents?

Mr. GUTTMAN. I'm saying the experience of the Congress and the Administration in the last decade looking at the nuclear weapons workers the atomic veterans, even radiation experiments is what happens when you have these kinds of incidents.

The problem the public has is not they are obtuse, not that they think low levels of radiation are dangerous but again and again it turns out the Government, in the case of DOE, its contractors don't keep records and don't disclose.

Senator REID. So you're saying they should?

Mr. GUTTMAN. That's right. What was done by the Administration in response to the President's Advisory Committee on Radiation experiments was incorporated in the Nuclear Workers Employee Act, that instead of having a longstanding holy war debate about low levels causing this and that, do you have the data? There should be a burden. One of the things you can put in the Act is a burden on whoever may be causing an accident, if you can't provide the documents and the monitoring to show years removed that someone was not—

Senator REID. I would say this to you is not theoretical, you've had experience where you have had problems in finding out and trying to settle claims for victims and there were no record there, is that right?

Mr. GUTTMAN. As we are well aware, the law you folks passed, the Employees Compensation Act, has a special section which is premised even with nuclear weapons workers. Richard Miller has said you can't even monitor the nuclear weapons workers who you know are working for you.

Senator REID. So the answer to my question is, "Yes, you have had experience?"

Mr. GUTTMAN. Yes, we have had experience.

Senator REID. Could you elaborate on your testimony that Price-Anderson does not cover acts of war. Ms. Brinkley also said the same thing. Should it?

Mr. GUTTMAN. That's for the Congress. I think what is for us to say is that is something you should address.

Senator REID. What is your opinion?

Mr. GUTTMAN. My opinion is it is an interesting question. I think it is a neutral question in the following respect. From the perspective of torts lawyers as we see from September 11, they would be just as happy if it didn't cover, it wasn't covered because then they could go to court and sue for unlimited damages. If one is con-

cerned about the health and safety of the nuclear industry, I'm not speaking for them, but it might be desirable to provide quite clearly that we want to address this in advance. I think the policy considerations are do you want to protect the industry in advance or do you want for all heck to break loose should something like this ever happen. How you provide for it, that's why you're deliberating. I wouldn't presume to tell you whether it should or shouldn't.

Senator REID. Senator Inhofe.

Senator INHOFE. Let me start by making a comment. I think a lot of the things you're talking about, Mr. Guttman, are not really in the jurisdiction of this committee. If you talk about the labs, that's DOE, not that we're not concerned, but I would ask Mr. Fertel if he has any ideas or comments as to what they are doing on this but make it very short.

Mr. FERTEL. I think your comment is appropriate. I think if you go to commercial plants and if Mr. Kane from the NRC was here you could certainly ask him or you could for the record. The records kept at the plants on exposures are very elaborate, very detailed and very comprehensive. We want them that way, the NRC wants them that way. It's a much different system than the old weapons complex system.

The other thing as John Q said, we see Price-Anderson right now as covering acts of terrorism, their policy covers it, our secondary financial protection covers it. It does not cover acts of war.

Senator INHOFE. Ms. Brinkley, I want to echo the remarks of our chairman on your presence here. We appreciate it very much.

This committee has been addressing clean air and emissions for several years. It has been quite a concern and I know you are concerned about it too. In my opening statement I mentioned that each year the U.S. nuclear powerplants prevent 5.1 million tons of sulfur dioxide, 2.4 million tons of nitrogen oxide and 164 metric tons of carbon from entering the Earth's atmosphere. Wouldn't you have to agree that is a benefit of nuclear energy?

Ms. BRINKLEY. I would have to respond that renewable clean energy sources such as photovoltaics, fuel cells and wind, hydro don't have any of those emissions at all. If our government would subsidize those industries the way they do the nuclear industry as Senator Voinovich expressed earlier, he believes the solar and wind power would be effective in say a 15 year span. Imagine if the government supported these renewable energy sources.

Senator INHOFE. I'm sorry I have to interrupt you but we're going to run out of time on this. I would say yes, government is supporting that, I'm supporting that, Senator Voinovich is supporting that.

We have a problem right now with the here and now. What happens if we were tomorrow to find out we'd lose 20 percent of our energy?

Ms. BRINKLEY. We talk about clean emissions but I don't think we can ignore the waste that is produced that nobody really knows what to do with. I think it's irresponsible for us to continue producing piles of nuclear waste with no disposal system. I don't think you can truly call this clean energy.

Senator INHOFE. We were talking about emissions and you've answered the question.

Mr. Fertel, in Ms. Brinkley's testimony she cites a study done for the NRC by Brookhaven Lab in 1997 that stated spent fuel pool fire could cause widespread contamination at a cost of $59 billion and property damage. In your view, is this realistic?

Mr. FERTEL. We actually offered NRC comments on that. We could submit them for the record if you'd like. We don't believe it's realistic, even though we think the study provided value and things we could look at to improve safety at the plants.

Senator INHOFE. I would like to have that for the record. I think it would be very appropriate at this point to have it in there.

Senator INHOFE. Mr. Quattrocchi, as I understand things changed after September 11 in terms of the two things that could happen in primary protection. One, it could affect raising that limit from $160 million to $200 million in 1988 or that time frame to $300 million or could have an effect on the premiums. Which of these do you think is going to happen and what kind of premiums are we looking at for this coverage?

Mr. QUATTROCCHI. Premiums in 2001 were roughly $275,000 for a single unit site, roughly $400,000 for a double unit site, and roughly $600,000 for a triple unit site. In 2002, those premiums were increased by 30 percent. I should add that up to 75 percent of the premiums we charge are actually refundable after a 10 year loss experience period. In fact, we've been making refunds every year since 1967 which is an indication of the safe record of the industry we insure.

On the terrorism issue, as I said, we have elected to continue to insure terrorism but we have imposed an industry aggregate of $200 million but again, the secondary policy will sit on top of that.

Senator INHOFE. Do other countries have the secondary financial protection program comparable to Price-Anderson? What do other countries do?

Mr. QUATTROCCHI. As a matter of fact, no other country has this system of protection. In every country I'm aware of, they essentially have a system that is very similar to Price-Anderson back in 1957. In other words, there is required insurance and then there is government indemnity which applies in excess of that. So there is no joint liability that has been accepted by utilities anywhere else but in the U.S.

Senator REID. Senator Voinovich?

Senator INHOFE. Let me make one last comment. I know I'm out of time and won't be able to stay for another round but I do have some questions for the record I'd like to submit to each of the witnesses.

Senator REID. I think we all have additional questions and I would ask panel members, our staff will give you these questions and within two weeks, if you'd get the answers back to us, we'd appreciate that.

Senator Voinovich?

Senator VOINOVICH. Mr. Bradford, you raise the concern in your testimony that nuclear facilities are only covered by $9 billion. Do you know of any other industry out there that has a $9 billion policy of coverage, any coal unit, natural gas, chemical, large manufacturing facility that does? It seems to me that the nuclear power industry is the most insured industry that we have. You talk about

this being a subsidy because there is a limit at the other end, but the fact of the matter is they do pay premiums every year for this insurance coverage.

One other thing that really needs to be pointed out, and we forget this, that all the costs we're talking about here are paid for by the ratepayers. It's interesting to me that there are so many people opposed to nuclear energy, and you raise a good point, Ms. Brinkley, about the fact it is about Yucca Mountain, what are we going to do with the waste an that question needs to be resolved if we're going to go forward at all with nuclear energy. That is one hopefully we will resolve this year.

Once that is resolved, the fact of the matter is all of these costs have to be picked up by the consumers. If we eliminate nuclear energy then we have to go to some other resources. Many people in your part of the country—there is a bill in here that will prevent us from burning coal which provides 50 percent of the energy across the country, and in my State, 80 percent.

So if you eliminate nuclear, you eliminate coal, all you're left with is gas, hydro and renewables. The fact of the matter is it's going to be a long time before these renewables are going to be fiscally and from an efficient point of view, available to provide energy for this country. So we have somewhat of a dilemma. How do we balance all of these different things that need to be taken care?

I'd like to take the rest of my time, Mr. Chairman, and give Mr. Fertel or Mr. Quattrocchi a chance to respond to anything else they'd like to respond to because they are the experts. Mr. Fertel, I'll call on you first.

Mr. FERTEL. I'd like to make two points. As Ms. Brinkley said, living around nuclear plants and their vicinity is something everybody wants them to be safe. Well, all the people that work at the plant live around the plant with their families. I think one thing you might benefit from is going to visit some plants and talking to the people there. No one wants them to operate safer than the guys that are there.

Senator VOINOVICH. Doesn't Homer Simpson work in a plant?

Mr. FERTEL. He "works" in Hollywood. That's fantasyland, sir. We'd love to take you to a plant if you'd like to visit one.

The other point that Peter Bradford was making was that with the competitive market, the subsidy to nuclear. I think if you see what's happening in the electricity markets now what you'd find is the nuclear plants are our most cost effective source of electricity. They are being dispatched 24 hours a day, 7 days a week, 365 days a year because there's cheap electricity put out on a grid. They have no problem competing. The subsidy is not there. The $88 billion liability is shown in the financial reports that the companies have. Nobody else shows any liability potential because they don't have that obligation.

If we have an Enron situation today, one of the things people are concerned about, they have a problem, it's a catastrophe, they don't have the assets. One thing they do have, Mr. Quattrocchi, is their insurance and they have all these other people out there that are going to be held responsible to pay for their problem, and they are exempted from certain tort liability defenses that industries can use. If you have an accident, immediately they start moving in to

pay for it. They can't raise the argument that it wasn't our fault or something else happened as a result of that. It's no fault insurance.

Mr. QUATTROCCHI. Let me make two quick points on the issue of a subsidy. A subsidy is usually defined as the transfer of government funds to a private entity. That is simply not the case in this business.

Second point, the insurance industry has a great deal of experience in handling litigation that has been unfettered by limits on liability. I mentioned in my testimony that no case comes to mind more poignantly than the Bhopol accident in 1984. After flirting with bankruptcy, Union Carbide ultimately settled that case for $470 million or roughly $1,000 for every person killed or injured. There was no limit.

Senator REID. Is that something you're proud of?

Mr. QUATTROCCHI. That's not something I'm proud of. I'm proud of the fact that the Price-Anderson system serves the public interest in a way that the absence of a limit on liability would not, Senator.

Senator REID. I would just say you'd better refine that answer a bit. The fact of the matter is one reason it settled so cheaply is it was some foreign country it happened in and if it had been in American courts, you know that wouldn't have happened.

I would also say in response to my friend, Senator Inhofe, when he makes the comment this committee doesn't have jurisdiction, this committee may not have jurisdiction of a lot of things but we have other responsibilities in the Senate and one of the things is I'm chairman of the Energy and Water Appropriations Subcommittee where we deal with energy we funded. So this testimony is extremely important.

I would also say that I really appreciate Ms. Brinkley's answer. One of the reasons we're not doing more with wind and other alternative energies is we in Congress have done nothing to support it. No wonder we are 10 or 15 years away. We have had to fight for skimpy dollars every year we have a bill. I recognize it is not going to change overnight but we have to start changing, in my opinion, our dependence on a number of things.

I would also say to you, George, Senator Voinovich, no matter what happens with the Secretary of Energy's recommendation on Yucca Mountain, it's not going to end this year. This is only a recommendation as to what should happen with nuclear waste. The Nuclear Regulatory Commission will spend at least ten years trying to figure out if Yucca Mountain can be licensed.

Mr. Bradford, could I ask you to respond to the statements by Mr. Fertel about why they really don't get a subsidy?

Mr. BRADFORD. I think it's important to distinguish between two parts of Price-Anderson and also with regard to Senator Voinovich's question. The retrospective premium elements, the money that is there up to $9 billion is not where the subsidy is. The subsidy is in the limitation on liability above that amount.

Senator VOINOVICH. Isn't that a subsidy also if you want to call it a subsidy to the ratepayers? What we forget about here is the companies are paying this money, the companies make x profit and

they pass it on to their customers. Ultimately, it's the consumer that pays for this one way or the other.

Mr. BRADFORD. If it's a subsidy to the customer and since restructuring I've stopped using the word ratepayer, if it's a subsidy to the customer, it comes at the expense of people living around the powerplants. In essence what's happening is that risk is being transferred, both risk of harm and risk of loss of money, onto the people around the powerplants or if Congress steps up and makes them whole, to the U.S. taxpayer. That risk is being shifted off the nuclear powerplant owner and as you suggest, probably also off the consumer of nuclear power. That's why that is a subsidy that works against not just wind and photovoltaics, but also against any inherently safe forms of nuclear energy.

Senator VOINOVICH. You're saying it gives them an advantage because of down the road protection of not being vulnerable in terms of liability. That's one way of looking at it. The other way of looking at it is what business entity in this country, and we have a lot of dangerous businesses in this country, have required they have to have $200 million worth of insurance each year and then everybody else in the industry says if something happens to them, we're going to let you use our insurance and by the way, for the next ten years, eight years or whatever, we're going to kick in $10 million a year to take care of providing for those people and businesses that have been injured? There's the other side of this coin that seems to be forgotten here.

Mr. BRADFORD. It is a subsidy that shows up in the short term because the cost of capital of the powerplant owner is lower to the extent that the investor receives a lower risk because there is a limit on the potential liability. So it is not a distant subsidy.

Secondly, other industries and other forms of electric power generation just don't have what that 1957 study, WASH 740, described as the ability to render an area the size of the State of Pennsylvania uninhabitable and to do the levels of damage that a nuclear powerplant could do. When you say that a coal plant or a set of wind generators doesn't have a limit on it.

Senator VOINOVICH. I'm talking chemical. There's all kinds of industries that could cause terrible damage to society. All I'm saying is you make a point but the other side of the coin is that there is coverage there for people that are injured and you might argue that it's not going to be enough to take care of their problems and in that case they'd come back to Congress and probably ask us, like they are in New York today, to come forward with additional money to help pay for that.

Senator REID. That's his whole point. That's the whole point he's making.

Senator VOINOVICH. The whole point is that there are people in this country that want to eliminate nuclear energy and I'm saying at this stage of the game, we have a problem of providing energy for those people who need energy today and take care of our energy needs in the future and what we're asking for is a renewal of something that's been around a long time so that we can continue to do that and hopefully expand as time goes on.

Senator REID. I don't think Mr. Bradford is talking about eliminating nuclear power. I haven't heard you say that.

Mr. BRADFORD. As others have said, if you remove the liability limit in reauthorizing Price-Anderson, indeed if you didn't reauthorize Price-Anderson, it would remain in effect for the existing plants. So the idea that 20 percent of the Nation's electric capacity will disappear if Price-Anderson is substantially modified just doesn't hold. What we're talking about is what kind of incentives removing the liability limit would give to the types of electric generation or the investments in energy efficiency—

Senator VOINOVICH. Mr. Bradford, that's the question I asked before and Mr. Quattrocchi, you're the insurance man. What's your answer to that? That is a very good point he makes, why bother with reauthorizing Price was the first question I asked. Why bother reauthorizing it if it takes care of the people already in the business? Why bother?

Mr. QUATTROCCHI. Let me make a point.

Senator REID. Let me say this: this committee has jurisdiction over any perspective powerplants, nuclear power plants. We have no jurisdiction over those already in operation as far as Price-Anderson. That's the arrangement that was made with Jeff Bingaman, chairman of the Energy Committee, so these hearings relate to what's going to happen in the future with nuclear power. Please go ahead.

[NOTE: Upon reviewing his statement, Senator Reid provided the following clarification for the record: "Since no action on the Price-Anderson Act would leave existing plants unnaffected, I am particularly interested in its effect on potential new nuclear power plants. I recognize that the Environment and Public Works Committee has jurisdiction over all Nuclear Regulatory Commission licensed facilities—existing and prospective. I have discussed this with several members."]

Mr. Quattrocchi. In my view as an insurer, the Act represents a balancing of interest between the public interest and the need for insurers and nuclear operators to have a certain semblance of certainty and predictability. If you take away one leg of a three-legged stool, in this case the limit on liability, the stool will fall over. For example, without a limit on liability, how many utilities would accept joint liability, responsibility for an accident in California for which a utility in New York is now responsible to pay retro premium? How many utilities would continue to accept that responsibility? I think, Senator, very, very few, if any.

Senator REID. Let me ask one last question. As I understand Price-Anderson if there were a catastrophic incident, then there is a responsibility to come forward with money.

Mr. FERTEL. Yes. Even short of that, there is a responsibility to come forth with money.

Senator REID. What would happen if there were a catastrophic accident, wouldn't that mean there would be less ability to come forward and these companies would be in bad shape? Where are we going to get the money? Mr. Guttman?

Mr. GUTTMAN. Yes, you're talking about the deregulation effect and the question I have is, is it possible that will make it even worse because you may have all your eggs in one company basket in Excelon or standalone plants which are limited in liability so that they have no other source? If the insurance industry is now

saying they are going to cover terrorism in their first $200 million, what does that mean about the rest? That's nice but now you have real ambiguity. I go to court representing all these fine folks, do I say it's not the first $200 million, it's the whole $9 billion? Where is that addressed in what you're thinking of because Senator Voinovich is saying the industry is paying for this. They're paying for it in the first $200 million. I think Mr. Bradford, Ms. Brinkley and I are saying the lion's share, and what you're suggesting, is the retrospective payment which is put at risk by the deregulation and restructuring and have not been studied and the NRC say we should look at this carefully.

Senator REID. The subcommittee stands in recess.

[Whereupon, at 11:50 a.m., the subcommittee was adjourned, to reconvene at the call of the chair.]

[Additional statements submitted for the record follow:]

STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

I want to thank the witnesses for being here today to discuss the reauthorization of the Price-Anderson Act.

As many of you know, Price-Anderson has been with us for a long time.

The Act was first established almost 50 years ago for two purposes:

First, to allow for the commercial use of nuclear energy by providing liability certainty to a complex, untested technology;

Second, to assure compensation to the public in the event of an accident

I think we all agree that it has performed the first function well—that was the easy part.

But it is the second that we must really address—that is the real challenge.

We must not shirk that responsibility. You know the builders of the Titanic told people it was unsinkable, and only when the boat was in the water did its vulnerabilities become apparent.

Thankfully, the Price-Anderson ship has not been put to the test yet. I hope it never is—but we must prepare for that possibility. And it is our job to make sure we don't skimp on the legislative lifeboats.

What should we do?

The nuclear power industry went through its troubled teenage years during the 1970s, moved through adolescence and has now settled into a comfortable middle age. It no longer needs the federal government to nurture it.

Over the years, Price-Anderson has shifted more to fulfilling the second goal—providing the public with compensation in the event of a catastrophic nuclear accident.

But the law has become an upgraded Model T, with original parts and newfangled additions that just don't match. What we really need is a brand new vehicle, one that is designed using today's understanding to secure tomorrow's energy industry.

The generation and selling of electricity are very different today than 50 years ago. For better or worse, we now have unregulated electricity markets in many states, where competition is king and consumers are no longer captive to rate monarchies.

A new electricity market demands a new Price-Anderson system.

This is not an easy task, however. The basic problem appears to be that the costs of an accident would be just too big. How big? The General Accounting Office reported in 1986 that the costs could be in the tens of billions or even in the HUNDREDS of BILLIONS depending on which way the wind is blowing.

There can be no doubt that without some form of insurance, no nuclear power plant has the assets to cover the costs of a truly catastrophic accident. The utility would simply go bankrupt first.

Unfortunately, even after 50 years, the private insurance industry still is only willing to insure a nuclear power plant for a few hundred million dollars—much less than the likely cost of a truly catastrophic accident. The bulk of the Price-Anderson insurance comes from the industry's promise to share the burden and costs—up to $9 billion—in the event of an accident.

That's like promising to pay your health insurance premiums only after you've been diagnosed with a debilitating disease—a disease that will keep you bedridden for years, unable to work or otherwise take care of yourself. NO insurance company

would be willing to let you get away with that. And we cannot allow nuclear power plants to operate without adequate insurance.

The question we then have to ask is how can we fill the void left by the private insurance companies and insure nuclear power plants for a reasonable sum, in a way that is both fair to potential accident victims and guarantees payment in the event of an accident.

Or perhaps the first question is why we should do this when we don't do it for other industries. Maybe the market decision not to insure nuclear power plants adequately means nuclear plants should not be built, especially now that other, safer alternative energy sources are available.

Today, I hope to hear our witnesses address these issues.

STATEMENT OF HON. JAMES M. JEFFORDS, U.S. SENATOR FROM THE STATE OF VERMONT

I am pleased to be here this morning to hear testimony regarding reauthorization of the "Price-Anderson" provisions of the Atomic Energy Act. My good friend Senator Reid, who as subcommittee chair has called this hearing, will be delayed slightly, so I am happy to proceed this morning on his behalf.

Price-Anderson was enacted in 1957 as an amendment to the Atomic Energy Act. Its purpose was to ensure that adequate funds would be available to compensate victims of a nuclear accident, and to remove the threat of unlimited liability that would deter private companies from engaging in nuclear activities.

Price-Anderson is due to expire on August 1, 2002. However, existing Price-Anderson coverage for already-licensed power plants will not expire, since under the law, existing power plants are covered for the lifetime of the facility. The Price-Anderson coverage we are talking about is that which will apply to any new facilities licensed after August. Nuclear power supplies a very important part of our energy mix. In Vermont, nuclear power from the Vermont Yankee plant provides almost 30 percent of our electricity, as well as providing electricity to other New England States. Nationwide, nuclear power produces 20 percent of our electricity use. As an emissions-free energy source, it has many benefits.

However, nuclear energy is also burdened with serious concerns over waste disposal, and safety. Price-Anderson acts as a means of encouraging the development of nuclear power, and also sets a framework for providing financial coverage in the event of an accident at any of our nation's nuclear power facilities. Price-Anderson provides several important public benefits including simplifying claims in the event of an accident, and providing for immediate reimbursement in the case of an emergency. There are nonetheless a number of very legitimate questions about the appropriateness and adequacy of this legislation.

For example, how do we best ensure that companies have sufficient financial resources to pay the deferred premiums, which are not due until an accident occurs but which form the bulk of the coverage amounts?

Also, while the approximately $9 billion coverage, per nuclear accident, that Price-Anderson would supply is high in terms of insurance coverage, is it sufficient to cover the actual public and private costs of a catastrophic nuclear accident?

Price-Anderson was initially contemplated as temporary coverage to help a fledgling industry. Should that coverage now be extended indefinitely as some would suggest? Does this kind of insulation from liability, with the Federal government bearing responsibility for anything above the $9 billion per accident coverage, unfairly benefit the nuclear industry over other desirable energy forms such as wind and solar? Is existing Price-Anderson coverage sufficiently broad to cover terrorist acts?

These are all very important issues, and I thank today's witnesses for sharing their time and expertise with the committee.

STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Last September, when I attempted to attach a national energy policy to the defense bill, I argued that a diverse and domestically produced energy supply was key to our national and economic security. I have been saying this for almost 20 years now. In the 1980's, when I was in the House, Secretary of Energy Don Hodel and I went on a national speaking tour on energy policy. Our message was that our nation must have adequate supply of energy at competitively sound prices to ensure national and economic security. This same message endures and applies today.

We must utilize the broadest possible base of our God-given resources: nuclear, oil, gas, coal, alternative, sun, wind, and conservation itself—among others—as a means of making these resources more available.

Currently, 103 U.S. nuclear units supply about 20 percent of the electricity produced in the United States. Going forward into the future, nuclear energy must be a key component of any national energy plan. The first step in that direction must be Price-Anderson Reauthorization. The Administration's National Energy Policy Development group agrees with this statement. I would like to insert the National Energy Policy Development group's findings and recommendations regarding nuclear energy into the record.

Because nuclear energy is an emission-free source of electricity, nuclear energy is also a key component to our national clean air goals. Each year, according to the Nuclear Energy Institute, U.S. nuclear power plants prevents 5.1 million tons of sulfur dioxide, 2.4 million tons of nitrogen oxide, and, 164 million metric tons of carbon from entering the earth's atmosphere.

Furthermore, as a former insurance executive, I think Price-Anderson, as an insurance program, is a good deal for the public. For over 45 years, Price-Anderson has:

- provided immediate and substantial private compensation to the public in the event of a nuclear accident;
- provided coverage for precautionary evacuations and out-of-pocket expenses;
- reduced delays often inherent in tort cases; and
- consolidated all cases into a single federal court.

Price-Anderson renewal enjoys substantial bi-partisan support. Both the Bush Administration and the previous Clinton Administration, which had submitted reports from NRC and DOE in the late 1990s supporting renewal of the Act with few changes, support reauthorization. The House has already passed by voice vote a Price-Anderson reauthorization bill that makes few changes to the commercial reactor provisions of the law.

While I understand that the chairman and others have concerns about Price-Anderson, we must work together to get this done by this August it is essential to the future of our national, energy, and environmental security.

STATEMENT OF HON. GEORGE V. VOINOVICH, U.S. SENATOR FROM THE STATE OF OHIO

Mr. Chairman, thank you for holding today's hearing on the reauthorization of the Price Anderson legislation.

As you know, I have introduced the Bill to reauthorize the Price Anderson Act, S. 1360. My Bill is cosponsored by Senator Smith and Senator Inhofe, the ranking members of both the full and subcommittee, and I appreciate their support on my legislation.

Mr. Chairman, as you know this law was first passed in 1957 and has been renewed three times since. The current version expires on August 1st of this year. Mr. Chairman, this is important legislation which provides the insurance program for commercial nuclear power plants and Department of Energy facilities.

I am pleased that the House of Representatives passed their version of the Bill on November 27th last year, and I hope that this committee and the Senate can move quickly to reauthorize this program early this year. This is the type of must-pass legislation that keeps the trains of government running on time.

I think it is important to note that during the previous Administration, both the Department of Energy and the Nuclear Regulatory Commission issued reports to Congress recommending the reauthorization of the law.

The Reports also called for a doubling of the annual premium paid by the nuclear reactors from $10 million to $20 million. This recommendation was made prior to the relicensing process and at that time the NRC projected that up to half of our nuclear reactor fleet would retire instead of being relicensed. However, thanks to the regulatory improvements made to the process, largely due to the oversight of this subcommittee, the NRC believes that most of our nuclear reactors will in fact be relicensed. Therefore, the NRC issued a statement last year revising their projections and recommending that the annual premium not be increased, and our legislation follows their recommendations.

Mr. Chairman, currently nuclear energy provides approximately 20% of our energy needs while fossil fuels such as coal and natural gas provide the bulk of the remainder. Coal and nuclear power have been inappropriately demonized over the last few years but the fact of the matter is both are efficient and cost-effective

sources of energy, and like it or not we are going to be dependent upon them for the foreseeable future.

Like many of my colleagues, I support investing in renewable energy. As a matter of fact, the Murkowski energy bill, which I am a co-sponsor, the first title is energy conservation, and the second is renewable energy. We provide over $5 billion for energy efficiency activities and $1.3 billion for renewable fuels; nevertheless we need to understand that wind and solar currently provide less than 1/10 of 1% of our energy needs. Even with significant investment these sources would not come close to meeting our growing energy demand, or replace our current energy sources.

It is extremely important that we maintain and expand nuclear power if we are to meet current and future energy needs. This legislation is fundamental to that happening as well as to providing insurance for the Department of Energy facilities.

Mr. Chairman, again I appreciate you holding this important hearing. I realize you have issues regarding the status of Yucca Mountain but I appreciate your ability to separate the renewal of this relatively non-controversial program from the larger issue of waste storage. This program is important to the thousands of government contractors who work for DOE and to our nation's nuclear reactors. Thank you.

STATEMENT OF WILLIAM F. KANE, DEPUTY EXECUTIVE DIRECTOR FOR REACTOR PROGRAMS, U.S. NUCLEAR REGULATORY COMMISSION

Mr. Chairman, Members of the subcommittee, I am pleased to appear before you today to present the views of the Nuclear Regulatory Commission (NRC) on extending and amending the Price-Anderson Act.

As you know, legislation will be needed to extend the Price-Anderson Act. The Act, which expires on August 1, 2002, establishes a framework that provides assurance that adequate funds will be available to compensate the public in the event of a nuclear accident and sets out a process for considering nuclear liability claims. Without the framework provided by the Act, new private-sector participation in nuclear power would be discouraged because of the risk of potentially large liability claims if such an accident were to occur.

I am here to deliver the strong and unanimous recommendation of the Commission that the Price-Anderson Act be renewed with only minor modifications. However, I would like to preface my statement of that position with the reminder that the Commission's primary concern is public health and safety. We are not a promotional agency. Our mission is to ensure the safe use of nuclear power and materials. We can look back on a successful history of safe operation and intend to exercise vigilance to maintain or improve on this record of safety. Nonetheless, it remains important to assure that if an improbable accident should occur, the means are provided to care for the affected members of the public.

As you know, Congress first enacted the Price-Anderson Act in 1957, nearly a half century ago. Its twin goals were then, as now:

- to ensure that adequate funds would be available to the public to satisfy liability claims in a catastrophic nuclear accident; and
- to permit private sector participation in nuclear energy by removing the threat of potentially enormous liability in the event of such an accident.

On original passage the Congress provided a term during which the Commission could extend Price-Anderson coverage to new licensees and facilities. When that term expired, the Congress then, and repeatedly since, decided that the nation's energy policy would be served by extending the Price-Anderson Act so that coverage would be available for newly licensed reactors. This action preserved the option of private sector nuclear power and assured protection of the public. At this point, in order to avoid confusion, I should note that Price-Anderson coverage for NRC licensees is granted for the lifetime of the covered facilities and does not "expire" in 2002. Thus, in any event, Price-Anderson coverage with respect to already licensed nuclear power reactors will continue and will afford prompt and reasonable compensation for any liability claims resulting from an accident at those facilities.

While Congress has amended the Price-Anderson Act from time to time, it has done so cautiously so as to avoid upsetting the delicate balance of obligations between operators of nuclear facilities and the United States government as representative of the people.

Perhaps the most significant amendments to date were those that effectively removed the United States government from its obligation to indemnify any reactor up to a half billion dollars and instead placed that burden on the nuclear power industry. Congress achieved this by mandating in 1975 that each reactor greater than 100 MW, essentially each reactor providing power commercially, contribute $5 mil-

lion to a retrospective premium pool if and only if there were damages from a nuclear incident that exceeded the maximum commercial insurance available. The limit of liability was then $560 million. Government indemnification was phased out in 1982 when the potential pool and available insurance reached that sum.

In 1988, Congress increased the potential obligation of each reactor in the event of a single accident at any reactor to $63 million (to be adjusted for inflation). The maximum liability insurance available is now $200 million. When that insurance is exhausted each reactor must pay into the retrospective premium pool up to $83.9 million, as currently adjusted for inflation, if needed to cover damages in excess of the sum covered by insurance. The $83.9 million is payable in annual installments not to exceed $10 million. Today, the commercial insurance and the reactor pool together would make available over $9 billion to cover any personal or property harm to the public caused by an accident.

In 1998, as mandated by Congress, the Nuclear Regulatory Commission submitted to the Congress its report on the Price-Anderson system. The report included a concise history and overview of the Price-Anderson Act and its amendments as well as an update on legal developments and events pertaining to nuclear insurance and indemnity in the last decade. Congress had also required the NRC to address various topics that relate to and reflect on the need for continuation or modification of the Act: the condition of the nuclear industry, the state of knowledge of nuclear safety, and the availability of private insurance.

After considering pertinent information, the Commission considered what its recommendations should be. It concluded then that it should recommend that Congress renew the Price-Anderson Act because it provides a valuable public benefit by establishing a system for the prompt and equitable settlement of public liability claims resulting from a nuclear accident. That, as I said at the outset, remains today the strongly held position of the Commission.

Having noted that substantial changes in the nuclear power industry had begun and could continue, the Commission believed it would be prudent to recommend renewal for only 10 years rather than the 15-year period that had been adopted in the last reauthorization so that any significant evolution of the industry could be considered when the effects of ongoing changes would be clearer. Notwithstanding that view, the Commission recommended that the Congress consider amending the Act to increase the maximum annual retrospective premium installment that could be assessed each holder of a commercial power reactor license in the event of a nuclear accident.

The NRC suggested that consideration be given to doubling the ceiling on the annual installment from the current sum of $10 million to $20 million per year per accident. The total allowable retrospective premium per reactor per accident was to remain unchanged at the statutory "$63 million" adjusted for inflation. (It is now $83.9 million as so adjusted). The Commission recommended consideration of an increase to $20 million because it then appeared likely that in the coming decade a number of reactors would permanently shut down. The effect of these shutdowns would have been to reduce the number of contributors to the reactor retrospective pool. Fewer contributors would, in turn, reduce the funds that, in the event of a nuclear accident, would become available each year to compensate members of the public for personal or property damage caused by an accident. Increasing the maximum annual contribution available from each reactor licensee would provide continuing assurance of "up front" money to assist the public with prompt compensation until Congress could consider whether to enact additional legislation providing further relief, should it be needed.

Further developments in the electric generation industry since the 1998 report to Congress have led the Commission to review its 1998 recommendations and to reevaluate its recommendation that Congress consider increasing the annual installment to $20 million. There is now a heightened interest in extending the operating life for most, if not all, of the currently operating power reactors, and some power companies are now examining whether they wish to submit applications for new reactors or complete construction of reactors that had been deferred. As a result, contrary to our former recommendations, the Commission does not believe that there is now justification for raising the maximum annual retrospective premium of $10 million. This level is adequate and does not need to be changed.

In summing up, I would like to leave these thoughts with you. To date, the United States government has not paid a penny for claims against nuclear power plant licensees. In the event a serious accident were to occur, over $9 billion will be available to pay compensation for any personal injury or offsite property damage. The money will come from insurance policies bought by the industry and from retrospective premiums that will be paid by industry. If those funds are inadequate, Congress will be called upon to decide what action is needed to provide assistance to those

harmed. We believe the public is protected by the broad base of prompt funding. The Price-Anderson Act further aids the public by establishing important procedural reforms for claims arising from nuclear accidents. It channels liability to the licensee, establishes a single Federal forum for all claims, eliminates the need to prove fault, requires waivers of other significant defenses, makes prompt settlements possible, and, if litigation is needed, establishes legal management processes to assure fairness and equity in distribution of damage awards.

The Commission reiterates its support for the Price-Anderson Act Reauthorization.

Thank you Mr. Chairman. I welcome your comments and questions.

RESPONSES OF WILLIAM F. KANE TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1. In Mr. Guttman's testimony, he raises concerns about the adequacy of the NRC's oversight of the decommissioning funds as utilities restructure. He quotes from a December 2001 GAO Report, which criticizes the consistency of NRC oversight. Could you comment on this report?

Response. The NRC is completing its comments on the final report and will send them to GAO and Congress, as required. The comments will also be submitted for the hearing record.

Question 2. It is my understanding that the Clinton Administration called for the reauthorization of Price-Anderson with very few changes. Is this correct and could you summarize the changes that were requested?

Response. Both the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) during the Clinton Administration submitted statutorily mandated reports to Congress on the reauthorization of Price-Anderson. In their respective reports, both NRC and DOE recommended that the Act be renewed.

In its 1998 report which solely addressed application of the Price-Anderson Act to incidents arising from NRC regulated facilities, the NRC concluded that, in view of the strong public policy benefits in ensuring the prompt availability and equitable distribution of funds to pay public liability claims, the Price-Anderson Act should be extended to cover future reactors. The Commission recommended that the same amount, type and terms of public liability protection required for current licensees should be required for future plants. In its only significant recommended change, the NRC suggested that Congress consider increasing the maximum annual installment on the retrospective premium that each reactor licensee would be responsible to pay following an accident from $10 million to $20 million. However, the NRC did not recommend a change in the total maximum retrospective premium amount, now $83.9 million. As you are aware, the Commission has subsequently withdrawn its recommendation that the $10 million maximum annual retrospective premium be raised. (See Response to Senator Reid's Question 1.)

The DOE report (which presumably represented the views of the Clinton Administration) addressed the Price-Anderson Act solely with respect to DOE's facilities and contractors, subcontractors and suppliers. DOE recommended renewal with very few changes.

The report contained five recommendations: (1) The DOE indemnification should be continued without any substantial change; (2) The amount of the DOE indemnification should not be decreased; (3) The DOE indemnification should continue to provide broad and mandatory coverage of activities conducted under contract for DOE; (4) DOE should continue to have authority to impose civil penalties for violations of nuclear safety requirements by for-profit contractors, subcontractors and suppliers; and (5) The Convention on Supplementary Compensation for Nuclear Damage should be ratified and conforming amendments to the Price-Anderson Act should be adopted.

RESPONSES OF WILLIAM F. KANE TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

Question 1. In past years there have been a number of studies that predict losses of life and massive property damage. These studies put forth numbers that are in the range of $59 billion to over $300 billion.

For what purpose were these studies conducted and what relevance do they have to liability coverage provided by the Price-Anderson Act?

Response. There have been a number of studies done over the years on the probabilities and consequences of nuclear accidents. Some of the studies have been done by AEC, NRC, DOE, and other, non-governmental groups. The NRC did not sponsor

and was not involved with studies that indicated damages in the range of $59 billion to over $300 billion. Thus, the NRC is unable to comment on the purposes of these studies and has no opinion on their relevance.

However, the studies that the AEC and NRC did sponsor were used primarily to evaluate the risk of severe accidents at nuclear power plants and to develop appropriate regulations and reactor oversight to minimize those risks. The studies were not used directly as a basis by Congress to establish the limit of liability under the Price-Anderson system. The NRC believes that the potential damages from most serious accidents would be covered by the current limit of liability of approximately $9 billion. In 1975, Congress explicitly committed to take necessary action to protect the public from the consequences of a disaster of such magnitude. In the 1988 Amendments, Congress redefined the procedures it would follow and described the goal as "full and prompt compensation" to the public for "all public liability claims" resulting from such a significant incident. SENATOR INHOFE

Question 2. Given the deregulation of electricity markets, can we be reasonably assured that utilities can pay the retrospective premiums? What would happen if a company declared bankruptcy, as did Pacific Gas and Electric Company?

Response. Under 10 CFR 140.21, the NRC requires its reactor licensees that are covered under the Price-Anderson system to provide annual guarantees of payments of retrospective premiums. These guarantees are applicable to rate deregulated companies as well as traditional electric utilities.

Under Part 140, a licensee is required to pay the retrospective premium, notwithstanding its financial status. However, the NRC could potentially face a conflict with other claims in a bankruptcy proceeding if there were an accident sufficient to trigger a retrospective premium assessment. The NRC would presumably require a licensee to pay the assessment, but the bankruptcy court could order the licensee not to pay it.

In the specific case of Pacific Gas and Electric Company's (PG&E) Chapter 11 filing, the NRC is being represented by the Department of Justice. It is unlikely that this issue will be specifically addressed unless there is an actual accident triggering a retrospective premium assessment during PG&E's time in bankruptcy. Also, as a practical matter based on previous utility bankruptcies, it is likely that the bankruptcy court will take on the order of 2 to 3 years to restructure PG&E's debts and complete the bankruptcy proceeding. Even if a severe accident occurs during this time, it is likely that the primary, $200 million layer will be sufficient to handle any short-term claims. Latent injury claims will take several years to arise and, even with the relatively streamlined Price-Anderson claims settlement structure, many shorter-term claims will likely end up before a Federal court for several years, with the result that retrospective premiums may not need to be called for until after a licensee emerges from bankruptcy.

Although a conflict between the NRC and other claims in a bankruptcy proceeding is possible, the NRC has had positive experiences so far with bankruptcy courts that have overseen Chapter 11 reorganizations of power reactor licensees. (So far, no power reactor licensees have filed for Chapter 7 liquidation. Because generators of electricity typically provide an essential service, it is unlikely that they would be liquidated unless their assets had become worthless. If liquidated, the reactor, as a valuable economic asset, would likely be sold to another company at the direction of the bankruptcy court and after approval by the NRC.) In the cases of Public Service Company of New Hampshire (Seabrook), Cajun Electric Cooperative (River Bend), El Paso Electric (Palo Verde), and Vermont Electric Generation & Transmission Cooperative (Millstone 3), the bankruptcy courts allowed these bankrupt licensees to pay all safety-related operational and decommissioning expenses (including, we understand, Price-Anderson primary layer and onsite property insurance premium payments). During its bankruptcy, PG&E has continued to meet all safety-related expenses for its nuclear plants.

The NRC has sought legislation from Congress to ensure that decommissioning costs receive explicit priority in bankruptcy proceedings. So far, the legislation has not been enacted. The NRC would support legislation to prioritize safety-related claims in bankruptcy proceedings and to address any potential conflict between the requirement to pay retrospective premiums and other claims in a bankruptcy proceeding if Congress determines such legislation would be appropriate.

RESPONSES OF WILLIAM F. KANE TO ADDITIONAL QUESTIONS FROM SENATOR GRAHAM

Question 1. Mr. Fertel of the NEI has testified that the groundwork is being laid for smaller modular reactors to come online. It was Mr. Fertel's testimony that Price-Anderson be amended to include these smaller reactors. You mention that the

industry has undergone and could still undergo substantial change but make no mention of modifications to allow for these new types of power plants. Do you agree that these smaller reactors should come under the auspices of Price-Anderson?

Response. Any reactor, no matter what its capacity, is mandatorily indemnified under the provisions of the Price-Anderson Act. Under current law even the smallest of the modular reactors under consideration would be required to buy the maximum insurance and be responsible for retrospective premiums. What the proponents of modular reactors seek is to allow these smaller reactors to be grouped and to buy the maximum insurance available for one reactor and to pay only one retrospective premium. The Commission agrees that the modular reactors should be covered under Price Anderson. However, the Commission has not taken a position whether modular reactors should be given special treatment. At the request of Senator Murkowski, the Commission provided the attached language to accomplish the grouping of modular reactors for the purposes of the retrospective premium without taking a position on whether the proposal should be enacted. In the bill that was passed by the House last year, H.R. 2983, provisions were included to address this issue.

RESPONSES OF WILLIAM F. KANE TO ADDITIONAL QUESTIONS FROM SENATOR REID

Question 1. In 1998, the NRC recommended raising the retrospective premium to $20 million from $10 million. The NRC has recently reversed this position, because it appears many plants will not be shut down. It would appear that having more utilities seek license extensions would indicate the industry is more, not less viable. In real dollars $10 million is much less today than it was in 1988. If the industry is more viable today than anticipated, shouldn't the industry be able to make a larger annual payment or at least one that keeps up with inflation?

Response. In a letter dated May 11, 2001, from Chairman Meserve to the Congress, the NRC indicated that it was withdrawing its previous recommendation that Congress should consider raising the maximum annual retrospective premium to $20 million and recommended, instead, that the premium remain at the current $10 million level. The annual retrospective premium determines the rate at which the funds for the retrospective premium pool will be collected. It does not influence the total amount to be collected in the retrospective premium pool. That amount remains the same despite a change in the retrospective annual premium. When the NRC made its original recommendation to Congress in 1998 that the annual retrospective premium be increased from $10 million to $20 million, the NRC was concerned that projections of reactor shutdowns would decrease the available pool of reactor licensees to pay retrospective premiums. However, recent changes in the industry suggest that the NRC's original concerns have been substantially met by revised decisions to continue plant operation, due, in part, to the expectation of the nuclear industry that most, if not all, power reactors will seek license extension.

The NRC also notes that, while the $10 million annual retrospective premium assessment has not been indexed to inflation, the overall assessment per reactor has been indexed. Thus, assuming that the number of reactors in the retrospective premium pool essentially remains the same, the overall amount of funds available for payment of claims under Price-Anderson will increase over time as the overall payments are adjusted for inflation. For example, a licensee of a single plant would be liable for a payment of $83.9 million per accident. This amount would be payable of a maximum of $10 million annually for approximately 8.4 years. As the $83.9 million payment is increased to take into account inflation, the licensee would still be required to pay only $10 million each year, but would be obligated to pay over a longer period until the total assessment were paid.

Because the bulk of claims arising from a serious accident are likely to arise from latent injuries that may take years, or even decades, to appear, the NRC does not believe that keeping the maximum annual retrospective premium assessment at $10 million will limit the amount of funds available to claimants when actually needed. Further, the Price-Anderson Act (Section 170(o) of the Atomic Energy Act) provides that no more than 15 percent of the limitation of liability, which is approximately $1.35 billion, can be paid out before a Federal district court is required to approve a plan for distribution of Price-Anderson funds. With the current $10 million annual retrospective premium assessment and 106 reactors presently under the system, a total of $1.26 billion, including $200 million in primary insurance, is available to pay shorter-term claims. Therefore, it is not necessary to increase the annual retrospective premium to pay for shorter-term claims that would be subject to detailed judicial review over several years.

Question 2. Under the Price-Anderson Act, if the NRC determines that assessing payment of insurance premiums including the $10 million per year annual premium would result in undue financial hardship or there was more than one nuclear incident in a year, funds would be sought from the U.S. Treasury to pay these costs. What rules does the NRC [have] in place that state the criteria and process by which such determination will be made, and to identify the steps to be taken if a financial hardship determination is made.

Response. The NRC has no rules in place that are specific to that purpose. In the near-half-century since enactment of Price-Anderson, there has been no call for funds in excess of the required first layer of insurance, and since creation in 1975 of the retrospective premium pool, no call has been made on that pool for funds. In the event that there were to be a call for funds and also financial hardship on the part of one or more reactor licenses, the Commission expects that any requests for special treatment would be entertained on a case-by-case basis in light of the public interest and the congressional purpose in enacting the statute.

If it were to appear necessary or desirable, following an accident, the NRC could promulgate regulations governing the assessment of lower annual payments to the retrospective premium pool without delaying compensation of victims. The insurers would stand ready to pay out $200 million immediately, and even assuming several defaults, some 90 to 100 reactors would be paying $10 million each immediately if called on. A similar payment from the reactor pool, if needed, could be expected in subsequent years. These funds would appear to be able to bridge any gap until the Commission promulgated any needed regulations. Thus, the regulations could be established significantly earlier than one could expect court judgments which would trigger the need for significant sums to pay damages. In the event of an accident where damages could reach or exceed the limit of liability, Price-Anderson prohibits payments in excess of 15 percent of the total limit of liability without court approval based on a distribution plan to be drawn up and adopted by the court or a court determination that the distribution will not prejudice such a plan.

It is also important to note, first, that currently the nuclear insurers cover defaults of individual licensees in paying the annual premium up to a total of $30 million in a single year, i.e. it would cover three separate defaults of the annual $10 million payment or a greater number of partial defaults in 1 year. The coverage would be for a maximum total of $60 million. Second, payment by the insurers or by the NRC with funds advanced by the U.S. Treasury does not excuse the defaulting licensee from its obligation to pay the full retrospective premium assessed. The licensee would remain legally obligated for that sum and, at least in the case of Federal funds advanced to the licensee, is statutorily required to repay at a later date with interest. See Atomic Energy Act of 1954, as amended, §170b.(2)(B) &(3).

Question 3. Has the NRC considered whether the Price-Anderson Act, as currently enacted, covers acts of terrorism? Please provide explanation of how to define "acts of terrorism." For example, should "acts of terrorism" be defined in distinction from "acts of war," which are currently excluded from coverage?

Response. "Acts of terrorism" are not excluded from Price-Anderson coverage; thus, claims for damages arising out of these acts would be covered. In the definition of "public liability" in Section 11.w of the Atomic Energy Act of 1954, as amended, "claims arising out of an act of war" are excluded from coverage. This definition is of course a statutory provision enacted by the Congress. While any needed interpretation of those terms by the agency entrusted to administer them is generally respected by the courts if it is a reasonable one, a question of this nature and magnitude—whether particular "acts of terrorism" constitute an "act of war" excluded by Price-Anderson—would likely need to be resolved by a court in the first instance.

Question 4. Has the NRC considered court decisions that appear to limit Price-Anderson Act coverage, to accidental as opposed to intentional, conduct e.g., In Re Cincinnati Radiation Litigation, 874 F. Supp 796 (SD Ohio 1995)? If so, provide the analyses of the scope and validity of these decisions. If not, does the NRC agree that the Price-Anderson Act, as currently in effect: (a) is limited as these court decisions provide; and (b) should be so limited.

Response. It is NRC's view that Price-Anderson Act coverage extends to both accidental and intentional acts which cause a nuclear incident, i.e., an unlikely but conceivable nuclear event or condition involving an unexpected or unwanted exposure to radiation that causes radiological harm. Moreover, based on the legislative history of the Act, it is clear that Congress was aware that it was enacting legislation which would cover damages from a nuclear incident caused by an intentional act of sabotage and would indemnify the wrongdoer. No case of which we are aware holds otherwise. The purpose of the Act, simply stated, was to assure the public that it would be financially protected in the event of a nuclear incident involving a facil-

ity, or its material. To accomplish this end, Congress deemed it appropriate to impose special financial protection requirements. These include the requirement that the licensee and the Atomic Energy Commission (now NRC or, as relevant, DOE) execute an indemnification agreement that would in turn indemnify any person who has caused the nuclear incident. Congress imposed these provisions to fill a void where commercial insurance was unavailable to cover the possibly enormous costs of damages in the event of a highly unlikely incident.

Nonetheless, the In re Cincinnati Radiation Litigation court correctly denied claims that Price-Anderson coverage extends to intentional, harmful acts by medical personnel in experimental irradiation of human subjects in which the facilities performed as designed without incident. In those experiments there was no "nuclear incident." The court found the nuclear source did not malfunction, but rather "was employed as intended" and thus could not give rise to a claim under Price-Anderson. Otherwise stated, the radiological harm occurred in the absence of a nuclear occurrence or incident. Moreover, and significantly in this case, the Court agreed that "Price-Anderson was never intended to create a Federal claim for the contained application of nuclear medicine and that such use of radiation in a controlled environment is distinguishable from the Fernald and Three Mile Island occurrences typical of those that the 1988 Amendments were designed to address." 874 Fed. Supp at 832.

Question 5. Has the NRC considered whether court decisions that indicate that the Price-Anderson Act should apply to product liability claims, such as the leaking of tritium out of Swatch watches (see, e.g., Gassie v SMH Swiss Corp, 1998 U.S. Dist Lexis 2003 (ED La 1998)). If so, please provide the analysis. If not, does the NRC agree that the Price-Anderson Act, as currently written: (a) does apply to such claims; and (b) should apply to such claims.

Response. At the outset, it may be helpful to clarify which of two common uses of the term "Price-Anderson Act coverage" is at issue here. First, the narrow (but common and frequently used) meaning of Price-Anderson coverage is that by the terms of an executed indemnity agreement between NRC and its licensee (or with DOE, its contractor) there is an assured scheme for insurance or other compensation funding and for indemnification of anyone liable for damages arising from a nuclear incident up to the limit of liability provided by the Price-Anderson Act. Second, the broader effect of Price-Anderson coverage is that there is original jurisdiction in a United States District Court or mandatory removal to a United States District Court.

Under the more narrow meaning, Price-Anderson clearly does not cover the Swatch watches because no such indemnification agreement exists with the producer of that product. Furthermore, the Commission has not specifically considered whether the Price-Anderson Act should apply to product liability claims such as the leaking of tritium out of Swatch watches. However, it is unlikely that such consumer product manufacturers would be granted Price-Anderson coverage because, among other possible reasons, there has been no demonstrated difficulty in obtaining adequate liability insurance. Other than its application to reactors, fuel facilities and the transportation and interim storage of certain nuclear wastes, the only application of Price-Anderson the Commission has considered in detail was whether Price-Anderson indemnification should be extended to cover the manufacture of radiopharmaceuticals. The Price-Anderson Act Amendments of 1988 required the Commission to conduct a negotiated rulemaking on that issue. After an extensive examination of the pros and cons of such an extension, the Commission concluded that it should not indemnify the manufacture of radiopharmaceuticals.

With respect to the broader effect of Price-Anderson coverage, the Commission has not had occasion to consider Gassie, a case not published in official reporters, and thus can neither agree nor disagree with that court's decision. Whether or not original Federal jurisdiction was available in a products liability case involving claimed radiological harm from wrist watches was at issue in the Gassie case cited in the question. The Commission also has not considered whether or not Price-Anderson jurisdictional provisions should apply to radiological harm from a source outside of the sphere of the production of nuclear energy which was the focus of the original enactment. A broad jurisdictional grant would support consistent application of any Federal regulation that might be applicable, while a narrower grant would show greater deference to State courts and possibly avoid some increase in the Federal dockets. These policy considerations are among those that the Congress might wish to consider.

Question 6. Do the NRC's license transfer requirements specifically and expressly provide for review of the new owner(s) ability to assure that Price Anderson Act fi-

nancial protection payments (including any retrospective payments) will be available if needed? If yes, please provide a copy of the provisions referred to.

Response. The NRC's license transfer requirements are contained in 10 CFR 50.80 and do not specifically or expressly refer to a transferee's ability to meet financial protection payments under the Price-Anderson system. However, 10 CFR 140.21 requires reactor licensees that are covered under the Price-Anderson system to provide annual guarantees of payments of retrospective premiums. When the NRC reviews a license transfer applicant's technical and financial qualifications to own and operate the facility being transferred, it ensures that applicants will obtain required Price-Anderson coverage and evaluates an applicant's guarantees of payment of retrospective premiums pursuant to 10 CFR 140.21. General findings on financial qualifications are contained in the Safety Evaluations prepared by the NRC staff that accompany the approval (or denial) of the license transfer. The NRC also understands that American Nuclear Insurers, which provides primary coverage under the Price-Anderson system and administers the secondary, retrospective premium assessment layer, requires its own guarantees of payment of retrospective premiums from the transferee.

Question 7. Would the NRC support amendments to the Price Anderson Act that require the same insurance coverage and the same emergency planning requirements for decommissioned reactors with spent fuel pools as it requires for operating reactors? If not, why not?

Response. There are presently ten reactors that have been granted exemptions from providing the maximum amount of primary insurance and from participating in the secondary retrospective insurance pool. The licensees of these reactors are required to provide primary insurance under the Price-Anderson system of $100 million. These reactors are in various stages of decommissioning. The NRC is currently preparing an assessment of emergency planning and insurance issues, among others, and is evaluating whether these exemptions should be continued and if so, whether they should be modified, i.e., made less or more strict. This evaluation is expected to be completed later this year.

Question 8. After approving a reactor license transfer to a limited liability corporation (LLC), does the NRC regularly review the financial viability of reactor licensees to assure they can afford to make payments for secondary insurance under Price-Anderson? Please explain.

Response. Yes. As described in the answer to Question 6 from Senator Reid, power reactor licensees are required, pursuant to 10 CFR 140.21, to provide, annually, guarantees of payment of retrospective premiums. The NRC annually reviews these guarantees for all its power reactor licensees, including those that are LLCs. All licensees so far, including LLCs, have used the cash-flow method of guarantee allowed under §140.21; that is, a licensee may demonstrate that it has sufficient cash-flow over 3 months to meet a $10 million retrospective premium payment for each reactor that it owns. As long as an LLC chooses that method and is able to pass the financial test for cash-flow each year, no additional guarantee is required. However, if a licensee cannot pass the cash-flow test, it must provide some other allowable guarantee. Such alternative guarantee methods include surety bonds, letters of credit, revolving credit/term loan arrangements, maintenance of escrow deposits of government securities, or such other type of guarantee as may be approved by the NRC. This final type of guarantee could include a guarantee by the parent company of an LLC, if approved by the NRC.

Question 9. In the event of bankruptcy, what NRC provisions are there to assure that a licensee would be able to meet their obligations for secondary protection? Has NRC established any requirements to assure that such funds are bankruptcy remote?

Response. Under 10 CFR 140.21, the NRC requires its reactor licensees that are covered under the Price-Anderson system to provide, annually, guarantees of payments of retrospective premiums. These "guarantees" are applicable to rate deregulated companies as well as traditional electric utilities. Under Part 140, a licensee is required to pay the retrospective premium, notwithstanding its financial status. However, the NRC could potentially face a conflict with claims in bankruptcy proceeding if there were an accident sufficient to trigger a retrospective premium assessment, in that the NRC would presumably require a licensee to pay the assessment, but the bankruptcy court could order the licensee not to pay it. Nonetheless, the NRC has had essentially positive experiences so far with bankruptcy courts that have overseen Chapter 11 reorganizations of power reactor licensees. (So far, no power reactor licensees have filed for Chapter 7 liquidation. Because generators of electricity typically provide an essential service, it is unlikely that they would be liquidated unless their assets had become worthless. If liquidated, the reactor, as

a valuable economic asset, would likely be sold to another company at the direction of the bankruptcy court and after approval by the NRC.) In the cases of Public Service Company of New Hampshire (Seabrook), Cajun Electric Cooperative (River Bend), El Paso Electric (Palo Verde), and Vermont Electric Generation & Transmission Cooperative (Millstone 3), the bankruptcy courts allowed these bankrupt licensees to pay all safety-related operational and decommissioning expenses (including, apparently, Price-Anderson primary layer and onsite property insurance premium payments). During its bankruptcy, PG&E has continued to meet all safety-related expenses for its nuclear plants.

The NRC would support legislation as part of broader legislation to prioritize safety-related claims in bankruptcy proceedings and to avoid any potential conflict between NRC requirements to pay into the retrospective premium pool and other claims in bankruptcy if the Congress determines such legislation would be appropriate.

STATEMENT OF JOHN L. QUATTROCCHI, SENIOR VICE PRESIDENT, UNDERWRITING, AMERICAN NUCLEAR INSURERS

Mr. Chairman and distinguished members of the subcommittee, I am John Quattrocchi, Senior Vice President, Underwriting at the American Nuclear Insurers or ANI. Joining me today is Tim Peckinpaugh, Washington, D.C. Counsel to ANI. We appear today on behalf of the member insurance companies of ANI. The National Association of Independent Insurers and the Alliance of American Insurers also join in our statement. We appreciate your invitation to present our views on the nuclear risk with a special focus on the financial protection requirements of the Price-Anderson Act.

ANI is a joint underwriting association that acts as managing agent for its member insurance companies. We are, in effect, a "pool" of insurance companies formed for the purpose of insuring a unique risk. Together with our reinsurance partners from around the world, we represent the worldwide insurance community.

We will not dwell on the advantages of nuclear power. We are not advocates for any particular energy source. However, as professional insurers and long-term observers of the energy scene, we believe nuclear power represents a safe, reliable and environmentally friendly part of our nation's energy mix. The nuclear industry has achieved an impressive safety record and, as insurers, ANI is proud of the role we've played in supporting their efforts.

ANI and its predecessor organizations were created in 1956 in response to Congress' urging that insurers find a way to insure what was then a fledgling technology. We worked closely with Congress and with the industry to develop the Price-Anderson law. The law is essentially an insurance program that had several purposes in mind.

- The first was to encourage the private development of nuclear power.
- The second was to establish a legal framework for handling potential liability claims.
- And the third was to provide a ready source of funds to compensate injured victims of a nuclear accident.

The Act represents a careful balancing of the interests of the public as private citizens and as participants in and beneficiaries of private business enterprise. We also believe the Act has been critical in enabling us to provide stable, high quality insurance capacity for nuclear risks in the face of normally overwhelming obstacles for insurers those obstacles being catastrophic loss potential, the absence of credible predictability, a very small spread of risk and limited premium volume. This has been accomplished for more than four decades without interruption and without the "ups and downs" (or market cycles) that have affected nearly all other lines of insurance.

KEY PROVISIONS OF THE PRICE–ANDERSON ACT

Financial Protection[1] *. . . In Two Layers*

To assure a source of funding to compensate accident victims, the law requires reactor operators to maintain primary financial protection equal to the maximum amount of liability insurance available from private insurance sources at reasonable terms.[2] This provision has enabled insurers to develop and sustain secure, high quality insurance capacity from worldwide sources. Evidence of this lies in the sta-

[1]Defined in Section 11.k. of the Atomic Energy Act of 1954, as amended.
[2]The Atomic Energy Act of 1954, as amended, Section 170.b.(1).

bility of limits, price and coverage that insurers have provided in what is a very special line of business. Indeed, primary insurance limits actually increased after the Three Mile Island (TMI) accident in 1979 from $140 million to $160 million, and prices rose only modestly. The primary limit was last increased to $200 million in 1988 coincident with the last renewal of the Act. This limit is written by ANI at each operating power reactor site in the U.S., which satisfies the requirement for primary financial protection.

The Act also requires reactor operators to participate in an industry-wide retrospective rating program for loss that exceeds the primary insurance limit.[3] ANI writes a Secondary Financial Protection (SFP) Master Policy through which we administer the SFP program. Under this policy, each insured is retrospectively assessable for loss that exceeds the primary insurance limit up to a maximum retrospective assessment currently set at $88.095 million (adjusted every five years for inflation) per reactor, per incident. In other words, the second layer of protection is drawn from reactor operators' own funds. Insurers have a contingent liability to cover potential defaults of up to $30 million for one incident or up to $60 million for more than one incident. Under the terms of the contract, however, ANI would expect to be reimbursed with interest for any funds it advances under this program. With 106 reactors in the program, the total level of primary and secondary financial protection is just over $9.5 billion ($200 million in the primary layer + $88.095 million in the secondary layer X 106 reactor units participating).

Limitation on Aggregate Public Liability[4]

The Act limits the liability of reactor operators or others who might be liable for a nuclear accident to the combined total of primary and secondary financial protection, though Congress is committed to providing additional funds if financial protection is insufficient.[5] Knowing the extent of one's liability provides economic stability and incentives that would not exist without a limit.

Legal Costs Within the Limit[6]

The expenses of investigating and defending claims or suits are part of and not in addition to the limit of liability. The inclusion of these costs within the limit enables insurers to offer their maximum capacity commitments without fear of exceeding those commitments. This provision is absolutely essential if insurers are to maintain and hopefully increase the assets they place at risk.

Economic Channeling of Liability[7]

The Act channels the financial responsibility and insurance obligation for public liability claims to the nuclear plant operator. This helps assure that injured parties will be able to establish with certainty liability for a nuclear accident that will be backed by solid financial resources to respond to those liabilities.

Waiver of Defenses[8]

In the event of what is called an Extraordinary Nuclear Occurrence (ENO),[9] insurers and insureds waive most standard legal defenses available to them under state law.[10] The effect of this provision is to create strict liability for a severe nuclear accident. Claimants in these circumstances need only show that the injury or damage sustained was caused by the release of nuclear material from the insured facility. Fault on the part of a particular defendant does not have to be established.

Federal Court Jurisdiction in Public Liability Actions[11]

Historically, state tort law principles have governed nuclear liability determinations. The Price-Anderson Act provides for a federal overlay to the application of state law. The Act confers jurisdiction over public liability actions on the Federal

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[3]Ibid.

[4]The Atomic Energy Act of 1954, as amended, Section 170.e. (1) (A) and Section 170.o. (1) (E).

[5]The Atomic Energy Act of 1954, as amended, Section 170.e. (2).

[6]The Atomic Energy Act of 1954, as amended, Section 170.e. (1) (A).

[7]The Atomic Energy Act of 1954, as amended, Section 11.t. and 170.c.

[8]The Atomic Energy Act of 1954, as amended, Section 170.n. (1).

[9]Defined in Section 11.j. of the Atomic Energy Act of 1954, as amended. Without citing all the specifics, the term refers to a significant nuclear incident that results in severe offsite consequences.

[10]The legal defenses waived in the policy include (i) any issue or defense as to the conduct of the claimant or the fault of the insured, (ii) any issue or defense as to charitable or governmental immunity, and (iii) any issue or defense based on any statute of limitations if suit is instituted within three years from the date on which the claimant first knew, or reasonably could have known, of his bodily injury or property damage and the cause thereof.

[11]The Atomic Energy Act of 1954, as amended, Section 170.n. (2).

District Court in which the accident occurs. This removes the confusion and uncertainties of applicable law that would otherwise result when multiple claims and lawsuits are filed in multiple courts. The provision also reduces legal costs and speeds the compensation process.

Precautionary Evacuations[12]

The system anticipates that insurers will provide immediate financial assistance to people who are forced to evacuate their homes because of a nuclear accident or because of imminent danger of such an event.

The Act, and these provisions in particular, have stood the test of time and served the public well as demonstrated by the response at Three Mile Island.

THE ACCIDENT AT THREE MILE ISLAND

The accident at Three Mile Island occurred on March 28, 1979. Within twenty-four hours of the Pennsylvania Governor's advisory for pregnant women and preschool age children to evacuate a five-mile area around the site, we had people in the area making emergency assistance payments. Two days later, a fully functioning claims office staffed with some 30 people was open to the public. The claims staff grew to over 50 people within the next two weeks. All of the claims staff came from member insurance companies from around the country. I spent about 10 days at the claims office shortly after it opened to lend whatever support I could.

As the office was being set up, we placed ads on the radio, television and in the press informing the public of our operations and the location of the claims office. Those people affected by the evacuation advisory were advanced funds for their immediate out-of-pocket living expenses, that is to say, expenses for food, clothing, shelter, transportation and emergency medical care. Approximately $1.3 million in emergency assistance payments were made to some 3,100 families without requiring a liability waiver of any kind.

We responded as quickly as we did because we had prepared for emergencies in advance. Emergency drills were conducted periodically, and an emergency claim response manual helped guide our response. Checks and other claim forms that had been pre-printed and stored for emergencies were immediately available to us. The insurance industry received high praise for its quick response at TMI. In responding as we did, the insurers helped to alleviate some of the fear and dislocation of those affected by the accident.

POLICY COVERAGE AND CLAIMS EXPERIENCE

The nuclear liability policy written for nuclear site operators is designed to respond to an insured's liability for damages because of bodily injury or offsite property damage caused by a large, sudden catastrophic accident. However, it can also respond to allegations of injury from very small amounts of nuclear material. That bears repeating. In addition to providing coverage for catastrophic events, we are providing coverage for alleged offsite damages from normal plant operations.

All of our insured facilities release very small amounts of material within acceptable regulatory limits. But the public perception of what is "acceptable" and what constitutes "damage" is a moving target. Indeed, almost all of our claims allege injury or damage (or fear of future injury or damage) from little or no documented radiation exposure. And, with the exception of the accident at Three Mile Island, few of the claims from members of the offsite public are the result of a clearly identifiable event. Instead, our claims experience is more related to routine releases and the latent injury phenomenon now popular at least in the U.S. in the toxic torts arena. The alleged damages usually involve somatic, psychosomatic or genetic effects from exposure to radiation at de minimis levels.

From inception, ANI has handled some 207 reported claims or incident notifications. We've paid just over $200 million for indemnity and legal defense and have incurred losses of $482 million, all through December 31 of last year. The difference between the paid and incurred loss figures represents what is reserved for indemnity and defense on outstanding claims.

Radiation claims are costly to defend and there is often no relationship between the amount of radiation alleged and the expense necessary to defend the claim. While the judicial process is expensive, it does expose claims that have no basis in scientific fact. Given the finite resources available to compensate truly injured victims, it serves no one's interest for insurers to compensate claims without merit. The importance of the legal framework established in the Act, including the cost of defense within the system, cannot therefore be overstated.

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[12]Defined in Section 11.gg. of the Atomic Energy Act of 1954, as amended.

NRC'S REPORT TO CONGRESS . . . PRIMARY LIABILITY LIMITS

In its 1998 Report to Congress on the status of the Act, the NRC strongly supported reauthorization of the Price-Anderson Act and offered eight recommendations. In the interest of time, and because the subcommittee is, I'm sure, familiar with the report, I will focus particular attention on just one of the recommendations specifically, that Congress discuss with insurers the potential for increasing the primary liability insurance limit. The NRC indicated in its report that an increase to roughly $350 million would at least keep pace with inflation since 1957.

As was noted earlier in my testimony, the Act requires power reactor licensees to maintain primary financial protection equal to the maximum amount of liability insurance available from private sources at reasonable terms. But for this provision, it is doubtful that limits at the levels written could have been sustained without interruption or fluctuation for more than forty years. To illustrate the point, when, in the mid–1980's, liability insurance became unavailable at almost any price for conventional lines of business, nuclear liability insurers continued to provide a stable market for their limited customer base thanks, in part, to this provision.

Liability limits have been increased periodically from $60 million in 1957 to $200 million presently. The limit was last increased to its present level in 1988 coincident with the last renewal of the Act. The attached Table of Limits outlines the history of primary liability limits from 1957.

We believe an increase in the level of primary insurance coverage would benefit the system and enhance public protection for a number of reasons:

(1) The existing limit has not changed since 1988 and its value has, in fact, been eroded by inflation. When measured against the rate of inflation from 1988 to June 1998, the limit would have grown to roughly $275 million. When measured against inflation from 1957 to June 1998, the limit would have increased to about $350 million.

(2) An increase in the primary limit to reflect the impact of inflation is consistent with inflationary increases mandated by the Price-Anderson law in the second layer. Section 170.t. of the Act requires that the maximum retrospective premium in the second layer be adjusted at five-year intervals. The maximum retrospective premium in the second layer has, in fact, been increased twice since 1988 to reflect the impact of inflation.

(3) A higher primary limit would provide an added buffer between loss in the primary layer and retrospective assessments on utility operators in the second layer. Sound funding for the remote, but nevertheless possible, nuclear catastrophe calls for pre-funding a substantial portion of the costs of that accident. The higher the potential retrospective liabilities on the nuclear industry in the second layer, the more desirable reasonable increases in the primary insurance layer become.

(4) The number of reactor licensees can be expected to decrease in the coming years as reactor units are sold to a relatively smaller number of buyers. The effect of this would be to substantially increase the maximum potential retrospective assessment on those remaining operators at a time of severe economic stress for nuclear utilities generally that is to say, following a large-scale nuclear accident. In these circumstances, a higher primary liability limit would provide a better balance between pre- and post-funded layers of accident protection, in effect enhancing the protection to the public.

(5) Deregulation of the electric utility industry may hamper a utility's ability to pass on to ratepayers the cost of a retrospective assessment. A higher primary limit would reduce the chances of, or at least delay, an assessment in the second layer.

Consistent with the long-standing objective of Congress to provide the most financial protection possible to compensate the public, we will work with our members and reinsurers to develop higher primary insurance limits coincident with a satisfactory renewal of the Act. Any effort on our part to increase the primary limit would also have to be balanced against the needs and desires of our customer base. If these needs can be balanced, our goal would be to develop only capacity that is financially secure and committed for the long term. In testimony I delivered before Congress in June of last year, I indicated that a reasonable goal might be a primary limit in the range of $300 million, again assuming a satisfactory renewal of the Act. While this remains our goal, I now have to qualify my remarks by indicating what should be obvious the events of September 11 will make it much more difficult for us to achieve the goal. The issue of terrorism is addressed in more detail later in my testimony.

POSSIBLE NEW PROTECTION IN THE SECOND LAYER

In the unlikely event that retrospective premiums in the second layer need to be assessed because of a severe nuclear accident, those assessments will be levied at

a time of great political and financial stress. The pressures on the utility that suffers the accident will, in all likelihood, be the most severe. For that reason, we have begun to discuss with the industry a potential new coverage under the existing Secondary Financial Protection (SFP) program that would pay up to one full retrospective premium (currently up to $88.095 million) on behalf of the utility at whose site the accident occurs. Payment of this retrospective premium would be made on a guaranteed cost basis that is to say, we would not expect to be reimbursed.

We envision that coverage would be added by endorsement to the existing SFP program for an additional per reactor premium. We would prefer that coverage be purchased on a voluntary basis and not made part of the financial protection requirements. For the coverage to be viable, at least half the number of reactor units in the SFP program would have to participate.

I have to again stress one point. Since coverage under the potential new product would apply on a guaranteed cost basis, we would have to secure additional capacity over and above whatever additional capacity might be developed for the primary layer. And, as with a possible increase in the primary limit, my comments about a possible new product in the second layer have to be qualified. The events of September 11 will make the development of any new product that requires additional capacity very difficult to accomplish. And, in any event, our first priority is to focus on our goal of increasing the primary liability layer.

PRICE–ANDERSON AS A SUBSIDY?

Some have argued that Price-Anderson is a subsidy for the nuclear industry. For what it's worth from our perspective as independent insurers, that view is clearly inaccurate. We are not aware of any payments made by the Federal Government to private licensees under Price-Anderson. Indeed, the industry not only pays the cost of the insurance required by the Act, it has paid millions of dollars in indemnity fees and has assumed more than $9 billion in potential retrospective assessments to compensate injured accident victims all of this at no cost to the government.

Some argue that the Act's limitation on liability is a subsidy for the industry in that it limits potential recoveries of accident victims. The fact is, however, that, in exchange for the limit on liability, the Act provides for a large, ready source of funds for accident victims that would not otherwise exist.

Insurers have a great deal of experience handling litigation that is "unfettered" by limitations on liability. No case stands out in my mind more than the Bhopal accident in India in 1984. As many as 4,000 people died and another 500,000 were injured. After years of litigation, Union Carbide settled with the Indian Government for $470 million or roughly $1,000 in compensation for each of those killed or injured.

The simple fact is that there is always a limit on liability that limit equal to the assets of the company at fault. Those who helped shape the Price-Anderson Act understood that fact. It was their belief that those who share in the benefits of nuclear energy should also share in the risks through a system of solid financial protection provided by industry and by government.

Beyond serving the public interest, the limitation on liability enables insurers to quantify their potential liabilities. Without the limitation, suppliers and others who might incur potential nuclear liabilities would be forced to seek separate insurance protection for their own accounts, in turn, exposing insurers to unacceptable accumulations. In these circumstances, the level of available liability insurance might well diminish.

ACTS OF TERRORISM

The tragic events of September 11 are having a profound effect on the worldwide insurance industry. While most insurers are absorbing the losses, insurance capital is obviously finite. We understand that future acts of terrorism have now been excluded under most commercial property and casualty reinsurance contracts. In turn, insurance companies that directly write commercial property and casualty policies are either seeking to exclude terrorism entirely or are reducing policy limits to their own net capacities. Premiums have also risen significantly.

As a joint underwriting association, ANI is a reflection of the insurance and reinsurance companies that comprise our membership. Indeed, for nuclear insurers, the risk assessment associated with terrorism has added significance since nuclear plants are said to be potential terrorist targets. In response to these developments, ANI took two actions effective on January 1, 2002 that are intended to maintain the long-term stability of the nuclear liability program and, at the same time, enable us to continue to provide coverage for terrorism. First, premiums were increased by 30% to reflect, at least in part, an exposure not otherwise contemplated

prior to September 11. Second, while we have decided not to exclude terrorism at this time, our policies are now subject to one shared industry aggregate limit of $200 million for liability arising out of terrorist acts. This aggregate limit for terrorism can be reinstated at our option depending on prevailing risk circumstances and the status of the reserves we maintain. The SFP program will continue to apply to loss that exceeds the underlying primary limit. This action was necessary to assure our capacity providers that their exposure to terrorist acts is quantified and capped.

As noted earlier, ANI is a reflection of its member companies and reinsurers. These companies have been hit hard by September 11 as has the entire insurance industry. The availability of insurance capacity worldwide has tightened considerably as a result, and will likely become tighter in the coming months. In the absence of some intervening solution, we think our goal of higher insurance limits will be difficult to achieve.

CONCLUSION

To the best of our knowledge, the financial protection that the Act provides the public far surpasses the performance of any other system in place in the United States. The essential fact is that the public is far better off with this system of financial protection than without it. For us as insurers, its provisions make an otherwise difficult risk insurable. We therefore urge the members of this subcommittee to support expeditious renewal of the Act, with little if any change, as recommended by the NRC report to Congress and the Administration's National Energy Policy released last year. In terms of the legislation pending before this subcommittee, ANI supports in general S. 1360, as introduced by Senator Voinovich and cosponsored by Senator Inhofe and others.

We are grateful to the subcommittee for the opportunity to express the views of insurers on this important issue.

ATTACHMENT TO TESTIMONY OF JOHN L. QUATTROCCHI

Table of Limits

History of Maximum Nuclear Liability Insurance Available from 1957 to Present Liability Limits

Year	Liability Limits ($ in Millions)	Percent Increase
1957	$60	
1966[1]	74	23.3%
1969	82	10.8%
1972	95	15.8%
1974	110	15.8%
1975[1]	125	13.6%
1977	140	12.0%
1979	160	14.3%
1988[1]	200	25.0%

[1]Coincident with the renewal of the Price-Anderson Act.

RESPONSES BY JOHN L. QUATTROCCHI TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1. Price-Anderson's only use came in 1979 with the accident at Three Mile Island. Could you explain why the insurers were able to respond and mobilize so quickly? Were all claims arising out of the Three Island Mile accident fully paid? Were there any defaults?

Response. As indicated in the testimony I presented before the subcommittee on January 23, we had representatives in the area making emergency assistance payments within 24 hours of the Governor's evacuation advisory. We were able to accomplish this because we prepared in advance. Emergency response drills were conducted periodically. An Emergency Claim Response Manual was drafted prior to the accident and helped guide our response. Claim forms, checks and other office supplies were pre-packaged and ready to go. In short, we were able to respond as quickly as we did because we planned in advance and were fully prepared to respond.

Approximately $1.3 million in emergency assistance payments were made to some 3,100 families without requiring a release of any kind. In 1981, we settled claims

for economic loss to businesses and individuals within 25 miles of the site for $20 million. As part of that same settlement, we paid another $5 million to establish a public health fund to study the health impact, if any, on people living in the area. Then in 1985, we paid $14.25 million to settle consolidated claims for bodily injury and emotional distress involving some 280 people.

While it was clear from the data that no one was actually physically harmed as a direct result of the accident, our agreement to settle the initial batch of bodily injury cases was a business decision that reflected the uncertainty of liability for physical harm induced by emotional distress. Shortly after that settlement was announced, an additional 2,200 claims were filed against the site operator and others alleging radiation-induced bodily injury, emotional distress and other damages. Those claims were considered to be without merit and have been vigorously defended. As the Federal District Court for the Middle District of Pennsylvania noted in granting summary judgment in favor of the defendants, and I quote:

" The paucity of proof alleged in support of plaintiffs' case is manifest . . . If the most eminent scientists in the world are unwilling to do more than speculate as to the casual link between radiation exposure and cancer induction at doses below 10 rems, no rational jury, confronted with identical evidence, could find it more likely than not that radiation induced a given neoplasm."

Insurance capital is obviously finite. In the final analysis, therefore, it serves no one's interest for insurers to compensate claims that have no basis in scientific fact. I might also point out that the Act applies to nuclear incidents generally and has, in fact, been employed as the legal mechanism to respond to a number of public liability claims regardless of the severity of the nuclear incident.

Finally, I assume that your question regarding "defaults" is a reference to possible defaults on the part of any of our participating member companies or reinsurers in responding to TMI claims. Assuming my interpretation of the question is correct, I would make two points in response. First, there were no defaults by any of our member companies or reinsurers. Second, all claim payments for indemnity and defense were made from an established loss reserve fund in which we set aside roughly 75 percent of each premium dollar to pay loss and expense, or refunds to policyholders.

Question 2. From this experience and your knowledge of the insurance industry, which system is more likely to provide the public prompt and significant amounts of compensation following a nuclear accident: a no-fault system like Price-Anderson in which the insurers and all the utilities pay or a traditional tort law system that requires the negligent party to pay?

Response. In the event of an Extraordinary Nuclear Occurrence (ENO),[1] insurers and insureds are obligated under the Act to waive most standard legal defenses normally available to them under state law. The effect of this is to create strict liability for a severe nuclear accident. To be compensated, claimants would have only to show that the injury or damage suffered was caused by the release of nuclear material from the insured facility. Fault on the part of a particular defendant need not be established in these circumstances.

Beyond this, the Act effectively channels economic liability to the plant operator.[2] This is done simply and effectively by the omnibus insurance provisions of the financial protection requirements. This helps assure that injured parties will be able to establish liability for a nuclear accident that will be backed by solid financial resources to respond to those liabilities. Channeling of liability to the plant operator is made possible by the Act's limitation on liability[3] which, in turn, makes possible the retrospective premium[4] payable by reactor operators in the event losses exceed the primary insurance layer.

When these provisions are taken together, there is very little question that the Act provides the public with far more protection than would the traditional tort law system.

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[1]Defined in Section 11.j of the Atomic Energy Act of 1954, as amended. Without citing all the specifics, the term refers to a significant nuclear incident that results in severe offsite consequences.

[2]The Atomic Energy Act of 1954, as amended, Section 11.t. and 170.c.

[3]The Atomic Energy Act of 1954, as amended, Section 170e.(1)(A) and Section 170.o.(1)(E).

[4]The Atomic Energy Act of 1954, as amended, Section 170.b(1).

RESPONSES BY JOHN L. QUATTROCCHI TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

Question 1. Testimony at the hearing raised concerns about the standard nuclear exclusion in homeowner's insurance policies. Why does the conventional insurance policy contain a nuclear exclusion?

Response. While Homeowner's insurance policies contain nuclear exclusions, it is incorrect to say that the homeowner is not covered for radioactive contamination damage caused by an accident at a nuclear power plant. Through the Price-Anderson Act, the Federal Government requires liability insurance to be provided by nuclear plant operators that, in fact, would respond to such damages at no cost to the homeowner. The protection afforded under the Act currently amounts to roughly $9.5 billion per incident, the first $200 million of which is written by ANI at each operating power reactor facility in the U.S. For loss that exceeds that primary layer of $200 million, utility operators are subject to retrospective assessments of up to roughly $88.1 million per reactor, per incident. The retrospective assessments are payable by utilities under a Secondary Financial Protection program, which ANI administers.

The nuclear exclusions in Homeowner's insurance policies exist for several reasons. First, insurers are channeling their maximum available capacities for the nuclear risk through ANI and would therefore be exposed to an undue cumulation risk if the same coverage were also provided under other policies they write. So, while radioactive contamination is excluded from individual Homeowner's policies, universal coverage is afforded under the policies written by ANI. Each of ANI's member insurance companies pledges a stipulated dollar amount and thus each knows in advance its maximum exposure for the nuclear peril. Without nuclear exclusions in conventional policies, ANI's member companies would be unable to determine their maximum nuclear exposures, which, in turn, would result in significantly reduced insurance capacity for nuclear risks.

Second, the nuclear peril is a classic example of one that presents low frequency but high severity loss potential. And it lacks credible predictability. The problem becomes apparent if you consider that the probability that any particular home will be damaged by fire is essentially random and predictably much the same for any policyholder during a given period of time, with some variations due to construction differences, proximity to water sources and so forth. Conversely, the risk that all policyholders in a given area will all have fires during the same period is very small. Where the opposite is true, that is, where a single loss can result in multiple large losses as, for example, in the case of floods or radioactive contamination, these perils are excluded under conventional insurance policies. As noted earlier, the nuclear peril presents even more of a problem than does flood because, while there is some statistical basis for predicting floods, there is no real basis for predicting nuclear occurrences.

Third, as with floods, the small number of customers who might be interested in radioactive contamination coverage presents insurers with the problem of adverse selection, that is, only those at greatest risk would have an interest in coverage, which, in turn, violates the principle of spreading risk over a large customer base. Since a basic principle of insurance is risk-spreading, this presents a genuine problem for insurers. The market simply would not bear premiums large enough to support each individual risk, and it would be unfair to ask the many who have no interest in or perceived need for coverage to subsidize the few who may.

With regard specifically to the nuclear peril, these problems were recognized early on by insurers and by Congress. At Congress' urging that insurers find a way to insure the nuclear risk, the insurance industry helped develop the Price-Anderson system which channels liability to a single operator. The industry also chose the "pooling" technique to spread the risk of a small number of insured facilities over a large number of insurance companies. To achieve the goal, the nuclear peril had to be excluded under conventional insurance policies because insurers are channeling their capacities through the pooling system.

Any suggestion that there is no insurance against radioactive contamination of homes stemming from an accident at a nuclear power plant is based on misinformation. Insurance is, in fact, provided efficiently under nuclear liability policies written by ANI and purchased by reactor operators, and again at no cost to the homeowner.

Question 2. Mr. Peter Bradford stated in his testimony that the Price-Anderson Act provides a subsidy to a nuclear powered electric generating plant that is not available to other fuel forms of electric generating power plants therefore reducing the nuclear industry's cost of capital. He also states that with Price-Anderson protection new nuclear power plants have a disincentive to build the safest plants. Is Price-Anderson a subsidy to nuclear plants or a mandate for payment that is not

imposed on other energy forms? Is the Act a disincentive to building the safest nuclear power plants?

Response. A "subsidy" is generally defined to mean a grant of money by a government to a private person or organization. In the Price-Anderson context, the Federal Government has never made any payments to or on behalf of private NRC licensees. Indeed, payments have been made in the reverse sequence that is, from private licensees to the Government as fees for indemnity. Moreover, the nuclear industry not only pays the cost of the insurance required by the Act, it has assumed more than $9 billion in potential retrospective assessments to compensate potential accident victims all this at no cost to the Government.

Some argue that the Act's limitation on liability represents a subsidy for the nuclear industry. The simple fact, however, is that there is always a limit on liability that limit equal to the assets of the company at fault. Limitations on liability through bankruptcy proceedings are frequent occurrences. Those who helped shape the Price-Anderson Act understood that reality. In exchange for a statutory cap on liability, the Act provides a large, ready source of funds that would not otherwise exist.

Experience clearly shows that relying on the tort system to compensate victims of a major accident often results in less rather than more protection for the public. Few, if any, negligent parties especially one that has suffered a major accident would have assets sufficient to pay $9.5 billion in claims. Rather than functioning as a subsidy, the Act serves the public interest and provides an incentive for private industry to assume the financial risk of pursuing a complex technology that benefits society as a whole.

Question 3. Are terrorist attacks covered under both the primary layer and the secondary financial protection layer of Price-Anderson?

Response. Liability arising out of a terrorist act at one of our insured reactor facilities is covered under both the primary and secondary financial protection layers. However, as a result of the tragic events of September 11, coverage under ANI's primary liability policies is now subject to one shared industry aggregate limit of $200 million, which can be reinstated depending on prevailing risk circumstances. This change was necessary to assure our capacity providers that their exposure to terrorist acts is quantified and capped. The secondary financial protection layer will continue to apply to loss that exceeds the primary limit and will drop down above any diminished primary limit.

RESPONSES BY JOHN L. QUATTROCCHI TO ADDITIONAL QUESTIONS FROM SENATOR REID

Question 1. In your testimony you state: "Sound funding for the remote but nevertheless possible, nuclear catastrophe calls for pre-funding a substantial portion of the costs of that accident. The higher the potential retrospective liabilities on the nuclear industry in the second layer, the more desirable reasonable increases in the primary insurance layer become." Currently the private insurance industry provides $200 million in insurance. You indicate in your testimony the private insurance industry may be willing to provide $300 million. You have also indicated that you may be willing to cover the secondary premiums that plants must pay if a nuclear catastrophe occurs. What other provisions would you recommend for the Price-Anderson Act to pre-fund a significant portion of the industry's total liability in the event of an accident?

Response. The primary insurance layer constitutes the pre-funded portion of the total financial protection available under the Act. The current primary insurance limit of $200 million represents a "working layer" of protection through which insurers can immediately respond to the consequences of a nuclear accident, as was the case at Three Mile Island. Since the current primary limit has been in place since 1988, an increase would help offset the effects of inflation, and provide a better balance between pre-and post-funded layers of protection. As indicated in my testimony our goal is to increase the primary layer to $300 million, assuming a satisfactory renewal of the Act.

While one cannot discount the possibility of a severe nuclear accident, the probability is very remote. Conservative estimates place the probability of a core-damaging accident in the U.S. coupled with a containment failure at approximately 1 in 10,000 years. Given these remote probabilities, it would be economically inefficient to require reactor operators to pre-fund any portion of their retrospective premium obligations. Again, however, a reasonable increase in the primary insurance limit would serve the same "pre-funding" purpose and provide more of a buffer between loss in the primary layer and retrospective assessments in the second layer.

The key in all of this is balance. The Price-Anderson Act's pre-funded primary layer and its post-funded second layer appear to strike a reasonable balance for responding to a remote risk that lacks credible predictability. Incidentally, my testimony indicates that we have begun to discuss with our customer base a potential new coverage in the second layer that would pay up to one (emphasis added) full retrospective premium (currently $88.095 million) on behalf of the utility at whose site the accident occurs. I also pointed out that the events of September 11 will make that very difficult to accomplish and that, in any event, our first priority is to focus on our goal of increasing the primary insurance limit.

Question 2. Do you know of any other industries in which companies contribute to a pool (either prospectively or retrospectively) that can be used to pay damages caused by an accident for which most of the contributors are not responsible? What are the liability limits, if any?

Response. We know of no other industry that has agreed to assume a shared financial responsibility for accidents that occur at a facility owned and operated by a separate and distinct business entity. It is the Price-Anderson Act that makes this possible with its system of "checks and balances." Care needs to be taken to avoid upsetting the balance, in which case the system will likely unravel.

STATEMENT OF MARVIN S. FERTEL, SENIOR VICE PRESIDENT–BUSINESS OPERATIONS, NUCLEAR ENERGY INSTITUTE

Chairman Reid, Ranking Member Inhofe and distinguished members of the subcommittee, I am Marvin Fertel, senior vice president of the Nuclear Energy Institute. I am pleased to have this opportunity to testify regarding the renewal of the Price-Anderson Act.

The Nuclear Energy Institute coordinates public policy on issues affecting the nuclear energy industry, including federal regulations that help ensure the safety of the 103 commercial nuclear power plants operating in 31 states. NEI represents nearly 275 companies, including every U.S. utility licensed to operate a commercial nuclear reactor, their suppliers, fuel fabrication facilities, architectural and engineering firms, labor and law firms, radiopharmaceutical companies, research laboratories, universities and international nuclear organizations.

For 45 years, the Price-Anderson Act has been a proven framework for providing the most effective third-party liability protection in the world. Given this proven record, Congress should renew it indefinitely. The industry supports renewing the Act without changing current processes applicable to commercial nuclear power plants. The industry also supports adding a provision to the law that would address new smaller, highly efficient modular reactors under consideration to meet the growing energy needs of the United States.

Even with indefinite renewal, Congress can, at any time, reopen the law if modifications are needed. In addition, Congress can request updates on the status of Price-Anderson Act implementation from the Nuclear Regulatory Commission in order to provide a basis for change if necessary.

The Price-Anderson Act ensures the availability of more than $9.5 billion to appropriately compensate members of the public as the result of a nuclear incident. It establishes a simplified claims process for the public to expedite the filing of claims and provides immediate reimbursement for costs associated with evacuation that may be ordered near nuclear facilities.

Congress Should Renew Price-Anderson Act Indefinitely

The industry recommends an indefinite renewal of the Price-Anderson Act. If in the future Congress wants to reconsider and amend the law it can do so at any time. The industry encourages Congress to hold periodic oversight hearings on the Act, and, if required, modify the law accordingly.

The industry believes that the retrospective maximum annual payment requirement should remain at $10 million per nuclear plant (or more than $1 billion in aggregate). In 1998, the NRC recommended that the retrospective premium be increased to $20 million, based in part on the assumption that 25 nuclear plants would close without relicensing, and that the money available annually to pay for third-party liability claims would decrease as a result. However, most, if not all, nuclear plants are expected to pursue relicensing. NRC Chairman Richard Meserve, in a May 11, 2001 letter to members of Congress, retracted the 1998 recommendation based on the number of plants seeking license renewal. To date, eight U.S. reactors have renewed their licenses and 14 are in the NRC's license renewal queue. Given this change in the marketplace, the NRC no longer believes that the increase in the retrospective premium to $20 million is necessary.

Price-Anderson Act Proven Effective Over 45 Years

The Price-Anderson Act of 1957, signed into law as an amendment to the Atomic Energy Act, provides for payment of public liability claims related to any nuclear incident. In its 1998 report to Congress, the Nuclear Regulatory Commission said that the Price-Anderson Act has "proven to be a remarkably successful piece of legislation" that has grown in depth of coverage and that proved its viability in the aftermath of the Three Mile Island accident.

Since the inception of the Price-Anderson Act, the law has been extended three times for successive 10-year periods, and in 1988 it was extended for 15 years. Unless Congress renews the Price-Anderson Act, it will expire on August 1, 2002.

The Price-Anderson Act is a proven law that works in these important ways:

- Ensures the availability of billions of dollars to compensate citizens affected by a nuclear incident.
- Establishes a simplified claims process for the public to expedite recovery of losses.
- Provides for immediate emergency reimbursement for costs associated with an evacuation of residents near a nuclear power plant.
- Establishes two tiers of liability protection for each nuclear incident involving commercial nuclear energy, and provides a guarantee that the federal government will review the need for compensation beyond that explicitly required by law.

For the primary level of coverage, the law requires nuclear power plant operators to buy all nuclear liability insurance available or provide for an equal amount of financial protection. That amount of insurance is $200 million at each nuclear power plant site.

For the second level, power plant operators are assessed up to $88 million for each accident that exceeds the primary level at a rate not to exceed $10 million per year, per reactor for a total of $9.3 billion. Industrywide, the NRC increases the aggregate amount required for inflation every five years. An important feature of the law is that it creates an industrywide obligation for providing the insurance by spreading the liability for a major accident across the entire industry. In addition, Congress may establish more assessments on the industry if the first two levels of coverage are not adequate to cover claims. The Price-Anderson Act framework provides the same level of protection for the public near DOE facilities as for the commercial sector.

Research and smaller power reactors are also required to partially self-insure against nuclear incident, with the federal government providing additional indemnity. Further, the Act also provides public protection liability insurance for research and university reactors which maintain the United States' leadership position in the development of new nuclear technologies, medical research and other advanced technologies.

The groundwork is being laid to license smaller, modular, more cost-effective and even safer reactors in the United States. Price-Anderson Act renewal should recognize this development and include these reactors in its protocols. The industry believes that provisions should be added to provide public liability protection for these smaller reactors. Specifically, we recommend that for purposes of the secondary financial protection requirements of the Price-Anderson Act, modular reactor facilities containing modules of between 100 megawatts to 300 megawatts, up to a total of 1,300-megawatts, be treated as a single facility.

The cost of Price-Anderson coverage is included in the cost of electricity; it is not a federal subsidy. That means the nuclear industry bears the cost of insurance, unlike the corresponding costs for some major power alternatives. For example, risks of dam failure and flooding at hydroelectric facilities are borne directly by the public, not the hydropower facilities.

In the history of the law, no taxpayer funds have been paid out for commercial losses under Price-Anderson. Of the approximately $180 million paid in claims since the Price-Anderson Act went into effect including the $70 million from the Three Mile Island accident all have been paid by the private insurers and the industry. In fact, Price-Anderson has resulted in payment of $21 million back to the government in indemnity fees.

Energy Department, Nuclear Regulatory Commission Recommend Renewal

The NRC and DOE recommend renewal of the Price-Anderson Act. The NRC, in 1998, said that "the structured payment system created to meet the two objectives stated in the Price-Anderson Act has been successful. The Commission believes that in view of the strong public policy benefits in ensuring the prompt availability and equitable distribution of funds to pay public liability claims, the Price-Anderson Act should be extended to cover future as well as existing nuclear power plants."

The Department of Energy, in 1999, said that the indemnification "should be continued without any substantial change because it is essential to DOE's ability to fulfill its statutory missions involving defense, national security and other nuclear activities "

The House of Representatives endorsed renewal of this important law on November 27, 2001 when it approved H.R. 2983, bipartisan legislation extending the law for 15 years.

The Price-Anderson Act has withstood court challenges dating back to 1973 when the Carolina Environmental Study Group, the Catawba Central Labor Union and 40 individuals brought suit against Duke Power Co., which was building nuclear power plants in North and South Carolina.

Overview of Nuclear Power Plant Performance

Nuclear power produces 20 percent of the nations' electricity supplying power to one of every five U.S. homes and businesses. The commercial nuclear industry is a dynamic, growing sector that for decades has played a key role in the economic growth, environmental protection and energy security of our nation.

Continuing a decade-long trend, U.S. nuclear power plants achieved record safety and reliability levels in 2001. The industry has sustained that trend and as a result of an increased capacity factor and outstanding reliability, the industry is on track to exceed the record 754 billion kilowatt hours (kWh) of electricity produced in 2000 based on the following:

- through September 2001, nuclear power plants generated more than 578 billion kWh of electricity, 1.2 percent above the record pace during the same period in 2000
- based on this trend, full year 2001 nuclear generation is projected to be more than 762 billion kWh
- through September 2001, U.S. net electricity generation was 2,886 billion kWh, roughly 1 percent higher than the same nine-month period in 2000. Coal-fired plants produced more than half (51.5 percent) of this electricity, followed by nuclear (20 percent), natural gas (16.7 percent), hydro (5.7 percent), oil (4 percent) and renewables (2.3 percent).

The industry's performance has been outstanding, and we believe it will continue to improve. The increased electricity generation from nuclear power plants in the past 10 years was the equivalent of adding 22 new, 1,000-megawatt plants to our nation's electricity grid.

The nation's nuclear energy plants are fully subject to, and in compliance with, the requirements of Price-Anderson, which is why it should be renewed indefinitely. The industry last year announced Vision 2020 a strategic plan to build 50,000 megawatts of new nuclear power generation during the next 20 years. This new nuclear power generation is essential to meet our increasing electricity demand and to maintain the 30 percent share of emission-free electricity generation today.

Many Americans are just beginning to focus on our increasing energy needs, including the vital role nuclear energy has played in protecting our air quality. Between 1973 and 2000, nuclear plants avoided the emission of 33 million tons of nitrogen oxide and 66 million tons of sulfur dioxide a vital role in meeting Clean Air Act Standards and roughly 2.8 billion tons of carbon.

Nuclear energy is our only expandable large-scale source of emission-free electricity and is responsible for nearly 70 percent of voluntary carbon reductions as part of DOE's climate challenge program. Reports from the Energy Department's Energy Information Administration have made a direct connection between increased production from U.S. nuclear plants and the fact that greenhouse gases and other emissions increased less than they otherwise would have in the United States.

Conclusion

Electricity is the engine that drives our economy. Therefore it is essential that the United States maintains its diverse domestic energy supply, which maximizes efficiencies and provides environmental benefits. Nuclear energy is the second-largest source of electricity in the United States, and the only widely used source that is both emission free and readily expandable. The industry's safety record, reliability, efficiency and price stability make nuclear power a vital energy source for the future.

One need only look at our recent energy situation in the United States, marked by thinning capacity margins and volatile prices for fossil fuels, to see why nuclear energy is so important to our nation's energy mix.

In the future, as electricity demand continues to rise, nuclear energy will be even more important to American consumers, and to our nation's economy as a whole. Our industry has proven over the past two decades that nuclear energy is a reliable,

efficient and safe source of electricity for our nation's economic growth. I urge the members of this committee to continue to support the role of nuclear energy as part of the United States' diverse energy policy.

The Price-Anderson Act has been an effective law for more than four decades. Congress has renewed it three times and should once again renew the Price-Anderson Act to provide appropriate compensation to the public in the unlikely event of a nuclear incident and to ensure the availability of new nuclear power plants.

Thank you for giving me this opportunity to share the industry's perspective on oversight of nuclear facilities and related matters.

RESPONSES OF MARVIN S. FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1. The bankruptcies of Enron and Pacific Gas and Electric have highlighted the inability of companies to meet their obligations. During the hearing, several witnesses raised this issue as an argument against Price-Anderson. Do you agree with this argument?

Could you explain the effect bankruptcies and potential bankruptcies have on the nuclear industry in regards to liability compensation with and without Price-Anderson?

Response. First, let me say that I completely disagree with those witnesses that profess that the bankruptcies of Enron and Pacific Gas and Electric can be used as an argument against the renewal of Price-Anderson. In this regard, it is important to recognize that Enron does not operate any nuclear plants. In fact, one likely contributing factor to the company's financial problems is that it primarily relied on trading, absent hard assets, to generate large quantities of revenue. In contrast, Pacific Gas and Electric has continued to serve its electric and gas customers in California as it goes through its bankruptcy proceeding. A major factor in restoring the financial health of Pacific Gas and Electric is the excellent performance of its two nuclear units at the Diablo Canyon Nuclear Power Station, which are generating a significant amount of revenue, cash-flow, and related "profits" for the company. While bankruptcies clearly have significant negative impacts on bondholders, shareholders, creditors and employees of a company, those witnesses that raise the specter of bankruptcy as a threat to the financial ability of a nuclear plant operator to meet its obligation under Price-Anderson are clearly missing the fact that in a bankruptcy situation the company has less obligation to pay certain creditors, actually making more money available to pay obligations that cannot be foregone. In the case of its Price-Anderson obligation, failure to meet that obligation could result in the Nuclear Regulatory Commission (NRC) suspending the plant's operating license, which would result in the loss of revenue from the plant—a loss of about $300 million per year for a 1000-megawatt plant operating in a competitive electricity market. The $10 million maximum annual obligation is about 3 percent, a small portion of the plant's annual revenue generation. Good business sense, and just plain common sense, clearly shows that bankruptcy, as undesirable as that may be to certain stakeholders and employees, does not threaten the ability nor the desirability of a nuclear plant operator to meet its Price-Anderson obligation.

This business-focused argument is further bolstered by the rigorous regulatory requirements imposed by the NRC.

The NRC regulations require that an owner/operator of a nuclear power plant have the financial ability to carry out the responsibilities to meet the obligations of the retrospective premium. These requirements are found in 10CFR140. This information is updated annually per the requirements of 10CFR140.21. The NRC reviews the annual submissions to assure the owner is able to carry out the necessary payments if called upon. If a nuclear plant operator incurs financial difficulties, the NRC reviews the conditions and requires the operator to provide assurance on how it would meet its obligations under Price-Anderson.

Therefore, under a bankruptcy situation, Price-Anderson obligations would be fully satisfied for both business and regulatory reasons. In the event the law was not renewed, the same business arguments for being able to meet the financial obligations are still true. However, if Price-Anderson were not renewed, new plants would not be subject to the regulatory requirements currently imposed on existing plants by the Price-Anderson Act, and the actions the NRC could take would be more limited than those required if the law were in effect.

RESPONSES OF MARVIN S. FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR GRAHAM

Question 1. You state in your testimony that Price-Anderson has been an effective law for more than four decades and that it should be renewed indefinitely with few changes. However, the NRC has testified that the renewal period should be shortened from 15 to 10 years to allow for review of how the law effects a constantly changing industry.

If the legislation were to be renewed indefinitely, how would you modify it to allow for flexibility within a rapidly changing industry?

Response. Our recommendation to renew the law indefinitely is based on the fact that the law has been renewed three times and has proven to be the most effective third-party liability insurance program in the world. As such, it doesn't seem necessary, nor desirable to sunset the law.

We do recognize, however, that the program has been improved as a result of congressional reviews over the almost five decades it has been in effect, and that both new information about liability programs and changes in the industry can necessitate a need to modify requirements in the law. With regard to the rapidly changing electricity industry, since the NRC issued its report, what has become clear is that most, if not all, of the nation's existing 103 nuclear plants will be renewing their operating licenses—thereby operating for an additional 20 years or on average for another 40 years. These decisions are predicated on the excellent performance of the plants and the fact that they are the lowest cost source of base load electricity in the United States. Therefore, while the electricity industry will continue to be restructured and consolidated, it seems very clear now that nuclear generation will remain a very stable and significant part of our generation mix, possibly seeing a significantly increased role as our nation's need for new base load electricity grows and our commitment to meeting clean air goals dictate the need for non-emitting generation like nuclear energy.

Given the comments above, we would propose that the law be renewed indefinitely and that it be modified as described below.

Currently the Act requires that the NRC make a report to Congress 5 years prior to it expiring. If the Act were to be renewed indefinitely, the NRC should be required to provide reports to Congress on a set frequency such as every 5 years. Congress could use the submittal of the report and its associated analyses and recommendations to hold oversight hearings concerning the need to amend Price-Anderson. Obviously, even without the NRC report, Congress could always hold oversight hearings and take actions it deems appropriate as a result of those hearings.

RESPONSES OF MARVIN S. FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR INHOFE

Question 1. In past years there have been a number of studies that predict losses of life and massive property damage. These studies put forth numbers that are in the range of $59 billion to over $300 billion.

For what purpose were these studies conducted and what relevance do they have to liability coverage provided by the Price-Anderson Act?

Response. The study that is generally referenced is one performed for the Nuclear Regulatory Commission by Sandia National Laboratory more than 20 years ago. As is the case for all types of risk assessment studies, this study included a number of scenarios. Over the ensuing decades since this study was prepared, the NRC has instituted a number of regulatory requirements and initiatives, including the industry's commitment to a severe accident management program, which have addressed and mitigated the relevance of accident scenarios evaluated in the study. Of significant importance the results of ongoing research, particularly related to the TMI accident, have resulted in a much better and more realistic understanding of what the "source term" characteristics would be in the event of an accident. The results of this research significantly reduce the projected offsite consequences, both health effects and economic impacts, associated with even unrealistic worse case scenarios.

In reviewing and discussing studies like the Sandia study, it is important to recognize that in worst-case scenario analyses, it is assumed that anything that can go wrong will go wrong, and that none of the mitigation equipment and actions are taken or, if taken, are effective. As mentioned above, this provides the upper limit of adverse consequences, ignoring the probability of their occurring and as such the real risk to the public.

Therefore, while studies like the Sandia study do provide valuable insights into how safety can be improved and have been used for that purpose, their worse case, unrealistic analyses are not useful indicators of consequences or offsite impact.

We recognize that, since such studies do produce quantitative estimates of what appear to be potential consequences, it is understandable that some would look to these purported estimates as potentially relevant to Price-Anderson. We reject their relevance for the reasons stated previously and would encourage those looking for more accurate indications for purposes of Price-Anderson to rely upon information like (1) the experience from TMI; (2) the evolution of regulatory requirements; (3) industry initiatives post-TMI; (4) advances in accident analysis research that significantly reduce offsite impacts; and (5) the excellent safety performance of the U.S. plants taken in its totality. Recognizing the magnitude of the obligation (i.e., $9.5 billion) currently imposed by the law, coupled with all of the expedited process provisions contained in the law that benefit citizens, we strongly believe the law, as is, is an exemplary public policy.

In response to a question at the hearing, I spoke about the industry's response to a recent NRC study on the potential hazards associated with a fire in a spent fuel pool and offered to provide our comments for the record. Attached is a copy of the letter we submitted to the NRC that contains our comments on that study.

Question 2. Given the deregulation of electricity markets, can we be reasonably assured that utilities can pay the retrospective premiums? What would happen if a company declared bankruptcy, as did Pacific Gas and Electric Company?

Response. The Congress and American people can be assured that nuclear generators can and certainly will pay any retrospective premiums required by the Price-Anderson Act. This assurance is predicated on a number of key facts.

First, the worst nuclear accident in the history of our nuclear program, TMI, has resulted in total cumulative payments over the last 23 years of under $200 million, or an amount covered by the primary layer of insurance available at every nuclear power plant site. Therefore, given our real experience with the TMI accident and the fact that all U.S. plants are much safer today than in 1979, there is a very low probability of having an accident, and if one occurred, there is a further low probability of incurring large offsite impacts and associated costs.

Second, a 1000-megawatt nuclear power plant produces about $300 million per year in revenue, assuming a competitive market with relatively low average electricity costs. Given this revenue value, the maximum annual retrospective premium is only about 3 percent of revenue.

Third, failure to meet the obligation under Price-Anderson could result in the NRC suspending the plant's operating license—costing the company $300 million or more in revenue, versus a $10 million maximum annual payment. Clearly, the ethical, regulatory and business forces to meet the Price-Anderson obligation are compelling.

With regard to the impact of a company like Pacific Gas and Electric declaring bankruptcy, Pacific Gas and Electric has continued to serve its electric and gas customers in California as it goes through its bankruptcy proceeding. A major factor in restoring the financial health of Pacific Gas and Electric is the excellent performance of its two nuclear units at the Diablo Canyon Nuclear Power Station, which are generating a significant amount of revenue, cash-flow, and related "profits" for the company.

While bankruptcies clearly have significant negative impacts on bondholders, shareholders, creditors and employees of a company, those witnesses that raised the specter of bankruptcy as a threat to the financial ability of a nuclear plant operator to meet its obligation under Price-Anderson are clearly missing the fact that in a bankruptcy situation the company has less obligation to pay certain creditors, actually making more money available to pay obligations that cannot be foregone. In the case of its Price-Anderson obligation, failure to meet that obligation could result in the Nuclear Regulatory Commission (NRC) suspending the plant's operating license, which would result in the loss of revenue from the plant—a loss of about $300 million per year for a 1000-megawatt plant operating in a competitive electricity market. The $10 million maximum annual obligation is only about 3 percent of the plant's annual revenue generation. Good business sense, and just plain common sense, clearly shows that bankruptcy, as undesirable as that may be to certain stakeholders and employees, does not threaten the ability nor the desirability of a nuclear plant operator to meet its Price-Anderson obligation.

This business-focused argument is further bolstered by the rigorous regulatory requirements imposed by the NRC.

The NRC regulations require that an owner/operator of a nuclear power plant have the financial ability to carry out the responsibilities to meet the obligations of the retrospective premium. These requirements are found in 10CFR140. This information is updated annually per the requirements of 10CFR140.21. The NRC reviews the annual submissions to assure the owner is capable to carry out the necessary payments if called upon. If a nuclear plant operator incurs financial difficul-

ties, the NRC reviews the conditions and requires the operator to provide assurance on how it would meet its obligations under Price-Anderson.

Therefore, under a bankruptcy situation Price-Anderson obligations would be fully satisfied for both business and regulatory reasons.

Question 3. Is it wise public policy to require utilities to pay prospectively under the second layer?

Response. It is not wise public policy to require prospective payments for funding the secondary layer under Price-Anderson. A key aspect of the Price-Anderson Act that makes it such an effective public policy is the creation, in effect, of an industry insurance pool to implement the Secondary Financial Protection provisions of the law. No other industry has such a large obligation, $9.5 billion, nor such an effective mechanism for meeting that obligation imposed on it. The assurance that this obligation will be met is founded in the law and the rules and regulations promulgated by the NRC to implement the law. Furthermore, the history of the Act demonstrates that, even for the TMI event, the primary level of insurance, $200 million, was more than adequate to provide for the necessary payments. Given both the legal/regulatory framework, the real world experience with implementation of the Act and the fact that the U.S. nuclear program is setting safety and reliability performance records, there are no compelling reasons to require utilities to pay prospectively under the second layer of the Act. In fact, the only obvious reason to impose such a requirement would be to increase the cost of electricity from nuclear plants and to hurt electricity consumers and the economy by such an action. Such a requirement would also increase the capital requirements for the industry by forcing it to place $9 billion into an account that has a very high likelihood of never being needed. To place this amount of money out of circulation would neither benefit the public nor the American economy, and would not be wise public policy.

Question 4. Mr. Peter Bradford stated in his testimony that the Price-Anderson Act provides a subsidy to a nuclear powered electric generating plant that is not available to other fuel forms of electric generating power plants therefore reducing the nuclear industry's cost of capital. He also states that with Price-Anderson protection new nuclear power plants have a disincentive to build the safest plants.

Is Price-Anderson a subsidy to nuclear plants or a mandate for payment that is not imposed on other energy forms? Is the Act a disincentive to building the safest nuclear power plants?

Response. Clearly the Price-Anderson Act imposes a significant financial obligation on the industry, mandating the payment of $9.5 billion. To my knowledge no other industry, or government program, outside of those covered by the Price-Anderson Act, have mandated obligations that even approach those covered by the Price-Anderson Act. No other fuel form has a legal requirement to have the funding available or the requirements established for responding to catastrophic events.

Mr. Bradford's assertion that the Act provides a subsidy to nuclear power that is unavailable to other fuel forms is blatantly wrong. First, no other fuel form has explicit financial obligations for third-party liability. Second, when one looks at nuclear energy, all of the costs for externalities are internalized. For nuclear plants, in addition to the Price-Anderson obligation, the cost of decommissioning, waste disposal, regulatory costs are all paid by the operator of the plant. The same cannot be said for any other form of electrical generation.

With regard to providing subsidies, a subsidy is a grant of money from the government to a private enterprise considered of benefit to the public. Under Price-Anderson, no funds have been provided to the commercial sector. In fact, the opposite has occurred as the industry has paid the Federal treasury over $20 million in indemnification fees during the early years the law was in effect. The payment from the private sector to the government is certainly not a subsidy.

With regard to cost of capital, the obligation imposed by Price-Anderson is reflected in the financial reports of nuclear operating companies and to that degree it is considered by the financial community. Again, no other fuel source reflects comparable liability as part of its financial statement. In summary, we don't understand how Mr. Bradford arrived at his assertion.

Mr. Bradford's other assertion that somehow Price-Anderson is a disincentive to building the safest plants is wrong and difficult to understand. First, the industry has spent hundreds of millions of dollars over the last decade designing and licensing the most advanced and safest reactors in the world. Currently the industry is working on even newer, smaller modular gas-cooled reactors, which if demonstrated to be economically and technically reliable, will be even safer than our current designs. The industry has been and is continuing to commit resources and money to enhancing the safety of future reactors. Mr. Bradford must be unaware of this or wouldn't have reached the conclusion he did.

In addition to the demonstrable evidence of the industry's commitment to newer, even safer reactors, any nuclear power plants must be built to meet stringent regulatory requirements, which ensure adequate protection of the public health and safety. Finally, Mr. Bradford seems to imply that the owner/investor in the plants would be less concerned about safety and his investment because he has insurance to pay third-party claims in the event of an accident. On its face, this doesn't make sense. The plant is built by the owner as an investment with an expectation of return on investment. If the plant doesn't operate or is shut down by the regulator for issues of safety, it is not fulfilling its purpose to provide electricity or to provide a return on investment. Additionally, Price-Anderson covers third-party liability, not other costs (property, business interruption, etc.) that would be incurred by the owner if an accident occurred. In conclusion, Price-Anderson is certainly not a disincentive to safety, but rather is an excellent public policy for compensating the public in the very unlikely event of an accident.

RESPONSES OF MARVIN S. FERTEL TO ADDITIONAL QUESTIONS FROM SENATOR REID

Question 1. According to the Nuclear Regulatory Commission regulations, nuclear power plants are only required to provide evidence that they can meet $10 million of the retrospective premium. What financial means do the owners use to demonstrate the ability to pay? Does this take into consideration the changing financial situation that may result from a catastrophic nuclear accident?

Response. Nuclear power plant owners demonstrate the ability to pay in a number of ways, including: Surety Bond, Letter of Credit, Revolving Credit/Term Loan Arrangement, Maintenance of Escrow Deposits of Government Securities, Annual Certified Financial Statement showing either that cash-flow (i.e., cash available to a company after all operating expenses, taxes, interest charges, and dividends have been paid) can be generated and would be available for payment of retrospective premiums within three (3) months after submission of the statement, or a cash reserve or a combination of cash-flow and cash reserve, or such other type of guarantee as may be approved by the Commission.

The $10 million is the annual obligation per reactor and NRC regulations require the licensees to demonstrate their ability to meet this annual obligation.

Even in the event of a catastrophic accident, it is unlikely that the offsite consequences would necessitate payment of the full obligation. However, if it did, the only facility that would be severely financially handicapped would be the one that had the accident. Under that situation, the company owning the facility could still be able to make the required payments, or it is possible that the company would have "insurance" provided by American Nuclear Insurers to meet that obligation, or it is possible that the rest of the industry would ensure that the full amount required under the Secondary Financial Protection Program was paid.

Question 2. Have these financial assurances been affected by the recent problems at Enron?

Response. Since the financial assurances required by the NRC represent either real financial instruments (e.g., surety bonds) or financial analyses based on cash-flow from actual plant and company operations, it is unlikely that the lessons-learned from the Enron situation would impact the veracity of these assurances.

STATEMENT OF PETER A. BRADFORD, VISITING LECTURER IN ENERGY POLICY AND ENVIRONMENTAL PROTECTION, YALE UNIVERSITY

Thank you very much for the invitation to testify regarding the renewal of the Price-Anderson Act. This is the second time I have done so, having testified also in 1985, on the last occasion that Price Anderson came up for renewal. Aspects of the law have provided for a system of self-insurance by the nuclear industry for some 45 years. While these provisions can and should be strengthened to assure funding in the event of a serious nuclear accident, the underlying concept is sensible.

However, the electric industry has changed significantly since Congress last renewed Price-Anderson. These changes undermine the wisdom and the fairness of applying the liability limitation provisions to new nuclear units and perhaps also to units whose licensed life is extended beyond its original term.

The most significant change is the opening of the electric power market to competition among all forms of power generation. A national policy requiring competitive electric power supply was achieved through the enactment of the Energy Policy Act of 1992 and subsequent proceedings of the Federal Energy Regulatory Commission. Pursuant to this national policy, all power plants should now have an equal

opportunity to sell into the wholesale electric market based on their costs and other operating characteristics. The basis for this policy is the belief that marketplace competition will produce lower prices and greater customer satisfaction than did the power plant selection process based on utility and governmental forecasts that prevailed when Price-Anderson was enacted and renewed.

In a competitive power generation market, capacity from nuclear plants must compete with capacity from fossil fuels and from renewable resources, none of which enjoy any type of federally mandated liability limitation. Under these circumstances, the liability limitation has two anticompetitive effects. First, new nuclear capacity appears cheaper than it really is relative to other sources, or—for that matter—relative to investment in energy efficiency. This is because its cost of capital does not reflect the risk of having to pay for damages in excess of $9 billion, when estimates of worst-case accident or sabotage scenarios are much higher than that. Second, any nuclear design that is truly inherently safe or that is at least incapable of doing more than $9 billion in damage does not enjoy the benefit of its improved safety in competition with those nuclear plants that do benefit from the liability limitation. Indeed, the liability limitation ultimately is less a subsidy of nuclear power than of nuclear catastrophe. As such, it removes market incentives for—for example—remote siting, underground siting and inherently safe designs. Companies offering designs that have such advantages would be well advised to volunteer to forego the liability limitation and the public skepticism that it engenders.

The risk of an accident that exceeds $9 billion in damages is in no way diminished by the Price-Anderson Act. The Act merely requires that—whatever that risk is—it will be borne either by those who suffer the damage or by the nation's taxpayers. In the wake of September 11, the possibility of a disaster involving nuclear energy and costing many times $9 billion is clearly not as low as we had thought. Rather than underwrite industry costs in the event of such an accident, it would seem wiser for Congress to adopt a framework that encourages the deployment of energy sources—conceivably including inherently safe nuclear sources—that do not carry with them the potential for inflicting such large damages.

No connection exists between the upper limit on liability and the more desirable features of Price-Anderson. Removal of the limit coupled with a provision extending the retrospective annual premium until all damages had been paid would provide more assurance to the general public than the present law. Indeed, most of the witnesses who testified in favor of Price-Anderson renewal in the House last year made little or no mention of the liability limit for nuclear power plants[1]. Their testimony urged retention of the mutual-insurance scheme and other aspects of the law. If they saw Price-Anderson as essential to future nuclear plants, to nuclear relicensing, to increasing the licensed output of nuclear power plants, they did not say so. Even the two witnesses who endorsed the liability limit offered no proof that it is still needed[2]. The most vehement claim that the liability limit is essential to the future of nuclear power was made by a witness opposing renewal[3].

The fact is that other industries—marine oil transport comes to mind—are required to provide a mutual insurance framework independent of any liability limit that may exist. And the Price-Anderson mutual-insurance requirement need not be modified if the liability limit were removed.

The Price-Anderson limited liability principle was originally adopted as part of a bargain that included detailed requirements for public participation in the nuclear licensing process. Over the years, those protections have been substantially eroded, usually on the basis of arguments that nuclear technology had substantially matured and no longer required so substantial a set of intervenor protections[4]. Furthermore, probabilistic risk assessment has been introduced into many aspects of nuclear regulation, again based on the rationale that the technology and risk assessment methodology have matured to an extent now adequate to provide informed judgment about accident probability[5].

What then are we to make of continued insistence on liability limits? Can it really be that all of this maturing, all of this increased database only counts when it is being used to reduce aspects of NRC safety oversight? That it counts for nothing in the context of reconsidering the liability limit?

Such a result is indefensible. If the technology is mature enough to cut public hearing and information rights to the vanishing point, if it is mature enough to circumscribe regulatory scrutiny with probabilistic risk assessment, then it is too mature to need a limitation on its liability for catastrophic accidents.

The justification for the limit dates from a time when other alternatives to fossil fuels did not exist. Now, however, at a time when competitive markets are actually providing as many or more new renewable megawatts worldwide as new nuclear megawatts, this argument is out of date. If nuclear law is to be updated—as industry witnesses urge—to take account of changes in the 1990s, then Congress should

take all of those changes into account. Congress should let nuclear power compete within a framework that will reward its safest designs to the fullest. Congress should not continue a framework that encourages facilities with a remote potential for extreme catastrophe to substitute for facilities that can provide or conserve energy in safer ways.

At the very least, those who support renewal of the liability limitation can hardly oppose measures providing support for renewable energy and energy efficiency as part of restructuring legislation. The liability limitation is a specific override of an asserted free market outcome—the unwillingness of private insurers to cover the full potential costs of a nuclear accident. If such a countermarket subsidy is to be offered to one technology, then the least that can responsibly be done is to ascertain its value and offer a comparable subsidy to other technologies that offer the same advantages of domestic supply and diminished air pollution, especially since these technologies really are in the startup phase that was said to justify the Price Anderson Act when first it became law, 45 years ago.

Thank you again for the invitation to testify.

[1] For example, Chairman Meserve of the NRC and Mr. Fertel of the Nuclear Energy Institute barely hint that they are testifying in favor of a liability limitation.

[2] Testimony of George Davis on behalf of Westinghouse and of John Quattrocchi on behalf of American Nuclear Insurers.

[3] Testimony of Anna Aurilio on behalf of the U.S. Public Interest Research Group.

[4] For indication that this process continues, see NRC's proposed "Changes to Adjudicatory Process" (RIN 3150–AG49), 66 FR 19609–19671 (April 16, 2001).

[5] See, for example, the October 11, 2000, letter from the Advisory Committee on Reactor Safeguards to Chairman Richard Meserve, stating, "In over two decades of development following the Reactor Safety Study, PRA reached a level of maturity that allows it to be used to identify unnecessary regulatory burden, as well as additional safety improvements". In his House testimony on Price-Anderson, Chairman Meserve noted, "Improved probabilistic risk assessment techniques combined with more than four decades of accumulated experience with operating nuclear power reactors has led the commission to realize that some regulations may not achieve their intended safety purpose and may not be necessary to provide adequate protection of the public health and safety."

RESPONSES OF PETER BRADFORD TO ADDITIONAL QUESTIONS FROM SENATOR REID

Question 1. Do you concur with the written testimony of Mr. Quattrocchi that the sale of reactor licenses to a relatively smaller number of buyers would have the effect of "substantially increasing the maximum retrospective assessment at a time of severe economic stress for nuclear utilities generally—that is to say, following a large scale nuclear accident?"

Response. Mr. Quattrocchi is right that the concentration of ownership of nuclear power plants will result in the retrospective premium being collected from fewer owners of nuclear power plants. Perhaps more importantly, the nuclear units are likely to represent a larger portion of the total assets of the companies (or corporate subsidiaries) that own them. Given the near certainty of financial stress for nuclear plant owners in the event of an accident serious enough to trigger assessment of the retrospective premium provisions, this means that the potential impact of such an accident on the owners of nuclear plants is likely to be greater than in past.

Question 2. What if the accident were the result of a terrorist attack?

Response. Assuming that a terrorist attack triggers the retrospective premium, I don't think that fact that the precipitating event was a terrorist attack makes much difference. The pressure to shut down other plants and the regulatory and financial perturbation would be similar. If anything, the overall financial turbulence and therefore the pressure on the creditworthiness of all electric companies would be greater. In light of the legislation assisting the airlines in the wake of September 11, Congress should expect to be asked to assist the electric industry to a comparable degree.

Question 3. Would you expect—as we saw following the September 11 attacks—a slowdown in the industry comparable to what we saw with the airline industry? Is it wise to require the majority of the coverage to come at a time when the power companies may be least able to afford it?

Response. I would expect substantial public demand for the closure of all nuclear units in the wake of a successful terrorist attack on any one of them. Following Three Mile Island, all of the other Babcock and Wilcox were shut down for several months. Depending on the severity of the damage and the uniqueness of the cir-

cumstances, something similar would follow a successful terrorist attack on a nuclear plant. However, the impact on the airline industry was caused in large part by the reluctance of the public to fly. While energy conservation would perhaps be among the public responses to an attack on a nuclear plant, no comparable fall of in demand seems likely, so the impact would be less driven by public reluctance to continue to consume the product of the afflicted industry.

Question 4. Do you know of any other industries in which companies contribute to a pool (either prospectively or retrospectively) that can be used to pay damages caused by an accident for which most of the contributors are not responsible? What are the liability limits if any?

Response. For the reasons set forth above, prefunding of some part of the insurance requirement seems wise. Both domestic and international law provide for prefunding to be used to clean up and compensate for oil spill damages. The United States Oil Pollution Act of 1990 provides for an Oil Spill Liability Trust Fund to be used to cover removal costs or damages resulting from discharges of oil. The primary source of revenue for the fund is a five-cents per barrel fee on imported and domestic oil. Additional sources include interest on the fund and penalties of various sorts assessed against those transporting oil in U.S. waters. In addition, States are permitted to go beyond the Federal law, and several (for example, Maine, Florida, Washington and Texas) have done so. Liability under the Federal law is limited, but I don't know the present limit.

As described by Susan Bloodworth in an article in the 1998 Florida State Journal of Land Use and Environmental Law entitled "Death on the High Seas: The Demise of TOVALOP and CRISTAL", "the International Convention on Civil Liability for Oil Pollution Damage (CLC) provides uniform rules and procedures for determining questions of liability and adequate compensation for oil pollution damage caused by vessels. The CLC imposes strict liability on shipowners for damages from an oil spill and for the costs of any action taken to minimize that damage. Compensation is keyed to the weight of the vessel. . . . To qualify for the limitation, the owner is required to keep on deposit a sum representing the limits of his liability. Additionally, any ship carrying in excess of 2,000 tons of oil in bulk as cargo is required to obtain a certificate attesting to its financial security.

The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund Convention) resulted from the CLC. Contributions to the fund are made by all persons receiving more than 150,000 tons of oil during the calendar year within a contracting State. The Fund Convention specifically provides for relief to claimants where vessel owners are not liable, are financially incapable of meeting their obligations, or where damages suffered exceed the owner's liability allowed under the CLC".

STATEMENT OF DAN GUTTMAN, FELLOW, CENTER FOR STUDY OF AMERICAN GOVERNMENT, JOHNS HOPKINS UNIVERSITY

I am an attorney in private practice. I am a Fellow at the Washington Center for the Study of American Government at Johns Hopkins University and of the National Academy of Public Administration. I appear on my own behalf as a citizen, but am privileged to draw on experience relating to the operations of nuclear power plants, the nation's nuclear weapons complex, and Cold War related exposures of citizens, nuclear weapons workers and "atomic veterans" to radiation risk.[1]

Summary

In the interim since the 1988 Price-Anderson Act amendments, Federal court decisions construing the law, electric utility industry restructuring, and inquiries and enactments treating revelations of Cold War era radiation exposures to citizens, soldiers, and nuclear weapons workers have highlighted issues which merit attention in current Congressional consideration of the Price-Anderson Act. This testimony

[1]The experience includes: (1) counsel to municipally and cooperatively owned electric systems in the purchase of nuclear power plant ownership shares and power supply, and related decommissioning costs;(2) special counsel to Senator David Pryor in oversight of Department of Energy contracting; (3) Executive Director, President Clinton's Advisory Committee on Human Radiation Experiments; (4) Commissioner, U.S. Occupational Safety and Health Review Commission; (5) counsel, nuclear weapons workers union (OCAW, and its successor PACE) on matters including the environmental cleanup of the weapons complex, the privatization of the U.S. Enrichment Corporation, and the Energy Employees Occupational Illness Compensation Act; (6) adviser to Nye County, Nevada, on matters related to the potential Yucca Mountain repository; (7) adviser to the special delegation to the United States of the Chancellor of Austria regarding the Temelin nuclear power plant.

will seek to identify some of these questions, which, of course, are now framed by the events of September 11, 2001.

Courts have agreed that the 1988 Price Anderson Act Amendments fundamentally restructured the law by: (1) creating a federal cause of action ("public liability") for claims related to nuclear incidents; where such claim exists, state law based claims on the facts are, with limited exception, precluded;[2] (2) providing that the legal principles, or rules of decision, for determining public liability are rooted in state law. However, in the context of this agreement, and with further developments since 1988 in mind, issues that warrant current attention include:

(1) What conduct will trigger, and require, Price Anderson Act jurisdiction?

Court decisions call into question: (a) whether the Act covers conduct that is intentional (as well as conduct that is accidental); (b) whether the Act requires that the defendant(s) be party to an indemnification agreement with the government; (c) whether the Act reaches into disputes regarding common commercial products; for example, watch dials.

Congress may wish to resolve conflicts or misunderstandings on the basis for, and scope of, Price-Anderson Act jurisdiction raised by court decisions.

(2) Are Acts of Terrorism Covered by the Act?

The Price Anderson Act (through the definition of "public liability") excludes claims "arising out of acts of war," raising obvious questions about the Act's coverage of damage and injuries stemming from acts of terrorism.

Congress may wish to consider whether the Price-Anderson Act should be amended to expressly address terrorist acts. Does Congress intend to cover "acts of terrorism?" If so, is the current statutory wording clear enough to embrace this intent? If the intent is not to cover nuclear accidents caused by acts of terrorism, how will they be covered? Assuming the intent is to cover such acts, what kind of finding or declaration will be required to trigger the Act—- and who shall be empowered to make this finding?

(3) Will The Retrospective Unit Owner Funding Required by the Act be Available in the Deregulation Era?

The Act relies on nuclear unit owners to make "retrospective" (i.e., post-accident) contributions where the initial tier of insurance is exhausted by an accident. Under the Act's present terms, and given the current number of operating units, this obligation may be in the range of $80–90 million per unit—or over $9 billion. The "retrospective" nuclear plant owner obligation, in short, is relied on to provide the lion's share of funding for relief in a major accident.

Since 1988, the utility industry has undergone profound restructuring, hallmarked by nuclear unit divestitures, corporate restructuring, and the consolidation of nuclear unit ownership. This restructuring, particularly when coupled with the well-known financial difficulties of major California utilities and Enron, raises questions about the premises of retrospective funding. The basic concern was identified in the NRC's 1998 Price-Anderson report to Congress, and it has just been underscored by a December, 2001 GAO report, which found that NRC reviews of license transfer applications did not provide adequate assurance that new corporate owners will have sums needed to provide for future decommissioning costs.

Indeed, the form restructuring is taking may render the public particularly vulnerable to funding shortfalls. As the GAO report observed, nuclear units are being consolidated under a limited number of "fleet" owners. This consolidation may yield important benefits in safety, reliability, and accountability. On the other hand, consolidation of ownership raises the possibility that the owner may have to bear retrospective payment burden measured in the hundreds, not tens, of millions, and the further possibility that the ripple of effects of an any nuclear accident on any utility system may cause cross-the-board unit shutdowns that will leave the "fleet" owner without revenue sources to pay retrospective commitments.

Congress should act to assure that industry restructuring does not come at the cost of the integrity of the Act's funding, whether by assuring that NRC license transfers provide for the needed commitments, specifying particular commitments (e.g., prepayment or reserve for Price Anderson obligations as condition for license transfer), or providing for a review and further steps thereafter.

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[2]For example, the Court of Appeals for the Third Circuit stated in In Re TMI, 940 F. 2d 832 (3d Cir. 1991), cert denied, 112 S. Ct. 1262 (1992):

The Amendments Act creates a federal cause of action which did not exist prior to the Act, establishes federal jurisdiction for that cause of action, and channels all legal liability to the federal courts through that cause of action...Congress clearly intended to supplant all possible state causes of action when the factual prerequisite of the statute are [sic] met.

(4) Should There be Clear and Consistent Treatment of Willful or Reckless Misconduct?

Potential liability for willful or reckless misconduct appears to differ depending upon whether the actor is a NRC licensee, a Department of Defense contractor, or a Department of Energy contractor. In the first case, courts have indicated that actors may, to some degree that itself may benefit from clarification, be liable for punitive damages; in the second case, procurement rules provide for limitation on indemnification in the case of willful misconduct, in the third case there is no evident limitation on indemnification.

Congress may wish to consider whether there is reason for the differing set of rules and, if not, to provide for a clear and consistent set.

(5) When Should State Established Duty(ies) of Care be Preempted?

Courts agree that the 1988 Amendments create a federal cause of action that is rooted in state law rules of decision, but have generally held that the duty of care owed by Price-Anderson defendants is that stated in Federal dose exposure regulations, to the exclusion of state law duty of care standards.

Congress may wish to consider whether this exception to the Act's reliance on state standards is warranted, particularly where the state standard may supplement, but not conflict with, the federal standard of care.

(6) What is the Burden of Proof to Show Causation of Injury Where Records are Inadequate?

In order to obtain Price-Anderson compensation, an individual may need to show not only that he or she was exposed to radiation hazard and that he is now sick, but also that the exposure caused the sickness. The difficulties of determining that harm to a specific individual (e.g., cancer) was caused by a specific exposure(s) to radiation are well understood, particularly when the injury manifests itself years after the exposure. We now know that when the government (and its contractors) exposed citizens, soldiers, and workers to radiation during the Cold War those responsible for exposures too often failed to keep the records, and provide for the monitoring, that might help determine cause and effect—and provide for compensation—at years remove. In light of this new understanding, Congress and the Executive branch have adopted the principle that where injured citizens show that they were likely exposed to potentially injurious amounts of radiation, the government (or contractors or further designees) bears the burden of providing exposure and monitoring data needed to defeat claims that the injury was caused by the exposure.

Congress may wish to consider the express incorporation into the Price-Anderson Act of the principle that those who expose citizens to radiation risk without providing for recordkeeping and monitoring bear the burden of showing that their conduct is not the cause of resulting injury.

(7) Is Justice Done by Current Statutes of Limitations Provisions Which May Preclude Recovery Where Injury is Latent for Years?

At least one court has indicated that adherence to the letter of the Price Anderson Act required it to do injustice by dismissing a case involving an alleged "nuclear incident" because of the failure of the state statute of limitations to contemplate injury from radiation exposure—i.e., injury that may be latent for many years before visible manifestation..

Congress may wish to revisit the workings of Price Anderson Act statutes of limitations where state law does not adequately contemplate the reality that some radiation injuries may be hidden for years before discovery.

Jurisdictional Requirements

1. Is an Indemnification Agreement a Prerequisite to the Triggering of Price-Anderson Jurisdiction?

Is an indemnification agreement a prerequisite for the triggering of Price-Anderson?

In Gilberg v. Stepan Co., 24 F. Supp 2d 325 (D. N.J. 1998) the court found that the existence of a Price-Anderson indemnity agreement with the government is key to the determination of whether a radiation release is covered by Price Anderson.

The case dealt with alleged contamination of the surrounding community from thorium tailings at a chemical plant that operated from 1918 to 1956. The court noted that the Atomic Energy Act authorized the NRC to license the production and possession of nuclear materials. Price Anderson did not mandate, as it does in regard to power plant licensees, that these further licensees be subject to assured pools of coverage. The Stepan court concluded that an "occurrence", under the definition of "nuclear incident," "can only be an event at the location of or the contract

location as those terms are defined as an applicable indemnity agreement." In the absence of such agreement, the court found, Price Anderson does not apply.

The Court explained:

While it is true that any thorium or thorium tailings at the facility may have been the subject of AEC or NRC licenses for source and/or byproduct materials...licenses for these types of materials have never been subject to Price-Anderson's financial protection provisions. Therefore, neither the AEC nor the NRC would have entered into an indemnification agreement covering activity conducted under such licenses. In the absence of an indemnification agreement, entered into under 42 U.S.C. Section 2210 and covering the activities which give rise to the liability alleged, there can be no "occurrence," that is no event at the site of "licensed activity" that would constitute a "nuclear incident." Without a nuclear incident, there is no claim for public liability, and without a claim for public liability there is no federal jurisdiction under Price-Anderson.[fns. Omitted]

Stepan's conclusion was embraced in Heinrich v. Sweet, 62 F. Supp. 2d 282 (D.Mass. 1999), which involved claims related to human radiation experiments conducted by doctors and universities under Atomic Energy Commission contract.

However, Stepan's conclusion has been rejected elsewhere,[3] including at least one case—Carey v. Kerr–McGee, 60 F. Supp 2d 800 (N.D. Ill. 1999)—which followed Stepan. Carey concerned allegations of contamination from thorium tailings at Kerr–McGee's West Chicago plant. Plaintiffs argued that for Price Anderson to apply there had to be a release of radioactive material from a facility which is both (a) licensed by the NRC and (b) covered by an indemnification agreement with the NRC. Because the facility, while subject to certain licensing, was not signatory to an indemnification agreement, plaintiffs contended that there was no "occurrence," as provided for by the Act and therefore it did not apply. The court, noting that the Act does not define occurrence, looked to Webster's dictionary and found that an occurrence had been alleged.

Is Intentional, in Addition to Accidental, Conduct Covered by the Act?

In re Cincinnati Radiation Litigation, 874 F Supp 796, 830–832 (SD Ohio 1995) involved claims of injury caused by human radiation experiments conducted by government supported experimental treatments of cancer patients. The court found that a "public liability" claim requires unintended, or accidental, conduct. Thus, even though radiation might have caused injury, there was no Price Anderson claim. The decision explained:

While the alleged conduct of the experiments and the alleged failure to inform the subjects of the experiments may be reprehensible, the operation of the Teletherapy Unit was an application of nuclear medicine. Thus, in this case the nuclear source at issue was employed as intended and cannot give rise to a claim under the Price-Anderson Act. Moreover, liability under the Price-Anderson Act turns on the existence of a "nuclear incident," which does not occur when there is no unintended escape or release of nuclear energy.

See also McCafferty v. Centerior Service Company, 983 F. Supp. 715 (N.D. Ohio 1997) ("all of Plaintiffs claims which arise as a result of their unintended exposure to radiated materials are preempted by the Amendments Act, and must be analyzed for inconsistencies with that legislation.")

In a subsequent human radiations experiment decision, Heinrich v. Sweet, 62 F. Supp. 2d 282 (D. Mass. 1999), the court determined that Price-Anderson jurisdiction was not governed by the intentionality of the conduct, but by whether the alleged conduct is subject to an indemnification agreement. Responding to the decision in In re Cincinnati Radiation Litigation, the court explained:

Several reported cases, however, appear to undermine this interpretation of the statute. See Day v. NLO Inc., 851 F. Supp. 869 (S.D. Ohio 1994)(Act applies to claims of occupational exposure to radiation not alleged to have been caused by accidental release); Sawyer v. Commonwealth Edison Co., 847 F. Supp. 96 (N.D. Ill. 1994) (Act applies to claim for injuries resulting from alleged ongoing occupational exposure); Coley v. Commonwealth Edison Co., 768 F. Supp. 625 (N.D. Ill. 1991)(same); Building and Constr. Trades Dep't v. Rockwell Int'l, 756 F. Supp. 492

[3]Stepan notes that the vast majority of litigated cases either dealt with indemnified facilities (e.g., power plants) or did not address the issue of whether indemnification was a requisite to Price-Anderson jurisdiction. Stepan addressed two prior cases, including Kerr–McGee Corp. v. Farley, 115 F. 3d 1498 (10th Cir. 1997), cert denied 118 S. Ct. 880 (1998) discussed below, which appeared to find Price-Anderson jurisdiction commensurate with NRC licensing authority.

(D. Colo. 1991) (Act applies to intentional and tort claims related to occupational exposure.)[4]

Following the analysis in Stepan, as discussed above, the Heinrich court held that the determinative issue was not intentionality, but indemnification.

Is Price Anderson Coverage Commensurate with the Use of Atomic Energy, or NRC Licensing Jurisdiction?

Some courts appear to find that Price-Anderson jurisdiction broadly attaches to activities that are, or may be, within NRC jurisdiction.

Kerr–McGee Corp. v. Farley, 115 F. 3d 1498 (10th Cir. 1997), cert. denied,118 S. Ct. 880 (1998) involved Navajo Tribal Court jurisdiction over a claim that tribe members had been injured by exposure to radioactive and toxic materials released from a Kerr–McGee facility on land leased from the tribe. Those alleging injury claimed that because there was no indemnification agreement, Price-Anderson jurisdiction did not apply (and, therefore, there was no question of whether the case had to be in Federal court, not tribal court). The court rejected the claim:

Nothing in [the Supreme Court's Silkwood decision] suggests that the absence of an indemnity agreement makes [the Act's] jurisdictional provisions inapplicable. Furthermore, as quoted...the jurisdictional provisions of [the Act], as amended by the 1988 Amendments, appear broad enough to create a federal forum for any tort claim even remotely involving atomic energy production.

Gassie v. SMH Swiss Corp., 1998 U.S. Dist. Lexis 2003 (E.D. La. Feb. 17, 1998) was a class action claiming injury from the leak of tritium (a radioisotope used to produce luminescence) from Swatch watches. The defendant was an NRC licensee. The Court found that the claim was a public liability claim arising out of a nuclear incident—and, under Price Anderson, therefore subject to removal from state to Federal court and treatment under the Act:

Although the words "any nuclear incident" were employed by Congress to convey the broad scope of the jurisdictional grant, there is little support in the legislative history or in other legal precedent for the idea that a products liability case, such as the one Plaintiffs have filed in this one, to conclude that the leaking of tritium from Swatch Watches constitutes a nuclear incident in terms of the Price-Anderson Act. However, there is also little support to negate Defendants' argument that Plaintiffs' claims constitute a public liability action arising from a nuclear incident. In fact, the unambiguous words of the Price-Anderson Act indicate that Plaintiffs' claims do constitute a public liability action arising from a nuclear incident.

The court concluded that Price-Anderson would apply to tritium leaks from watches, unless Plaintiffs could establish (which the court found they did not) that the NRC permitted regulatory control of byproducts to be assumed by the State (Louisiana in the case at hand).

II. Post–September 11: Are Acts of Terrorism Covered by the Act, or Are they Excluded as "Acts of War"?

After September 11, there is obvious need to consider the applicability of Price-Anderson to nuclear incidents stemming from terrorist activity. It is not clear whether, and under what circumstances, the Act would cover damage and injury resulting from terrorist conduct.

The Act's definition of "public liability" excludes "claims arising out of an act of war." See 42 U.S.C. Section 2014(w)(ii). Thus, depending on the definition of "Acts of War," the Price-Anderson Act may include or exclude the consequences of terrorist activity.

Congress should consider whether it wishes to revisit the "acts of war" exclusion, to provide clarification of what is intended in light of recent events. For example:

Does Congress intend that the "acts of war" exclusion is also intended to exclude "terrorist" conduct? If so, does the Act currently make this clear? If Congress intends the Act to provide for terrorist accidents, does the current language make that clear? Where there is uncertainty about particular "terrorist" conduct, who (e.g., Congress and/or the Executive or the court) will be responsible for determining the scope of the exclusion, and by what means (e.g., Presidential directive, NRC review)? In the absence of clarification, the answers to such questions may fall by default to the courts, which would plainly benefit from Congressional guidance.

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[4]See also, Bohrmann v. Maine Yankee, 926 F. Supp. 211 (D. Maine) where the court found that an intentional tort theory, as provided by Maine law, could be pursued under Price-Anderson. ("There is no reason apparent to this Court to believe that Congress intended that a defendant be insulated from liability for intentional acts solely by complying with the federal safety standards...); Caputo v. Boston Edison Co., 924 F. 2d 11 (1st Cir. 1991)(worker injury claim for intentional infliction of emotional distress removed to federal court pursuant to Price Anderson Amendment Act of 1988, dismissed for lack of factual support).

III. Is The Act's Reliance on Retrospective Funding Reliable in Light of Utility Industry Restructuring?

Retrospective premium payments comprise the lion's share of potential funding in the case of a severe accident. Given current industry deregulation, there is need to assure that these payments will be available if needed.

Price-Anderson creates a two-tier system to provide funding to the current liability limit of approximately $9.4 billion. Pre-paid private insurance set at $200 million is to be supplemented by retrospective deferred payments on each unit in the event of an accident requiring additional sums. The deferred payments are based on a formula where reactor owners each provide an equal amount per unit per accident to the limit of $9.4 billion. (For example, assuming 110 reactors are operating, a per unit payment of $83.9 million would yield $9.23 billion).

At the time of the 1988 Amendments, the landscape was still dominated by vertically integrated utilities with names that likely incorporated the name of the locality or region long served.

Since 1988, names and corporate structures have changed beyond ready recognition. Some vertically integrated utilities have divested themselves of nuclear units, others have sought to build fleets of units, and new entrants into the business have considered purchasing units. Moreover, as experiences in California and with Enron show, the once unthinkable prospect of the bankruptcy of a purveyor of electric "utility" service has now become quite thinkable.

In theory, the NRC will assure the continued adequacy of funding through reviews conducted in the transfer of unit licenses to new owners. In December 2001 the General Accounting Office ("GAO") reported on the adequacy of NRC oversight of decommissioning funding in the restructuring environment.[5]

The GAO found that "for the most part" NRC reviews of new owners' financial qualifications "enhanced the level of assurance that they will safely own and operate their plants in the deregulated environment." (Report, at 6). However, the GAO found substantial basis for concern that financial reviews may not be adequate where the transfer is not predicated on the precomittment of the amounts potentially required. Thus, in the case of the NRC review of a merger that has yielded the nation's largest "fleet" of nuclear units, the GAO found (report at 6):

The new owner did not provide, and the NRC did not request, guaranteed additional sources of revenue above the market sale of its electricity, as other new owners had. Moreover, NRC did not document its review of the financial information—including revenue projections, which were inaccurate—that the new owner submitted to justify its qualifications to safely own and operate 16 plants.[6]

The GAO concluded (at 34):

NRC's inconsistent review and documentation of license transfer requests creates the appearance of different requirements for different owners or different types of transfers...While its standard review plan offers a sound basis for obtaining consistency, NRC is clearly not consistently achieving the desired results.

Moreover, the 1998 NRC report to Congress records that, even prior to deregulation, studies showed that utilities could not be expected to "afford" retrospective payments in excess of $32 million (in 1996 dollars).[7] The report pointed out that deregulation might reduce this amount further:

the current deregulatory environment, which may lead to restructuring within the nuclear power industry, may impact the ability of some nuclear power entities to handle a $20 million annual retrospective premium assessment.[8]

[8] The report explained: "The 1979 NRC staff study determined that assessments at the $10 million level were manageable but that problems might arise at the $20

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[5]"NRC's Assurance of Decommissioning Funding During Utility Restructuring Could be Improved," GAO–02–48, December 2001.

[6]The GAO elaborated, at page 21: ". . . when plant owners requested that their operating licenses for eight plants be transferred to a contractor, NRC maintained the existing level of assurance by continuing to hold the plant owners responsible for collecting decommissioning funds. In addition, when NRC approved requests to transfer licenses related to the sale of 15 plants, decommissioning funding assurances were increased because the selling utilities prepaid all or most of the projected decommissioning costs, and either the sellers or the new owners provided additional financial guarantees for those projected costs that were not prepaid. However, when NRC approved requests to transfer licenses in which the new licensee intended to rely on periodic deposits into external sinking funds for decommissioning, it did not always obtain the same level of financial assurance...Among other things, NRC approved two requests to transfer ownership of 25 plants without verifying that the new owners would have guaranteed access to the decommissioning charges that their affiliated entities would collect.

[7]"The Price-Anderson Act: Crossing the Bridge to the Next Century a Report to Congress," Prepared by ICF Incorporated for the U.S.Nuclear Regulatory Commission. See Appendix A.

[8]

million, and higher, assessment levels. The 1983 Report to Congress, using financial data from 1981, demonstrated that assessments at the $50 million level per reactor could pose major problems for all four of the utilities and especially for the two with more than one reactor each. It also showed how utilities began to evidence financial distress at assessment levels ranging between $10 and $20 million. That finding supported the 1979 NRC staff study's findings that recommended limiting the maximum assessments to $10 million per year, because higher assessments could cause financial distress. Using the Melicher method to evaluate the four utilities, this analysis concludes that the maximum annual assessment that all four utilities could afford seems to range between $20 and $50 million. This is consistent with the previous analyses' findings concluding that the maximum assessment level utilities could afford was between $10 and $20 million, which equal $16 and $32 million, respectively, in 1996 dollars when adjusted for inflation. However, the current deregulatory environment, which may lead to restructuring within the nuclear power industry, may impact the ability of some nuclear power entities to handle a $20 million annual retrospective premium assessment."

Indeed, the form restructuring is taking may render the public particularly vulnerable to funding shortfalls. As the GAO report observed, nuclear units are being consolidated under a limited number of "fleet" owners. This consolidation may yield important benefits in safety, reliability, and accountability. On the other hand, consolidation of ownership raises the possibility that the owner may have to bear retrospective payment burden measured in the hundreds, not tens, of millions, and the further possibility that the ripple of effects of an any nuclear accident on any utility system may cause cross-the-board unit shutdowns that will leave the "fleet" owner without revenue sources to pay retrospective commitments.[9]

In sum, Congress should act to ensure that industry restructuring does not render the retrospective payment obligation's that is at the core of Price-Anderson an illusion. In substance, as well as form, NRC reviews of nuclear unit ownership changes must provide assurance that the new owner(s) will be capable of making such Price-Anderson payments as may be called for. If, as the GAO report on decommissioning funding indicates, the NRC cannot uniformly provide this assurance, then Congress should consider alternatives, perhaps including demonstration of guaranteed availability of Price-Anderson funding.

IV. Punitive Damages: How Should Willful or Reckless Misconduct Be Treated?

An actor whose willful or reckless misconduct causes harm may be treated differently depending upon whether the actor is a Department of Energy ("DOE") contractor, a Department of Defense ("DOD") contractor, or an NRC licensee. In the first case, under present laws and rules government will generally pick up the costs of all litigation and damage paymentsBregardless of the actor's culpability. In the latter cases, the actor who engages in willful or reckless misconduct is on notice that it may be responsible for payments in its own right.

The standard nuclear indemnification clause applied by DOD (under 50 U.S.C. Section 1431), provides, in part:[10]

(d) When the claim, loss, or damage is caused by willful misconduct or lack of good faith on the part of any of the Contractor's principal officials, the Contractor shall not be indemnified for—

(1) Government claims against the Contractor (other than those arising through subornation); or

(2) Loss or damage affecting the Contractor's property.

Thus, DOD contractors (many of whom, of course, are also DOE contractors) are not completely off the hook for damages stemming from "willful misconduct or lack of good faith."

Similarly, courts have found that NRC licensees may themselves be liable for punitive damages in cases where the sums involved are beyond those which the Federal government is obligated to pay.

In Silkwood v. Kerr–McGee, 464 U.S. 238 (1984)—which directly involved the question of federal preemption of state causes of action and did not directly involve Price-AndersonB the Supreme Court held that punitive damages under state laws would not frustrate the federal scheme for regulation of nuclear matters. The 1988 amendments, addressing the Silkwood decision's provision of punitive damage, ex-

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[9]For example, a "fleet" owner may face the shutdown of much or all of its fleet if an accident elsewhere is caused by a design flaw common to the fleet units. When nuclear unit ownership was relatively dispersed, it might be hypothesized that individual utilities could offset the impact of cross-the-board nuclear unit shutdowns by generation (and related revenues) from other generation sources; will this be the case under restructuring?

[10]See, Federal Acquisitions Regulations—Part 52; Solicitation Provisions and Contract Clauses; 52.250–1—Indemnification Under Public Law 85–804 (Apr 1984).

pressly limited punitive damages.[11] However, some post 1988 court decisions provide that punitive damages may still be in order when, in essence, they do not come out of the government's hide.[12]

In Re: TMI, 67 F. 3d 1119 (3d Cir. 1995), the Court of Appeals considered the availability of punitive damages in light of the 1988 amendments. The court concluded that "it is clear from the unambiguous language of those [1988] Amendments that Congress did not intend to change the result the Supreme Court had reached in Silkwood." The Court elaborated: The Court of Appeals noted that in enacting the 1988 Amendments Congress "did not hesitate" to overturn "certain court decisions, but only partially limited Silkwood's holding." The Court also reviewed the legislative history of the 1988 Amendments, finding "lucid declarations" of Congressional intent to allow punitive damages.[13]

See also, Smith v. General Electric, 938 F. Supp 70 (D. Mass.1996)("a claim for punitive damages may be asserted directly against a defendant who 'supplied materials or services' to a nuclear power plant so long as such an award is authorized by the law of the forum");[14] Corcoran v. New York Power Authority, 935 F. Supp. 376 (S.D.N.Y. 1996)(denying motion to dismiss claims against non-licensee because "it is incongruous to argue that contractors cannot be subject to suit simply because they may be indemnified [by the licensee]."[15]

In sum, by contrast to the DOD rules and the potential for punitive damages awaiting NRC licensees, it appears that the current operations of the Price Anderson and procurement law may provide some deterrence (and/or post accident punitive damages) where an NRC licensee or DOD contractor engages in willful misconduct, but no such deterrence or relief in the case of a DOE contractor. If this is so, what basis is there for permitting DOE contractors to continue to be the exception to the rule?

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[11]42 U.S.C. Section 2210(s) provides: "No court may award punitive damages in any action with respect to a nuclear incident or precautionary evacuation against a person on behalf of whom the United States is obligated to make payments under an agreement of indemnification covering such incident or evacuation."

[12]Court decisions that indicate that punitive damages are still available make plain that punitive damages cannot be had against the government, but make less plain what this means. For example; (1) if punitive damages must come from funding other than that provided by the government, what does this mean when the government stands as ultimate indemnitor? (2) is the test whether the funding comes from the first or second tier of payments, and, if so, by what rationale does one determine which pot the punitive damages come from? (3) are punitive damages always available from those who are not directly indemnified by the government (e.g., a contract supplier to an indemnified utility)?

[13]The Court concluded: "Because there is no conflict between the Amendments Act and the substantive laws of Pennsylvania which allow punitive damages, we will instruct the district court to proceed with the litigation of these matters in a manner consistent with this opinion. In so doing, we emphasize that the district court has authority to prioritize the various claims if punitive damages are awarded and that the Price-Anderson Act's tri-level insurance scheme is easily adaptable to such a prioritization of claims. It cannot be gainsaid that "if there is a limited fund, priority should be given to compensating those who have been injured rather than conferring windfalls on those who have already been compensated.".. We see nothing in the Act that precludes a district court from using its discretion to limit or even preclude punitive damages in accordance with the financial constraints of the fund and the Act's prohibition against punitive damage awards being paid out of the federal layer of insurance. However, we do not express any view as to whether the district court should so exercise its discretion."

[14]In Smith v. General Electric 938 F Supp 70 (D.Mass 1996), the court explained in denying General Electric's Motion to dismiss the claims against it: "The purpose of the channeling provision of the Price-Anderson Act is to make third party vendors like GE indemnitees of nuclear plant operators like Boston Edison. The Act does not exonerate GE of its legal liability, it merely shifts the obligation to pay damages to Boston Edison. The distinction between an indemnitee and a party immune from suit is critical, especially in a punitive damages context...As the Third Circuit pointed out in TMI...the limitation on punitive damages in the 1988 Amendments Act applies only when the United States is an indemnifying party . . ."

The basis of plaintiff's punitive damages claim is the allegation that GE knowingly and recklessly sold defective fuel rods to Boston Edison. While it is true that Price-Anderson will eventually require Boston Edison to indemnify GE for any damages, to dismiss GE at this stage as a party would hinder plaintiffs from developing proof of knowing or reckless conduct on GE's part.

[15]Perhaps by contrast, in O'Conner v. Commonwealth Edison, 13 F. 3d 1090 (7th Cir. 1994)(pipefitter sues utility) the Seventh Circuit noted, in dicta at footnote 13: "Silkwood's holding regarding damages was overruled by the Amendments Act which specifically bars punitive damages." See, for the same language, footnote 5 to Nieman v.NLO Industries, 108 F. 3d 1546 (6th Cir. 1997).

V. Duty of Care: Should Federal Numerical Dose Regulations be the Duty of Care to the Exclusion of State Standards?

A predicate to recovery under tort law is a finding that the defendant has breached its "duty of care." The majority of courts have found that the duty of care is measured by the applicable federal numerical dose regulations, to the exclusion of further duty(ies) of care provided by normally governing state tort law.[16]

The exclusive application of the Federal duty of care appears to be in conflict with underlying Price Anderson Act policy that, while federal courts will have jurisdiction over claims arising from nuclear incidents, principles of state law are to be applied in determining compensatory damage claims. There is obvious wisdom in assuring that federal nuclear safety standards are not undermined by conflicting state law. However, the question is whether this principle should govern without consideration of whether state standards are in conflict with federal standards.

The tension between state law standards and federal safety standards was crystallized and addressed in the seminal Karen Silkwood case, Silkwood v. Kerr–McGee, 464 U.S. 238 (1984), In that case the Supreme Court permitted claims for damages, even punitive damages, to proceed even where the Plaintiff did not claim that maximum radiation exposure levels had been exceeded.[17] The Supreme Court observed [fns.omitted]:

Although the Price-Anderson Act does not apply to the present situation, the discussion preceding its enactment and subsequent amendment indicated that persons injured by nuclear incidents were free to utilize existing tort law remedies.

In sum, it is clear that in enacting and amending the Price-Anderson Act Congress assumed that state law remedies, in whatever form they might take, were available to those injured by nuclear incidents. This was so even though it is well aware of the NRC's exclusive authority to regulate safety matters. No doubt there is tension between the conclusion that safety regulation is the exclusive concern of the federal law and the conclusion that a State may nevertheless award damages based on its own law of liability. But as we understand what was done over the years in the legislation concerning nuclear energy Congress intended to stand by both concepts and to tolerate whatever tension there was between them....It may be that the award of damages based on the state law of negligence or strict liability is regulatory in the sense that a nuclear plant will be threatened with damages liability if it does not conform to state standards, but that regulatory consequence was something that Congress was quite willing to accept.

In the interim since the 1988 Amendments, however, courts have generally found that federal standards govern to the exclusion of state standards—without need for analysis of the potential for conflict between the two.

For example, in Roberts v. Florida Power & Light, 146 F. 3d 1305 (11th Cir. 1998), the plaintiff—a former nuclear power plant worker suffering from terminal cancer—alleged, among other things, that Florida Power & Light ("FPL"):

"unreasonably exposed him to more radiation than was necessary, that the company did not help him take precautionary steps, such as buying appropriate clothing, and that FPL did not warn him of the danger of working at the plant."

The plaintiff alleged that these failures were violations of duties owed to him under the common law of the state of Florida. FPL successfully sought to dismiss Mr. Roberts' suit on grounds that Mr. Roberts did not plead that the FPL plant had exceeded federally-determined radiation standards.

A related question is whether a plaintiff in a case where there is no extraordinary nuclear occurrence determination must show that his/her exposure exceeded the federal numerical dose limit,

In In Re: TMI, 67 F.3d 1103 (3d Cir. 1995), the court considered whether individual plaintiffs had to show that they were exposed in excess of the permissible level. Defendants argued that even where the defendant admittedly violated the permissible level, each plaintiff had to show that he/she was exposed in excess of the permissible level The court held that: "the duty of care is measured by whether defendants released radiation in excess of Section 20.105 or 20.106, as measured by

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[16]The courts have further held that the Federal standard to be applied is the applicable numerical standard, and not ALARA (the "As Low as Reasonably Achievable" principle). See, e.g. In Re: TMI, 67 F.3d 1103 (3d Cir. 1995)(Awe note that no court appears to have actually applied ALARA as part of the duty of care.") Carey v. Kerr–McGee, 60 F. Supp. 2d 800 (N.D. Ill. 1999) identifies McCafferty v. Centerior Service Comm 983 F Supp 715, 718 (N.D. Ohio 1997) as a decision which finds ALARA to be applicable. However, that decision agreed that the occupation dose limits—not ALARA—defines the standard of care.

[17]The Supreme Court recorded that the NRC had "determined that Kerr–McGee's only violation of regulations throughout the incident was its failure to maintain a record of the dates of two urine samples submitted by Silkwood."

the boundary of the facility, not whether each plaintiff was exposed to those excessive radiation levels." The court added that "[o]f course, plaintiffs must still prove causation and damages before they may recover."

In Roberts v. Florida Power & Light, however, as the court of appeals summarized, the district court found that: "[s]ince there was no extraordinary nuclear occurrence involved in this case, the district court concluded that under the Amendments Act, the plaintiffs must allege and prove that the defendant breached its duty of care by exposing Bertram Roberts to an amount of radiation in excess of federally defined permissible radiation dose standards." This holding was affirmed by the court of appeals: "[a]s plaintiffs have failed to allege that FPL breached its duty of care by exposing Bertram Roberts to an amount of radiation in excess of the permissible amount allowed by federal regulation, they have failed to state causes of action for negligence, strict liability or loss of consortium."[18]

In sum, Congress may wish to consider whether state law duty of care standards should support claims where they are not in conflict with the numerical standards set by the Federal government.

VI. Who Bears the Burden of Proof of Causation in the Absence of Adequate Records?

As the Cold War recedes into history, there have been new inquiries into the radiation exposures of "Cold War Veterans," those workers, servicemen, and further citizens who served in the development, production, and testing of nuclear weapons. It is useful to place the Price-Anderson scheme in the context of the findings of these inquiries, and the evolving burden of proof principles that they have led to.

In 1995 the President's Advisory Committee on Human Radiation Experiments reported that from the 1940's to the early 1970's numerous citizens were unknowingly exposed to radiation risk by virtue of being made subject to human radiation experiments. In a nutshell:[19]

1. From the 1942–43 dawn of the Manhattan Project, the government, its contractors, and biomedical researchers were well aware that radiation posed potential risk to weapons workers, and that such risk had to be understood and monitored;

2. At its 1947 creation, the Atomic Energy Commission and its contractors engaged in a long hidden policy and practice of hiding risks from affected citizens to avoid liability and embarrassment—even where national security itself did not require secrecy. The committee recommended, and the Administration accepted, that where such coverup occurred, research subjects (or survivors) be compensated even in the absence of physical injury.

3. The Advisory Committee found that the hidden policy and practice of keeping secrets to avoid embarrassment and liability applied to workers, and their communities, as well as to experimental subjects. Ongoing disclosures show that the policy and practice was not effectively countermanded, and continued well past mid-century.

4. The Advisory Committee found that government and its contractors were well aware that radiation risks might be latent for years, with injury occurring long after exposure. However, they failed to provide for monitoring and recordkeeping sufficient to assure that risk would be minimized and that its dimensions could be known at years remove. This finding, recent disclosures show, applies to weapons workers as well.

The committee recommended, and the Administration accepted, that in circumstances where citizens are exposed to nontherapeutic radioactive risk and the government (and/or private entities assisting it) fail to provide or withhold the information needed by citizens to protect themselves, there should be a presumption of compensation where: (1) the individual can demonstrate that he or she was present within the zone of exposure; (2) injury that is potentially related to the exposure is shown.

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[18]Similarly, in Lokos v. Detroit Edison, 67 F. Supp. 2d 740 (E.D. Mich. 1999)(individual claim of cancer related to occupational and community exposure to Fermi Power Plant), the court stated that: "[t]o prevail in their PLA, plaintiffs must prove two essential elements: (1) Mrs. Lokos' exposure exceeded the federal numerical dose limits; and (2) such overexposure caused her to suffer a compensable injury under the Amendments Act." The plaintiff, pointing to the TMI decision, argued that a breach of duty occurs whenever excessive radiation is released, whether or not anyone is present in the area exposed. The Court stated that in TMI defendants admitted that the permissible levels were exceeded at the site boundary, and there was no such evidence in the case at hand.

[19]The committee's report is available as The Human Radiation Experiments: Final Report of the President's Advisory Committee (Oxford, 1996)("Final Report").The Final Report contains a "Citizen's Guide" to accessing the documents and other materials reviewed by the committee. Page references in this testimony are to the Oxford edition.

The Advisory Committee's findings and the consequence for the burden of proof were part of the underpinnings of the fall 2000 Nuclear Workers' compensation Act.

First, the Act finds:

(2).... workers were put at risk without their knowledge and consent for reasons that, documents reveal, were driven by fears of adverse publicity, liability, and employee demands for hazardous duty pay

(3) Many previously secret records have documented unmonitored exposures to radiation and beryllium and continuing problems at these [nuclear weapons complex cites].

Second, in light of these findings, the Act provides that, upon finding that data is not adequate to render determinations with regard to particular claimants the burden shifts to the government.[20]

In sum, it is well appreciated that contests over causation of potentially radiation induced injury is often difficult, costly, and controversial. Recent experience shows that it may be wise to give notice that the burden of proof will be borne by those exposing citizens to radiation risk without keeping records or providing monitoring needed to show cause and effect at some later date.

VII. Statute of Limitations: Three years from discovery rule for Nuclear Incidents?

At what point will Price Anderson Act claims be barred because they are filed too late—even where those claiming radiation related injury could not reasonably have known of their illness and its cause at an earlier time?

In Lujan v. Regents of the U. of California, 69 F. 3d 1511, the Plaintiff brought suit to recover for the death of her daughter, who died at 21 as the result of recurrent brain cancers experienced since she was 18 months old. The brain cancers were alleged to result from releases from Los Alamos national laboratory. The suit was brought six years after the death.

Following the New Mexico state rule that wrongful death actions must be brought within three years of death, the district court dismissed the case. The Court of Appeals recognized that the application of the three year rule to radiation exposures was potentially unjust, but concluded that it was dictated by Congress:

We recognize, as did the district court, that exposure to radiation "can occur without the slightest indication of its presence and the effects of such exposure may lie dormant for years."..Congress was not unaware of the potential for injustice in cases such as this...Yet it chose not to extend the three-years-from discovery rule to all public liability actions when it extended federal jurisdiction to cover all such actions. It is not for us to correct Congress' alleged oversight.

Congress may wish to assure itself that the Price-Anderson Act does not work to prevent the bringing of otherwise meritorious claims because some state limitations statutes may not contemplate the long term latency of radiation risk.

This concludes my testimony. Thank you very much.

RESPONSE OF DAN GUTTMAN TO ADDITIONAL QUESTIONS FROM SENATOR VOINOVICH

Question 1. In your testimony, you raised the issue of possibly requiring companies to pre-pay their Price-Anderson obligations. Could you explain how this might work?

Response. As indicated in the testimony, the question of prepayment arises where, in light of the deregulation of the utility industry and altered industry structure, there may no longer be comfortable assurance that nuclear unit owners will likely have continuing generation related revenues to make retrospective payments, when and if needed. This might occur, for example, (1) where a company operated a nuclear unit as a standalone entity, and the unit was not operating follow an accident (either because it was the locale for the accident, or because of cross-the-board unit shutdowns); (2) where a company had a fleet of nuclear units, and an accident required cross-the-board design review related shutdowns; (3) where a unit owner entered into bankruptcy.

As the experience with decommissioning funding shows, a number of possibilities may be employed to provide assured prepayment of funds. The alternatives to be reviewed include, but not limited to:

- requirement that the unit owner take out insurance for the retrospective, as well as the initial tier, of Price-Anderson obligations. In light of the 45 years of operating performance under Price-Anderson, it would seem reasonable to test the mar-

[20]Section 3626 ("Designation of Additional Members of Special Cohort") empowers an expert panel to determine whether there are classes of workers "who likely were exposed to radiation but for whom it is not feasible to estimate with sufficient accuracy the dose of radiation they received.

ket and determine the price and terms on which such insurance would now be available;

- requirement that the new or current unit owner take out a letter of credit or other secure arrangement to assure the availability of fund;
- requirement that, where a new owner cannot, for whatever reason, provide appropriate pre-payment, the transferring utility provide equivalent assurance as a condition to the transfer. (I note that NUREG–1577, which is applied to financial reviews in license transfers, refers specifically and at length to decommissioning costs, but not to Price-Anderson costs);
- provision that unit owners establish a separate fund to set aside potential retrospective obligations, as is often done in regard to decommissioning costs;

Congress may also wish to ask the NRC, in coordination with the SEC and other relevant agencies, to provide protocol for assuring availability of Price-Anderson commitments in case of a bankruptcy.

Question 2. In the past, we have had problems with trust accounts, such as the Yucca Mountain Fund or the Superfund Trust Account, being co-mingled with social security and Medicare funds.

If the government sets up another trust account for liability insurance for nuclear power plants, how would we ensure that it would not become co-mingled.

Response. I did not, and do not, suggest that the government set up a government operated trust account. Rather, as indicated in response to question 1, I suggest that the NRC assure that moneys will be available in whatever nongovernmental fund or account best satisfies the requirements of the unit owner and the public interest in assured availability of Price-Anderson funding in a deregulated environment.

Question 3. Furthermore, since these funds have not been needed over the last 45 years, what would become of the interest that is generated, and is this a good use of capital funds?

Response. This question appears to contain two components; first, why should money be set aside if it is not likely to be needed (and, by that token, is this a good use of the funds)? second, assuming there is money (or interest) left over, how should it be disbursed?

As to the first questions, ideally, the market provides the best test of the value of setting funds aside for Price-Anderson purposes as opposed to putting them to some other use. However, through Price-Anderson the State has preempted the market. As the question suggests, this would be a good time to put matters to the market test; it would seem reasonable to determine whether the insurance industry is, in light of the 45 years experience, prepared to offer insurance for the retrospective component. If, as the question suggests, there is little likelihood, as we all hope, that the funds will be needed in the future, then the amounts needed to purchase insurance for this contingency should be relatively small. In any case, the private insurance market should provide a basis for assessing this likelihood.

Second, the treatment of any interest would seem to be a matter resolved under longstanding utility regulatory principles. The utility industry, as a capital intensive industry, has long and deep experience with "timing issues" in the collection and disbursement of funds.

For example, generating facilities such as nuclear units cost large sums to construct, these sums must be obtained by the utility in advance of construction, there may be multiyear lead times before the plant is in service, and those who receive the benefit of plant operations years, even decades, after construction—may well have not borne any cost for the construction of the facility that serves them.

The general principle is to match rewards to the class that contributed the risk. While, under this principle, particular individuals (be they customers or stockholders) may not gain the interest from particular prepayments they made, on the average (because plants will continue to be needed and each new generation of stockholder and customer will make its contributions) equity will be done. Thus, by way of applying these traditional principles to the Price-Anderson context, if ratepayers prepaid the costs (whether through insurance or otherwise), they should receive the interest; if stockholders prepaid the cost, the interest should go to stockholders. See the classic statement of the risk/reward principle in Democratic Central Committee v. Washington Metropolitan Area Transit Committee, 485 F. 2d 786, 821 (D.C. Cir.1973) where the court explained:

The relevant principles can be stated simply. Consumers become entitled to capital gains on operating utility assets when they have discharged the burden of preserving the financial integrity of the stake which investors have in such assets.

Finally, I note that the determination of who bears the risk, and should reap the reward, may require appropriate adjustment in the transition from cost of service to market based rate regulation.

STATEMENT OF CHRISTIE BRINKLEY, STAR FOUNDATION, EAST HAMPTON, NY

Mr. Chairman and members of the committee, my name is Christie Brinkley. I wish to thank you for the opportunity to appear here today. I am here today as a member of the STAR Foundation, a non-profit environmental group based in East Hampton, NY. STAR Foundation is located at 66 Newtown Lane, East Hampton, NY. Phone: 631–324–0655.

Two individuals are joining me: The first is Robert Alvarez, who spent several years dealing with nuclear issues as staff member to Senator John Glenn, and served at the Department of Energy as Senior Policy Advisor. He is the Executive Director at the STAR Foundation.

On my other side, is my favorite architect and the chairman of the Board of Directors at the STAR Foundation Mr. Peter Cook. He is also my husband.

Peter and I joined the STAR Foundation after we learned we were raising our three children in the cross hairs of several very old and troubled nuclear reactors. And we decided we had to learn everything we could about the Oyster Creek Reactors to our south, the Indian Point Reactors to our west, and the Millstone Reactors 11 miles north from the area of Long Island that we call home. And we are not alone over 24 million people in the Greater New York City area live within this radius of the three reactor stations.

Like many Americans, after the terrorist attacks of September 11th, we became very concerned with the safety of our family and friends. We attended public meetings with local emergency response officials, where many questions were asked

- How can we protect our children in the event of a nuclear emergency?
- What if it happens at night while we are sleeping?
- How will we be notified to take shelter? Or should we evacuate?
- What are teachers supposed to do?
- Do we rush to school?
- Is it really possible to safely evacuate densely populated areas like Long Island or New York City where there are few and highly congested roads bridges and tunnels?

No clear answers were provided.

Unfortunately these questions are no longer abstractions given that highly destructive acts of terror have become a reality in the United States.

Price Anderson Fails to Adequately Protect Americans in the Event of an Accident

Today this subcommittee is addressing a law the Price Anderson Act—that deals with how Americans are going to be compensated after a major nuclear accident. Before we go any further, I just have to say what I think we all know in our hearts. No one could ever be truly compensated for the loss of a loved one, or the loss of a birthplace, a hometown, a way of life or peace of mind. This discussion today is really about an industry owning up to its responsibilities.

I am not an expert on the Price Anderson Act, but what I do know leaves me filled with questions and serious concerns. There are about 145 million people just like me who live within a fifty-mile radius of a nuclear power station, and I'll bet they'd be interested to know that if they took out their home-owners insurance policy they would see in black-and-white that it does not protect them in the event of a nuclear accident. You can get insurance against a meteor hitting your home, but not one private insurance company in America will cover your home from a nuclear power plant accident.

Instead, we are supposed to be compensated under the Price Anderson Act, which sets a maximum limit of $9.4 billion in damages in the event of a nuclear catastrophe a number which the history reveals was simply pulled out of thin air.

The $9.4 billion limit does not match up with recent damage estimates done by the Nuclear Regulatory Commission (NRC). A study done for the NRC by Brookhaven National Laboratory in 1997 reported that a spent fuel pool fire could contaminate a large area. It could cause thousands of fatal cancers and cost about $59 billion in property damage and economic loss. With your permission I would like to place this study into the record of this hearing.

When reauthorizing Price Anderson, it is worth asking why the liability limits set by the Price/Anderson Act are not based on the cost of a major credible accident like the one identified by Brookhaven Labs.

With the Advent of Deregulation and Limited Liability Corporations Running Nuclear Power Plants, Price Anderson Should Replace Retrospective Insurance with Prospective Coverage

Unlike private insurance, reactor owners do not have to come up with over 98% of the $9.4 billion that they are supposed to pay out until after major nuclear accident occurs. After an initial payment of $200 million is made, the rest of the payments are limited to only $10 million per reactor per year—and this limited amount doesn't have to be paid if the reactor owner can demonstrate it would be too financially difficult. This is like having a homeowner's insurance policy where most of the insurance premiums don't have to be paid until after the house burns down!

With the advent of deregulation, limited liability corporations are taking ownership of almost half of the fleet of the nation's nuclear power reactors. Many of these limited liability corporations are thinly capitalized. What guarantees are there the nuclear power generators will come up with the necessary funds to pay claims if such a terrible event arises? Or will taxpayers have to foot the bill?

Enron and Pacific Gas & Electric own nuclear power plants and in bankruptcy. Can these bankrupt companies meet their obligations to compensate victims in the event of a nuclear accident? Or will the taxpayer have to bail them out?

The nuclear industry should not be allowed to avoid paying its insurance premiums up front like all other American businesses and families. The money to pay for an accident should be available with no questions asked.

If the nuclear industry can't come up with the funds to compensate victims because they can't afford it, is it really fair and reasonable for the taxpayer to be stuck with the costs of paying for a major nuclear accident?

Are Acts of "Terrorism" Included or Excluded from Price Anderson Coverage?

After September 11th our world has unfortunately become a more dangerous place, and nuclear power stations are now frequently reported as being targets for terrorists.

In light of the greater dangers from terrorism in our country, it is my understanding that the Price/Anderson Act excludes "acts of war" from coverage for nuclear accidents. Does this mean that if the nuclear power company asserts that a terrorist attack against a nuclear reactor station is an "act of war," then the nuclear power industry does not have to pay? Were the acts of September 11 an "act of war?" Was the bombing in Oklahoma City an "act of war?"

Nuclear Security Act of 2001

It is abundantly clear that radiation from a nuclear accident does not follow arbitrary rules that say dangerous contamination will only travel 10 miles and then stop. The Chernobyl accident is a tragic reminder of the absurdity of this assumption. The STAR Foundation and numerous groups around the country have repeatedly asked the NRC for several years to expand its evacuation zone beyond 10 miles, but to no avail.

It is also clear from the most recent government announcements, that nuclear generating plants are potential targets of terrorism.

I extend my thanks to Senator Clinton from my home state, Senator Reid, Senator Jeffords, and Senator Lieberman for introducing the Nuclear Security Act of 2001, which strengthens safety and security at nuclear power plants, and expands emergency response planning near nuclear power stations from 10 miles to 50 miles.

These concerns may explain, in part, why Germany, Sweden and Austria are turning away from nuclear power for safer energy alternatives, and why England is now seriously reconsidering its commitment to nuclear energy?

Summary

I hope that the committee will find the answers to these questions and seek reasonable solutions. And I hope and trust that this committee will also help insure that the risks and consequences of such terrible acts are minimized. I wish once again to thank the members of the committee for the privilege of appearing here today.

SUPPLEMENTAL DOCUMENT TO THE TESTIMONY OF CHRISTIE BRINKLEY, STAR FOUNDATION

COMMENTS ON NUREG—1738 TECHNICAL STUDY OF SPENT FUEL POOL ACCIDENT RISK AT

Decommissioning Nuclear Power Plants

Executive Summary

The Commission issued a Staff Requirements Memorandum dated December 21, 1999, on improving decommissioning regulations for nuclear power plants. The SRM states "The Commission approved the development of a single, integrated, risk informed decommissioning rule for emergency preparedness, insurance, safeguards, operator training and staffing, and backfit." The SRM goes on to direct the staff to ensure all realistic scenarios for offsite consequences are appropriately considered during the rulemaking process.

The approach taken in the staffs technical report for risk informing the decommissioning regulations is not based on realistic scenarios. In fact by compounding overly conservative estimates of seismic :risk, pool fragility and the probability and magnitude of the postulated zirconium fire and its consequent releases the report is a worst case estimate. While, the report concludes that the risk is small and that any releases are well below the quantitative health objectives the decisions regarding the continued applicability of emergency preparedness, financial protection and security must be made on the basis of a realistic risk assessment.

Discussion

Overly conservative estimates of seismic risk, pool fragility and the probability and magnitude of the postulated zirconium fire and its consequent releases are compounded to derive what is in essence a worst case estimate. The report also appears to establish a "zero risk" threshold for eliminating requirements for the spent fuel pool. For example, item 3 of the conclusions in the executive summary states "Insurance, security, and emergency planning requirement revisions need to be considered in light of other policy considerations, because a criterion of "sufficient cooling to preclude a fire" cannot be satisfied on a generic basis."

This approach is contrary to the Commission's Safety Goal Policy that states PRA evaluations in support of regulatory decisions should b e as realistic as possible. The Safety Goal Policy also states that "PRA and associated analyses (e.g., sensitivity studies, uncertainty analyses, and important measure;:,) should be used in regulatory matters, where practical within the bounds of the state-of-the-art, to reduce unnecessary conservatism associated with current regulatory requirements, regulatory guides, license commitments, and staff practices."

The study provides sensitivity analyses but no effort was made to derive a best estimate of risk. A good understanding of the underlying phenomenology would greatly assist in defining mean estimates and understanding the uncertainty in the estimates. Enclosure 1 provides specific technical recommendations on considerations for deriving a supporting phenomenology. Data is also referenced in the enclosure that demonstrates that the risk of the cask drop damaging the pool sufficiently to cause rapid drain down is likely zero, not one as assumed in the technical report.

Commission actions to establish regulatory requirements based on the staffs technical study may be precedent setting in that the study uses bounding estimates of seismic risk as the basis for assessing the need for continued applicability of emergency preparedness and insurance. Extraordinarily low frequency accidents should not be used as the predominant basis for regulations in an era of risk informed regulations. Most of the seismic risk for draining the pool comes from events with frequencies greater than one in a million years. The risk from these low frequency events should be considered well below that which can be reasonably required for adequate protection of public health and safety.

Enclosure 2 provides a discussion of seismic risk and recommendations on treatment of seismic risk where the risk is the predominant contributor to the overall risk profile. None of the operating plant requirements being considered, i.e., emergency preparedness, financial protection and security, are underpinned with explicit values for acceptable risk. However, if a realistic estimate indicates that the risk of a zirconium fire is negligible then the Commission's decision on whether to mandate these costly requirements is very straightforward.

The report's descriptions of events and consequences could be written more clearly. For example, the report compares risk from a single event for operating plants (seismic) to a worst case estimate of the total risk from the spent fuel pool. The reader can conclude that pools pose a risk that is comparable to operating plants and therefore should be expected to be subject to operating plant requirements, specifically emergency preparedness, and financial protection.

Industry Recommendations

1. The report should be withdrawn and reissued when—the technical basis has been corrected and the report has been subjected to an independent peer review. Although the staff repeatedly emphasizes that the risks are well below the safety

goals, this conclusion is insufficient. The informed decisions that must be made regarding the applicability of emergency preparedness, financial protection and security cannot be made without a realistic estimate of risk. Accordingly, industry recommends that the staff develop a phenomenological basis for the events leading to releases from the postulated zirconium fire in spent fuel pools. These efforts along with efforts to reduce unnecessary conservatism will support development of mean estimates and a characterization of uncertainty that can be used to establish a better estimate of the risk (see enclosure 1 for specific recommendations). Enclosure 2 provides specific recommendations on treatment of seismic risk.

2. A formal peer review should be performed. NRC has stressed to the industry the importance of the peer review process to ensuring quality PRAs. Taking this step for its own study is consistent with R.G. 1.174, which is cited by NRC as the basis for the approach taken in the study.

3. The report should only discuss the risk estimate and the technical basis needed to support the risk estimates. The report should avoid inferring policy decisions that the Commission will make on what constitute,; negligible risk for the purpose of evaluating the continued applicability of emergency preparedness, insurance and security.

4. Once the study is revised it is still possible the study may be limited in its usefulness because the generic study may contain many assumptions that don't pertain to specific plant circumstances. The report will only be useful in granting exemptions on a plant specific basis (one of the stated objectives of the study) if the report contains explicit criteria for application of generic risk insights on a plant specific basis. Criteria to be considered, depending on what contributes to the generic risk profile after the study is revised, might include:

- decay heat
- the likelihood of draining the spent fuel pool given realistic seismic events,
- likelihood of cask drops damaging the pool sufficient to drain the pool
- likely configuration of fuel following an event that could drain the pool
- likelihood of cladding oxidation propagating beyond assemblies with the highest decay heat
- time period over which postulated releases could occur, and
- recovery actions available to eliminate or mitigate potential releases.

5. A clear discussion is needed in the report to characterize the relative risk of spent fuel pools vis a vis operating plants. In addition, the report needs to capture important differences between the conclusions of the generic study and alternate conclusions that may be reached on a plant specific basis when assumptions in the generic study are not applicable at a given plant.

ENCLOSURE 1

Recommended Actions to Complete the Spent Fuel Pool Risk Study and Support

Development of a Best Estimate of Risk

The staffs technical study of spent fuel pool accident risk was portrayed as a scoping study or bounding estimate by the staff and the ACRS at a recent Commission briefing (February 20, 2001). However, this important distinction is not featured prominently in the report. The use of bounding estimates does not provide a means to portray risk in a risk-informed framework. As a result, decisionmakers are unable to use these evaluations to make reasoned judgments. This appears to be contrary to NRC Severe Accident Policy Statement as described in Reg. Guide 1.174:

"The Safety Goal Policy Statement discusses treatment; of uncertainties at some length. It stresses the need to consider potential uncertainties in regulatory decisionmaking. While it adopted mean estimates for implementing the quantitative objectives, it also asserted the need to understand the important uncertainties in risk predictions."

It is recommended that the following actions be taken by the staff to develop realistic estimates of the risk of the releases from spent fuel pools for decommissioning plants.

1. Address the many conservative assumptions in the study that are compounded to arrive at a worst case estimate of risk. Examples, include:

- The "smart" seismic event that drains the pool, but only to the worst case configuration, i.e., within one-foot of the bottom of the pool to block air intakes.
- The radionuclide release that is used to characterize the consequences is based on a fire engulfing 3.5 cores whereas the report indicates that a maximum of two cores will be involved in the postulated fire at times greater than 1-year following discharge of the last core. Even the twocore calculation is strongly dependent on how the fuel is stored, i.e., are the most recently discharged bundles stored adjacent to each other or are they distributed throughout the pool? Overall the combination

of worst case assumptions from unique plant configurations of highest fuel burnups permitted by regulation and assuming that those high burnups are reached through one cycle in the reactor ,Ls being used to create an "extreme worst case" configuration.

• No characterization of probability is provided for the assumption of 1 percent release of fuel fines. While the staff report slates the inclusion leads to small increases in offsite consequences, this assumption increases population doses by 50 percent.

The 100 cask lifts per year is provided as the basis for a yearly risk of damaging the pool sufficiently to drain the pool. However, based on the staffs estimate of the inventory of fuel in the pool for BWRs and PWRs the entire inventory would be offloaded in from 30–60 casks, resulting in a maximum of 60–120 lifts for the life of the pool. Accordingly this risk should not be treated as a recurring annual risk factor.

2. Cask drop sequence was not adequately analyzed.

Analyses that have a fundamental impact on the probability and consequences of the postulated zirconium fire should be performed. For example, no structural analysis was performed to determine whether a cask drop could actually damage the pool sufficiently to cause a large leak. EPRI sponsored work at Sandia labs (Full-Scale Tornado-Missile Impact Tests, EPRI NP–440, July 1977), NRC sponsored work (Summary and Evaluation of Low-Velocity Impact Tests of Solid Steel Billets onto Concrete Pads, NUREG CR–6608:, 1997) and full scale studies sponsored by BNFL provide a significant technical lbasis showing minimal damage from such drops.

Evaluation of the available data shows that a straightforward criterion can be developed to determine if cask drop could cause a rapid drainage of the spent fuel pool. Application of this criterion to a cask drop through water in an existing fuel pool calculates a damage condition that is an order of magnitude less than that necessary to cause catastrophic failure of the concrete floor or walls. Therefore, the probability of causing a failure that would rapidly drain a spent fuel pool is zero.

3. Mechanistic evaluations are needed to realistically assess consequences.

Mechanistic evaluations of consequences of the postulated zirconium fire should be performed in a manner consistent with the available experimental data base. For example, experiments have shown that the degree to which the fuel oxidizes determines the amount and rate of cesium and ruthenium releases. Sensitivity studies show that for fuel that has been out of the reactor for one to 3 years, assuming a small and large release of ruthenium, effects the consequences by two orders of magnitude. Currently, the report merely provides the results of this sensitivity analysis, i.e., shows consequences of negligible and one hundred percent ruthenium release.

Data exists to permit a best estimate to be formulated. A best estimate should be developed and reported in addition to the result., of the sensitivity analyses. The CODEX and TMI–2 data and MELCOR code provide parts of the technical basis that can be used to estimate the extent of oxidation that can occur before the fuel and cladding melt, liquefy, and then slump. Once material relocation occurs the amount of cladding and fuel exposed to further oxidizing by air or steam is significantly reduced. Fission product release tests performed at ORNL (Test VI–7) and Chalk River (Test H02) with irradiated fuel heated in air indicate that all cladding and fuel must be oxidized before any significant ruthenium releases are observed.

The TMI–2 experience indicates that a small fraction of fuel could be left as small declad (without cladding) pieces/pellets on top of the rubble bed. These would have an opportunity to be further oxidized. Because the top of the bed would be subject to radioactive cooling any oxidation occurring would take place at lower temperatures and consequently would occur over a very long period of time, several days to months.

4. Analyses are needed to establish a timeframe for potential recovery actions.

Evaluations are needed to assess the leakage rates from the pool following a cask drop or seismic event. Furthermore all mechanisms for cooling, including the results of vaporization of water in the lower regions of the pool and estimates of natural circulation through the bundles at various levels of pool drain down should be assessed to better represent the rate of fuel heat up for the postulated events.

Preliminary industry evaluations indicate that the postulated event might evolve over very long periods of time, e.g., days to months. Potential recovery actions should be evaluated commensurate with the best estimates of time available.

ENCLOSURE 2

TREATMENT OF SEISMIC RISK

Introduction

The report's treatment of seismic risk should be re-evaluated. The report characterizes risk of a zirconium fire in the spent fuel pool based on bounding estimates of seismic risk. Further, because of the inherent robustness of spent fuel pools; most of the seismic risk comes from very low frequency initiators. Very low frequency initiators should not be used as the predominant basis for regulations in an era of risk informed regulations. At some point the frequency of seismic events become so low that their consideration is below that which is :necessary for adequate protection of public health and safety. Accordingly, the prioritization of NRC and industry resources to address these worst case accident sequences regardless of probability may be an imprudent use of resources.

Regulatory Guide 1.174 states deterministic and probabilistic approaches should be used in an integrated fashion. Although deterministic approaches for evaluating the seismic hazard were fully developed and included in appendices to the report, the report does not make good use of the findings in characterizing the seismic risk for the report's readers. Further, the report implies that industry would incur large costs from application of a seismic checklist to confirm that the pools have a high confidence of low probability of failing at seismic events 2–3 times the safe shutdown earthquake. These costs do not appear to confer commensurate benefit in terms of reduction of costly emergency preparedness and financial protection requirements that were in place when the plant was operating. By contrast, the staff appears to be using a zero risk standard for evaluating the applicability of these requirements.

Commission safety goals are based on quantitative numbers that are a ratio of nuclear to non-nuclear risks (e.g., the probability of an early fatality should not exceed 1/1000 of the "background" accidental death rate). The staff provided estimates of the amount of collateral non-nuclear damage resulting from severe earthquakes that could damage the pool in an appendix to the report, but the concept was not included in the main body of the report where risk is discussed. When criteria are developed for what constitutes negligible risk for purposes of evaluating the need for protective requirements, these criteria should consider the collateral non-nuclear damage that will occur when very large, very low probability seismic events are the predominant contributor to the overall risk.

Discussion

I. Estimates of seismic risk are bounding

The report states in several places that the EPRI and LLNL seismic hazard curves are equally valid. However, the report also states that sites on the east coast that don't meet the staffs pool performance risk guidelines under the LLNL hazard estimate would be required to perform additional analyses if those sites request exemptions from emergency planning or financial protection. The staffs deferral to the more conservative LLNL curves when the EPRI curves are stated to be equally valid does not reflect the tenets of a risk informed approach as directed by agency policy and guidance. The EPRI curves most likely represent a very conservative estimate of seismic risk due to the conservatism in the estimate of a generic pool fragility value and the large amount of uncertainty inherent in predicting very low frequency events. These low frequency events contribute 95 percent of the seismic risk.

The staff extended LLNL seismic hazard curves beyond the return periods typically used for evaluating seismic risk at operating plants and requested that industry provide similar extensions for EPRI seismic hazard curves for the purpose of the spent fuel study. Figures 1–3 show the distribution of seismic risk across peak ground accelerations for spent fuel pools at three sites on the east coast. Note that for the Surry pool the 50th percentile of the annual probability of exceedance is 1 in a million years between peak ground accelerations of .!5 and .6 g. In fact, the preponderance of the seismic risk is attributable to very low probability very large seismic events. For Surry an examination of Figure 3 reveals that 95 percent of the risk occurs at levels in excess of 0.5 g, 3 times the safe shutdown earthquake (SSE) for this plant; 60-plus percent of the risk comes from seismic events exceeding 1.0g, 4–5 times the SSE for this plant.

The ability to address seismic events that are not expected to occur is exacerbated by the fact that the tails of the curves are driven by uncertainty. For example, an examination of Figure 4 reveals that uncertainty increases from a factor of 10 in the realm of plausible earthquakes to a factor of 1600 at earthquakes of 1.0g. The diverging nature of the uncertainty curves means that real improvements in seismic

capacity will be masked by uncertainty, as seismic events become larger, and more implausible. In addition, risk estimates are likely to be highly overly conservative at the high ground motion levels predicted for seismic events of this size.

Probabilistic analyses should be performed because these analyses define the upper boundaries.' However, a lower limit based on curves that are truncated at certain very low return frequencies, should be employed for regulatory decisionmaking regarding the need for protection requirements. For example, risk estimates for regulatory purposes based on return frequencies not exceeding E4–E5 at the 50th percentile makes it clear to stakeholders that very low frequency events are outside the boundaries for practical decisionmaking.

II. Deterministic and probabilistic approaches should be used in evaluating the acceptability of seismic risk.

The staff concludes that pools are inherently rugged and likely to have seismic capacities beyond the 0.5g value used in the seismic checklist developed to confirm robustness of pool designs. The report concludes that the seismic risk upon successful implementation of the checklist is acceptable: estimates of the mean risk for pools on the east coast are 2 E–7 using EPRI curves and 2.E–6 using LLNL curves. However, the finding that the risk is acceptable was never reconciled with subsequent treatment of the risk. As noted above, in some places the report appears to be applying a zero risk standard. In other places the report states that plants not meeting the pool performance guideline using the LLNL risk curves must perform additional analyses as a basis for requesting exemptions to emergency preparedness and financial protection requirements. The latter discussion implies that the staff has established but not explicitly stated a non-zero risk value that can be used to evaluate the necessity of emergency preparedness and financial protection requirements. Clearly defined criteria should be established by integrating the probabilistic and deterministic insights,.

Any use of the seismic checklist developed by NRC needs to be carefully evaluated. Application of the checklist as currently drafted equates to requiring licensees to perform a slightly simplified fragility analysis of their pools. Industry estimates the cost of this simplified fragility analysis to be on the order of $50,000.00 per pool evaluated. These costs do not include internal plant resources that would be needed to support the consultant's efforts. To retain these costly requirements and require a seismic evaluation when the plant shuts down would be nonsensical and unsupportable. These requirements (EP, insurance and security) were considered adequate to address a range of accident events and sequences when the plant was operating. In addition, the seismic capacity of the plant and pool were also considered to be acceptable during plant operations. To retain these requirements and require further seismic analysis for a single accident sequence based on seismic risk that is several times higher than the design basis of the plant is unsupportable.

1 We believe fewer insights are forthcoming from analyses using expanded seismic hazard curves for spent fuel pools than might be forthcoming for operating plants, i.e., the simple massive design of the pool will fail beyond some level. Nonetheless, the analysis should be performed.

III. Commensurate non-nuclear damage should be considered where seismic risk from very low probability seismic events dominates the risk profile.

This approach was used in past NRC policy documents. For example, NUREG 1150, Severe Accident Risks: An Assessment for five U.S. Nuclear Power Plants, October, 1990, did not provide consequences and risks for large seismic events because of the non-nuclear offsite effects of a large earl;hquakes. The report observes:

"The NRC, in its promulgation of safety goals indicated a preference for quantitative goals in the form of a ratio or percentage of nuclear risks relative to nonnuclear risks. . . . The NRC intends to further investigate the methods for assessing losses from earthquakes in the vicinity of the Surry and Peach Bottom sites with a view of comparing the ratio of seismically induced reactor accident losses with the overall :flosses. There has been at least one study that suggests that the reactor accident contribution to seismic losses is very small relative to the non-nuclear losses."

Recommendations:

1. Efforts should be made to reduce the bounding nature of the probabilistic risk estimates used in the report. The EPRI curves should be employed to arrive at a more realistic estimate of seismic risk. In addition, while the expanded seismic curves are useful to provide a bounding estimate of risk, curves that are truncated at low probabilities should be employed fir decisionmaking on the need for additional protection requirements. Consideration of collateral nonnuclear effects for large, low probability seismic events may provide additional insights for deter-

mining where the risk curve should be truncated for regulatory decisionmaking purposes.

2. Deterministic approaches should be integrated with probabilistic approaches to more appropriately characterize seismic risk and to clearly define criteria for evaluating the need for emergency preparedness and financial protection and other protection requirements applicable to operating plants. The maximum credible earthquake concept should be utilized in this evaluation. Any requirement to apply the seismic checklist should be counterbalanced by equivalent reductions in other requirements.

8/31/97

NUREG/CR-6451
BNL-NUREG-52498

A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants

Prepared by
R. J. Travis, R. E. Davis, E. J. Grove, M. A. Azarm

Brookhaven National Laboratory

Prepared for
U.S. Nuclear Regulatory Commission

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Manuscript Completed: April 1997
Date Published: August 1997

Prepared by
R. J. Travis, R. E. Davis, E. J. Grove, M. A. Azarm

Brookhaven National Laboratory
Upton, NY 11973

G. J. Mencinsky, NRC Program Manager

Prepared for
Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
NRC Job Code L2590

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FIGURES

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EXECUTIVE SUMMARY

The long-term availability of less expensive power and the increasing plant modification and maintenance costs have caused some utilities to re-examine the economics of nuclear power. As a result, several utilities have opted to permanently shutdown their plants. Each licensee of these permanently shutdown (PSD) plants has submitted plant-specific exemption requests for those regulations that they believe are no longer applicable to their facility. The preparation and subsequent review of these exemption requests represents a large level of effort for both the licensees and the NRC staff. This experience has indicated the need for an explicit regulatory treatment of PSD nuclear power plants.

This report presents a regulatory assessment for generic BWR and PWR plants that have permanently ceased operation in support of NRC rulemaking activities in this area.

After the reactor vessel is defueled, the traditional accident sequences that dominate the operating plant risk are no longer applicable. The remaining source of public risk is associated with the accidents that involve the spent fuel. Previous studies have indicated that complete spent fuel pool drainage is an accident of potential concern. Certain combinations of spent fuel storage configurations and decay times, could cause freshly discharged fuel assemblies to self heat to a temperature where the self sustained oxidation of the zircaloy fuel cladding may cause cladding failure.

Spent Fuel Configurations

This study has defined four spent fuel configurations which encompass all of the anticipated spent fuel characteristics and storage modes following permanent shutdown. Spent fuel which (due to a combination of storage geometry, decay time, and reactor type) can support rapid zircaloy oxidation is designated as Spent Fuel Storage Configuration 1 - "Hot Fuel in the Spent Fuel Pool." Configuration 1 encompasses the period commencing immediately after the offload of the core to a point in time when the decay heat of the hottest assemblies is low enough such that no substantial zircaloy oxidation takes place (given the pool is drained), and the fuel cladding will remain intact (i.e., no gap releases).

After this point, the fuel is considered to be in Configuration 2 - "Cold Fuel in the Spent Fuel Pool." The fuel can be stored on a long-term basis in the spent fuel pool, while the rest of the plant is in safe storage or decontaminated (partial decommissioning). Alternatively, after decay heat loads have declined further, the fuel can be moved to an ISFSI (designated as spent fuel storage Configuration 3). This would allow complete decommissioning of the plant and closure of the Part 50 license. Spent fuel storage Configuration 4 assumes all spent fuel has been shipped offsite. This configuration assumes the plant Part 50 license remains in effect only because the plant has not been fully decontaminated and cannot be released for unrestricted public access.

A representative accident sequence was chosen for each configuration. Consequence analyses were performed using these sequences to estimate onsite and boundary doses, population doses and economic costs.

Regulatory Assessment

After a plant is permanently shutdown, awaiting or in the decommissioning process, certain operating based regulations may no longer be applicable. A list of candidate regulations was identified from a screening of 10 CFR Parts 0 to 199. The continued applicability of each regulation was assessed within the context of each spent fuel storage configuration and the results of the consequence analyses. The regulations that are no longer fully applicable to the permanently shutdown plant are summarized below:

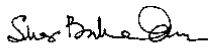
The set of regulations that are designed to protect the public against full power and/or design basis accidents are no longer applicable and can be deleted for all spent fuel storage configurations of the permanently shutdown plant. These regulations include combustible gas control (50.44), fracture prevention measures (50.60, 50.61), and ATWS requirements (50.62).

Other regulations, although based on the operating plant, may continue to be partially applicable to the permanently defueled facility. This group of requirements includes the Technical Specifications (50.36, 36b), the fire protection program (50.48) and Quality Assurance (50.54(a) and Part 50 Appendix B).

The requirements for emergency preparedness (50.47, 50.54(q) and (t), and Part 50 Appendix E), onsite property damage insurance (50.54(w)) and offsite liability insurance (Part 140), were evaluated using the accident consequence analysis. Since the estimated consequences of the Configuration 1 representative accident sequence approximate those of a core damage accident, it is recommended that all offsite and onsite emergency planning requirements remain in place during this period, with the exception of the Emergency Response Data System requirements of Part 50, Appendix E. Subject to plant specific confirmation, the offsite emergency preparedness (EP) requirements are expected to be eliminated for Configuration 2, on the basis of a generic boundary dose calculation. Part 50 offsite EP requirements can also be eliminated for Configurations 3 and 4 because the spent fuel has been transferred to an ISFSI (subject to Part 72 requirements) or transported offsite. Without spent fuel, the plant is not a significant health risk. It is recommended that the onsite property damage and the offsite liability insurance levels remain at operating reactor levels for the duration of Configuration 1. The consequence analyses support reduced insurance requirements for the remaining configurations (2,3, and 4).

FOREWORD

The information in this report is being considered by the U.S. Nuclear Regulatory Commission (NRC) staff in the development of amendments to its regulations for permanently shutdown nuclear power reactors in the process of decommissioning. The NRC has undertaken a number of initiative to reduce the regulatory burden for licensees that are in the process of permanently removing nuclear facilities from service. This report provides baseline data to the NRC for evaluating which regulations may be considered for amending to enhance the regulatory effectiveness during decommissioning.



Dr. Sher Bahadur, Chief
Regulation Development Branch
Division of Regulatory Applications
Office of Nuclear Regulatory Research

ACRONYMS

AC	alternating current
AEC	Atomic Energy Commission
ANI	American Nuclear Insurers
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
BNL	Brookhaven National Laboratory
BWR	boiling water reactor
BWST	borated water storage tank
C	Celsius
DECON	decontamination
DOE	Department of Energy
ECCS	emergency core cooling systems
EDE	effective dose equivalent
EDG	emergency diesel generator
EOF	emergency operations facility
EP	emergency planning and preparedness
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
EQ	environmental qualification
FSAR	final safety analysis report
GWD	gigawatt day
H	high release factors
HLW	High Level Waste
HVAC	heating, ventilation and air conditioning
IAEA	International Atomic Energy Agency
ISFSI	independent spent fuel storage installation
ISI	inservice inspection
IST	inservice testing
KW	kilowatt
L	low release factors
LOCA	loss of coolant accident
LWR	light water reactor
MACCS	Melcor Accident Consequence Code System
MAERP	Mutual Atomic Energy Reinsurance Pool
MRS	monitored retrievable storage
MTU	metric ton of uranium
MW, MWe	electrical megawatt
NEIL	Nuclear Electric Insurance Limited

ACRONYMS (Cont'd)

PAGs	protective action guides
PNL	Pacific Northwest Laboratory
POL	possession only license
PRA	probabilistic risk assessment
PSD	permanent shutdown
PWR	pressurized water reactor
QA	quality assurance
RG	regulatory guide
RPS	reactor protection system
RSS	Reactor Safety Study
SAFSTOR	safe storage with deferred decontamination
SBO	station blackout
SSCs	structures, systems and components
SFP	spent fuel pool
SFUEL1W	a spent fuel heatup code
SHARP	spent-fuel heatup code
SMN	special nuclear material
SMUD	Sacramento Municipal Utility District
SNL	Sandia National Laboratory
SRO	senior reactor operator
TMI	Three Mile Island
TSC	Technical Support Center
US	United States

1 INTRODUCTION

The long-term availability of less expensive power, compounded by the increasing plant modification and maintenance costs, have caused some utilities to re-examine the economics of nuclear power. As a result, several plants with years, some with decades, left on their operating licenses have opted to permanently shutdown their facilities.

At present, six (6) nuclear power plants[1] are permanently shutdown in various stages of the decommissioning process. The absence of a clearly defined regulatory path for these licensees has become apparent. Each of the permanently shutdown (PSD) licensees has submitted plant-specific exemption requests for those regulations that they believe are no longer applicable to their facility. The lack of a regulatory roadmap for the permanently defueled plant has resulted in a large effort for both the licensees and the NRC staff attributable to the development and review of plant-specific exemption requests. This experience has established the need for an explicit regulatory treatment of PSD nuclear power plants, including:

- the clarification of the regulations for decommissioning nuclear power plants,
- the activities that are permissible for major phases of the decommissioning process,
- the specification of those Part 50 regulations that are applicable only to plants authorized to operate.

Brookhaven National Laboratory (BNL) has undertaken a program (FIN L-2590) "Safety and Regulatory Issues Related to the Permanent Shutdown of Nuclear Power Plants Awaiting Decommissioning," to support the last NRC goal stated above, i.e., "to determine the extent and types of safety criteria that should remain as part of the decommissioning regulations to assure that the health and safety of public is protected when a licensee enters the permanent shutdown condition in preparation for plant decommissioning."

This NUREG/CR documents the results of this program.

The remainder of this report is structured as follows:

Section 2, "Background" presents a brief discussion of the changes that are likely to take place when a licensee permanently ceases operation of a nuclear power plant. As the primary source of public risk, the focus of this discussion is the storage alternatives for the spent fuel. This section, in conjunction with Appendix A, "Previous Examinations of Spent Fuel Pool Accidents," also summarizes the assumptions and conclusions of earlier studies in this area. This information can be helpful as it provides the necessary context for the assessment of the present study's assumptions and conclusions.

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[1] Fort St. Vrain, Rancho Seco, San Onofre Unit 1, Three Mile Island 2, Trojan, and Yankee Rowe, are undergoing decommissioning. Shoreham has completed the process and the license has been terminated.

2 BACKGROUND

Once a decision is made to permanently cease operation of its nuclear power plant, the licensee will defuel the reactor vessel. In parallel (or perhaps in anticipation of permanent shutdown) the licensee will apply for an NRC license amendment to withdraw the authority to operate the plant. It also provides a basis to remove the regulatory requirements that are no longer necessary to protect the health and safety of the public. Thus, the amendment to remove the authority to operate provides a basis for a licensee to begin eliminating personnel, equipment, and activities pursuant to 10CFR 50.59 analyses, license amendments and exemption requests. The regulatory ambiguity regarding the permanently shutdown nuclear power plant has prompted the NRC to develop further guidance in this area*. However, the basis for any regulatory relief must ultimately address the potential impact on public health and safety. Previous decommissioning studies[3-4] have shown that the offsite doses associated with decommissioning accidents that do not involve spent fuel are negligible. Therefore, this study has focused on the spent fuel storage alternatives after a plant has been permanently shutdown and the potential public risk associated with each alternative.

After the reactor vessel is defueled the traditional accident sequences that dominated the operating plant risk are no longer applicable. The remaining source of public risk is associated with the accidents that involve the spent fuel stored in the spent fuel pool (SFP). As discussed in Appendix A, accidents involving spent fuel, although limited to the 1/3 core offloads associated with refueling were considered as part of the spectrum of nuclear power plant risk as early as the Reactor Safety Study (WASH 1400). More recently, Sandia National Laboratories (SNL) studies[5-6] have indicated that complete spent fuel pool drainage, with certain combinations of spent fuel storage configurations and decay times, could cause freshly discharged fuel assemblies to self heat to a temperature where the oxidation of the zircaloy fuel cladding may become self sustaining. Follow-up efforts by BNL[7] applied simplified PRA analyses to quantify the frequency of initiating events that could compromise the SFP integrity; the conditional probability of subsequent system failure, fuel failure probability; the magnitude of radionuclide releases to the environment and the consequences of those releases.

A 1989 BNL report,[8] describes a value/impact assessment of various proposed options intended to reduce the risk posed by potential accidents occurring in commercial nuclear power plant spent fuel pools. As was the case with previous efforts, attention was limited to an operating plant. The risk dominant accidents, source terms and inventory considered in this later effort were identical to those investigated by Sailor, et al. in Reference 7. Major differences in the estimation of the off-site consequences exist between these two studies which are primarily attributable to the higher population density assumptions of the later report.

This study has defined four (4) spent fuel configurations which encompass all anticipated spent fuel characteristics and storage modes following permanent shutdown. Spent fuel which, due to a combination of storage geometry, decay time, and reactor type, can support rapid zircaloy oxidation is designated as Spent Fuel Storage Configuration 1 - "Hot Fuel in the Spent Fuel Pool." Configuration 1 encompasses the period commencing immediately after the offload of the core to a point in time when the decay heat

*Although a licensee is prohibited from making changes that materially affect costs, methods, or options for decommissioning the facility, the extent of permissible decommissioning activities has been clarified by issuance of final rule (61 FR 39278) amending regulations on decommissioning procedures.

of the hottest assemblies is low enough such that no zircaloy oxidation takes place, and the fuel cladding will remain intact (i.e., no gap releases).

At this point the fuel is considered to be in Configuration 2 - "Cold Fuel in the Spent Fuel Pool." The fuel can be stored on a long-term basis in the spent fuel pool, while the rest of the plant is in SAFSTOR* or decontaminated (partial decommissioning). Alternatively, after decay heat loads have declined further,** the fuel can be moved to an ISFSI (designated as spent fuel torage Configuration 3). This would allow complete decommissioning of the plant and closure of the Part 50 license.

Given the present unavailability of a permanent geological high level waste repository, or an interim Monitored Retrievable Storage (MRS) facility the fuel is expected to remain onsite for an indefinite time period.

At some point in the future, a MRS facility or a high level waste repository will become available. Spent fuel storage Configuration 4 assumes all spent fuel has been shipped offsite. This configuration assumes the plant Part 50 license remains in effect only because the plant has not been fully decontaminated and cannot be released for unrestricted public access.

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*Safe storage followed by deferred decontamination.

**Limits are placed on the burnup, decay time, enrichment and decay heat of the spent fuel assemblies to ensure the ISFSI design heat load is not exceeded. Although 10CFR Part 72 specifies a minimum of one year pool decay time, plant ISFSI technical specifications specify minimum decay times up to 10 years.

3 SPENT FUEL STORAGE CONFIGURATION INPUT ASSUMPTIONS

The purpose of this section is to define the input assumptions for each spent fuel storage configuration to support the consequence analyses of the next section. A set of assumptions was developed that is used in Section 4 to provide an estimate of the accident consequences that envelope future end of life nuclear power plant shutdowns, as well as plants that have prematurely ceased operation. However, an effort has been made to avoid unduly pessimistic assumptions or combinations of assumptions. The accident consequences thus obtained, are believed to be reasonably bounding for present and future closures and are not so overly conservative as to clearly represent some high (but unspecified) percentile result.

The input assumptions for each configuration will be discussed for PWRs and BWRs, respectively. Table 3.1 presents a summary of this section.

3.1 Configuration 1 - Hot Fuel in the Spent Fuel Pool

Spent fuel storage Configuration 1 commences immediately after the permanently shutdown facility has completed the reactor vessel defueling. This configuration models the potential consequences of rapid zircaloy oxidation resulting from an event which has caused the draining of the spent fuel pool. After a suitable time period, dependent on assembly burnup and racking geometry, the decay heat is low enough to preclude the rapid oxidation phenomenon. The end of this configuration is defined as that point in time when the fuel decay heat is low such that the cladding remains intact upon extended exposure to the air.

The consequence analysis input assumptions for Configuration 1 are provided below in the form of generic PWR and BWR plant configurations.

3.1.1 Representative Plant and Fuel Pool Data

The representative PWR* chosen for this study is a single 1130 MWe unit with 193 assemblies in the core. The corresponding 1155 MWe BWR has 764 assemblies. In accord with the industry trend to maximize storage capacity, both plants have high density fuel racking geometries.** The PWR spent fuel racks have a 10.40 inch cell to cell pitch and a five inch orifice at the bottom of each cell.[9] The BWR spent fuel racks a 6.255 inch pitch. Each BWR cell has a 4-inch orifice.[10] Variation in these parameters exist among various rack designs and manufacturers. These values were chosen to represent typical attributes.

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*The representative PWR and BWR geometries and spent fuel data were developed from a review of a limited set of plant information. They are generally the most conservative values from that set of information and are viewed as reasonably conservative, but not necessarily the most limiting configurations.

**Previous studies of the spent fuel rapid oxidation phenomenon have assumed a low density racking configuration for BWRs. (See Appendix A).

The spent fuel pool storage capacities were 1460 intact assemblies for the generic PWR and 3300 assemblies for the generic BWR. These are the average pool capacities of the current 193 assembly PWRs and 764 assembly BWRs. In order to envelope end of life shutdowns, this analysis assumed that the pools are full. The last full core offload was assumed to contain high burnup fuel (60,000 and 40,000 megawatt days per metric tons of heavy metal (MWD/MTU), PWR and BWR, respectively), to reflect the current trend to increase burnup. The earlier refueling discharges began at 20,000 MWD/MTU and increased linearly with each subsequent discharge to the ultimate assumed burnup. Consistent with Regulatory Guide 4.7, an exclusion boundary of 0.4 miles was assumed for each plant.

3.1.2 Accident Initiator and Timing

The accident initiator was a composite of events that can cause draining or boiloff of the spent fuel pool and expose the relatively hot spent fuel assemblies to an air environment. The initiator includes beyond design basis seismic events, spent fuel cask drop events, and other less dominant events such as spent fuel pool loss of cooling/makeup.

The composite initiator frequency of 2E-6 (PWR) and 7E-6 (BWR) events per year is adapted from the NUREG-1353 "best estimate" with modifications to reflect a higher spent fuel cask drop contributor associated with a higher assumed spent fuel transfer rate for the permanently shutdown plant. For the purposes of the offsite liability insurance discussion in Appendix B, the initiator frequency is equivalent to the release frequency.

The accident timing considered the minimum in-core decay requirements of the Standard Technical Specifications (about 4 days) and industry experience of several weeks to fully offload a core during refueling outages. For this study, the Configuration 1 accident initiator was assumed to occur 12 days following final shutdown.

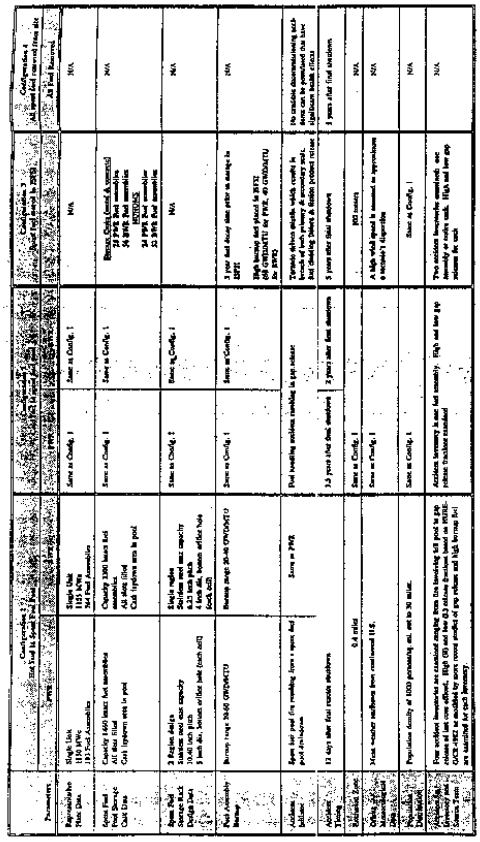
3.1.3 Critical Decay Time

Previous studies[3-7] have defined the critical decay time as the duration, measured with respect to reactor shutdown, when the most recently discharged set of fuel assemblies have sufficient decay heat, that if the fuel pool were to completely drain, would heat to the point that clad oxidation would become self sustaining and eventually result in extensive clad failure with fission product release. This time is a function of the reactor type, spent fuel storage rack geometry and fuel burnup.

To be conservative, this effort chose to examine high density rack geometries for both PWR and BWR plants. In the time frame of the previous studies, high density racking was not widely used by in BWR plants. The previous efforts, therefore, do not provide results for this case.

The PWR high density racking geometry with a 5-inch orifice (albeit with low burnup fuel) was examined in NUREG/CR-4982. A 700 day critical decay time was estimated, using the SFUEL1W[5,6] code, based on a minimum decay power of 6 KW/MTU.

Table 3.1 Spent Fuel Storage Configuration Matrix



It should be stressed that there are uncertainties associated with this SFUEL1W calculation. The authors of the present study fully agree with the code limitations presented in NUREG/CR-4982 report. The SFUEL1W code provides a stylized analysis of the progression of events following the complete loss of spent fuel pool coolant and as such, does not have the ability to realistically model actual spent fuel pool configurations.

In response to the need to accurately predict the likelihood of reaching critical clad temperatures with realistic spent fuel pool configurations, BNL has developed the SHARP code (Spent-fuel Heatup: Analytical Response Program.)[45]

This code has been used, in conjunction with the Configuration 1 spent fuel data from Table 3.1 to develop maximum clad temperature as a function of decay time, given a loss of all spent fuel pool water. These relationships are presented as Figures 3.1 and 3.2 for the PWR and BWR representative geometries.

The end of Configuration 1 has been defined as the decay time that is necessary to ensure that the fuel rod cladding remains intact given a loss of all spent fuel pool water. The previous study[7] defined 650°C as a maximum temperature for cladding integrity. The Workshop on Transportation Accident Scenarios[47] estimated incipient clad failure at 565°C with expected failure at 671°C, presumably based on expert opinion. Given that the large seismic event is the dominant contributor to the configuration 1 initiator, it is likely that it would take a prolonged period of time to retrieve the fuel, repair the spent fuel pool or establish an alternate means of long-term spent fuel storage. Therefore, we presume there will be a significant period of time that the fuel will be exposed to air. On this basis, BNL has chosen a temperature of 565°C as the critical cladding temperature. This results in critical decay times of about 17 months for the representative PWR and 7 months for the representative BWR.

3.1.4 Meteorological and Population Data

Weather and its variability play an important role in the estimation of consequences that may result from a release of radioactivity to the environment. The prevailing weather conditions at the time of release will influence: the extent of downwind transport and lateral dispersion; the atmospheric concentration; and the extent and severity of land contamination. The SNL Siting Study, NUREG/CR-2239[17] and a BNL reassessment[44] were utilized to develop a representative meteorology for the continental United States composed of: mean weather attributes (wind speed, stability, class occurrence total hours, and amount of rain for Omaha, NB); a generic mean wind rose; and an average mixing height.

This study has adopted a generic population distribution within a 500 mile radius of the site that will reasonably envelope the majority of the current reactor sites* and account for future population growth over the life of the plant.

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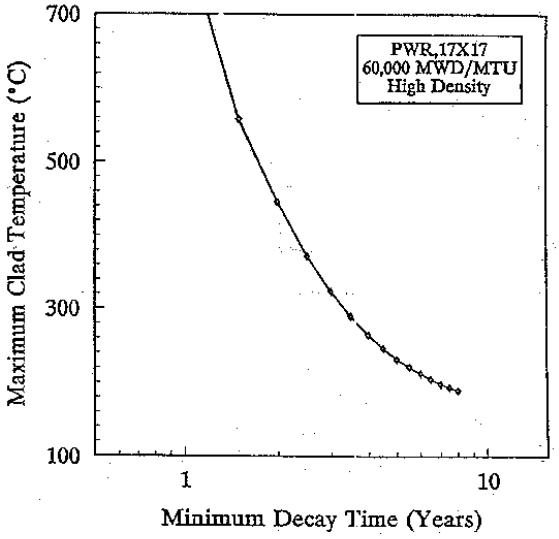
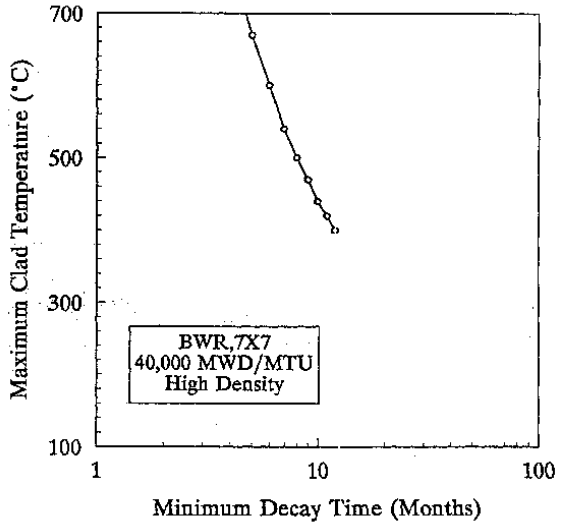
*There are several existing plant sites (i.e., Indian Point, Limerick, and Zion) that precede the issuance of R.G. 4.7 and exceed the site population distributions generally considered acceptable by current NRC policy.

A uniform population distribution (0-30 miles) of 1000 persons per square mile has been specified based on the end of life average population density from Regulatory Guide 4.7. Between 30 to 50 miles, we have assumed a large city of 10 million and a uniform population density of 280 persons/mile^2 for the remaining land in this region.[14] A uniform population density of 200 persons/mile^2 (twice the current average of the 48 contiguous states) was assumed for the area 50 to 500 miles from the plant.



(Adapted from Reference 46)

Figure 3.1 Spent fuel temperature as a function of time for the representative PWR configuration



(Adapted from Reference 46)

Figure 3.2 Spent fuel temperature as a function of time for the representative BWR configuration

3.1.5 Accident Inventory and Source Term

The spent fuel pool inventory at accident initiation is a function of the ages and burnups of the spent fuel discharges that occurred over the life of the plant. The DOE High Level Radioactive Waste Management Database[15] was used as the source of the generic spent fuel inventory data for discharges one year or older.

The inventory of material at risk 12 days after reactor shutdown (i.e., at the beginning of Configuration 1) was developed from both the DOE Spent Fuel Data Base and the default reactor core inventories provided in the MELCOR Accident Consequence Code System (MACCS).

MACCS Version 1.5.11.1[16-17] was used in the next section to model the postulated accident consequence. Like other consequence codes, MACCS models radionuclide releases that occur shortly after reactor shutdown. The code has a default set of risk dominant radionuclide species that is consistent with the premise of a release within days of shutdown. In contrast, the inventory of the spent fuel pool, including the last core offload, has had sufficient time for the short lived isotopes, which have important dose contributions, to decay away. The concern is that perhaps the MACCS default set of isotopes might not accurately model long lived isotopes that are relatively insignificant for short-term releases, but rise in prominence for spent fuel pool accidents. The code default isotopes set was spot checked with the DOE database[15] inventory for two offloads. It was determined that the MACCS code will capture greater than 90% of the activity in the spent fuel. Therefore, it was not necessary to revise the code's default isotope set to include any additional radionuclide species.

The atmospheric source term is a set of characteristics describing the radionuclide release to the environment. These characteristics include: the number of plume segments released, the associated timing duration and release height of each segment, the emergency response warning time and the radionuclide release fractions.

This study examined four cases for Configuration 1. The assumptions for each case are described below:

Case 1 Complete draining of the spent fuel pool occurs twelve days after shutdown. Rapid cladding oxidation starts in the last full core discharge and propagates throughout the pool.

Case 2 Complete pool drainage occurs, again at twelve days. The rapid zircaloy oxidation is limited to the last full core discharge (plus the last refueling offload for PWRs).

Case 3 Complete pool drainage occurs one year after shutdown. The lowered decay heat does not cause rapid oxidation, however the assemblies reach high temperatures and 50 percent of the fuel rods in the pool fail, resulting in a gap release.

Case 4 Partial pool drainage occurs at twelve days, exposing the upper portion of the fuel assemblies. This case assumes all fuel rods in the last full core discharge experience cladding failure, again resulting in a gap release.

This study used the release fractions of NUREG/CR-4982, as modified by studies associated with gap inventory and high burnup fuel.[18-22,33] Table 3.2 provides the source terms developed for the present study.

The majority of the high release fractions for Cases 1 and 2 were largely adopted from NUREG/CR-4982. However, the lanthanum (La) and cerium (Ce) groups have been adjusted slightly to reflect the observed release of fuel fines as part of the gap release in high burnup fuel. The low release fractions for Cases 1 and 2 assumed a decontamination factor (DF) of 10 for all fractions

Table 3.2 Configuration 1 Release Fractions

Case	Release Characterization	NG	I	Cs	Te	Sr	Ru	La	Ce	Ba
1H, 2H	Fire/High release	1.0	1.0	1.0	2E-2	2E-3	2E-5	6E-6	6E-6	2E-3
1L, 2L	Fire/Low release	1.0	0.5	0.1	2E-3	2E-4	2E-6	6E-7	6E-7	2E-4
3H, 4H	Gap/High release	0.4	3E-2	3E-2	1E-3	6E-6	6E-6	6E-6	6E-6	6E-6
3L, 4L	Gap/Low release	0.4	3E-3	3E-3	1E-4	6E-7	6E-7	6E-7	6E-7	6E-7

except noble gases and iodine. Cases 3 and 4 heat the fuel cladding to failure, but do not result in fire. The gap release fractions developed for this work differs markedly from the previous efforts. The noble gas fraction, 0.4, was based on high burnup/high linear power calculation and is therefore believed to be conservative. The fractions for the cesium (Cs), iodine (I), and tellurium (Te) groups were based on experimental observation. In the case of the high gap release, these were increased by a factor of ten to reflect evidence that these fractions may increase for high burnup fuels. For both the high and low gap releases, the Te fractions were corrected for the interaction observed to occur with the cladding, since unoxidized cladding will be present. The fractions for the remaining groups are established by the release of fuel fines.

For the set of low gap releases (Cases 3 and 4), all release fractions were reduced by an order of magnitude (DF=10) with the exception of noble gases (NG).

3.1.6 Emergency Response and Other Data Requirements

The MACCS code can model various emergency response actions such as evacuation, sheltering, and post accident relocation (including dose criteria). Consistent with NUREG/CR-5281,[8] this study assumed a short-term emergency response of no planned evacuation, followed by relocation at one day if projected doses are unacceptable. Long-term protective actions include permanent relocation, crop interdiction, and land decontamination or condemnation. The dose threshold for these actions are the MACCS default values which were also utilized in NUREG-1150.[23]

The code also considers land usage and economic data for the region surrounding the reactor site to estimate accident cases. The national average value of farmland of $2094/hectare and a mean value of $73,750/person for non-farm wealth was assumed.[23] The Omaha, Nebraska region, also used for the

mean meteorology, was used to model the code's agricultural data block, including the growing season and the fraction of land used for farming.

These estimated accident costs will be used to analyze the insurance issues for permanently shutdown nuclear power reactors.

3.2 Configuration 2 - Cold Fuel in the Spent Fuel Pool

Spent fuel storage Configuration 2 models the continued storage of the fuel in the spent fuel pool. Time has reduced the decay heat, and the rapid clad oxidation or clad rupture events of Configuration 1 are not likely. This section summarizes the input assumptions, such as accident initiator, and source terms that differ from those of the previous section. Other parameters (i.e., spent fuel pool data, rack design, and fuel burnup) remain consistent with the Configuration 1 baseline. A summary of each spent fuel configuration is provided in Table 3.1.

3.2.1 Accident Initiator and Timing

By definition, Configuration 2 eliminates the pool drainage accident scenarios of Configuration 1 from consideration. The prolonged exposure of the low-decay heat fuel in air is not expected to cause fuel rod clad failures. BNL has adopted the traditional fuel handling accident analysis of Regulatory Guide 1.25, with modifications. The present study assumed a single assembly is dropped in the spent fuel pool, resulting in damage to 100 percent of the rods in the affected assembly.

The estimated initiator frequency of 3E-4 events per year* was developed from industry refueling outage data reported in Reference 48, modified to reflect a higher assumed spent fuel transfer rate.

The accident was assumed to occur after the transition from Configuration 1, one to two years after final reactor shutdown.

3.2.2 Accident Inventory and Source Terms

The accident inventories for the Configuration 2 accident cases consist of a single two year old PWR fuel assembly or a single one year old BWR assembly. As before, the DOE spent fuel database**[15] was used to assemble the isotope quantities for the MACCS default set of nuclides.***

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*This is also the estimated release frequency.

**At 60,000 and 40,000 MWD/MTU burnup for the PWR and BWR cases, respectively.

***In both reactor types the MACCS default, risk dominant nuclides represent about 89 percent of the total activity in the fuel.

The source term is composed of the single assembly gap release. In addition to partial releases of the noble gases and iodine (if present), small releases of the remaining nuclide groups are expected on the basis of experimentally observed releases of fuel fines. The Configuration 2 high gap release fractions are the same as Case 3H of Table 3.2 in the previous section. The low gap source term assumes a DF of 100 to credit the scrubbing effect of the water overlying the spent fuel and the retention of the building.

3.3 Configuration 3 - All Fuel Stored in an Independent Spent Fuel Storage Installation (ISFSI)

As discussed in Section 2, after a sufficient decay period, long-term spent fuel storage outside the spent fuel pool becomes a possibility. The decision to apply for a Part 72 license and to transfer all fuel to an onsite ISFSI is a licensee decision that is based, in part, on such plant-specific factors as the timing and method of plant decommissioning,* the preexistence of a licensed ISFSI, and the anticipated start of fuel shipments to a DOE facility. This section discusses the supporting assumptions for Configuration 3 that differ from the previous spent fuel storage configurations.

3.3.1 Accident Initiator and Timing

The Configuration 3 accident initiator** is assumed to be a tornado driven missile that pierces one cask of the ISFSI. An initiator frequency is developed, for the purposes of the offsite liability discussion in Appendix B. The Electric Power Research Institute document, EPRI NP 3365, "Review of Proposed Dry Storage Concepts Using PRA,"[49] developed an initiator frequency of 6E-6 events per year for the extremely severe tornado (windspeed of 567 miles/hour) that would be necessary to generate a missile that could pierce an ISFSI cask. The report conservatively assumes the probability of missile generation,*** missile strike and impact orientation are unity. In addition, the windspeed and the missile speed are considered to be equal; no slippage is considered. Therefore, the extremely severe tornado initiator frequency is also the ISFSI cask release frequency.

BNL believes there are also additional conservatisms embedded in the development of the severe tornado initiator frequency. The frequency was based on a Zion PRA[42] initiator frequency of 1E-3 tornados/mile^2-year for all tornados. According to Regulatory Guide 1.76,[13] the Zion plant is in tornado Region 1. Tornado Region I has the most severe design conditions. It comprises over 50% of the land area of the

*Partial DECON or SAFSTOR could allow long-term utilization of the spent fuel pool without significant impact on the facility decommissioning plan. Complete DECON would require fuel transfer to permit decommissioning of the spent fuel pool and supporting equipment.

**Current licensing documents for spent fuel casks and modular concrete vaults do not postulate any credible accident scenarios which will breach the ISFSI.[24-25]

***The vast majority of missiles do not have the rigidity, shape, or weight to pierce the ISFSI cask.

contiguous United States, or in excess of 1,560,000 square miles. Everything else being equal, we would expect to see an average of:

1,560,000 miles^2 x 6E-6 extremely severe tornados/mile^2 - year = 9 extremely severe tornado events per year.

Although windspeeds have been estimated that are in excess of 400 mph,[54] to the best of our knowledge, there has never been a tornado of the magnitude that would be necessary to fail an ISFSI cask.

The equation used in the EPRI report to estimate the annual probability of exceeding a velocity V at a site is:

$$P(V) = \lambda \left(\frac{V_d}{V} \right)^{\frac{1}{k}} R'(V)$$

where λ = local mean rate of occurrence of tornadoes per square mile per year.
V_d = gale velocity
k = 0.5 to 1.6 a parameter value depending on a given storm, and conservatively recommended as 1.6 until such time as additional data becomes available

$R'(V)$ = 17.4 exp (-0.014v for $V \geq 290$ mph.

(As developed in Reference 54.)

The factor R'(V) is an approximation (based on tornado data) that accounts for the relative frequency of different tornado events, with their respective peak velocities and correlated path dimensions. Since a tornado of the magnitude of the ISFSI initiator exceeds the information that was used to develop (R'(V), the use of this equation is suspect.

On the bases of the frequency discussion, we believe that the initiator frequency of this extremely severe tornado is overstated. In our judgement, the frequency should be at least 2 orders of magnitude less.*

Table 3.3 Configuration 3 Release Fractions

NG	I	Cs	Te	Sr	Ruv	La	Ce	Ba
0.40	1.5E-5	2.25E-5	1.5E-5	1.5E-5	1.5E-5	1.5E-5	1.5E-5	1.5E-5

*This judgement is supported by NUREG/CR-4461, "Tornado Climatology of the Contiguous United States,"[55] which identifies the windspeed of 10^{-7} probability of tornado strike for all of the U.S. to be significantly less than that required to pierce an ISFSI cask. The staff has referenced NUREG/CR-4461 in the advanced reactors evaluations and is using the same to develop new guidance with less maximum windspeeds for tornado design criteria.

With regard to accident timing, although 10CFR Part 72 allows a minimum in-pool decay time of one year the current vendor requirements and license submittals specify five-to-ten year minimum decay times.[24,25] This study assumed accident initiation at five years after final shutdown.

3.3.2 Exclusion Area and Meteorology

In accordance with 10CFR72.106, this study assumes the distance from the ISFSI to the exclusion area is 100 meters. The onsite weather modeling assumes "A" stability weather with a high wind speed (30 meters/second), approximating the rapid dilution associated with a tornado to develop an estimated dose at the exclusion boundary. The offsite dose model uses the MACCS code. As discussed in Section 4, the use of MACCS under these conditions adds additional uncertainty, but the authors believe the results obtained beyond the exclusion boundary are a conservative approximation.

3.3.3 Accident Inventory and Source Term

The storage capacity varies for each ISFSI type. A metal or concrete storage cask can accommodate 28 PWR or 56 BWR fuel assemblies. Each NUHOMS unit has a slightly smaller design capacity of 24 PWR or 52 BWR assemblies.[26] This study utilized the higher capacity cask inventories and further assumed the high burnup of the previous configurations, 60,000 (PWR) and 40,000 (BWR) MWD/MTU.* The DOE spent fuel database[15] was again used to assemble the quantities of radionuclides for input into the MACCS code.

Licensed ISFSIs are substantial engineered enclosures. The catastrophic failure of the current designs is not believed to be credible. Any damage to the ISFSI and the contained fuel is expected to be limited. Therefore, the accident inventory assumes that all of the fuel rods in one assembly are breached.

The best estimate release fractions for Configuration 3 were developed by a peer group.[39] The group reviewed published information,[21,40-42] and considered the effect of high burnup on the particulate release fractions to the cask. Since the ISFSI design pressure is slightly above atmospheric (~0.4 bar), there could be a slight driving force to the environment if the cask integrity is compromised. A bounding calculation was performed to estimate the fission product retention. Assuming isentropic expansion of the gas within the ISFSI and an environmental pressure associated with a tornado, a decontamination factor (DF) of about 2 was obtained. The Configuration 3 release fractions are presented in Table 3.3.

3.4 Configuration 4 - All Fuel Removed from the Site

In the future, when a DOE MRS (or a high level waste repository) becomes operational, the option of offsite storage (or disposal) of spent fuel will become available. At that time, the DOE will begin accepting spent fuel shipments with a minimum of five years decay.[23] In order to envelope future plant

*Although presently limited to a maximum burnup level of 40,000 MWD/MTU it is anticipated that future ISFSI storage concepts will be licensed for high burnup fuel.

shutdowns when the offsite shipment of fuel can be accommodated, this configuration assumed a five year onsite decay prior to the start of Configuration 4.

Publicly available literature[34] was reviewed to identify potential accidents that could occur during the decommissioning of nuclear power plants.

After all the spent fuel has been removed from the site, the estimated inventory that remains, although considerable, is primarily attributable to activated reactor components and structural materials. There are no credible accident sequences that can mobilize a significant portion of this activity. As a result, the potential accidents that could occur during the decommissioning of a nuclear power reactor in Configuration 4 have negligible offsite and onsite consequences. In order to develop onsite property damage insurance recommendations for Configuration 4, a rupture of the borated water storage tank is postulated.[43,44] To support the offsite liability insurance discussions of Appendix B a tank rupture initiator was developed assuming a seismic induced failure. The initiator frequency is approximately 2E-7 events per year based on a tank fragility from Reference 50 and a seismicity curve representative of the eastern United States from Reference 51. Although the health effects are negligible, the cleanup costs are significant.

4 RESULTS OF THE CONSEQUENCE ANALYSES

The MELCOR Accident Consequence Code System, MACCS[16-7] was used in this study to model offsite consequences. The principal phenomena considered in MACCS are atmospheric transport, mitigative actions based on dose projection, dose accumulation by a number of pathways (including food and water ingestion), early and latent health effects, and economic costs.

The prediction of onsite consequences (occupational doses) has traditionally been estimated through deterministic calculation of dose rate(s), dose(s) and contamination level(s), generally of a scoping or bounding character. Typical of these methods, was the guidance provided by Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors."[28] A typical application of this method was documented in NUREG/CR-5771.[29]

In this study, a variety of deterministic methods were applied. These included the standard method as outlined in relevant Reg. Guides, and/or alternate methods, such as the Ramsdell model,[30] for estimating the concentration of material entrained in the building wake. The methods are important for predicting on-site consequences, a region generally not modelled adequately by the MACCS code.

4.1 Configuration 1 - Results

A series of MACCS code calculations were performed to quantify the postulated accidents cases for the Configuration 1 conditions described in Section 3.1. For each accident, Cases 1 through 4, and each generic reactor type, two calculations were performed: one using the set of high release fractions (H) and a second employing the set of low release fractions (L). The latter generally included a DF of 10 for particulates to reflect potential for retention of activity in structures. The results are tabulated in Tables 4.1 and 4.2.

A case by case comparison of the results for Configuration 1 indicates that the generic PWR and BWR results are very similar. Generally, the results are within 20 percent of one another, although in a few comparisons the differences may be somewhat larger. This similarity would be expected on the basis of *identical* site assumptions, weather conditions, interdiction criteria, and source term fractional releases adopted for both reactor evaluations. PWR inventories were generally larger than corresponding BWR inventories. The higher PWR consequences were attributable to the assumed higher burnup, the inclusion of the last normal refueling discharge in cases where the last core discharge was considered, and the relatively larger PWR pool size in the cases that considered full pool involvement.

Table 4.1 Mean PWR Consequences

Accident	Inventory	Distance (miles)	Prompt Fatalities	Societal Dose (person-rem x10⁶)	Latent Fatalities	Condemned Land (sq. miles)	Total Cost ($x10⁹)**
Case 1H	full pool	0-50	70	74	31,300	467	287
		0-500	95	339	143,000	2790	566
Case 1L	full pool	0-50	1.2	62	25,300	297	100
		0-500	1.2	130	53,800	869	117
Case 2H	last core*	0-50	29	81	33,200	286	186
		0-500	33	226	94,600	776	274
Case 2L	last core*	0-50	0.3	42	16,800	156	56
		0-500	0.3	70	28,800	188	59
Case 3H	50% pool	0-50	0	32	13,200	25	25
		0-500	0	48	20,400	25	25
Case 3L	50% pool	0-50	0	6	2,400	2	1.1
		0-500	0	8	3,400	2	1.1
Case 4H	last core*	0-50	0	24	10,100	15	15
		0-500	0	36	15,400	15	15
Case 4L	last core*	0-50	0	4	1,500	1	0.8
		0-500	0	5	2,300	1	0.8

* The "last core" also includes the last normal refueling discharge
** excludes health effects

A limited comparison can be made of the results obtained in this effort with those of previous investigations. The consequence estimates obtained here are generally higher. For example, the societal dose commitment (0 to 50 miles) for the worst case accident (fire, full pool involvement, high release fractions) reported by Sailor[7] was 2.6 million person-rem; Jo[8] reported 25.6 million person-rem; while in the present work 75.3 million person-rem (BWR) was obtained. As discussed in Appendix A, these early efforts used identical inventory and source term assumptions. The differences observed were primarily due to the population assumptions. The average population density (0-50 miles which includes the large city) used herein was about 1800 persons per square mile. This would support an approximate increase
of a factor of two over the dose reported by Jo. The second major reason the consequences are greater is the radionuclide inventory used here. The assumptions made for reactor power, end of plant life fuel burnup and fuel pool capacity, resulted in an inventory which has substantially higher quantities of the long lived radionuclides than previous studies. For example, the total BWR pool inventory of Cs-137 was about a factor of 3 greater than developed by Sailor for the Millstone plant. Thus, the limited comparisons would indicate that the consequences determined in this study were generally higher than the former studies. The consequences are consistent with earlier work, when gross differences in the underlying assumptions are taken into account.

Table 4.2 Mean BWR Consequences

Accident	Inventory	Distance (miles)	Prompt Fatalities	Societal Dose (person-rem x 10^6)	Latent Fatalities	Condemned Land (sq. miles)	Total Cost $x10^{9**}$
Case 1H	full pool	0-50	74	75	31,900	456	280
		0-500	101	327	138,000	2170	546
Case 1L	full pool	0-50	1.3	58	23,600	286	97
		0-500	1.3	120	49,800	784	113
Case 2H	last core	0-50	24	81	33,000	262	167
		0-500	26	207	86,400	521	234
Case 2L	last core	0-50	0.2	38	15,300	140	48
		0-500	0.2	62	25,700	159	51
Case 3H	50% pool	0-50	0	29	12,200	23	23
		0-500	0	45	18,900	23	23
Case 3L	50% pool	0-50	0	5	2,100	2	1.0
		0-500	0	7	3,000	2	1.0
Case 4H	last core	0-50	0	20	8,300	13	12
		0-500	0	30	12,700	13	12
Case 4L	last core	0-50	0	3	1,300	1	0.7
		0-500	0	4	1,900	1	0.7

** excludes health effects

The total costs of fuel pool accidents observed in this study were found to rise more sharply than the societal dose. This reflects the tradeoffs of protective (interdiction and relocation) actions. These actions are, of course, intended to limit public exposure to the released radioactivity, but at the increased cost of primarily population dependent interdiction and relocation expenses. Again the major obvious factors, which will drive costs up in comparison to earlier studies, are the larger population at risk and the larger inventory of material considered in this study. This observation is supported by a comparison of the condemned land. Comparing Case 1H in Table 4.1 or 4.2 with case 1A of Table A.2, it can be seen that the condemned area has doubled. Although, Table A.2 identifies this as interdicted area, which might be subject to a different interpretation given the usage of this term by the MACCS code, the text of the Sailor study clearly stated "... interdicted area (the area with such a high level of radiation that it is assumed that it cannot ever be decontaminated)." Condemned land is defined as farmland permanently removed from production, as such it does not account for the population affected area. However, the condemned area for case 1H in the present study clearly indicates a more extensive contamination of all lands when compared to the former study. This increase translates into increased costs.

Table 4.3 PWR Core Melt Accident Results

Accident	Inventory	Distance (miles)	Prompt Fatalities	Societal Dose (person-rem x10^6)	Latent Fatalities	Condemned Land (sq. miles)	Total Cost ($x10^6)
RZ1 with evacuation	3800 Mwt core	0-500	88	70.*	35,000	2000	NR
RZ1 no evacuation	3800 Mwt core	0-500	160	220.	110,000	2000	NR

* Doses that were not reported, have been estimated from the number of latent fatalities and the BEIR-V recommended risk coefficient of 5.0E-4 fatalities per person-rem.

(Reproduced from Reference 14)

For perspective, it is interesting to provide some comparison to core melt accidents. A major core melt accident (RZ1, large early release) was selected from the results reported in Reference 14. This study employed many of the assumptions, i.e., population distribution and weather conditions, that were employed in the present analysis, thus allowing for reasonable comparison. The core melt accident source term was 100% of the noble gases, 27% of the iodine group, 21% of the cesium group, 10% of the tellurium group, 12% of the barium and strontium groups, 0.52% of the ruthenium group, 0.2% of the lanthanum group and 0.6% of the cerium group. Table 4.3 summarizes the reported results.

The core melt accident results are provided for two emergency protective actions: one in which a representative evacuation was modelled along with long term protective actions; and a no evacuation, no long term protective action case. The later case, while unrealistic, provides a very conservative bounding estimate of the consequences. A case with protective actions identical to this study was not reported. However, the results of such an analysis would have provided results intermediate to those reported (with the exception to condemned land which is not affected by emergency response). Comparison with the results shown in Tables 4.1 and 4.2 clearly indicates that for worst case assumptions, i.e., full pool involvement and large source term, the postulated Configuration I spent fuel pool accident may have *comparable* consequences to a major core melt accident.

Previous studies have elected to quantify the risks and costs of fuel pool accidents using either Case 1 or Case 2 results. In their final analysis, Sailor, et al.,[7] chose the last refueling offload/maximum source term accident results. In Jo, et al.,[8] a worst case (full pool/maximum source term accident) and a best estimate case (last refueling/maximum source term accident) were explored. For the present evaluation, BNL recommends that the estimated consequences for case 2L be used. This case assumes that the accident is limited to the last full core discharge (plus the last normal refueling discharge in the case of a PWR) and the lower release fractions, that reflect some credit for fission product retention.

This recommendation has been made for the following reasons. As discussed in NUREG/CR-4982, there is a large degree of uncertainty associated with the fire propagation throughout the entire pool. Additionally, mitigative options such as rack modifications,[5,6] (i.e., increased hole size) and fuel

management practices (including checkerboarding of fresh assemblies and the use of regions in the SFP) are all possible. Thus, it is possible to reduce the likelihood of propagation into the older assemblies. Regarding the lower fractional releases in the recommended case, BNL considered the implications of the accident that occurred at the Chernobyl Unit-4 power plant in the Ukraine.[31] Although Chernobyl is clearly not an analog of the accidents treated in this section, several similarities exist which have relevance to the fuel pool accident. These include oxidation of the clad, failed reactor structure and the availability of air. (There are of course many dissimilarities, such as the burning of the graphite moderator which provided additional heating and the expulsion of fuel fragments to the environment during the violent steam explosion.) Nonetheless, it is difficult to envision that the spent fuel pool accident(s) could result in much greater release. The estimated Chernobyl release, as a fraction of core inventory, was 1.0 of the noble gases, 2.0E-1 of the iodine, ~1.3E-1 of the cesium and tellurium, 4.0E-2 of the strontium, 5.6E-2 of the barium, and approximately 3.0E-2 of the ruthenium, cerium and lanthanum group nuclides.

A comparison with the source terms in Table 3.2, shows better agreement for the noble gas (NG), I and Cs groups with the low (Case 2) release source term. In contrast, the Chernobyl releases for Te and the nonvolatiles greatly exceed any of the releases shown. There are two justifications for the lower Te and nonvolatile group releases used in this study. In the case of Te, the formation of an intermetallic compound with Zr in the clad is known to suppress Te release until the clad is completely oxidized. At Chernobyl, complete oxidation of the clad probably occurred in the rubble bed that the reactor became. In the spent fuel pool accident, Sailor et al. believed that cladding would melt prior to complete oxidation, relocate and be quenched on the floor of the pool. The cladding material would thus retain Te.

4.2 Configuration 2 - Results

The offsite consequences for Configuration 2, "Cold Fuel in the Spent Fuel Pool," were modeled with the MACCS code using the input assumptions of Section 3.2. The deterministic treatment outlined in Reg. Guide 1.25 was not pursued because it provided a limited description of the consequences.*

The estimated offsite consequences for each reactor type and assumed environmental release is shown in Table 4.4.

As expected, these results indicate a far lower level of offsite consequences than the Configuration 1 cases. The much lower inventory is the obvious reason for the low level of predicted accident consequences. In no case is prompt fatalities indicated. Societal doses are very much lower than those developed for Configuration 1 accidents. These low doses are reflected in the low numbers of latent fatalities estimated. For either reactor type a very small area of farmland is predicted to be permanently condemned, only when the high gap release fractions (worst case assumptions) are employed. These lands are well within 10 miles of the plant. When the low gap release fraction (central estimate) was

*The Reg. Guide 1.25 methodology is limited to noble gases and iodine. The extension of this methodology to address the small fraction of particulates postulated for Configuration 2 is beyond the scope of this program.

employed, the condemnation of land was not predicted. The estimated total off site cost, excluding health costs, range from 28 million dollars to negligible, dependent on reactor type and release assumptions. These costs are very much lower than the Configuration 1 accident.

Table 4.4 Mean Offsite Consequences - Configuration 2

Generic Plant Type	Release Characterization	Distance (miles)	Prompt Fatalities	Societal Dose (person-rem)	Latent Fatalities	Condemned land (sq. miles)	Total Cost** $x10^6$
PWR	High gap	0-50 0-500	0 0	2.E+5 3.E+5	100 134	0.03*	28
PWR	Low gap	0-50 0-500	0 0	3.E+1 4.E+1	1 2	0.0	neg.
BWR	High gap	0-50 0-500	0 0	7.E+4 9.E+4	31 40	0.002*	6
BWR	Low gap	0-50 0-500	0 0	8.E+1 1.E+2	0.4 0.5	0.0 0.0	neg.

* Indicates within 10 miles of plant, ** excludes health effects, "neg" denotes negligible

To estimate the dose at the site boundary (0.4 miles beyond the point of release) the MACCS calculations were repeated, since centerline dose was not predicted for the "relocation only" emergency response. The code requires an evacuation model to calculate centerline dose. To maximize time in the plume, BNL chose a ten hour delay to start the evacuation. Thus, individuals near the site boundary were exposed for ten hours to the release, then evacuated. The lifetime whole body effective dose equivalent for this exposure was calculated. Both the high and low source terms assumed for Configuration 2 were evaluated. As calculated by the MACCS code, these doses included exposure from all direct pathways.

In the mean, the doses at the site boundary were estimated to be 930 and 0.9 mrem, for the high and low PWR Configuration 2 release assumptions. The BWR doses were estimated to be about a factor of 4 lower.

For the purpose of regulatory requirement analysis, it is recommended that the consequences developed with low fractional releases be employed. The consequences estimated with the high gap releases should be viewed as an upper limit, as no credit is taken for retention in the pool or in the undamaged housing structure. Clearly, some level of fission product retention in the pool and in the structure is to be expected. The low fractional releases therefore would appear to provide a more reasonable estimate of the actual releases that could occur.

Configuration 2 - Onsite Consequences

Onsite dose assessments were performed with the Ramsdell model[30] and the model provided in Reg. Guide 1.145.[32] These deterministic analyses, which take into account the entrainment of the release into a building wake, were performed for two polar weather conditions to provide an indication of the range of anticipated dose(s). Descriptions of these dispersion/dose models are provided in Reference 30. For the Ramsdell model, unstable A and stable G weather conditions were evaluated at a 1 meter/sec wind speed. For the Reg. Guide 1.145 model, Class A and F weather were evaluated. The release was assumed to occur at a height of 10 meters and the reactor structure had an effective area of 1500 square meters which enters into the description

Table 4.5 Configuration 2 Estimates of the Committed 50 Year Dose to a Worker

Model	Weather Stability	Committed Dose (rem)	
		PWR	BWR
Ramsdell	A	0.88	0.24
	G	1.23	0.33
Reg. Guide 1.145	A	0.60	0.16
	F	4.24	1.14

of the building wake. The integral 50 year effective whole body dose commitment from cloudshine and inhalation were estimated 100 meters downwind of the release. The necessary dose conversion factors were taken from the MACCS code DOSDATA file.[16] These calculations conservatively assumed an individual is immersed in the release plume for the entire 2 hour duration of the release.

Table 4.5 provides the estimated on site ("parking lot") dose assessment. Only the lower release for each generic reactor type was evaluated.

The range of dose is dependent on both the assumed weather conditions at the time of release and the model that was employed to arrive at the result. In all cases, the estimated doses for the single assembly fuel handling accident are relatively low.

Since the Ramsdell model has been developed more recently than the regulatory guidance and since it has been based on the results of experimentation, the authors were inclined to place more confidence in its estimates. Thus assuming stable weather condition G at the time of release for a degree of conservatism, the onsite worker dose from the postulated fuel handling accident were estimated at 1.2 and 0.3 rem, PWR and BWR, respectively.

The cleanup and decontamination costs for the Configuration 2 fuel handling accident were estimated using the cost estimates provided in a study performed by Pacific Northwest Laboratories (PNL).[34] Three reactor accident regimes were considered in the PNL study. The least severe of these regimes, assumed

that the accident involved a 10% cladding failure, no fuel melting, moderate contamination of structures and no significant damage to the physical plant. While the extent of assumed fuel damage was greater than the single assembly fuel handling accident, several similarities are observed. The cleanup and decontamination of the plant structure(s) to bring the plant the site to a safe condition will require damaged fuel removal, water cleanup, and surface decontamination of walls, floors, etc. Since a release of fuel fines for a mechanical disruption of the fuel cladding is postulated, and complete retention in the pool coolant is not assured, potential fission product contamination of the interior of the structure housing the spent fuel pool must be assumed. As such, the estimate developed by PNL provides a basis for estimating the cleanup cost of a fuel pool accident. The costs were $98 and 72 million (1981$) for BWR and PWR plants, respectively. If we assume that the extent of contamination and complexity of cleanup and decontamination are proportional to material at risk in the respective accidents and the cleanup cost escalates at 5% per year, the BWR and PWR costs for a fuel handling accident are $2.7. and 7.8 million dollars, respectively. Since these costs may not be totally elastic, a contingency factor of three has been added. This places the total onsite cost at approximately $9 to 24 million dollars. These costs are relatively small and further quantification is not believed to be necessary for this analysis.

4.3 Configuration 3 - Results

Offsite consequences were again modelled with the MACCS code. The identical set of assumptions that were employed in the Configuration 1 and 2 analyses were used for Configuration 3 with the following exceptions: the exclusion boundary was 100 meters; the release height was 1 meter; and the height and effective width of the ISFSI were 2 and 6 meters, respectively. The appropriate Configuration 3 inventories and source terms were used. The use of the MACCS code, or for that matter any Gaussian dispersion model, at a distance of 100 meters is debatable. It is generally agreed that the experimentally determined dispersion parameters, and more importantly, the analytical expressions used within the MACCS code to summarize this data, provided a better picture of plume behavior at a distance greater than several hundred meters. Thus, the estimated results of the MACCS code close to the point of release are subject to an additional degree of uncertainty, whereas results beyond several hundred meters are not. However, this limitation is minor in comparison to the limitation discussed below.

The standard treatment of estimating offsite consequences with the MACCS code, and in particular sampling representative weather conditions, is in conflict with the assumed accident scenario. The accident was assumed to be initiated by a tornado driven missile with resultant very rapid release of material. The weather conditions at the time of release are therefore more accurately described as high turbulence with very high velocity winds. Accurate treatment of these conditions is beyond the capabilities of the MACCS code. However, the results obtained with the code executed in the typical fashion of accident analysis, should provide a conservative estimate of the accident consequences. (It can be stated that the anticipated dispersion occurring in the wake of a tornado would be much greater than that predicted for practically all other weather conditions).

The estimated offsite consequences for each type of reactor fuel is presented in Table 4.6.

The offsite consequence estimates provided in Table 4.6 are qualitatively comparable to those obtained for Configuration 2, and low in comparison to Configuration 1.

To obtain an estimate of the dose at the site boundary (for Configuration 3 the site boundary was placed at 100 meters beyond the point of release), the MACCS calculations were not repeated as was the case for Configuration 2. The results of the Reg. Guide 1.145 treatment,[32] which were intended to assess worker exposures, also serve as a reasonable estimate of the dose at the site boundary, since the ISFSIs were located 100 meters from the exclusion boundary in this study. The 50 year committed doses are 472 millirem for the PWR and 82 millirem for the BWR. The difference in estimated committed doses is primarily attributable to the greater nuclide inventory and the higher burnup associated with the PWR assembly.

Table 4.6 Mean Offsite Consequences - Configuration 3

Generic Plant Type	Distance (miles)	Prompt Fatalities	Societal Dose (person-rem)	Latent Fatalities	Condemned Land (sq. miles)	Total Cost ($x10^6$)*
PWR	0-50	0	5.9E+2	1.8E-1	0.002	neg.
	0-500	0	6.9E+2	2.2E-1		
BWR	0-50	0	1.2E+2	4.2E-2	0.0	neg.
	0-500	0	1.5E+2	5.1E-2		

"neg" denotes negligible, * excludes health effects

Onsite costs for Configuration 3 are estimated to be the sum of the replacement cost of the damaged cask and of the removal and disposal cost of contaminated soil. The cost of an ISFSI cask is $0.75 to 1 million dollars. The onsite area that is contaminated is estimated to be 0.002 square miles. Assuming the affected soil is removed to a depth of 3 inches and a disposal cost of $320.00 per cubic foot, the soil cleanup costs are approximately 5 million dollars. The total estimated costs are about 12 million dollars, including a contingency factor of about two.

4.4 Configuration 4 - Results

After all the spent fuel has been removed from the site, the radionuclide inventory that remains, although considerable, primarily consists of activated reactor components and structural materials. There are no credible accidents that can mobilize a significant portion of this activity. Previous studies[3,4] have estimated that routine and postulated accident releases to the environment were in the range of μCi to 10 mCi. Releases of this magnitude are also expected to result in negligible onsite accident worker doses and negligible onsite contamination.

For the purpose of estimating onsite accident cost one could consider an accident at a power plant similar to the postulated borated water tank rupture accident that was discussed in the Rancho Seco exemption

request.[35] This scenario postulated that the most severe accident was the postulated rupture of the borated water storage tank (BWST) which could release about 450,000 gallons of slightly radioactive water onto the plant grounds. The level of released activity was small, but it was assumed that a cleanup of the grounds would be required. The cost of cleanup is driven by the volume of liquid and not directly by the level of activity in the water. This is illustrated by Tables 4.7 and 4.8 which present the expected concentration of radioisotopes in the BWST. Table 4.7 presents the expected level of short-lived radioisotopes, while Table 4.8 provides the level of long lived radioisotopes at selected times after shutdown. Most of the radioisotopes listed in Table 4.7 decay to nothing within 120 days, and virtually all are gone after 1 year.

At Rancho Seco, the BWST has a capacity of 450,000 gals. The activity of this water is extremely low, and after 5 years is primarily due to tritium with an activity of 5000 curies, (a soft beta emitter) and approximately 60 mCi of Cs-137. This amount of radioactivity is generally considered to be a trace contamination; all the shorter half-lived nuclides, shown on Table 4.8, have decayed away. The cleanup estimate developed by the Sacramento Municipal Utility District (SMUD) for the Rancho Seco plant primarily consisted of the removal and disposal of 18 inches of gravel and two feet of the underlying soil in the vicinity of the BWST. This would result in the disposal of about 150,000 ft^3 of soil. SMUD assumed a 1991 waste disposal cost of $150.00 per cubic foot. Waste transportation costs were neglected.

BNL modified the Rancho Seco plant specific estimate to make it more generic by using the 1995 disposal cost of $320.00/$ft^3$ for the Barnwell facility.[36] This results in a cleanup cost of about $54 million.*

However, it is likely that much of this contaminated water would migrate toward the water table and not be captured by the mechanical removal of the surface soil. The contaminated water could reach the water table below the site and result in tritium levels in excess of the maximum concentration limit for drinking water. BNL has calculated that in the time it takes the plume to reach the site boundary, radioactive decay and dispersion could be expected to reduce the tritium concentration below the maximum concentration limit for drinking water, thus it is assumed no treatment would be required.

In order to encompass the cost of onsite groundwater characterization, groundwater monitoring and sample testing over approximately 60 years, the waste disposal estimate of $54 million has been multiplied by a factor of ~2 to $110 million.

*Consisting of removal, disposal and restoration costs. Waste transportation costs were neglected.

Table 4.7 Activity of the Short-Lived Isotopes in the Boric Acid Concentration Tanks

Isotope	Concentration (μCi/ml)	Max. Activity (μCi in 450,000 gal)
I-131	2.45E-08	50.11965
I-132	0	0
I-135	3.36E-09	6.873552
I-136	1.09E-11	0.22298
Cs-136	6.23E-07	1274.471
Mo-99	1.90E-07	388.683
Y-90	9.20E-09	18.82044
Kr-85m	1.24E-13	0.000254
Kr-88	0	0
Xe-131m	9.52E-09	19.47506
Xe-133	8.57E-07	1753.165
Xe-133m	5.88E-09	12.02872
Xe-135	1.80E-10	0.368226
Y-91	5.34E-08	109.2404

Table 4.8 Activity of the Long-Lived Isotopes in the Boric Acid Concentrate Tanks

Isotope	Concentration (μCi/ml)	Activity (Ci) in 450,000 gal.					
		Initial Activity	@120D	@1 yr	@2 yr	@5 yr	@10 yr
H-3	2.5	5110	5020	4830	4570	3860	2910
Cs-137	0.00003	.0610	.0605	.0596	.0582	.0543	.0484
Kr-85+	3.30E-08	6.7(-4)*	6.6(-4)	6.3(-4)	5.9(-4)	4.8(-4)	3.5(-4)

+Assumed release to atmosphere at time of spill
*6.7(-4) - 6.7×10^{-4}

5 REGULATORY ASSESSMENT SUMMARY

The preceding sections of this report have provided an overview of the processes that are likely to occur when a nuclear power plant permanently ceases operation. The primary focus of this study has been the storage alternatives for the spent fuel. Section 4 examined multiple cases for each spent fuel configuration. A "best estimate" case/consequence analysis was presented for each spent fuel storage configuration including: societal dose, latent fatalities, the amount of condemned land, and the estimated cost of the postulated accident.

After a plant is permanently shutdown, awaiting or in the decommissioning process, certain operating based regulations (or technical issues) may no longer be applicable. The purpose of this section is to present the results of this regulatory assessment.

A list of candidate regulations was identified from a screening of 10CFR Parts 0-199.[27] Each of these technical issues was subjected to a detailed review which included federal register notices, SECYs, NRC policy statements, regulatory guides, standard review plans, NUREGs, NUREG/CRs, \etc, to develop an understanding of the regulatory bases. The continued applicability of each technical issue was assessed within the context of each spent fuel storage configuration, the results of the consequence analyses, as well as the expected plant status.

With the possible exception of Part 171, "Annual Fees for Licensees," each regulation is ultimately focussed on the protection of public health and safety. However, a particular regulation may not be applicable to a permanently shutdown plant in general, or a specific spent fuel storage configuration. For example, an exemption from the containment leakage testing requirements of 10CFR50.54(a) for a permanently defueled plant will not impact public health and safety as the plant risk is primarily associated with the spent fuel that is now stored in the spent fuel pool outside the primary containment.

The results of the regulatory assessment are presented in Table 5.1. The detailed recommendations, including regulatory background, specific cites, and regulatory assessment are included as Appendix B to this report.

Table 5.1 Assessment of Continued Regulatory Applicability for Permanently Shutdown Nuclear Power Reactors (Summary)

Technical Issue	10CFR Reference[1]	Regulatory Applicability[24,29] Configuration 1	2	3**	4	Notes
Fitness for Duty	Part 26 55.53(j), (k) 72.194	P F	N N	N N F	N N	9,10
Technical Specifications	50.36, .36a, .36b 72.26, 72.44	P	P	P F	P	11
Combustible Gas Control	50.44	N	N	N	N	
ECCS Acceptance Criteria	50.46	N	N	N	N	
Emergency Planning and Preparedness	50.47, .54(q),(t) App. E 72.32	F	P	P F	P	12,13
Fire Protection	50.48, App. R 72.122	P	P	P F	P	15
Environmental Qualification	50.49	N	N	N	N	
QA Program	50.54(a), App. B Part 72, Subpart G	P	P	P F	P	16
Operator Requalification Program	50.54(i), 55.45, 55.59 72.44(b) Part 72, Subpart I	P	P	N F	N	17
Operator Staffing Requirements	50.54(k), 50.54(m)	N F	N P	N N	N N	18
Containment Leakage Testing	50.54(o), App. J	N	N	N	N	
Security Plan	50.54(p), 70.32, Part 73 Part 73 App. B and C 72.44(e) Part 72 Subpart H Part 73	P	P	N F	N	19
Onsite Property Damage Insurance	50.54(w) Part 72	F	P	P *	P	
Inservice Inspection Requirements	50.55a(g)	P	P	N	N	21
Fracture Prevention Measures	50.60, .61, Apps. G and H	N	N	N	N	
ATWS Requirements	50.62	N	N	N	N	

Technical Issue	10CFR Reference[1]	Regulatory Applicability[2,3] Configuration 1	2	3**	4	Notes
Fitness for Duty	Part 26 55.53(j), (k) 72.194	P F	N N	N N F	N N	9,10
Loss of all AC Power	50.63 72.122(k)	N	N	N F	N	22 23
Maintenance Effectiveness	50.65 POL before 7/10/96 POL after 7/10/96	N P	N P	N N	N N	24
Periodic FSAR Update Requirement	50.71(e) 72.70	P	P	P F	PN	26
Training and Qualification of Nuclear Power Plant Personnel	50.120	P	P	N	N	
Material Control/Accounting of Special Nuclear Material (including US/IAEA Agreement)	70.51, .53, 74.13(a) (Part 75) 72.72, .76	F	F	N F	N	27 27
Financial Protection Requirements	Part 140 Part 72	F	P	P *	P	
Annual Fees for Licenses	171.15 171.16	P	P	P F	P	29

[1] See discussion in Appendix B.

NOTES TO TABLE 5.1

1. 10CFR Parts 0 to 199, revised January 1, 1995.

2. All other regulatory requirements applicable to nuclear power reactors and not listed in this table are assumed to remain in effect, unless addressed by a plant-specific exemption.

3. The spent fuel storage configurations are defined in Sections 2 and 3 of this report. Briefly:

   Configuration 1 - hot fuel in the spent fuel pool
   Configuration 2 - cold fuel in the spent fuel pool
   Configuration 3 - all fuel stored in an ISFSI
   Configuration 4 - all fuel shipped offsite

4. Configuration 1 also assumes the licensee has a Possession Only Licensee or that a confirmatory letter has been issued to prevent refueling the vessel without NRC authorization.

5. F-Regulation continues to be fully applicable for this spent fuel storage configuration.
   P-Regulation is assessed to be partially applicable for this configuration.
   N-Regulation is not considered applicable to this configuration.

6. A permanently shutdown nuclear power plant may store its fuel in an Independent Spent Fuel Storage Installation, before, during, and after the plant itself has been decommissioned. As such, Configuration 3 must examine the regulatory requirements for the plant without fuel (similar to Configuration 4) and the ISFSI. This necessitates two (or more) entries in Table 5.1 for Configuration 3. The first (and second, if applicable) pertains to the plant itself prior to the completion of decommissioning. The last entry examines the Part 72 requirements for the ISFSI.

7. The requirements of Configuration 3 remain applicable until all fuel has been removed from the ISFSI and shipped offsite.

8. In addition to the applicable provisions of Part 72 as noted for Configuration 3, Parts 20, 21, 71, and 73 remain applicable to the transportation of spent fuel from the ISFSI to a HLW repository or MRS.

9. Although the Part 26 requirements may no longer be appropriate for certain spent fuel storage configurations, the recordkeeping requirements of Section 26.71 are still applicable.

10. The Part 26, Fitness for Duty requirements remain applicable for Configuration 1. However, the scope of the program can be limited to those personnel with unescorted access to the fuel building.

11. The technical specification requirements are very plant specific. Plant systems and controls necessary for the continued public health and safety will vary from plant to plant. BNL

recommends a plant-specific amendment request to reduce the scope of the operating tech specs or institute defueled tech specs.

12. BNL recommends that all emergency planning and preparedness requirements remain applicable to Configuration 1, with the exception of the Emergency Response Data System (Part 50, Appendix E, VI).

13. BNL recommends site-specific calculations to establish a new smaller EPZ boundary for the plant for Configuration 2. Based on the assumption (subject to plant-specific verification that no members of the public will be exposed in excess of the EPA PAGs, BNL recommends the licensee apply for exemptions from the following Part 50 EP requirements for Configuration 2:

- The early public notification requirements of 50.47(b)(5) and Appendix E.IV.D.3.
- The periodic dissemination of emergency planning information to the public of 50.47(b)(7) and Appendix E.IV.E.8.
- Offsite emergency facilities and equipment such as the EOF, and the emergency news center (50.47(b)(8), Appendix E.IV.E.8).
- Offsite radiological assessment and monitoring capability, including field teams (50.47(b)(9)).
- Periodic offsite drills and exercises (50.47(b)(14), Appendix E.IV.F.3).
- Licensee headquarters support personnel training (50.47(b)(15), Appendix E.IV.F.b.h).

Since decommissioning accidents that do not involve spent fuel have negligible public health consequences offsite EP can also be eliminated for Configurations 3 (plant only) and 4.

14. The emergency planning requirements for ISFSIs that are not associated with an operating nuclear power plant are the subject of a final rule issued on June 22, 1995 [60FR32430].

15. Each licensee has a Fire Protection Program that, in addition to safe shutdown requirements, has training requirements, administrative procedures and controls, and detection/suppression requirements for plant areas that contain radioactive inventories with potential offsite consequences. BNL recommends deleting requirements directly related to safe shutdown capability. Further reductions in the scope of the fire protection program should be on a plant-specific basis.

16. Permanently defueled plants are expected to be able significantly to reduce the scope of their QA program without impacting public health and safety. In accordance with 50.54(a)(3), any proposed changes to the previously accepted QA program must be approved by the NRC.

17. The licensee should submit, per 10CFR50.54(i), a revised operator requalification program limited to fuel handling to reflect the defueled configuration.

18. BNL recommends that at least one licensed SRO be present or readily available on call at all times (see 50.54(m)(l)), for Configurations 1 and 2. Our concern is maintaining fuel cooling

under off normal conditions and the ability to carry out the units' emergency plan (EP), at least in its early stages.

19. In comparison to an operating unit, a permanently defueled plant has less vital equipment and a potentially smaller vital area(s). Accordingly, it is expected that these licensees will continue to apply for exemptions to reduce the scope of the plan.

20. Not used.

21. The scope of the Inservice Inspection Program can be reduced to address only those systems in the existing plan that support spent fuel storage. Some plants do not include spent fuel cooling in their program and may eliminate the Program in its entirety.

22. The intent of the Station Blackout (SBO) Rule is to maintain the risk of fuel damage due to SBO to $\sim 10^{-5}$/reactor year. Permanently shutdown plants meet the intent of 10CFR50.63. BNL recommends existing SBO plant procedures and training be revised to reflect the storage of all fuel in the spent fuel pool.

23. For Configuration 3, offsite power is required for ISFSI security and monitoring systems.

24. The Maintenance Rule does not become effective until July 10, 1996. Plants that request a POL prior to that date should not be subject to this requirement. A facility that is permanently shutdown after that date will have a program to enhance maintenance effectiveness which can be reduced to those systems that support fuel storage and handling, building ventilation and filtering, and radiation monitoring.

25. Not used.

26. ISFSIs are currently required to submit an *annual* FSAR update per 10CFR72.70.

27. The Part 70 license remains in effect until the site is released for unrestricted use. However, an exemption from the special nuclear material (SNM) control and accounting requirements of Parts 70 and 74 and the safeguards requirement of Part 75 can be issued after the SNM has been disposed of. However, please note that an ISFSI has its own requirements under Part 72.

28. Not used

29. Although the current practice is to grant full exemptions from the annual licensing fees for permanently shutdown power reactors, BNL proposes a partial exemption for future years. As the NRC experience with large power reactor decommissioning grows, a fee based on the services provided to these licensees could be applied. Alternatively, Part 171.15 fee that is equivalent to the ISFSI annual fee may be appropriate.

30. This regulatory assessment assumes an onsite, operating spent fuel pool is not necessary to satisfy the fuel retrievability requirement of 72.122(l).

6 SUMMARY AND CONCLUSIONS

Brookhaven National Laboratory (BNL) has undertaken a program (FIN L-2590), "Safety and Regulatory Issues Related to the Permanent Shutdown of Nuclear Power Plants Awaiting Decommissioning." This report summarizes the results of the program, which performed a regulatory assessment for generic BWR and PWR plants that have permanently ceased operation.

Previous studies have concluded that decommissioning accidents that do not involve spent fuel have negligible off-site and on-site consequences. Therefore this study focused on current and future spent fuel storage alternatives for the permanently shutdown facility. Four spent fuel storage alternatives were identified:

Configuration 1 -	Hot fuel in the spent fuel pool
Configuration 2 -	Cold fuel in the spent fuel pool
Configuration 3 -	All fuel stored in an ISFSI
Configuration 4 -	All fuel removed from the site

Each of these configurations was further defined to support the consequence analyses and the regulatory assessment. A set of assumptions was developed to envelope future end of life nuclear power plant shutdowns, as well as plants that have prematurely ceased operation. Thus, this study postulated: higher end of life fuel burnups than presently experienced; spent fuel pools at full capacity; and a high population density to account for future industry and population trends. In addition, this study also differs from previous efforts because the gap release source terms, used herein, are partially based on experimental results and include a small fraction of fuel fines.

Consequence Analyses

Several accident cases, with different inventory and release assumptions, were evaluated for each spent fuel storage configuration. Table 6.1 presents the consequences for the accident cases that were adopted for the regulatory assessment. The Configuration 1 accident postulates an event that causes the draining or boiloff of the water in the fuel pool, exposing the relatively hot spent fuel assemblies to an air environment. The most recently discharged assemblies self heat to a point where the Zircaloy oxidation becomes self sustaining, resulting in extensive clad failure and fission product release. As shown in Table 6.1, the Configuration 1 accident consequences are severe, approximating those of a core melt accident. These results are higher in comparison to previous studies. This is primarily attributable to the higher population assumption used herein. A secondary contributor is the greater radionuclide inventory. The assumptions made for reactor power, end of plant life fuel burnup and fuel pool capacity* resulted in an

*Does not impact the recommended Configuration 1 accident consequences.

inventory with substantially higher quantities of long lived radionuclides than those assumed in previous studies."

After sufficient decay time has elapsed and the rapid oxidation phenomenon is not likely, the fuel was considered to be in Configuration 2, "Cold fuel in the spent fuel pool." The accident initiator was the drop of a single assembly, resulting in a gap release. In addition to partial releases of the noble gases and iodine (if present), small releases of the remaining nuclide groups are expected on the basis of experimentally observed releases of fuel fines. The source term for the recommended Configuration 2 accident case includes credit for the scrubbing effect of the water overlying the fuel.

As shown in Table 6.1, the estimated consequences of the bundle drop accident are very much lower than those of Configuration 1. However, the consequences are higher than a Reg. Guide 1.25 analysis which would not consider particulates in the gap release source term.

Although the long term storage of spent fuel in the fuel pool is possible, this study considered the transfer of all fuel to an ISFSI. For accident analysis purposes, the Configuration 3 initiator is a tornado generated missile that pierces one cask of the ISFSI. The recommended accident cases assume one assembly is damaged. A high burnup gap release with a small amount of particulates was again assumed. As shown in Table 6.1, the estimated consequences are generally less than the Configuration 2 results.

After all fuel has been removed from the site, the radionuclide inventory that remains, although considerable, cannot be easily dispersed into the environment. Previous studies have estimated very low accident releases that would have negligible offsite and onsite health effects. For the purpose of estimating an onsite accident cost, this study considered the postulated rupture of the Borated Water Storage Tank. The level of released activity, although small, was assumed to require a cleanup. As shown in Table 6.1, BNL estimated a cleanup cost of 110 million dollars for this accident.

Regulatory Assessment

After a plant is permanently shutdown, awaiting or undergoing decommissioning, certain regulations, which are based on full power operation, may no longer be applicable. BNL identified a list of candidate regulations (or technical issues) from a screening of 10CFR Parts 0-199. Each of these technical issues was subjected to a detailed review which included federal register notices, SECY memos, NRC policy statements, regulatory guides, standard review plans, NUREG reports, NUREG/CR reports, etc. to develop an understanding of the regulatory bases. The continued applicability of each technical issue was assessed within the context of each spent fuel storage configuration, the results of the consequence analyses, as well as, the expected plant configuration.

The public risk associated with a permanently shutdown nuclear power plant is very different from an operating unit, both in magnitude and content. Accident sequences such as LOCAs and ATWs are no

"NUREG/CR-4982 used Millstone and Ginna information (Circa 1987) to develop a "snapshot" of plant specific spent fuel pool radionuclide inventories that have since been exceeded.

longer relevant to the defueled facility. Regulations that are designed to protect the public against full power and/or design basis accidents are no longer applicable. Therefore, it is recommended that the following regulations be deleted for all spent fuel storage configurations of the permanently shutdown plant:

- Combustible Gas control (50.44)
- ECCS Acceptance Criteria (50.46)
- Environmental Qualification (50.49)
- Operator Presence at the Controls (50.54 (k))
- Containment Leakage Testing (50.54(0), Appendix J)
- Fracture Prevention Measures (50.60, 50.61, Appendices G and H)
- ATWS Requirements (50.62)
- Loss of All AC Power (50.63)

Other regulations, although based on the full power operating plant, may continue to be partially applicable to the permanently defueled facility. Typically, the scope of these requirements can be reduced to eliminate those that do not pertain to the safe storage of the spent fuel or are no longer necessary to protect the health and safety of the public. The following regulations have been assessed to remain partially applicable for one or more configurations of the permanently shutdown plant:

- Fitness for Duty (Part 26, 55.63(j),(k))
- Technical Specifications (50.36, .36b)
- Fire Protection Program (50.48, Appendix R)
- Quality Assurance Program (50.54(a), Appendix B)
- Operator Staffing Requirements (50.54(m))
- Operator Requalification Program (50.54(i), 55.45, 55.59)
- Security Plan (50.49(p), 70.32, Part 73, Part 73 Appendices B and C)
- Inservice Inspection Requirements (50.55a(g))
- Maintenance Effectiveness* (50.65)

Several technical issues do not fit into these categories. They are discussed below.

We have recommended the continued application of the periodic FSAR update requirement (50.71(e)) to provide a basis for the 50.59 safety evaluations that will be performed when a plant ceases operation. The special nuclear material control requirements of Parts 70 and 74 should continue as long as fuel remains within the plant. The annual fees for the permanently shutdown plant licensees (171.15) should be adjusted to reflect the generic regulatory costs that are directly applicable to their facility type.

The emergency planning and preparedness requirements (50.47, 50.54(q), (t) and Appendix E) and the insurance issues (50.54(w) and Part 140) were evaluated using the accident consequence analyses of this

*Assumes a formal request for permanent cessation of operation after 7/10/96.

study. The estimated consequences for the Configuration 1 accident approximate those of a core damage accident.

It is recommended that all offsite and onsite emergency planning requirements remain in place, with the exception of the Emergency Response Data System requirements of Part 50, Appendix E, VI.

The offsite emergency planning and preparedness (EP) requirements are expected to be eliminated for Configuration 2, based on the results of the generic PWR calculation which estimated a 9 millirem dose at the exclusion area boundary (see Table 6.1).* Part 50 offsite EP requirements can also be eliminated for Configurations 3 (plant only) and 4 because the spent fuel has been transferred to an ISFSI (Part 72 requirements) or transported offsite. Without spent fuel, the plant is not a significant health risk.

It is recommended that the onsite property damage and the offsite liability insurance levels remain at operating reactor levels for the duration of Configuration 1. The consequence analyses of Section 4 support reduced insurance requirements for the remaining configurations.

*However, since plant specific parameters (such as exclusion areas) can vary we recommend that the licensee perform a plant specific evaluation for Configuration 2.

Table 6.1 Generic PWR Accident Summary[1]

Spent Fuel Storage Config.	Accident Timing (yrs after final SD)	Recommended Accident Case	Offsite Consequences						Dose at Exclusion Boundary (rem)	Onsite Cleanup Cost ($)
			Distance (miles)	Prompt Fatalities	Societal Dose (person-rem)	Latent Fatalities	Condemned Land (sq. miles)	Total Cost ($)		
1	~0	2L[2]	0-50 0-500	0.3 0.3	4.2E+7 7.0E+7	16,800 28,800	156 188	5.6E+10 5.9E+10	NC	NC
2	3.5 (PWR)	Low gap release	0-50 0-500	0 0	3000 4000	1 2	0 0	neg.	.009	3.2E+7
3	5	Single best assembly, estimate release	0-50 0-500	0 0	590 690	0.18 0.22	0.002 0.002	neg.	0.472	1.2E+7
4	5	BWST failure	-	-	-	-	-	-	-	1.1E+8

[1]The accident consequences associated with the generic PWR are more severe than the comparable BWR cases.

[2]Rapid zircaloy oxidation involving the last full core offload (and the last normal offload for PWRs) low release fractions assumed.

NC = not calculated; neg = negligible

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APPENDIX A PREVIOUS ANALYSES OF SPENT FUEL POOL ACCIDENTS

A.1 DISCUSSION

The Reactor Safety Study[1] considered accidents involving spent fuel. The inventory of material that was potentially at risk was limited to one third of a reactor core. This was consistent with the intention of the routine shipping of spent fuel for reprocessing (or disposal). The Reactor Safety Study concluded that the risk associated with spent fuel storage was extremely small in comparison to that associated with the operating reactor core.

During the Carter administration a federal moratorium halted the reprocessing of spent commercial reactor fuel. Given the absence of away-from-reactor storage facilities or a permanent disposal facility, utilities had no alternative but to store spent fuel at the reactor site. This led to increasingly larger inventories of fuel being stored in reactor spent fuel pools. Modified spent fuel storage racks have also been employed to further increase the ultimate capacities of most reactor spent fuel pools.

A.S. Benjamin and others[2,3] published investigations of the probable course of events following the complete draining of a spent fuel pool. A theoretical model and the computer codes SFUEL and SFUEL1W were developed and employed to analyze the thermal-hydraulic behavior of stored spent fuel assemblies on exposure to air. These studies indicated, that for certain combinations of storage configurations and decay times, freshly discharged fuel assemblies could self heat to a temperature where the air oxidation of the zircaloy fuel cladding would become self sustaining. The additional chemical heat released during clad oxidation, which is comparable to the decay heat, then causes a rapid temperature increase with the resultant failure of the cladding. Additionally, these studies further concluded that for certain conditions, the cladding of freshly discharged assemblies would attain a sufficiently high temperature to heat adjacently located assemblies, with lower decay heat, to the point of "ignition" (self sustaining clad oxidation). The possibility of propagation from assembly to assembly with the involvement of the entire spent fuel pool inventory was not ruled out in all cases.

V.L. Sailor, et al.,[4] reported a study of severe accidents in spent fuel pools. Their investigation provided an assessment of the potential risk from possible accidents in spent fuel pools. The authors describe their effort as a "simplified analysis which followed the logic of a typical probabilistic risk assessment (PRA)." To assess the risk Sailor, et al., quantified the frequencies of initiating events that could compromise the integrity of fuel pool, the probability of system failure conditional on the initiating event, fuel failure occurrence, the magnitudes of radionuclide releases to the environment and the consequences which result from those releases as well as the consequences associated with these releases.

In the Sailor study, two plants were primarily selected for examination on the basis of perceived vulnerability to seismic events. A preliminary screening study using RSS methodology indicated seismic

initiated pool failure was the dominant risk contributor. The selected plants were the Millstone 1 (BWR) and the Ginna (PWR) plants. The operating histories of these plants were used to model, through application of the ORIGIN code, realistic radionuclide inventories present in their respective spent fuel pools, at the time the study was performed.

The accident initiators considered in Sailor's work were loss of pool heat removal capability, structural failure of the pool due to missiles, seismic events or the drop of a heavy load on the pool wall, and the draining of the pool due to pneumatic seal failure. The study concluded accidents which lead to the complete draining of the spent fuel pool caused by loss of cooling, missiles and pneumatic seal failure were very unlikely. However, failures resulting from seismic events and the drop of a heavy load were concluded to be credible, though the frequencies of these accidents was assessed to be quite uncertain. As part of Sailor's study, BNL performed a review of the SFUEL1W models and code. Limited verifications of the code's prediction with the results of small scale experiments performed at SNL were also made. Sailor, et al., concluded that the SFUEL1W code "provides a valuable tool for assessing the likelihood of self-sustaining clad oxidation for a variety of spent fuel configurations assuming the pool has been drained."

Although BNL made at least one modification to the SFUEL1W code, their predictions of critical decay times,* were in good agreement with the earlier published results of the SNL staff.

To estimate the release of radioactivity from the fuel pins, the authors employed the CORSOR code,[5] using the time-temperature histories obtained with the SFUEL1W code. These results are reproduced in Table A.1. The releases are expressed as sets of fractions, which are applied to the total inventory of material involved in the accident. The initial inventory of radionuclides available for release as noted above was calculated with the ORIGIN code using the operating histories of the selected plants. The calculated inventories were a realistic snapshot of the activity present in the spent fuel pools of the selected plants at the time Sailor's study was completed. These inventories are not presented here for several reasons. Both plants investigated were relatively small: 2011 Mw thermal in the case of the BWR and 1520 Mw thermal for the PWR. Continued operation at these plants has also increased their present spent fuel pool inventories. But more importantly, the last one third core discharge was for a normal refueling, and this would represent a significant underestimation of a full core off-load, which was evaluated in the present study.

Offsite accident consequences in NUREG/CR-4982 were calculated with the CRAC2 computer code.[6] Major assumptions used in the evaluation included: a generic site having uniform population density of 100 persons per square mile (approximately the national average); generalized average weather conditions; and the emergency response action being relocation 24 hours after release (criterion 25 rem whole body projected individual dose commitment). The consequences reported, societal dose and

*The cooling time required to lower the decay heat of freshly discharged fuel assemblies to a point where the self-sustaining clad oxidation is unlikely to occur.

interdicted land, are presented in Table A.2. The risk estimates of Sailor's work have been superseded by more recent studies.[7-8] However, it should be noted that to evaluate the risk the authors ultimately selected the consequence results of an accident where the only the last refuelling discharge is involved. In this accident, fire does not propagate its way throughout the entire spent fuel pool, but the maximum release fractions were assumed (no credit taken for structures removing activity).

The 1989 report of J. Jo, et al.[7] described a value/impact assessment of various proposed options[2-4] intended to reduce the risk of potential accidents occurring in the commercial nuclear power plant spent fuel pool. As was the case with previous efforts, attention was limited to an operating plant. The risk dominant accidents, source terms and inventory assumptions were identical to those investigated by Sailor, et al. Major differences in the estimation of the offsite consequences existed between these two studies. Jo, et al., used the MELCOR Accident Consequence Code System (MACCS), Version 1.4.* This code, developed by Sandia National Laboratory for the NRC, has replaced the CRAC2 code for offsite consequence assessment. The MACCS code has been used exclusively in the preparation of NUREG-1150 and its supporting documentation.[10] Site assumptions which significantly affected the predicted consequences also differed. The Zion site was selected by Jo to represent the "worst" case conditions in regard to population density distributed about a plant site. The actual population distribution, weather conditions, land usage fraction and regional economic data associated with the Zion site were employed. These actual data, coupled with release assumptions of 100 percent pool involvement and the set of maximum fractional releases specified by Sailor, were used to evaluate a **worst** case. For a **best** estimate calculation of accident consequences, the study assumed: only the last refueling discharge is involved in the fire; Zion weather; average land usage and economic data for the state of Illinois; a 95 percent land fraction and a uniform population density of 340 persons per square mile out to 50 miles beyond the plant.* In both cases examined, no planned evacuation was modelled, since this was stated to have only a small effect on total costs and societal doses. However, people were relocated at one day based on projected 7 day dose commitment of 25 rem. (Prior to relocation people were assumed to be engaged in normal activity, which afforded them limited protection from the early dose pathways.) The long term dose limit of 25 rem effective dose equivalent (EDE) employed in this effort was consistent with WASH-1400. The results of these calculations are shown in Table A.3. The public dose and offsite property damage were reported out to 50 miles from the plant. The public doses reported by Jo, et al., are factors of 3.5 and 10 (best estimate and worst case, respectively) higher than those reported by Sailor, et al. The population density assumptions of the latter study (340 and 860 persons per square mile versus the 100 used in the Sailor study) account for 98 and 87 percent, respectively, of the observed increases. As such, and notwithstanding consequence codes differences in the release and health effects modeling, the societal dose results of Sailor and the more recent Jo effort appear to be fairly consistent.

*The average population density for existing plants, circa 1980.[11]

Appendix A

Table A.1 Estimated Radionuclide Release Fraction During a Spent Fuel Pool Accident Resulting in Complete Destruction of Cladding (Cases 1 and 2)

Chemical Family	Element or Isotope	Release Fraction*	
		Value Used	Uncertainty Range
Noble gases	Kr, Xe	1.00	0
Halogens	I-129, I-131	1.00	0.5-1.0
Alkali Metals	Cs, (Ba-137m) Rb	1.00	0.1-1.0
Chalcogens	Te, (I-132)	0.02	0.002-.02
Alkali Earths	Sr, (Y-90), Ba (in fuel)	$2x10^{-3}$	10^{-4}-10^{-2}
	Sr, Y-91 (in clad)	1.00	0.5-1.0
Transition Elements	Co-58 (assembly hardware)	0.10	0.1-1.0
	Co-60 (assembly hardware)**	0.12	0.1-1.0
	Y-91 (assembly hardware)	0.10	0.1-1.0
	Nb-95, Zr-95 (in fuel)	0.01	10^{-3}-10^{-1}
	Nb-95, Zr-95 (in clad)	1.00	0.5-1.0
Miscellaneous	Mo-99	$1x10^{-4}$	10^{-5}-10^{-3}
	Ru-106	$2x10^{-5}$	10^{-6}-10^{-4}
	Sb-125	1.00	0.5-1.0
Lanthanides	La, Ce, Pr, Nd, Sm, Eu	$1x10^{-4}$	10^{-5}-10^{-3}
Transuranics	Np, Pu, Am, Cm	$1x10^{-4}$	10^{-5}-10^{-3}

*Release fractions of several daughter isotopes are determined by their precursors, e.g., Y-90 by Sr-90, Tc-99m by Mo-99, Rh-106 by Ru-106, I-132 by Te-132, Ba-137m by Cs-137, and La-140 by Ba-140.

**Release fraction adjusted to account for a 100% release of the small amount of Co-60 contained in the zircaloy cladding.

(Reproduced from NUREG/CR-4982)

Table A.2 CRAC2 Results for Various Releases Corresponding to Postulated Spent Fuel Pool Accidents with Total Loss of Pool Water

Case Description		Whole Body Dose (Man-rem)	Interdiction Area (sq. miles)
1A.	Total inventory 30 days after discharge 50 mile radial zone	2.6×10^6	224
1B.	Total inventory 90 days after discharge 50 mile radial zone	2.6×10^6	215
1C.*	Total inventory 30 days after discharge 500 mile radial zone	7.1×10^7	224
2A.	Last fuel discharge 90 days after discharge 50 mile radial zone (maximum release fraction)	2.3×10^6	44
2B.	Last fuel discharge 90 days after discharge 50 mile radial zone (minimum release fraction)	1.1×10^6	4
2C.	50% of all fuel rods leak 1 year after discharge 50 mile radial zone	4.0	0.0

*Note that the consequence calculations in NUREG-1150 are based on a 50 mile radial zone. Case 1C is given as a sensitivity result.

(Reproduced from NUREG/CR-4982)

Table A.3 Offsite Consequence Calculations

Case	Characterization	Source Term*	Population	Public Health Dose (person-rem)	Offsite Property Damage ($1983)
1	Average case	Last fuel discharge 90 days after discharge	340 persons/mile^2	7.97×10^6	3.41×10^9
2	Worst case	Entire pool inventory 30 days after discharge	Zion population (roughly 360 persons/mile^2	2.56×10^7	2.62×10^{10}

(Reproduced from NUREG/CR-5281)

Table A.4 Onsite Property Damage Costs Per Accident ($)

Item	Best Estimate	Worst Case
Cleanup and Decontamination	1.65E8	1.65E8
Repair	7.2E7	7.2E7
Replacement power	8.67E8	1.66E9
Total number of operating years remaining	29.8 years	29.8 years
Number of years plant is out of service	5 years	7 years
Expected Dollar loss	8.24E9	1.29E10

(Reproduced from NUREG/CR-5281)

Occupational exposure for a major spent fuel pool accident was assumed in the Jo report to be similar to the estimated occupational exposure, of 4850 man-rem,[11] incurred during the recovery of the Three Mile Island plant. The Jo report stated that "This exposure is small compared to the potential off-site dose impact and more refined quantification appears to be unwarranted."

Onsite property damages were also estimated in the Jo study. The cost of a major spent fuel pool accident was expected to be similar to the cost associated with a Category II severe accident as defined in Reference 13. The estimates provided in the Jo report are reproduced in Table A.4.

A.2 REFERENCES

1. "Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," U.S. Nuclear Regulatory Commission, NUREG-75-014 (WASH-1400), October 1975, App. I, Section 5.

2. Benjamin, A.S. et al, "Spent Fuel Heatup Following Loss of Water During Storage," NUREG/CR-0649, May 1979.

3. Pisano, N.A. et al., "The Potential for Propagation of a Self-Sustaining Zirconium Oxidation Following Loss of Water in a Spent Fuel Pool," (Draft Manuscript, January 1984) (Note: The project ran out of funds before the report was published.

4. Sailor, V.L. et al., "Severe Accident in Spent Fuel Pools in Support of Generic Issue 82," NUREG/CR-4982, July 1987.

5. Kuhlman, M.R. et al., "CORSOR User's Manual," NUREG/CR-4173, March 2985.

6. Ritchie, L.T. et al., "Calculations of Reactor Accident Consequences Version 2, CRAC2: Computer Code, User's Guide," NUREG/CR-2326, February 1983.

7. Jo, J.H. et al., "Value/Impact Analyses of Accident Preventive and Mitigative Options for Spent Fuel Pools," NUREG/CR-5281, March 1989.

8. Throm, E.D. "Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools," NUREG-1353, April 1989.

9. Jow, H-N. et al., "MELCOR Accident Consequence Code System (MACCS)," NUREG/CR-4691, February 1990.

10. "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

11. Aldrich, D.C. et al., "Technical Guidance for Siting Criteria Development," NUREG/CR-2239, December 1981.

12. Heaberlin, S.W. et al., "A Handbook for Value-Impact Assessment," NUREG/CR-3568, December 1983.

13. Burke, R.P. et al., "Economic Risks of Nuclear Power Reactor Accidents," NUREG/CR-3673, April 1984.

APPENDIX B DETAILED REGULATORY ASSESSMENT

B.1 INTRODUCTION

This section provides a detailed assessment of each of the regulations (or technical issues) that may not be fully applicable to permanently shutdown nuclear power plants. This list of candidate regulations was identified from a screening of 10CFR Parts 0-199[1] and is presented in Table B.1. Each of these technical issues was subjected to a detailed review which included federal register notices, SECY memos, NRC policy statements, regulatory guides, standard review plans, NUREG reports, and NUREG/CR reports to develop an understanding of the regulatory bases. The continued applicability of each technical issue was assessed within the context of each spent fuel storage configuration,* the associated safety hazard analysis results, as well as the expected plant status.

With the possible exception of Part 171, "Annual Fees for Licenses," each regulation is ultimately focussed on the protection of public health and safety. However, a particular regulation may not be applicable to a permanently shutdown plant in general, or to a specific spent fuel storage configuration. For example, an exemption from the containment leakage testing requirements of 10CFR50.54(o) for a permanently defueled plant will not impact public health and safety as the plant risk is primarily associated with the spent fuel that is now stored in the spent fuel pool outside the primary containment.

The remainder of this appendix examines each of the candidate regulations of Table B.1. A short discussion of the regulatory background and objective is provided. Our assessment of the continued applicability to each spent fuel storage configuration is stated with additional supporting information, as necessary.

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* The spent fuel retrievability requirements for ISFSIs may perturbate the regulatory assessment presented in this appendix. An ISFSI storage method (i.e., NUHOMS or storage only casks) that is presently not licensed for offsite transportation under 10CFR Part 71, may require an operating onsite spent fuel pool to comply with the retrievability requirement of 72.122(l). The BNL recommendations assume: dual purpose cases are used; a NUHOMS transport cask will be licensed; storage only casks (with modifications) can be licensed for transport; or that fuel transfer methods will be licensed that do not require an operating onsite spent fuel pool.

Table B.1 Assessment of Continued Regulatory Applicability for Permanently Shutdown Nuclear Power Reactors (Summary)

Technical Issue	10CFR Reference*	Regulatory Applicability** Configuration 1	2	3***	4
Fitness for Duty	Part 26 55.53(j), (k) 72.194	P F	N N	N N F	N N
Technical Specifications	50.36, .36b 72.26, 72.44	P	P	P F	P
Combustible Gas Control	50.44	N	N	N	N
ECCS Acceptance Criteria	50.46	N	N	N	N
Emergency Planning	50.47, .54(q),(t) App. E 72.32	F	P	P F	P
Fire Protection	50.48, App. R 72.122	P	P	P F	P
Environmental Qualification	50.49	N	N	N	N
QA Program	50.54(a), App. B Part 72, Subpart G	P	P	P F	P
Operator Requalification Program	50.54(i), 55.45, 55.59 72.44(b) Part 72, Subpart I	P	P	N F	N
Operator Staffing Requirements	50.54(k), 50.54(m)	N F	N P	N N	N N
Containment Leakage Testing	50.54(o), App. J	N	N	N	N
Security Plan	50.54(p), 70.32, Part 73 Part 73 App. B and C 72.44(e) Part 72 Subpart H Part 73	P	P	N F	N
Onsite Property Damage Insurance	50.54(w) Part 72	F	P	P	P

*See discussion in the text.

Technical Issue	10CFR Reference[1]	Regulatory Applicability[2-5] Configuration 1	2	3[6,7]	4
Inservice Inspection Requirements	50.55a(g)	P	P	N	N
Fracture Prevention Measures	50.60, .61, Apps. G and H	N	N	N	N
ATWS Requirements	50.62	N	N	N	N
Loss of all AC Power	50.63 72.122(k)	N	N	N F	N
Maintenance Effectiveness	50.65 POL before 7/10/96 POL after 7/10/96	N P	N P	N N	N N
Periodic FSAR Update Requirement	50.71(e) 72.70	P	P	P F	P
Training and Qualification of Nuclear Power Plant Personnel	50.120	P	P	N	N
Material Control/Accounting of Special Nuclear Material (including US/IAEA Agreement)	70.51, .53, 74.13(a), Part 75 72.72, .76	F	F	N F	N
Financial Protection Requirements	Part 140 Part 72	F	P	P *	P
Annual Fees for Licenses	171.15 171.16	P	P	P F	P

NOTES TO TABLE B.1

1. 10CFR Parts 0 to 199, revised January 1, 1995.

2. All other regulatory requirements applicable to nuclear power reactors and not listed in this table are assumed to remain in effect, unless addressed by a plant-specific exemption.

3. The spent fuel storage configurations are defined in Sections 2 and 3 of this report. Briefly:
   Configuration 1 - hot fuel in the spent fuel pool
   Configuration 2 - cold fuel in the spent fuel pool
   Configuration 3 - all fuel stored in an ISFSI
   Configuration 4 - all fuel shipped offsite

4. Configuration 1 also assumes the licensee has permanently caused operation and that a confirmatory letter has been issued to prevent refueling the vessel without NRC authorization.

NOTES TO TABLE B.1 (Cont'd)

5. F - Regulation continues to be fully applicable for this spent fuel storage configuration.
   P - Regulation is assessed to be partially applicable for this configuration.
   N - Regulation is not considered applicable to this configuration.

6. A permanently shutdown nuclear power plant may store its fuel in an Independent Spent Fuel Storage Installation, before, during, and after the plant itself has been decommissioned. As such, Configuration 3 must examine the regulatory requirements for the plant without fuel (similar to Configuration 4) and the ISFSI. This necessitates two entries in Table B.1 for Configuration 3. The first (and second, if applicable) pertains to the plant itself prior to the completion of decommissioning. The last entry examines the Part 72 requirements for the ISFSI.

7. The requirements of Configuration 3 remain applicable until all fuel has been removed from the ISFSI and shipped offsite.

8. In addition to the applicable provisions of Part 72 as noted for Configuration 3, Parts 20, 21, 71, and 73 remain applicable to the transportation of spent fuel from the ISFSI to a HLW repository or MRS.

9. This regulatory assessment assumes an onsite, operating spent fuel pool is not necessary to satisfy the fuel retrievability requirement of 72.122(l). See the introductory section of Appendix B for further information.

B.2 REGULATORY ASSESSMENT

Fitness for Duty Program

Background

The Fitness for Duty Program is contained in Part 26 of Title 10, Code of Federal Regulations. Another reference to the Fitness for Duty can be found in the Operators Licenses Section (10CFR55.53(j),(k)). The licensing requirements for the independent storage of spent nuclear fuel and high level radioactive waste (10CFR72.194) do not require a formal fitness for duty program.

The Fitness for Duty Final Rule was published in the June 7, 1989 Federal Register (54 FR 24468) The Supplementary Information, published with the rule, provided the general background, the need for a rule and a summary of comments on the proposed rule with NRC responses.

The NRC stated that the objective of the rulemaking was to provide reasonable assurance that nuclear power plant personnel were not mentally or physically impaired from any cause which could adversely affect their ability to safely and competently perform their duties. The rulemaking action was taken to significantly increase the assurance of public health and safety. All workers with unescorted assess to the nuclear power reactor protected area, as well as personnel who are physically required to report to the TSC or the EOF under emergency conditions, fall within the scope of this rule.

The associated backfit analysis found that the rule will prove a substantial increase in the overall protection of public health and safety and that the direct and indirect costs of implementation are justified in view of the increased protection. In response to comments on the proposed rule, the NRC reiterated that the Fitness for Duty Rule was limited to nuclear power reactors and they saw no reason to extend the coverage of the rule to other facility types such as non-power test reactors, materials facilities, and special nuclear materials licensees. By extension, one can surmise that the lesser public risk associated with non-power reactors, materials licensees, and independent spent fuel storage installations (ISFSIs) did not warrant the implementation of a fitness for duty program at those facilities.

Assessment

Configuration 1, "Hot Fuel in the Spent Fuel Pool" postulated rapid zircaloy oxidation of the spent fuel rods after the loss of pool water inventory. The safety hazard analyses of Section 4 has estimated consequences that are approximately equal to a severe core damage accident. Given the potential magnitude of the consequences, it is appropriate that a formal fitness for duty program, in accordance with the requirements of 10CFR Part 26, remain in place. In recognition of the defueled status of the permanently shutdown plant, and the lack of significant non-fuel sources of public risk,[2,3] it is recommended to reduce the scope of the program to those personnel with unescorted assess to any area that contains equipment necessary to support and maintain continued safe storage or handling of spent fuel. As shown in Table B.1, the Part 26 requirements should remain fully applicable for licensed operators (10CFR55.53(j),(k)).

Configuration 2, "Cold Fuel in the Spent Fuel Pool," has sufficiently low decay heat loads such that the cladding will remain intact even if all spent fuel pool water is lost. Configuration 2 considers the consequences of a dropped fuel assembly. The safety hazard analysis, as discussed in Section 4, shows minimal offsite consequences. On this basis, it appears that the Part 26 requirements for Configuration 2 can be deleted without a significant impact on the public health and safety.

In lieu of long-term storage in the spent fuel pool, a permanently shutdown nuclear power plant may store its spent fuel in an Independent Spent Fuel Storage Installation (ISFSI), before, during, and after the plant itself has been decommissioned. As such, Configuration 3 must examine the regulatory requirements for the plant without fuel (similar to Configuration 4) and the ISFSI. Although the postulated accident for Configuration 3 does result in offsite consequences, the results are not dependent on human intervention. Other postulated ISFSI accidents found in the literature[4,5] do not result in significant offsite consequences.

As discussed below, decommissioning accidents, not involving spent fuel, do not have offsite consequences. Therefore, a Part 26 program for Configuration 3 would not significantly impact the health and safety of the public. The requirements of 10CFR72.194 regarding the physical condition of certified ISFSI operation personnel govern.

Configuration 4, "All Fuel Removed from the Site," assumes that all spent fuel has been shipped offsite, including any that might have been stored in an ISFSI. As discussed in Section 4, the postulated accidental radioactive releases to the atmosphere during decommissioning do not pose a significant threat to the onsite workers and/or the public.

Based on the limited consequences associated with Configuration 4, a Part 26 Fitness for Duty program would not have a significant effect on public health and safety.

Although the Fitness for Duty Program requirements may no longer be appropriate for certain spent fuel storage configurations, the record keeping requirements of section 26.71 are still applicable.

Technical Specifications

Background

Section 50.50 of 10 CFR, "Issuance of Licenses and Construction Permits" provides that each operating license for a nuclear power plant issued by the NRC will contain such conditions and limitations that the Commission deems appropriate and necessary. Operating technical specifications, imposed by Section 50.36 in the interest of the health and safety of the public, are included as Appendix A of the operating license.

Under 10CFR50.36b non radiological environmental technical specifications to protect and monitor the plant's impact on the environment can be included as Appendix B to the license.

Each applicant for an operating license proposes technical specifications for its plant which are then reviewed by the NRC and modified, as necessary,. This process results in a set of plant-specific technical specifications that reflect plant-specific design and siting characteristics. Additional changes, in the form of license amendments, may be granted by the NRC over the operating life of the plant, as appropriate.

Assessment

Very few plants have a defueled mode in their technical specifications. After a permanent cessation of operations issued, the existing technical specifications can be modified to include a permanently defueled mode to reflect the more limited range of postulated accident and radiological consequences associated with a permanently shutdown nuclear power plant. The defueled mode will represent a significant scope reduction in comparison to the operating plant technical specifications requirements. For example,

shutdown margin calculations, (normally required for all tech spec modes) and cooling tower drift or noise monitoring programs would no longer be necessary from a health and safety or an environmental impact perspective.

Since the technical specifications can be very plant specific, it is recommended that the licensee submit an amendment request to reduce the scope of the operating technical specifications and the environmental technical specifications* (or institute a permanently defueled mode) after permanent cessation of operations. Subsequent amendments to the plant technical specifications may be appropriate as the spent fuel decay heat declines (Configuration 2) or if all fuel is moved to an ISFSI** or removed from the site (Configurations 3 and 4, respectively).

Combustible Gas Control

Background

The combustible gas control requirements are found in 10CFR50.44. These requirements were instituted to "improve hydrogen management in LWR facilities and to provide specific design and other requirements to mitigate the consequences of accidents resulting in a degraded reactor core" [46 FR 58484, 12/2/81].

Assessment

The requirements focus on the capability for: measuring hydrogen concentrations, ensuring a mixed atmosphere and controlling combustible gas mixtures, post LOCA. The concern is that hydrogen generation due to metal water reaction or the radiolytic decomposition of water during a LOCA could result in a detonation or deflagration that could fail primary containment.

Obviously, the post LOCA control of combustible gases inside containment is an operating plant issue. The permanently shutdown plant stores all of its fuel outside containment; the reactor pressure vessel and the primary containment are no longer necessary fission product barriers. Therefore, it is recommended that the requirements of 10CFR50.44 be removed for all four spent fuel configurations for the permanently shutdown nuclear power plants.

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*The technical specifications on effluents for nuclear power reactors (50.36a and Appendix A) continue to remain fully applicable to permanently shutdown plants.

**ISFSIs have their own technical specification requirements under 72.26 and 72.44.

Appendix B

ECCS Acceptance Criteria

Background

The acceptance criteria for emergency core cooling systems (ECCS) for light water reactors is found in 10CFR50.46. This section requires that the ECCS be designed to limit post LOCA peak cladding temperature, clad oxidation and hydrogen generation to specified values and provide for long-term cooling. Acceptable ECCS evaluation models must address the sources of heat during a postulated LOCA, clad swelling or rupture, blowdown phenomena, etc. Although this section is primarily addressed during the design phase, operating license holders are required to estimate the effect of a change or an error in the ECCS evaluation model or the model application. Section 50.46(a)(3) specifies the reporting and reanalysis requirements, which are dependent on the magnitude of the error or change.

Assessment

The purpose of these requirements is to ensure that the ECCS design can, and continues to be able to, mitigate the design basis LOCA throughout the operating life of the plant. Without fuel in the vessel, a permanently shutdown plant could make changes to its ECCS systems without a significant public health and safety impact, yet an ECCS re-evaluation could be required. Therefore, the ECCS acceptance requirements of 10CFR50.44 may be deleted for all spent fuel storage configurations of the permanently shutdown plant.

Emergency Planning

Background

The emergency preparedness requirements for nuclear power reactors are contained under 10CFR50.54, "Conditions of Licenses." Paragraph (q) requires that a licensee, authorized to possess and operate a nuclear power reactor, follow and maintain in effect emergency plans which meet the standards of Section 50.47(b) and Appendix E to Part 50. Paragraph (t) of 50.54 emphasizes the revision and maintenance of the emergency preparedness program and requires an annual independent review. Section 50.47(b) presents sixteen requirements for offsite and onsite emergency response. Appendix E to Part 50 generally augments the requirements of 50.47(b).

Due to the lower inherent risk to the public, other facilities licensed by the NRC typically have less stringent emergency preparedness (EP) requirements than nuclear power reactors. For example, research reactors and special nuclear materials licensees are also subject to the requirements of Appendix E to Part 50. However, the size of the emergency planning zone for these facilities and the degree of compliance to the requirements of Appendix E are determined on a case by case basis. Materials license applicants, under 10CFR30.32(i) with quantities of radioactive material in excess of Appendix C to Part 30 must furnish either:

- An evaluation showing that the maximum dose to a person offsite due to a radioactive release would not exceed one rem effective dose equivalent or five rems to the thyroid.

- An emergency plan for responding to the release of radioactivity.

Assessment

The estimated offsite consequences of a rapid zircaloy oxidation event in the spent fuel pool dictate the continuance of all nuclear power reactor emergency preparedness regulatory requirements* for Configuration 1, "Hot Fuel in the Spent Fuel Pool."

Section 4 of this report developed consequence estimates based on generic BWR and PWR plant parameters, source term assumptions and recommended accident cases. The recommended accident case for Configuration 2 had an estimated dose at the exclusion area boundary (0.4 miles) of 9 millirem for the generic PWR. This dose is well below the EPA Protective Action Guide (PAG) whole body dose of 1 rem at the exclusion area boundary. Since this dose estimate is based on generic plant assumptions (such as the exclusion area boundary, it is recommended that the permanently shutdown plant perform a plant specific evaluation for Configuration 2 and specify sufficiently sized emergency planning zone (EPZ) so that the EPA PAGs are not exceeded at the EPZ boundary. Based on our generic calculations for Configuration 2 Section 4.2, BNL believes a permanently shutdown plant EPZ can be reduced so that it resides entirely within the former full power exclusion zone, i.e., within the site boundary.

Section 4 has also stated that decommissioning accidents that do not involve spent fuel do not pose a significant health risk to the public. Therefore, offsite emergency planning is not required for Configurations 3 (plant only) and 4.

It is recommended that the permanently shutdown licensee apply for exemptions from the following *offsite* emergency planning requirements for Configurations 2,3, (plant only) and 4:

- The early public notification requirements of 50.47(b)(5) and Appendix E.IV.D.3.
- The periodic dissemination of emergency planning information to the public (50.47(b)(7) and Appendix E.IV.E.8).
- Offsite emergency facilities and equipment such as the EOF, and the emergency news center (50.47(b)(8), Appendix E.IV.E.8).
- Offsite radiological assessment and monitoring capability, including field teams (50.47(b)(9)).
- Periodic offsite drills and exercises (50.47(b)(14), Appendix E.IV.F.3).
- Licensee headquarters support personnel training (50.47(b)(15), Appendix E.IV.F.b.h).

*except the Emergency Response Data System Requirements of Part 50, Appendix E, VI.

The NRC has recently issued a final rule [60 FR 32430, 6/22/95]. The emergency planning requirements for a typical, storage only ISFSI are provided in paragraphs 72.32 (a), (c) and (d).

Onsite emergency planning requirements should remain applicable for all spent fuel storage configurations.

Fire Protection

Background

Section 50.48 of 10CFR states, "each operating nuclear power plant must have a fire protection plan that satisfies Criteria 3 of Appendix A of this part." Criterion 3 states that fire detection and fighting systems of appropriate capacity and capability are required to minimize the effects of fires on structures, systems, and components important to safety. Section 50.48 further states that basic fire protection guidance provided in two documents: Branch Technical Position APCSB 9.5-1 and its Appendix A. The appropriate document is dependent on the plant's status as of July 1, 1976. The Branch Technical Position (BTP) APCSB 9.5-1 is applicable to new plants docketed after that date, while Appendix A to the BTP addresses older plants that were operating or under design or construction prior to 7/1/76.

Assessment

Although the emphasis of both these documents is the preservation of the safe shutdown capability during and after a fire, the guidance recognizes other sources of risk that are not related to reactor shutdown or in vessel decay heat removal. Appendix A to BTP APCSB 9.5-1 requires:

- The fire protection program for new fuel storage areas (and adjacent fire zones that could affect the fuel storage zone) be fully operational before fuel is received at the site.
- Fire protection and automatic detection for the spent fuel pool area.
- Radwaste building detection and protection.
- Materials that contain radioactivity must be stored in closed metal tanks or containers, away from ignition sources of combustibles.

Each licensee has a fire protection program that, in addition to safe shutdown requirements, has fire brigade training requirements, administrative procedures and controls, and detection and suppression requirements for plant areas that contain radioactive inventories with potential offsite consequences. For Configurations 1, 2, 3, (plant only) and 4, we recommend eliminating those requirements directly related to safe shutdown capability. Additional reductions in the scope of the 50.48 fire protection program can be examined on a plant-specific basis.

ISFSIs, under spent fuel storage Configuration 3, are subject to the fire protection requirements of Section 72.122.

Environmental Qualification

Background

The Environmental Qualification (EQ) of Electric Equipment Important to Safety for Nuclear Power Plants (10CFR50.49) was published as a final rule in the January 21, 1983 Federal Register (48FR2729). The supplementary information provided with the rule states:

> *The scope of the final rule covers that portion of equipment important to safety commonly referred to as "safety related".... Safety-related structures, systems, and components are those that are relied upon to remain functional during and following design basis events to ensure (i) the integrity of the reactor coolant pressure boundary, (ii) the capability to shut down the reactor and maintain it in a safe shutdown condition, and (iii) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guidelines of 10CFR Part 100. Design basis events are defined as conditions of normal operation, including anticipated operational occurrences; design basis accidents; external events; and natural phenomena for which the plant must be designed to ensure functions (i) through (iii) above.*

Assessment

The EQ rule is clearly limited to electrical equipment that must function during design basis events. In response to comments on the final rule, the Commission stated that the EQ rule does not cover the electrical equipment located in a mild environment. With the permanent cessation of operations, the design basis accidents of the FSAR are limited to Section 15.7, Radioactive Release from a Subsystem or Component. The harsh environment associated with loss of coolant accidents is no longer applicable. Therefore, 10CFR50.49 can be deleted for the permanently shutdown plant.

Quality Assurance (QA) Program

Background

The plant-specific QA program that implements the Part 50 Appendix B QA requirements is described or referenced in the Safety Analysis Report per 10CFR50.34(b)(6)(ii). Under paragraph (a) of "Condition of Licenses (50.54)," the licensee is required to implement the QA program described (or referenced) in the SAR. Furthermore, paragraph (a)(3) requires NRC submittal and approval of any proposed changes that reduce the commitments in the previously accepted QA program.

Assessment

The permanently defueled plant can make selected changes to its operating based QA program without impacting public health and safety. As previously discussed in the technical specification section, each plant should evaluate the scope of their QA program and submit the revisions that are appropriate to their facility and mode of spent fuel storage for NRC approval. Perhaps R.G. 1.33 can be revised (or another RG issued) to address the QA program for the PSD plants.

Operator Requalification Program

Background

Section 54(i) of 10CFR Part 50 requires an operator requalification program that meets the requirements of 10CFR55.59(c). The licensee may not decrease the scope of the program, except as authorized by the Commission.

Assessment

Part 55 states the requirements for granting and maintaining operator's licenses and is oriented toward operating nuclear power reactors. As a consequence, portions of this section are not applicable to a permanently defueled facility. The following sections should be revised to eliminate those regulatory requirements that solely pertain to operating nuclear power reactors:

55.41, 55.43, 55.45(a), 55.59(c) - Written examinations, operating tests, and requalification program requirements should reflect the permanently defueled plant configuration and the accidents that are applicable to the permanently shutdown facility.

55.45(b) - The operating tests for a permanently defueled plant should be administered in a plant walk-through. Simulation facilities are designed for operating power reactors, have limited usefulness for the defueled configuration, and should not be required for the administration of operating tests. In addition, Section 55.53(k) should be revised to reflect any modifications to the fitness for duty program that may be adopted for the permanently shutdown nuclear power reactor.

When all fuel is removed from the plant, either to an ISFSI (Configuration 3) or offsite (Configuration 4) there is no longer any need for operators licensed under Part 55, and the requalification program can be terminated."

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*As discussed in Section D.1, this regulatory assessment assumes an operating onsite spent fuel pool is not necessary for fuel retrievability. Therefore, licensed fuel handlers are not necessary for Configuration 3.

Operator Staffing

Background

The licensed operator staffing requirements for nuclear power reactors are delineated in Sections 50.54(k) and (m).

Paragraph (k) requires a licensed operator to be present at the controls at all times during the operation of the facility. A nuclear power unit is considered to be operating when it is in a mode other than cold shutdown or refueling. By extension, the permanently defueled condition does not require a licensed operator to be continuously present at the controls.

Paragraphs (m)(2)(i) presents onsite licensed operator staffing requirements for nuclear power reactors. The requirements are based on the number of units operating (i.e., not in cold shutdown or refueling) at a site and the number of control rooms. However, onsite staffing is required for non-operating units.

Assessment

The onsite staffing requirements of Section 50.54(m) (2)(i) shou'd remain in effect for Configuration 1. Our concern is the continued ability to: recover from off-normal events (such as the loss of fuel pool cooling) and activate the unit(s) emergency plan. The lower decay heat of the fuel assemblies in Configuration 2 subject to the same concern as Configuration 1. There is a long time for recovery from most off normal events.* Therefore, it is not necessary to require continuous operator staffing onsite unless spent fuel or other objects are being moved within or above the spent fuel pool, or other work is in process that poses a potential near term challenge to fuel cladding integrity. Since Configurations 3 and 4 do not require licensed operators, other personnel would have to be charged with the emergency plan responsibilities.

Containment Leakage Testing

Background

Conditions of Licenses, 10CFR50.54, Paragraph (o) states that primary reactor containments for water cooled power reactors are subject to the requirements of Part 50, Appendix J. This appendix requires periodic testing to verify the leaktight integrity of the primary containment and those systems and components which penetrate the containment.

*The representative accident sequence, a fuel assembly drop assumes an operator is present.

Assessment

The primary containment of an operating plant is one of several fission product barriers designed to protect the public's health and safety in the event of an accident. In contrast to an operating plant, a permanently defueled facility stores all of its fuel outside containment. The defueled containment is not a source of public risk; previous decommissioning studies[2,3] have determined that there are not significant offsite consequences associated with accidents that do not involve spent fuel. Therefore, the continued maintenance of containment leakage integrity does not enhance public health and safety and it is recommended that these testing requirements be eliminated for the permanently shutdown plant.

Security Plan

Background

As part of the "content of applications" of Section 50.34, applicants for a Part 50 license are required to submit a physical security plan and a safeguard contingency plan. The physical security plan addresses vital equipment, vital areas, and isolation zones and also demonstrates the applicant's compliance with the requirements of Part 73.

The safeguards contingency plan includes plans for dealing with threats, thefts, and radiological sabotage of special nuclear material in accordance with the criteria of Part 73, Appendix C, Section 50.54(p) "Conditions of Licenses", requires prior Commission approval of any changes that would decrease the effectiveness of the security plan,* the guard training and qualification plan, and the submitted portion of the safeguards contingency plan Part 73 and the associated Appendices B and C provide physical protection requirements, access authorization requirements, general criteria for security personnel and safeguards contingency plan criteria for Part 50 licensees.

Independent Spent Fuel Storage Installations also have similar requirements for the ISFSI physical security, guard training and safeguards contingency plans under Section 72.44(e), Part 72 Subpart H, Part 73, and Part 73 Appendix C.

Assessment

The intent of the physical security, guard qualification and training, and the safeguards contingency plan is to protect the facility against radiological sabotage and to prevent the theft of special nuclear material. In comparison to operating units, permanently shutdown plants have a limited number of vital areas that are necessary for the protection of those systems required to support spent fuel cooling and storage.

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*Changes that do not decrease the safeguards effectiveness of the aforementioned plans may be made without prior Commission approval.

For permanently shutdown nuclear power plants with fuel storage in the spent fuel pool (Configurations 1 and 2), the use of license amendment requests is recommended to reduce the scope of the security plan with regard to the number and extent of vital areas and equipment.* When the fuel is moved to an ISFSI or offsite (Configurations 3 and 4, respectively) there is no longer any need for the physical security, safeguards contingency or guard qualification and training plans for the permanently shutdown facility.** Please note that the ISFSI has physical security requirements under Part 72 Section 72.44(e), and Subpart H which are independent of the plant status. Under Configuration 4, all spent fuel will be shipped offsite and will become the responsibility of the DOE.

Onsite Property Damage Insurance

Background

The onsite property damage requirements for nuclear power plants are found in 10CFR 50.54(w). Each licensee is required to have a minimum coverage limit of $1.06 billion or whatever amount is generally available from private sources, whichever is less. This insurance must be dedicated to the expenses associated with returning and maintaining the reactor in a safe and stable condition in the event of an accident and, removing or controlling onsite radioactive contamination such that personnel exposure limits are consistent with the occupational exposure limits of 10CFR Part 20. In the event of an accident with estimated cleanup costs above a threshold of $100 million, paragraph 50.54(w)(4) provides for an automatic prioritization of stabilization activities.

The onsite property damage insurance requirement was instituted in March, 1982 (47FR 13750) and became effective on June 29, 1982. This regulation has been amended several times over the years. During the amendment processes, the Commission provided its views in several areas that are germane to the permanently shutdown plant. These are:

- the purpose of the regulation,
- the required amount of insurance and the updating mechanism, and
- the $100 million threshold for automatically determining stabilization priorities.

Each of these areas is discussed below. The regulatory intent is illustrated with cites from the appropriate Federal Register Notices. The Commission's philosophy is then summarized and applied to the PSD plant.

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*This reduction in the scope of the program could also conceivably reduce the size of the security force and procedures.

**References 2 and 3 and the consequence analysis for Configuration 4 (Section 4.4 of this report) indicate that once all fuel is removed the predicted offsite releases of accidents that could occur during the decommissioning process are much less than the 10CFR Part 100 limits.

Appendix B

The Purpose of the Regulation

The onsite property damage insurance requirement of 10CFR 50.54(w) was adopted as a final rule in 1982 (47FR 13750, March 31, 1982). As part of this Federal Register Notice, the public comments on the proposed rule were discussed. Several commenters suggested that the rule apply only to insurance covering decontamination of a facility suffering an accident and not to "all risk" property damage insurance. The Commission agreed, stating:

> *"Because decontamination insurance is the Commission's only concern from the point of view of protecting public health and safety, coverage to replace the existing facility on an "all risk" basis is beyond the scope of the Commission's authority."*

This position has been reaffirmed in two subsequent amendments to the regulation (52FR 28963 8/5/87, 55FR 12163 4/20/90. The 1987 amendment also introduced a decontamination priority which established a priority for stabilizing the reactor after an accident to prevent any significant risk to the public health and safety.

The Required Amount of Property Damage Insurance and the Updating Mechanism

When the onsite property insurance requirement, 10CFR 50.54(w), was originally instituted (47FR 13750, 3/31/82), the Commission required licensees to "take reasonable steps to obtain onsite property damage insurance available at reasonable costs and on reasonable terms from private sources".* The minimum coverage limit was specified as both:

1. the maximum amount of property insurance offered as primary coverage by either American Nuclear Insurers/Mutual Atomic Energy Reinsurance Pool (ANI/MAERP) or Nuclear Mutual Limited (NML) - $500 million, and

2. any excess coverage in amount no less than that offered by either ANI/MAERP - $85 million or Nuclear Electric Insurance Limited (NEIL) - $435 million.

Thus, the minimum required was originally $500 million primary coverage and $85 million excess coverage. By buying both excess layers, many licensees purchased a total of $1.02 billion in onsite property damage insurance (49FR 44646, 11/8/84). The Commission did not quantify a required insurance value at that time. The minimum requirement was viewed as a reasonable amount of insurance, pending the completion of a study evaluating the cleanup costs of accidents of varying severity. That study was issued as NUREG/CR-2601, "Technology Safety and Costs of Decommissioning Reference Light Water Reactors Following Postulated Accidents".[9]

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*Or to demonstrate an equivalent amount of protection

NUREG/CR-2601 evaluated cleanup costs following three full power accidents of varying severity at two reference light water reactors. The scenario 1 accident is postulated to result in 10% fuel cladding failure, no fuel melting, moderate contamination of the containment structure, but no significant physical damage to buildings and equipment. The scenario 2 accident is postulated to result in 50% fuel cladding failure, a small amount of fuel melting, extensive radioactive contamination of supporting buildings, and minor physical damage to buildings and equipment. The scenario 3 accident is postulated to result in 100% fuel cladding failure, significant fuel melting and core damage, severe radioactive contamination of the containment structure, moderate radioactive contamination of supporting buildings, and major physical damage to structures and equipment. A TMI-2 type accident was assumed in the study to be of intermediate severity (scenario 2).

The cleanup costs established in the report ranged from $105.2 million to $404.5 million for the reference PWR and from $128.5 million to $420.9 million for reference BWR. Although these costs are considerably lower than the roughly $1 billion estimated to be required to cleanup TMI-2, the NRC noted (52FR28963 8/5/87) that the estimates do not include several TMI cost components such as, inflation during the cleanup, additional decontamination of the containment building, and the cost of facility stabilization. These additional cost considerations cause the NUREG/CR-2601 cost estimates to increase to $1.06 billion for the most severe accidents studied and somewhat less for a TMI-2 type accident.

One conclusion the NRC drew from this study was that the minimum insurance requirement of $585 million would be insufficient for some accidents. Accordingly, the NRC amended 10CFR 50.54(w) (52FR 28963, 8/5/87) to require power reactor licensees to maintain at least $1.06 billion of onsite property damage insurance. The NRC noted that previous exemptions from the full amount required by 10CFR 50.54(w) were still valid. These exemptions were granted to four licensees of small reactors based on plant specific analyses of accident costs. The NRC stated:

> *"Increasing the required amount of insurance based on general technical studies in no way negates the continued validity of the specific studies upon which the existing exemptions were based."*

The August 5, 1987 Federal Register Notice also presents a summary of comments on the method of future adjustment of the insurance requirement. The NRC agreed with many commenters that an adjustment formula tied to a measure of inflation (e.g., the Consumer Price Index or the Handy-Whitman Construction Index) would not accurately reflect decontamination cost changes. Although it is expected that nuclear power reactor licensees will purchase the maximum amount of insurance that is reasonably available, the NRC reserves the right to perform periodic analyses to determine changes in accident recovery costs and to conduct rulemaking based on these analyses.

Appendix B

The Threshold for Automatically Determining Stabilization Priorities

In response to the 1987 final rule on changes in property insurance requirements, several petitions for rulemaking (noticed in 53FR 36335, 9/19/80) were received that requested clarification of the decontamination and stabilization priorities. As part of that rulemaking (55FR 12163, 4/2/90), the NRC amended 50.54(w)(4) to require dedication of insurance proceeds to decontamination and stabilization activities only if the estimated costs exceeded $100 million. This cutoff was viewed as a relatively minor accident where the availability of funds for stabilization decontamination activities is not considered to be an issue.

However, the Commission stated in this rulemaking that if disputes over the stabilization and decontamination process arise, the Rules of Practice under 10CFR Part 2 provide adequate procedures to resolve any issues.

Summary

This background discussion establishes that the purpose of 10CFR 50.54(w) is to protect health and safety in the unlikely event of an accident at a nuclear power plant. The minimum insurance requirement to assure post-accident recovery is based on the estimated stabilization and decontamination costs developed in NUREG/CR-2601 for two reference plants. Since it is not the Commission's intent to require more insurance coverage than is necessary for these purposes, licensees of smaller reactors have been granted exemptions from the full insurance requirement based on plant specific analyses that demonstrate lower cleanup costs. Finally, the NRC retains the authority to establish accident recovery and cleanup priorities, regardless of the estimated stabilization and decontamination costs.

Clearly the development of lower onsite property damage insurance requirements for the PSD plant is consistent with the intent of the regulation.

Assessment

Section 4 of this report developed accident consequence estimates for the four spent fuel storage configurations that were assessed for this program.

Configuration 1, "Hot Fuel in the Spent Fuel Pool," postulated rapid zircaloy oxidation of the spent fuel rods after the loss of the pool water inventory. The safety hazard analysis (Section 4) has estimated consequences that are approximately equal to a severe core damage accident. Given the potential magnitude of the consequences, it is appropriate that the onsite property damage insurance requirements of 10CFR 50.54(w) remain fully applicable for Configuration 1.

Configuration 2, "Cold Fuel in the Spent Fuel Pool," has sufficiently low decay heat loads such that the cladding will remain intact even if all spent fuel pool water is lost. Configuration 2 considers the

consequences of a dropped assembly. The Configuration 2 onsite cleanup costs has been estimated at $24 million.

In lieu of long term storage in the spent fuel pool, a permanently shutdown nuclear power plant may store its spent fuel in an Independent Spent Fuel Storage Installation (ISFSI), before, during, and after, the plant itself has been decommissioned. As such, Configuration 3 must examine the regulatory requirements for the plant without fuel (similar to Configuration 4) and the ISFSI. The postulated accident for Configuration 3 is a non-mechanistic breach of the ISFSI which damages a singleBWR or PWR fuel assembly.* The Configuration 3 onsite cleanup cost is estimated at $12 million.

Configuration 4, "All Fuel Removed from the Site," assumes that all spent fuel has been shipped offsite, including any that might have been stored in an ISFSI. As discussed in Section 4, the postulated accidental radioactive releases to the atmosphere during decommissioning do not pose a significant threat to the onsite workers or the public. For the purpose of estimating onsite accident cleanup costs, the postulated scenario for Configuration 4 is the rupture of the borated water storage tank. Approximately 450,000 gallons of slightly radioactive water is released causing soil contamination. The estimated cleanup cost is $110 million.

Inservice Inspection and Testing ISI and IST Requirements

Background

10CFR50.55a, Codes and Standards, require that ASME Code Class 1, 2, and 3 pumps, valves, vessels, piping, and supports meet the testing and examination requirements set forth in Section XI of the ASME Boiler and Pressure Vessel Code. Each licensee is required to update and submit their ISI and IST Programs every ten years to the edition and addenda referenced in 10CFR50.55a(b), 12 months prior to the start of the 10 year interval. The initial interval begins at the issuance of the operating license. Section XI provides testing requirements to verify the operational readiness of pumps and valves and the structural integrity of pressure retaining components and their supports.

The ISI and IST Programs contain a plant-specific list of the applicable components, code classification, code category, examinations or tests to be performed, and the frequency and schedule of examination or testing. When the code requirements are impractical, for instance due to plant design, or would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety, the regulations permit alternatives to be used when authorized by the Commission.

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*This consequence estimate may not envelope sabotage scenarios which could conceivably involve a greater radionuclide release. These scenarios are safeguard information. The information on radionuclide release (if any) is not available to BNL.

Assessment

Each licensee is required to determine the ASME Code Class 1, 2, and 3 components and prepare and ISI and IST program for these components. Each program is plant specific depending on the design of the plant and the classification of components. The classification may be determined based on Regulatory Guide 1.26, NUREG-0800, or the ANSI/ANS Standards N52.1 and 51.1, depending on the age of the plant and the agreements made with the NRC. The systems important to the permanently defueled plant are radiation monitoring, fuel building, HVAC, and spent fuel pool cooling cleanup. The ASME Boiler and Pressure Vessel Codes do not address instruments and controls such as radiation monitoring. Fuel building HVAC, and spent fuel pool cooling systems may be included in the IST programs, depending on whether they perform a design basis safety-related function. Non-safety related components are not required to be examined or tested in accordance with the Code. Additionally, some plants may not include HVAC systems in the ISI/IST programs because they do not contain water, steam, or radioactive waste.

It is recommended that licensees of permanently shutdown plants reduce the scope of the ISI and IST programs to eliminate those systems that do not support spent fuel storage and handling (including cooling and cleanup) and HVAC. Although the revised program should be submitted to the NRC, approval is not necessary, unless relief requests are revised or added.

Fracture Prevention Measures

Background

Sections 50.60, 50.61, and Appendices G and H to Part 50 specify fracture toughness requirements and material surveillance programs for the reactor coolant pressure boundary of light water reactors. The intent of these regulations is to maintain reactor coolant pressure boundary integrity by assuring adequate margins of safety during any condition of normal operation (including anticipated operational occurrences).

Assessment

Once the permanently shutdown plant has been completely defueled, the measures required by these regulations are no longer necessary. These requirements can be eliminated for all spent fuel storage configurations without impacting the health and safety of the public.

ATWS Requirements

Background

The purpose of 10CFR50.62 is to require improvements in the design and operation of light water cooled nuclear power plants to reduce the likelihood of RPS failure following anticipated operational occurrences. This regulation also requires improvements in the capability to mitigate the consequences of an ATWS event.

Assessment

Although ATWS can be a significant contributor to operating plant risk, it is not applicable to permanently shutdown plants where fuel is stored in subcritical arrays. This regulation can be eliminated for all spent fuel storage configurations of the permanently defueled plants without impacting public health and safety.

Loss of All AC Power Requirements

Background

The loss of all AC power requirements Station Blackout Rule is found in 10CFR50.63. The regulation requires that all light water cooled nuclear power plants be capable of withstanding a complete loss of AC power for a specified duration and maintain reactor core cooling during that period. The NRC intent is to provide further assurance that a loss of both the offsite and onsite emergency AC power systems will not adversely affect public health and safety.

The Station Blackout (SBO) rule was published in the June 21, 1988 issue of the Federal Register (53FR23203). The supplementary information provided with the rule indicates that the purpose of this regulation is to explicitly require that nuclear power plants be designed to insure that core cooling can be maintained for a specific duration (coping period) without onsite or offsite AC power. The coping period can range from two to sixteen hours depending on the plant-specific design and the site characteristics.

Assessment

The objective of the rule is to reduce the risk of severe accidents resulting from SBO by maintaining highly reliable AC electric power systems and, as an additional defense in depth, assuring that plants can cope with a loss of all AC power for some period of time. The goal is to maintain the core damage frequency contribution of SBO to about 10^{-5}/reactor year.

Although the rule is oriented toward core damage, the objective of reducing severe accident risk due to SBO can be applied to a permanently defueled plant.

Based on the analysis in NUREG/CR-1353,[6] a total loss of spent fuel cooling would allow over 40 hours of boiloff before any spent fuel would be exposed. This time is well in excess of the maximum coping period required by the rule. The long period before fuel damage occurs allows ample time for offsite power recovery or fuel pool makeup.* BNL has estimated a fuel damage frequency of 5E-7 (with credit for one emergency diesel generator (EDG)) and 4E-5 (no EDGs credited) for an extended loss of all AC power.

BNL believes that permanently shutdown nuclear power plants meet the intent of 10CFR50.63. For consistency with Reg. Guide 1.155, we recommend that the existing (operating based) SBO plant procedures and training be revised to reflect the storage of all fuel in the spent fuel pool (Configurations 1 and 2).

The ISFSI of Configuration 3 should fully conform to the requirements of Section 72.122(k), however since all fuel has been removed from the plant (Configurations 3 and 4) the requirements of 10CFR50.63 are not applicable.

Maintenance Effectiveness

Background

The NRC amended its regulations under 10CFR50.65 to require commercial nuclear power plant licensees to monitor the effectiveness of maintenance activities on safety significant plant equipment. The intent is to minimize the likelihood of failures and events caused by the lack of effective maintenance. The rule will require that licenses:

- Perform annual evaluation of the effectiveness of the maintenance program.
- Assess the overall impact of monitoring and maintenance activities (which require taking equipment out of service) on the performance of safety functions.

The rule will become effective on July 10, 1996.

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*Reference 6 has estimated a 24 hour recovery period for actions that require access to the spent fuel pool. These could include the use of the fire protection system to provide pool makeup. Remote recovery actions, such as offsite power recovery, are not limited by the auxiliary building radiation levels and must be accomplished before boiloff exposes the fuel.

Assessment

Section 50.65, paragraph b (scope of the monitoring program) includes safety-related structures, systems, and components that are relied upon to remain functional during and after design basis events to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to 10CFR Part 100 guidelines. Also included within the scope of the maintenance effectiveness program are non-safety related structures, systems, and components (SSCs) that are relied upon to mitigate accidents. Furthermore, draft regulatory guide DG-1001 [DG-1001, 8/1/89] clarifies the scope of the rule as including "SSCs in the balance-of-plant that would significantly impact safety or security."

Using the draft regulatory guide and other industry guidance each licensee will develop a prescriptive maintenance effectiveness program to meet the intent of the rule.

Plants that have formally ceased operations prior to July 10, 1996 (the effective date of the rule) are not expected to have implemented a maintenance effectiveness program. It is recommended that these facilities be exempted from the requirements of the rule.

Plants that operate after July 10, 1996 should have a maintenance effectiveness program in place. The scope of the program will vary from plant-to-plant based on plant-specific design and operating attributes. When a plant is permanently shutdown many of these structures, systems, and components can be removed from the maintenance effectiveness program. For these plants, the scope of the maintenance effectiveness program can be reduced to reflect the permanently shutdown plant configuration, i.e., it would only apply to the structures, systems, and components necessary to support safe fuel storage in the spent fuel pool (Configurations 1&2).

The requirements of Section 50.65 are not applicable to spent fuel storage Configurations 3 and 4.

Periodic FSAR Update Requirements

Background

10CFR50.71(e) requires NPP licensees to file FSAR revisions annually or six months after each refueling outage (provided the interval between successive updates to the FSAR does not exceed 24 months). The updated FSAR shall "include the effect of all changes made in the facility or procedures described in the FSAR all safety evaluations performed by the licensee either in support of requested license amendments or in support of conclusions that changes did not involve an unreviewed safety question all analyses of new safety issues performed by or on behalf of the licensee at Commission request."

The NRC position on the continued applicability of 50.71(e) to permanently shutdown plants appears to be evolving. Schedular exemptions from 50.71(e) have been issued to PSD licensees in the past.[7]

However, more recently, the Yankee Nuclear Power Station received an exemption from the FSAR update requirements.*

Assessment

* *

After a decision to permanently shutdown a facility has been formalized with the NRC, a licensee may begin making extensive changes to plant structures, systems, and components that are no longer necessary. Each of these changes will require a 50.59 safety evaluation which in turn requires a FSAR review. The continuance of the FSAR update requirement will provide a somewhat current plant reference source for future safety evaluations and will also continue to serve as a licensing document. In the supplemental information provided as part of the Final Rule [45FR30614, May 9, 1980] the scope of the rule was specifically extended to include older plants without FSARs including the Indian Point 1 and Humboldt Bay plants that were permanently shutdown at the time. In addition, wenote the periodic* FSAR update requirements for ISFSIs, a passive storage system, without the support systems required for fuel storage in the spent fuel pool. It is recommended that the FSAR update requirements of 50.71(e) be maintained for all spent fuel storage configurations, with schedular exemptions as necessary to encourage a timely submittal that documents the plant at major decommissioning milestones. However, the scope of the document is expected to be reduced to reflect the decommissioning process, i.e., the removal of plant systems, structures, components, and procedures, that are no longer necessary from a health and safety perspective. The ISFSI update requirements of 70.72 remain, although for consistency, a biennial update period should be considered.

Training and Qualification of Nuclear Power Plant Personnel

Background

In 1993 the NRC amended its regulations [58 FR 21904, 4/26/93] to require that each applicant and each holder of a license to operate a nuclear power plant establish, implement, and maintain a training program. The new requirement, 10CFR 50.120, uses a systems approach to training to ensure nuclear power plant personnel will be qualified to operate and maintain the facility in a safe manner for all modes of operation.

The rule requires training and qualification of the following nuclear power plant personnel:

- Non-licensed operator
- Shift supervisor
- Shift technical advisor

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*10CFR72.70 currently requires an annual FSAR update for ISFSI licensees. The similar requirement for Part 50 licensees was revised from an annual to a refueling outage basis not to exceed 24 months. (57FR39353, 8/31/92).

- Instrument and control technician
- Electrical maintenance personnel
- Mechanical maintenance personnel
- Radiological protection technician
- Chemistry technician
- Engineering support personnel

Licensed operators, such as control room operators and senior control room operators, are not covered by this rule and will continue to be covered by 10CFR Part 55. Because some senior control room operators may also be shift supervisors, only those aspects of training related to their shift supervisor function are covered by this rule.

As part of the public comments to the proposed Rule, several commenters recommended that facilities undergoing decommissioning, where all fuel has been permanently removed from the reactor vessel, or those with a possession only licensee, not be subject to this Rule. The Commission disagreed, stating that the provisions of the Rule are applicable to all Part 50 licensees. The Commission maintained that the systems approach to training embodied in the Rule will ensure that training programs are revised to reflect changing plant conditions. Permanent changes to the plant (i.e., decommissioning) that make some or all of the existing training programs unnecessary can be addressed by the exemption process. Since the public risk associated with the permanently shutdown nuclear power plant is associated with the spent fuel, it is recommeaded that the requirements of 50.120 continue for Configurations 1 and 2 for only those personnel that are responsible for fuel handling and the continued safe storage of the spent fuel.

As shown in the safety hazard analyses of Section 4, after the spent fuel has been moved to an ISFSI or offsite, the risk to the public is negligible. The training and qualification requirements of 50.120 can therefore be removed for Configurations 3 and 4.

Material Control/Accounting of Special Nuclear Material (including US-IAEA Agreement

Background

Part 70, Sections 51 and 63 provide general material balance, inventory, recordkeeping, and status report requirements that are applicable to nuclear power reactors. Section 53 refers to 10CFR74.13(a) and 75.35 which provide additional detailed material status report requirements including reporting form numbers and submittal dates.

Independent spent fuel storage installations have similar requirements as specified in 10CFR72.72, 72.76, and 75.35.

Assessment

The material control and accounting requirements of Parts 70, 74, and 75 remain fully applicable for permanently shutdown plants in spent fuel storage Configurations 1 and 2. Licensees in Configurations 3 should be exempted from the Section 70.51 and .53 and, as applicable, Part 74. Material accounting requirements will remain for the ISFSI under Parts 72 and, as applicable, Part 75. If all fuel is removed from the site, the material control and accounting requirements of Part 70, and all of Parts 74 and 75 are not longer applicable.

Financial Protection Requirements

Background

The financial protection requirements for large nuclear power plants* are found in Part 140 of 10CFR. At the present time, paragraph 140.11(a)(4) requires a primary layer of financial protection of $200 million. A secondary layer of financial protection is also mandated. This is an industry retrospective rating plan providing for deferred premium charges equal to the pro rata share of the public liability claims and costs. Under this plan, the current maximum deferred premium charges for each nuclear reactor which is licensed to operate is $75.5 million with respect to any nuclear incident.** No more than $10 million per incident is required in a calendar year. The total financial protection for any incident would equal the primary layer of $200 million plus the secondary layer of $75.5 million times the number of reactors covered, or in excess of $8 billion.

This liability insurance covers claims resulting from a nuclear incident or a precautionary evacuation. In addition to accidents involving offsite releases, public evacuation and land contamination, the insurance covers liability arising from power plant effluents, storage and transportation of spent fuel,*** and radioactive waste materials. Included in the insurance coverage are defense costs for claims settlement.

10 CFR Part 140 was established in 1957 pursuant to Section 170 of the Atomic Energy Act of 1954, commonly called the Price-Anderson Act. One of the purposes of the Act was to protect the public by assuring the availability of funds for the payment of claims arising from a catastrophic nuclear incident. The Act required the AEC's reactor licensees to furnish financial protection (in the form of nuclear

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* i.e., a nuclear reactor facility that is designed for producing 100,000 electrical kilowatts or more.

** plus any surcharge assessed under subsection 170o (1)(E) of the Atomic Energy Act of 1954, as amended.

*** The liabilities and indemnification requirements associated with the transfer of spent fuel from the licensee to the Department of Energy will be evaluated on a case by case basis at a future time when spent fuel is shipped to a repository.

liability insurance or the equivalent) to cover public liability claims against the licensee and all others who might be liable for a nuclear incident. A second major provision required the AEC to indemnify the licensee and all others who might be liable in the amount of $500 million over and above the financial protection required. The Act also limited the liability from a nuclear incident to the sum of the financial protection required plus the AEC's indemnity. For large reactor licensees this resulted in a statutory liability limit of $560 million. The Act had similar provisions for certain licensees not operating reactors and to certain AEC contractors.

The financial protection requirement for large nuclear power plants was (and remains) the maximum amount of liability insurance available at a reasonable cost and on reasonable terms from private sources. The amount was originally $60 million. The required amount has been increased in step with increases in the amount of privately available nuclear energy liability insurance. The current requirement for this primary layer of insurance is $200 million. Other licensees generally have lesser financial protection requirements which consider type, size, and location of the licensed activity and "other factors pertaining to the hazard."

In 1975, the Price-Anderson Act was modified and extended until 1987 (Public Law 94-197). This amendment established a secondary layer of insurance by requiring that a retrospective premium of $2 to $5 million be established for large nuclear power plants. Part 140 was revised (42FR 46 1/3/77) to establish a retrospective premium of $5 million per facility per incident. The NRC chose the $5 million level because such a premium would not present an undue burden on any size utility. Moreover, since the $5 million requirement was the highest allowed by Public Law 94-197, it would result in the maximum financial protection available to pay public liability claims.

In 1988, Public Law 100-406 modified and extended the Price-Anderson Act to the year 2002. The retrospective premium was increased to $63 million per reactor per incident. This limit was subsequently increased to $75.5 million (58FR 42851 8/12/93) by Section t of the Act, based on the consumer price index change since 1988.

This discussion of the offsite liability insurance requirement has established that one intent of the Price-Anderson legislation is to protect the public by ensuring that timely compensation is available in the event of claims arising from a catastrophic nuclear incident. Unlike the onsite property damage insurance requirement, the offsite liability levels as mandated by Congress do not appear to have an explicit technical basis.

The primary insurance requirement, presently at $200 million, is based on the maximum amount of liability insurance available from private sources. Similarly, there does not appear to be an explicit technical basis for the secondary layer retrospective premium of $75.5 million per reactor.

Although the permanently shutdown nuclear power plant has a lower public risk, many activities that have the potential for public liability claims will continue until all radioactive materials are removed and the

site is released for unrestricted access. This implies that the offsite liability insurance requirement should continue although, for most configurations a lower requirement should suffice.

Assessment

There are three major considerations that are germane to this offsite liability assessment. Each is discussed below:

- **The Relationship of Accident Probability to the Liability Insurance Requirements**

One purpose of the Price-Anderson Act was to protect the public by assuring the availability of funds for the payment of claims arising from a catastrophic nuclear incident. Probabilistic Risk Assessments (PRAs) provide a mechanism to examine the relationship of accident frequency and accident consequence for a given enterprise. Full power PRAs of nuclear power plants show increasing consequences with decreasing accident frequencies. The accident consequences can be used to determine liability insurance levels.

Although Congress did not explicitly state its intent when specifying or amending the Price-Anderson Act, some inferences can be drawn from a review of the hearing transcripts.

On March 3, 1976, shortly after the Price-Anderson Amendments Act of 1976 (Public Law 94-197) was adopted, the Joint Committee on Atomic Energy held a hearing to consider whether the financial risk to utilities under the Price-Anderson system should be increased.[10] The hearing transcript provided the following insights:

From the prepared statement of Larry Hobart, Assistant General Manager, American Public Power Association (p. 34)

> *Public Law 94-197 was the result of extensive committee hearings and vigorous Congressional debate extending over a two-year period. During Congressional consideration of the legislation, the level of financial risk to be imposed on electric utilities was the major focus of attention. Testimony was taken on a variety of approaches to the question. The range of retrospective premiums provided under current law is the end-product of that very detailed examination.*
>
> *The decision by Congress took into account the conclusions of this committee relative to risk to the public, including evaluation of the findings of the study "An Assessment Accident Risks in U.S. Commercial Nuclear Power Plants" prepared under the direction of Dr. Norman C. Rasmussen of the Massachusetts Institute of Technology. The committee stated in its report of November 13, 1975, on this legislation that: "Insofar as the amount of financial protection for the public is concerned, both Dr. Rasmussen testimony before the joint Committee last year and the final report*

affirm that the total of public and private indemnity provided for by this bill is adequate to cover any credible accident which might occur."

As part of the general discussion, committee member representative John B. Anderson of Illinois stated (P. 11):

One further comment on the question of the $560 million limit on liability. We did have some testimony before Joint Committee when we considered the extension of Price-Anderson to the effect that this would afford protection for about 96 percent of all the accidents that might occur.

In other words, that 96 percent of the probable accidents that could occur would be below the extent of the limits imposed on liability under this statute and the kind of accident that would exceed that amount would be one that would probably occur once in every 5,000 years and that as the pool floats upward, as it will do under the legislation, as I know the Senator is aware, to about $1 billion by 1985 this would include 99 percent of all accidents that might occur. In other words, accidents that would exceed that $1 billion would likely occur once in 10,000 years.

The witness, Senator Charles H. Percy from Illinois responded in part,

The committee was very wise to establish through the Rasmussen report the fact that the risks are relatively low. We needed some means of bringing it down from a 10,000-year span to what we can really comprehend in relation to our own insurance policies. We don't have to be concerned about 10,000 years so much as the probability of an accident occurring once in 10,000 chances in 1 year or once in a thousand chances in 10 years. The Rasmussen study shows that when 100 reactors are on line, the probability over a 10-year period of an accident with $900 million in property damages, a 2,000 square mile decontamination area, a 130 square mile relocation area, 300 early illnesses and total health effects over a 30 years of 5,100 latent cancer deaths, 42,000 thyroid nodules and several hundred genetic defects, is one in a thousand.

On the basis of this testimony we can extrapolate that the frequency (F) of a release resulting in the stated consequences is:

F/ reactor year x 100 reactors x 10 years = 1.0E-3, therefore:
F = 1.0E-6/reactor year

These statements (and the intent of the Joint Committee) can be interpreted two ways:

The intent of the committee was to ensure that the primary and secondary layers of financial indemnity will afford protection for about 96 to 99 percent of the accidents that might occur.

2. The intent of the committee was to determine a credible accident frequency, and establish indemnity levels based on the estimate consequences of that credible accident.

For the purposes of operating power reactors these two interpretations have the same outcome. However, for the PSD plant they can produce disparate results, when the release frequency distribution is different from the full power operation of a nuclear plant. For example, if a release frequency ranged between 1E-7 and 1E-10, with 1E-9 and greater comprising 99 percent of the total frequency, interpretation number 1, would require the financial protection levels based on a 1E-9 accident. However, interpretation number 2 would not require any liability insurance.

It is likely that Congress implicitly assumed a credible accident frequency (interpretation number 2). We believe that the intent of Congress in establishing a retrospective premium in the range of $2 to $5 million was to ensure that adequate funds were available to cover any credible accident that might occur. That level of funds appears to be $1 billion. The associated "credible" accident frequency is about 1E-6 per reactor year.

The release frequency estimates for the spent fuel storage configuration representative accident sequences are provided in Section 3. The release frequency for the Configuration 1 accident is in the E-6 range for both BWRs and PWRs. The spent fuel assembly drop (Configuration 2) is 3E-4 events per year. The ISFSI release frequency (Configuration 3) of 6E-6 events per year is from an EPRI study. However, as discussed in Section 3, it is our judgement that this frequency is overstated by at least two orders of magnitude. The estimated release frequency is approximately 3E-7 events per year. The Configuration 4 seismically induced borated water storage tank (BWST) rupture has been estimated at 2E-7 events per year.

Table B.2 A Comparison of Consequence Estimates

	Early Fatalities	Latent Fatalities	Societal Dose (Person-Rem)	Boundary Dose (Rem)	Condemned Land (Sq. Miles)	Total Offsite Costs $
Configuration 2	0	2	4000	0.009	0.0	neg
Configuration 3	0	0.22	690	0.472	0.0002	neg
TMI 2[1]	0	0.4	~2000	0.100	0.00	neg[2]

1. TMI 2 accident information is from the Rogovin Report (Ref. 12)
2. Established based on milk and vegation sampling results reported in Reference 12. All samples were well under EPA protective action levels.

- **The Relationship that Accident Consequence Calculations Have to Actual Liability Expenses**

Consequence codes such as the MELCOR Accident Consequence Code System (MAACS) are used to estimate the outcomes of radiological accidents in terms of health effects, population dose, and economic cost. It appears that one bases of the offsite liability requirement for large power reactors is an estimate of accident consequences. However, these calculations are not necessarily representative of actual experience.

For example, Table B.2 presents the consequence estimates for Configurations 2 and 3 using the MAACS Code. The Three Mile Island Unit 2 accident data is also provided for comparison. The table shows that the TMI 2 offsite health and economic consequences are similar to the estimates for Configuration 2 and 3. Yet, as of 1993, $60 million has been awarded settlement of claims arising from the TMI 2 accident. A significant number of claims were still unsettled as of 1993.[11]

There clearly is a disparity between the expected consequences and the public's perception of an accident. The Rogovin Report[12] recognized this stating:

> *In our view, the fact that there will be no adverse radiation health effects, or very minimal effects, from the Three Mile Island accident has not been clearly understood by the public. It is clear to us that the public misconception about the risks associated with the actual releases measured during the accident, as well as about the risks associated with nuclear power plants generally, has been due to a failure to convey credible information regarding the actual risks in an understandable fashion to the public.*

Despite significant education efforts, the majority of the public is not comfortable with nuclear power. In all likelihood, the public mistrust of all things nuclear will continue for the foreseeable future. In this environment the public reaction to relatively minor incidents will be exacerbated, (e.g., precautionary evacuation) and result in economic consequences that are far in excess of code predictions.

- **The PriceAnderson Requirements for Non Operating Reactors and ISFSIs**

Section 170 of the Atomic Energy Act,* Part a requires that:

> *"Each licensee issued under Section 103 or 104 and each construction permit issued under Section 185 shall, and each licensee issued under Section 53, 63, or 81 may, for the public purposes cited in Section 2 1. have as a condition of the license a requirement that the licensee have and maintain financial protection of such type and in such amounts as the Nuclear Regulatory Commission (in this*

*Commonly known as the Price-Anderson Act.

section referred to as the "Commission") in the exercise of its licensing and regulatory authority and responsibility shall require..." (emphasis added)

The NRC must require financial protection for licensees issued under Section 103 (commercial licenses), Section 104 (medical therapy and research and development) and for construction permits and operating licenses under Section 185. Section 170b gives the Commission the authority to require less than the maximum amount of primary financial protection, in consideration of other factors including, the type, size, and locations of the licensed activity. However, the Act specifies primary and secondary insurance amounts for facilities designed for producing substantial amount of electricity. Financial protection is not mandated for Sections 53, 63, and 81 which addresses the domestic distribution of: special nuclear material, source material, and byproduct material, respectively.

There has been significant debate regarding the applicability of Section 170 to permanently shutdown facilities. After a sufficient cooling period such that there is no longer the threat of rapid zircaloy oxidation, the accidents that could be associated with the PSD facility have significantly reduced consequences. Cases can be made for removing the offsite liability insurance requirement or continuing it with less than the maximum amount required for the permanently shutdown facility.

Section 4 of this report developed accident consequence estimates for the four spent fuel storage configurations that were assessed for this program.

Configuration 1, "Hot Fuel in the Spent Fuel Pool," postulated rapid zircaloy oxidation of the spent fuel rods after the loss of the pool water inventory. The safety hazard analysis has estimated consequences that are approximately equal to a severe core damage accident.

Configuration 2, "Cold Fuel in the Spent Fuel Pool," has sufficiently low decay heat loads such that the cladding will remain intact even if all spent fuel pool water is lost. Configuration 2 considers the consequences of a dropped assembly. The safety hazard analysis, as discussed in Section 4 of shows negligible offsite costs.

In lieu of long term storage in the spent fuel pool, a permanently shutdown nuclear power plant may store its spent fuel in an Independent Spent Fuel Storage Installation (ISFSI), before, during, and after, the plant itself has been decommissioned. As such, Configuration 3 must examine the regulatory requirements for the plant without fuel (similar to Configuration 4) and the ISFSI. The postulated accident for Configuration 3 is a breach of the ISFSI which damages a single BWR or PWR fuel assembly.* The estimated offsite cost is negligible

*This consequence estimate may not envelope sabotage scenarios which could conceivably involve a greater radionuclide release. These scenarios are safeguard information. The information on radionuclide release (if any) is not available to BNL.

Configuration 4, "All Fuel Removed from the Site," assumes that all spent fuel has been shipped offsite, including any that might have been stored in an ISFSI. As discussed in Section 4, the postulated accidental radioactive releases to the atmosphere during decommissioning do not pose a significant threat to the onsite workers or the public. For the purpose of estimating onsite accident cleanup costs, the postulated scenario for Configuration 4 is the rupture of the borated water storage tank. Approximately 450,000 gallons of slightly radioactive water is released causing onsite soil contamination and potential contamination of the water table. BNL has performed calculations that indicate tritium levels will be below the maximum concentration limit for drinking water at the site boundary. Offsite remediation has not been considered and again offsite costs are considered to be negligible.

Given the potential magnitude of the consequences, it is appropriate that the offsite liability insurance requirements of 10CFR Part 140, both the primary and secondary levels, remain in place for Configuration 1.

The insurance recommendations for the remaining configurations are not as straightforward. Qualitative justifications can be made for anywhere from $0 to $200 million.

Since the analyses show minimal offsite consequences, a case can be made for eliminating the offsite liability requirements for Configurations 2, 3, and 4. Any liability awards *should* be minimal and the licensee should be able to pay those awards in a timely manner, thereby satisfying the intent of the Price-Anderson Act.

Conversely, the $200 million figure recognizes the possibility of a large suit for alleged damages due to routine, low level radioactive effluents from the plant during decommissioning.

All things considered, a $100 million offsite liability insurance requirement is a reasonable compromise for the permanently shutdown plant. The TMI 2 experience has shown that significant judgements can be awarded, despite negligible offsite consequences. It is also recommended that these plants be allowed to withdraw from the secondary level of protection. In addition, the exemption process could be used to justify lower plant specific requirements, as deemed appropriate.

For the independent spent fuel storage installations (ISFSIs) that are not covered under an existing site policy, it is acknowledged that a lower liability limit could be justified. The passive nature of the installation, and the expected lack of radioactive effluents, routine or otherwise, conceivably results in less liability exposure.

Appendix B

Annual Fees for Licensees

Background

Part 171 of 10CFR, "Annual Fees for Nuclear Power Reactor Operating Licenses," was published on September 18, 1986 [51FR33224] as a final rule. The rule assessed an annual fee for FY1987 for every power reactor licensed to operate. The annual fee was instituted to comply with the statutory mandate of the Consolidated Omnibus Budget Reconciliation Act of 1985. The scope of this section was expanded [56FR31472, 7/10/91] to include other entities including nonpower reactors, materials licensees, part 72 ISFSI licensees, fuel facilities, etc., in response to the congressional mandate requiring the NRC to recover approximately 100% of its budget authority in FY1991 and the four succeeding years. In the Responses to Comments, Section D, Specific Fee Issues of the Final Rule, the NRC responded to the issue of annual fees for shutdown plants. Two commenters had indicated that charging the full annual power reactor fee was not fair because certain costs allocated to all power reactors were not applicable to permanently shutdown plants. The Commission responded that the proposed rule excluded power reactors with a POL* from the FY 1991 fee base. This waiver was extended and remains in effect for FY95.

Assessment

The NRC is required to recover approximately 100% of its budget authority. The licensing and inspection fees assessed under Part 170 recover the costs of providing individually identifiable services to specific applicants for, and holders of, NRC licenses and approvals. Part 171 provides for the recovery of NRC budgeted costs for generic regulatory activities for each class of licensee. For example, the generic activities associated with power reactor licensees include: reactor decommissioning, license renewal, construction permit, and operating license reviews. Also included are generic costs such as the Incident Response Center and certain other NRC efforts that can support other licensees, but are primarily established for the power reactor licensee. Costs attributable to types of licenses other than power reactors (i.e., part 72 licensees) consists of generic regulatory costs and other costs not recoverable under Part 170, including rulemaking, upgrading safeguards requirements, modifying the standard review plans and developing inspection programs.

Permanently shutdown power reactor licensees continue to require NRC services, although not to the extent of a full power licensee. It is recommended that the Part 50 licensees, authorized to possess but not operate a nuclear power reactor be assessed as a group for the NRC services that are to be provided. If the appropriate fees cannot be accurately assessed at this time, perhaps a fee that is equivalent to the annual ISFSI fee can be instituted.

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*or with a formal NRC order prohibiting placing fuel back in the reactor vessel.

B.4 REFERENCES

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5. Topical Report for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel," NOHOMS-24P, NUH-002, Rev. 2A, Chapter 8, April 1991.

6. Throm, E.D. "Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools," NUREG-1353, April 1989.

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8. NRC Letter (Morton B. Fairtile) to the Yankee Atomic Electric Company (Jane M. Grant), docket number 50-29, "Exemption from 10CFR50.71(e) - Periodic Submittal of an Updated FSAR (Tac No. M83789)," dated July 23, 1992.

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10. Hearing Transcript "To Consider Whether Financial Risk to Utilities Under the Price-Anderson System Should be Increased," before the Joint Committee on Atomic Energy Congress of the United States, Ninety Fourth Congress, Second Session, March 3, 1976, CIS-1976-J801-16.

11. SECY 93-127, "Financial Protection Requirements of Licensees of Large Nuclear Power Plants During Decommissioning," May 10, 1993.

12. "Three Mile Island, A Report to the Commissioners and to the Public," Nuclear Regulatory Commission Special Inquiry Group, 1980.