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What are the security threats to further development of nuclear power plants in the U.S.?

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THESIS

WHAT ARE THE SECURITY THREATS TO FURTHER DEVELOPMENT OF NUCLEAR POWER PLANTS IN THE U.S.?

by

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March 2010

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What are the security threats to further development of nuclear power plants in the U.S.? The U.S. stands alone today in terms of the vast nuclear armory at its disposal. It is clear we know something about how to build nuclear weapons, and yet, we are not world leaders in the field of nuclear power. Nuclear energy has the potential to be an alternative fuel source that would be sustainable and economical. Nuclear power is controversial in the U.S. because it raises issues of domestic energy policy, funding, regulation, safety, and especially security. In turn it can affect U.S. investments, foreign policy, economy, and jobs.

As America struggles with its dependence on foreign oil, we must seek alternative fuel sources. The President has made energy a priority and is pushing for a "clean energy economy." Not to pursue alternative fuel sources will directly impact our ability to be economically competitive, as other countries will have cheaper electricity for manufacturing and services. We need to protect the U.S. from economic and strategic risks associated with our reliance on foreign oil. We also need to address the destabilizing effects of a changing climate, Internet is heavily impacted by our energy use.

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WHAT ARE THE SECURITY THREATS TO FURTHER DEVELOPMENT OF NUCLEAR POWER PLANTS IN THE U.S.?

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ABSTRACT

What are the security threats to further development of nuclear power plants in the U.S.? The U.S. stands alone today in terms of the vast nuclear armory at its disposal. It is clear we know something about how to build nuclear weapons, and yet, we are not world leaders in the field of nuclear power. Nuclear energy has the potential to be an alternative fuel source that would be sustainable and economical. Nuclear power is controversial in the U.S. because it raises issues of domestic energy policy, funding, regulation, safety, and especially security. In turn, it can affect U.S. investments, foreign policy, economy, and jobs.

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
CIP	Critical Infrastructure Plan
COL	Combined Operating License
DBT	Design Basis Threat
DHS	Department of Homeland Security
EPACT	Energy Policy Act of 2005's
EPR	European Pressurized Reactor
EU	European Union
Euratom	European Atomic Community
FISMA	Federal Information Security Management Act of 2002
FOAKE	First-of-a-Kind Engineering costs
FBI	Federal Bureau Investigations
GAO	General Accounting Office
LCOE	Levelized Cost of Nuclear-generated electricity
IAEA	International Atomic Energy Agency
IT	Informational Technology
MIT	Massachusetts Institute of Technology
NAS	the National Academy of Sciences
NCD	National Cyber-Security Division
NEI	Nuclear Energy Institute
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
PRA	Probabilistic Risk Assessment
POGO	The Project on Government Oversight
SCADA	Supervisory Control and Data Acquisition
TFEC	Transatlantic Forum on Energy Cooperation
UN	United Nations

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This paper is dedicated to my husband, John, whose patience and support has been unwavering. Also, for my daughter, Rachel, who is fascinated by “power boxes” and anything to do with electricity, and started me on the quest to understand nuclear power plants.

This is also a special dedication to Commander Philip A. Murphy-Sweet who was killed in Iraq on 7 April 2007. We worked together and shared an office while assigned to MNSTC-I at Camp Phoenix. He was a graduate of the Naval Postgraduate School and, many times, as I walked the campus, I thought of you and your family together here.

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I. INTRODUCTION

A. THE CASE FOR NUCLEAR POWER USE TAB KEY

This thesis seeks to dispel the myth that all nuclear reactors are inherently dangerous and to establish that nuclear power plants can both satisfy this country's energy needs and do so in a way that reduces or eliminates the security risks posed by its current reliance on fossil fuels. Today, nearly one-fourth of the electricity being consumed in the United States is generated by nuclear energy plants; yet nuclear energy remains an underdeveloped industry whose potential to serve this country's needs has only been tapped. Decades after the incidents at Three Mile Island and Chernobyl, a public perception persists that nuclear power plants pose significant risk to the homeland security of the United States because they would stand as attractive targets for international terrorists. However, those holding this viewpoint conveniently ignore the reality that American dependence on fossil fuels and the continued importation of oil from foreign countries, some of Internet are known as safe harbors and breeding grounds for terrorists, already compromises U.S. national security to an alarming degree. Nuclear technology could free the United States from its dependence on foreign oil and bring it closer to energy independence. In addition, a transition towards nuclear power would reduce carbon and other pollutants' emissions; these are the inevitable byproduct of generating electricity through the burning of fossil fuels at conventional power plants.

The rest of the introduction is allocated to highlighting the importance of energy for the United States in terms of economics and national security. The Executive branch and the private sector each have important roles in expanding the use of nuclear energy. The U.S. need to recognize that different energy options available to the U.S. and the acknowledgment that other nations' use of nuclear power for electricity to keep costs down while electricity usage increases. One, of the key problems, is that upcoming economies of China, India, Japan and South Korea are planning to build eighty?-four new nuclear power plants among them and the U.S. currently has plans to build one. Lastly, the literature review that focuses on two key questions: (1) what is the United States'

present energy policy for nuclear power? (2) What is the national plan in case of a nuclear incident, accident or terrorist attack on a nuclear power plant?

B. IMPORTANCE

> So we have a choice to make. We can remain one of the world's leading importers of foreign oil, or we can make the investments that would allow us to become the world's leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity.[1]
>
> —President Obama, March 19, 2009

The United States must continue to hold its position as the leading nation in the international arena in terms of economics and protection of its own security interests. As long as the United States remains dependent on other countries, including potentially hostile nations, for vital energy resources, its leadership position in the global hierarchy will remain vulnerable. To successfully extract itself from the control of the international entities upon Internet it depends for foreign oil, this country must seriously and avidly seek alternative fuel sources.

The President has made solving this country's energy quandary a policy priority for his administration. The clean energy economy envisioned by the current administration cannot be achieved unless alternative fuel sources are discovered and exploited to the greatest extent possible. A failure to consider alternatives such as nuclear energy will directly and negatively impact the ability of the United States to compete economically in the global arena with nations that have already tapped into sources of cheaper electricity for manufacturing and other vital infrastructural needs. To remain powerful and respected on the international stage in the 21st century and beyond, the United States must protect itself from economic and security risks resultant from a dependency on foreign oil. These include not only the potential of terrorist disruptions

[1] "Energy & Environment," The Whitehouse Office of the Press Secretary, http://www.whitehouse.gov/issues/energy-and-environment.

and a loss of economic competitiveness, but also the destabilizing effects of a rapidly changing environmental climate, caused in great part by the mass consumption of fossil fuels.[2]

Furthermore, the success and extent of this country's economy recovery will depend largely on the choices the current administration makes regarding energy policy. The Executive branch must promote policies with respect to energy that will strengthen the nation's relative economic position in the world and stimulate job creation. In turn, the Legislative branch must support the Executive branch in enacting clean energy initiatives by convening oversight committees and conferring budgetary authority. The Judicial branch will do its role by upholding federal regulations and their enforcement and deciding related lawsuits. Given the social and political turmoil that frequently ensues at the local and state level when nuclear plants are to be planned for their launch, there is a possibility that the federal courts will be called upon to hear cases involving the construction, operation, and management of new plants. In addition, Homeland Security department has the responsibility of monitoring the security of nuclear power plants. This security oversight apparatus adds another layer of governmental bureaucracy to the nuclear power puzzle.

Counter-arguments to the development of nuclear power plants and an increased reliance on nuclear energy center, primarily on safety and the well-known nuclear reactor melt-downs at the U.S.' Three Mile Island station, as well as the Ukrainian nuclear power plant—Chernobyl. Other voices rose in opposition to nuclear energy quote high costs associated with the building of new nuclear power plants. A third frequently-aired objection to greater reliance on nuclear energy is the problem of the storage of nuclear waste, Internet this paper will address only tangentially and only as it pertains to potential security risks to nuclear power plants.

[2] "Fact Sheet: President Obama Highlights Vision for Clean Energy Economy," Rochester Democrat online, April 22, 2009, http://www.therochesterdemocrat.com/index.php/test/print/fact_sheet_ president_obama_ highlights_ vision_for_clean_energy_economy/.

1. The Executive Role in Expansion of Nuclear Power

Early in his presidency, President Obama made it clear that he wanted to transition America to an economy based on clean energy. On April 5, 2009, President Obama addressed the issue of clean energy during a speech in Hradcany Square, Prague, Czech Republic. Obama spoke of climate change and ending not only America's, but also the world's dependence on fossil fuels. He spoke explicitly of using energy sources of alternative means. These include wind and solar power. He further declared the United States would be the leader in breaking worldwide dependency on fossil fuel. However, he was actually referring to America's dependency on foreign oil.[3] In U.S. domestic energy policy, the President has indicated that he would like to lead the U.S. to a "clean energy economy." As he has stated in several key speeches at home and abroad, he would like to see the manufacturing base of the United States reconstituted, retrofitted, and modernized using "green" technology. He believes that using renewable energy sources such as bio fuels and nuclear energy will result in cheaper costs for the electricity required to support America's manufacturing sector and thus enhance U.S. competitiveness as an exporter of goods, supplies, and services.[4] However, the President's current plans for this energy transition in the manufacturing sector are projected to take ten years, and only $150 billion have been allocation to this initiative. This falls far short of the substantial cash infusion that nuclear power industry needs and requires right now.[5]

The current presidential administration understands the benefits of nuclear energy as well as the importance of alternative energy sources to the long-term strategies of the United States in the areas of national security and economic leadership. For the President, developing nuclear power is not just a means of priming the economic pump; it

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[3] "Remarks by President Barack Obama at Prague, Czech Republic," *The White House Office of the Press Secretary*, http://www.whitehouse.gov/the-press-office/remarks-president-barack-obama-prague-delivered.

[4] "Fact Sheet: President Obama Highlights Vision for Clean Energy Economy," *The White House Office of the Press Secretary*, http://www.whitehouse.gov/the-press-office/clean-energy-economy-fact-sheet.

[5] Ibid.

is also a way to strengthen national security since increased reliance on nuclear energy will reduce the dependency of the United States on foreign imports of oil.[6] The fact that nuclear power is a form of "clean energy" that does not produce harmful emissions dangerous to the environment is another benefit of the current administration's support of nuclear power plants.[7] Nuclear power is a sustainable energy source. This is due to the use of uranium, Internet is more economical than coal or oil and Internet could help break the United States of its dependency on foreign oil when it is utilized with other sources of energy.[8] At this time, nuclear power plants already produce 20 percent of U.S. electricity and nuclear energy accounts for 17 percent of electrical power used internationally.[9]

2. Private Sector's Role in Expansion of Nuclear Power

A surge in nuclear power plant construction is coming in the region of United States of America. Already, applications for plant construction, as well as for uranium mining, have increased. Five years ago, there were zero such applications. As of May 2009, however,

> Two United States utilities have recently signed engineering, procurement, and construction contracts for four nuclear plants - the first such orders since 1978. The NRC expects to receive twenty-three combined operating license (COL) applications (authorizing both the construction and operation of one or more nuclear power reactors) by the end of 2010 for licenses to construct and operate thirty-four new reactor units.[10]

At the time of this writing, eighteen domestic companies have made it known they are submitting applications for new licenses to build 26 new nuclear power plants.[11]

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[6] "Energy and Environment," *The White House Office of the Press Secretary*.

[7] Marci and Greg Lusted, *A Nuclear Power Plant* (Michigan: Lucent Books, 2005), 11.

[8] Ibid., 12.

[9] Ibid., 13.

[10] Roland M Frye Jr,. "The Current "Nuclear Renaissance" in the United States, Its Underlying Reasons, and its Potential Pitfalls," *Energy Law Journal* (Washington: 2008. Vol. 29, Issue 2, available via proquest online.

[11] David Biello, "Reactivating Nuclear Reactors for the Fight against Climate Change," *Scientific American* January 27, 2009, http://www.scientificamerican.com/article.cfm?id=reactivating-nuclear-reactors-to-fight-climate-change.

Nuclear plants are very expensive to build, and cost over-runs are to be expected since engineers in the United States have little experience in building them; the last newly built nuclear power plant in the U.S. was constructed in 1973.

Much of the motivation for the increase in uranium mining and nuclear plant construction applications is related to new regulatory limits on carbon emissions that have been imposed on operators of conventional power plants. These new regulations, in turn, are tied to a new appreciation for the environment and growing concerns regarding the effects of climate change, Internet is attributed largely to the build-up of greenhouse gasses resulting from power plant emissions of carbon and other pollutants.[12] Construction of nuclear power plants on a large scale will result in an explosive-like expansion in construction jobs. It will also develop jobs related to the fields of maintenance, operation, and security for these facilities. It has been estimated that the construction of a single nuclear plant could generate up to 1300 jobs, with the subsequent creation of an additional 400 jobs in plant maintenance, operation, and security for each reactor.[13]

The U.S. has been involved with nuclear technology since the 1950s. These nuclear projects were expensive, and American society was not driven to utilize the full energy capabilities of nuclear power because cheap petroleum was readily available as a primary fuel source. As the U.S. global economy expanded exponentially in the mid-twentieth century, it did so using oil-based technologies, not alternative fuel sources. Oil remains available, even though it is not as plentiful or as inexpensive as it once was, today's consumers are accustomed to using it and willing to pay higher prices for its convenience. Meanwhile, the United States still dominates the global economy using oil based technologies. However, the fuel and energy landscape is changing as competitor countries begin to break their dependence on oil and turn to alternative fuels, such as

[12]. Roland M. Frye, Jr. "The Current "Nuclear Renaissance" in the United States, Its Underlying Reasons, and its Potential Pitfalls" *Energy Law Journal*. Washington: 2008. Vol. 29, Issue 2, available via proquest online.

[13] Ibid.

nuclear power. For example, in the near future, China has plans to build thirty-four new plants: India plans twenty-three, Japan twelve, South Korea seven, and Russia seven.[14]

The American economy is driven by market forces of supply, demand, and profits. At present, no incentives exist that are strong enough to force the market to make the conversion from foreign imported oil to domestically produced alternative fuel sources. It cannot be assumed that businesses will voluntarily change from the current electrical grid to something else, Internet would involve significant capital investment on their part, as well as, possibly, a change in their mode of operation. Businesses would gladly change if it meant that electrical power would be substantially cheaper and their profits would rise as a result of the transition. However, in general, American businesses are not currently worried about power since it is still available and its costs are currently acceptable.

3. Different Energy Options

Nonetheless, converting to nuclear energy is not an all or nothing solution—it can be one piece of the energy solution. If the United States converts just part of the national grid to nuclear power and also utilizes solar, wind, and domestic oil sources, the amount of oil that the country needs to import from foreign sources will be significantly reduced.

> In 2003, "the United States consumed an average of 20 million barrels of oil and natural gas per day, or 7.3 billion barrels per year. About 56 percent of the oil used in the United States is imported. In 2003, the United States produced about 7.8 million barrels of oil and natural gas per day, or about 2.9 billion barrels per year. U.S. oil reserves (including the Gulf of Mexico) total 22.7 billion barrels, Internet would last less than eight years at today's rates of consumption and imports. Gasoline for cars and light trucks accounts for about 45 percent of U.S. oil consumption."[15]

Obviously, the United States is dependent on foreign oil imports, as 56 percent of the oil it consumes is imported from foreign oil sources.

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[14] ICJT, Nuclear Training Centre "Nuclear Power Plants in the World," http://www.icjt.org/an/tach/jestvet/jesvet.htm.

[15] Tom Kenworthy, "Energy Independence May Be a Pipe Dream," USA Today, October 24, 2004, http://www.usatoday.com/news/politicselections/nation/issues/2004-10-24-energy-independence_x.htm.

If the United States can reduce its oil importation, it will enjoy long-term benefits, the primary one being that it will no longer be so entrenched in the politics of the Middle East nor held hostage to the whims of governments potentially hostile to U.S. interests who have the power to decide whether, and at what cost, the United States can receive and use essential fuel resources. By utilizing alternative fuel sources, the U.S. can weather the current energy crisis and benefit from advanced technology in the areas of solar power, bio fuels, hydro power, and nuclear energy. Once the United States breaks its dependence on oil, its resources, financial, political, and diplomatic, will be freed to address other pressing issues. The money paid to countries of foreign oil can be used to invest in domestic or other foreign policies more conducive to United States national security and other domestic and international interests.

4. Other Nations and Nuclear Power

Other nations have benefitted from increased development and utilization of nuclear power. Because of its development of nuclear plants, France has been able to ride out the foreign oil debacle. Although France continues to import some oil, its national electrical grid is fueled by nuclear power. With its increased production of nuclear energy, France has so much excess electricity that it has been able to export it to other nations in the European Union. France's European neighbors purchase electricity from France because doing so do is cheaper for them than producing their own.

Japan is another example of a country that has been able to extract itself from the treacherousness of Middle Eastern oil politics. While the Japanese economy suffered a decade-long economic recession in the 1990s, from Internet it still has not completely rebounded, the effects of this decline would have been far worse had Japan been dependent on foreign oil. Even in the midst of the current economic downturn, Japan has announced plans to build twelve new nuclear reactors to meet current and future power requirements.[16] They understand and have accepted that they must spend monies on their

[16] World Nuclear Association, "Nuclear Power in Japan," http://www.world-nuclear.org/info/inf79.html.

critical infrastructure, including nuclear power, in order to maintain their self-sufficiency in the future and to cut down on environmentally damaging emissions of pollutants.

Cheap coal is available in large quantities in China, but that country is still planning to build new power plants in the next decade, Internet would run on nuclear power. As it moves into a highly industrialized economy, China will require more energy in the future and, in order to conserve their own resources, they have decided to capitalize on nuclear technology. China understands and accepts the need for self-sufficiency and the dangers of dependencies on coal and oil, Internet are the in fact the fossil fuels.

The pros of nuclear power include potential advancements in the nuclear industries, Internet will lead to technology breakthroughs, new workforce employment, and availability of cheaper electricity that will propel manufacturing and industry and allow the populace to reap the benefits of cheaper power. The United States may someday find itself in the position that the Ukraine found itself after the Chernobyl accident, without adequate electrical power. The United States may have to learn to live with the risk and mitigate it the best we can until some other source of energy can meet our requirements. Nuclear power does have positive attributes, we know how to manage it, we understand how to produce it, it offers clean emissions in the environment, and we will eventually figure out the best way to store or use nuclear waste.

C. PROBLEMS AND HYPOTHESES

The federal government plays a key role in domestic energy policy. But President Obama faces strong opposition from Congress, and in the case of nuclear power, from the American public as well.[17] Since America is based on an open economy, nuclear power plants are owned by private corporations, where in other economies they would be state owned. This creates problems between government regulatory enforcement and the private sector. The power from nuclear power plants is regulated by the Department of Energy, but the physical plants are regulated and monitored by Department of Homeland

[17] Kent Garber, "Gauging the prospects for nuclear power in the Obama era," U.S. News & World Report, http://www.usnews.com/articles/news/energy/2009/03/27/gauging-the-prospects-for-nuclear-power-in-the-obama-era.html.

Security, Office of Infrastructure Protection. There are security concerns regarding the actual plants, the communities near nuclear power plants, the transport of nuclear waste, and the storage of nuclear waste.

The U.S. has been involved with nuclear technology since the 1950s. Even then nuclear projects were expensive, but as a society, we were not driven to utilize the capability of nuclear power since we had cheap petroleum oil available as a primary fuel source. As the U.S. global economy took off, it did so with oil-based technologies, and not alternative fuel sources. Currently there is still the resource of oil, and consumers are willing to pay higher prices for it. The U.S. remains a leader in the global economy using oil- based technologies, but the landscape is changing as competitor countries are starting to break their dependence on oil and are turning to alternative fuels, such as nuclear power. As of August 2009, there are eighty-four new nuclear power plants being planned by the China, India, Japan, South Korea and Russia, while the U.S. is only schedule to build one new nuclear power plants. This could put the United States in a negative economic position in terms of hedging electricity costs in the future, Internet may lead to other countries having an advantage of having electricity cheaper and that would make their goods and services cheaper than U.S. goods and services.

D. LITERATURE REVIEW

The issue of security threats starts with a thorough understanding of what a modern nuclear power plant can do for a community, and what more plants can do for the nation and the world because of their potential to have a large positive impact on climate change. Considerations include actual electrical power generated, technologies developed, safety, and finally the costs of building and maintaining a nuclear power plant through its life cycle. As the current presidential administration knows, there are benefits of nuclear energy beyond the economic security that comes with nuclear power. National security is positively affected, as well, since further nuclear power development shifts the U.S. away from dependency on foreign oil.[18] Further benefits that can be considered that

[18] "Energy & Environment," The Whitehouse Office of the Press Secretary.

nuclear energy is clean energy, since it does not produce emissions that are harmful to the environment.[19] Though there is disagreement in the energy sector that the resulting nuclear waste disallows it to be classified as a clean energy method. Nuclear energy could help break the US dependency on foreign oil. Along with utilizing other sources of clean energies, such as solar, wind and water, may be a possible solution at this time

Nuclear power is old technology. The U.S. opened its first commercial nuclear power plant in 1957.[20] There has been steady progress in updating nuclear technology, though most of it has taken place in weapons production, or by other countries developing new methods for using its peaceful properties. France and Japan use nuclear powered electricity extensively and plan to build new plants to replace old ones, increasing capacity to accommodate expansion of their economies and citizenry.[21] A comparison look of how the US and France, each protect their nuclear power plants against domestic and foreign threats is useful in US planning for the future.[22]

Nuclear power plants, by their very nature, compel serious consideration in terms of economic, political, and security issues. There are several problems to consider and many are too large for the scope of this paper and further analysis is needed. Therefore, the limited approach is first, it is necessary understand the present energy policy and the Nuclear Power 2010 program published by the Department of Energy.[23] Second, what is the national plan in case of a nuclear incident, accident or terrorist attack on a nuclear power plant?[24]

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[19] Marci and Greg Lusted, *A Nuclear Power Plant* (Michigan: Lucent Books, 2005), 11.

[20] Ibid., 8.

[21] John Palfreman, " Nuclear Reaction Why do Americans fear nuclear power?" FRONTLINE, http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html.

[22] "Action at Golfech N-Plants ".Nuclear Information and Resource Service http://www10.antenna.nl/wise/index.html?http://www10.antenna.nl/wise/452/4475.html.

[23] The U.S. Department of Nuclear Energy, *Building New Nuclear Plants*, 2008. Washington D.C.: http://www.nuclear.gov/pdfFiles/factSheets/BuildingNewNuclearPlants.pdf.

[24] Dr. Edwin Lyman, "Nuclear Plant Protection and Homeland Security" Union of Concerned Scientists, Citizens and Scientists for Environmental Solutions, 2003, http://www.ucsusa.org/nuclear_power/nuclear_power_risk/sabotage_and_attacks_on_reactors/nuclear-plant-protection-and.html.

E. SUMMARY

The paper is organized into seven chapters. Chapter I serves as the introduction for the case for nuclear power in the United States. Chapter II gives historical background to understand the United States position on nuclear power. Chapter III attempts to understand the current thinking of nuclear power plants as possible terrorist targets. Reviewing both physical and cyber attacks and what vulnerabilities are susceptible to a potential attack. Chapter IV examines the potential violent threats to plant construction from domestic or international groups. This chapter will address the issue of security threats that could face newly-built nuclear power plants located in the United States. Chapter V explores the potential monetary costs to safeguard nuclear plants from terrorist threats. Chapter VI discusses Department of Homeland Security role to prepared potential threats to the plants. Chapter VII will compare the development of nuclear power plants in Europe. Chapter VIII will conclude with options that the United States has today and are viable in the future.

These chapters will illustrate that nuclear power plants can both satisfy the United States energy needs that may reduce or eliminate the security risks that currently exist due to the U.S.' heavy reliance on fossil oil.

II. HISTORICAL BACKGROUND ON NUCLEAR POWER PLANTS

The incidents at Three Mile Island and Chernobyl effectively soured the opinion of the American public in the 1970s and 1980s on the widespread, standard nuclear energy use and development as a power source. However, the Three Mile Island incident is best understood, not as an example of how nuclear technology is bound to fail but rather as a demonstration of how well the United States is equipped to handle an emergency situation, should one arise in connection with a domestic nuclear power plant. Moreover, while the Chernobyl incident was tragic, it must be understood that this meltdown could have been prevented, and, had it occurred in the United States, it would have been because the United States had then, superior nuclear technology and stricter safety standards than those that governed the Chernobyl plant. The following chapters of this thesis will address the issue of security threats that could face newly-built nuclear power plants, Internet are situated in United States of America. This will be done by identifying the actual scope and likelihood of these potential threats and analyzing how these threats can be eliminated, neutralized, and defended against.

A common argument used in the U.S. against nuclear energy development or employment is safety. For instance, the Three Mile Island incident in the year 1979 is commonly cited by critics. In accordance to the data complies by World Nuclear Organization and the Department of Energy, the Three Mile Island nuclear power accident, is the accident that occurred March 28, 1979. The plant's reactor was running at nearly 97 percent of its maximum output. Meanwhile, in the secondary cooling circuit a minor malfunction occurred. This resulted in a temperature rise in the primary coolant.[25] As a result, the reactor shut down automatically. Then a relief valve failed to close so the primary coolant drained away and the core suffered severe damage. This was compounded by the fact that the operators did not understand what was happening in

[25] Canadian Nuclear Association, "Nuclear Power Accidents," http://www.cna.ca/curriculum/cna_safety/ nuclear_accidents-eng.asp?bc=Nuclear+Power+Accidents&pid=Nuclear+Power+Accidents.

the plant's reactor. They could not immediately discern the cause of the unplanned automatic shutdown of the reactor. Their resultant improper actions compounded the plant's woes.

What the American public saw, and still remembers, are a failed nuclear reactor, and a potentially dangerous industrial plant accident. However, this public perception is based on a significant misperception, due, in part, to difficulties in communication between various state and federal agencies--the same kinds of problems that were documented after the consequences of September eleventh attacks. Due to a misunderstanding by plant operators of the information that they were receiving from the plant's computers, an evacuation was ordered. However, the evacuation was based not on an actual danger, but rather on an unsubstantiated, and ultimately false, fear that there could have been a breach in the plant's containment shell. It has been extensively documented in the book "Crisis Contained, The Department of Energy at Three Mile Island," by Phillip L. Cantelon and Robert C. Williams, that radiation readings of hundreds of environmental samples taken from Three Mile Island following the accident were far below the health limits, and at no time were humans or any of the areas plant and animal life in any danger from leaked radiation.[26] In fact, there are no known injuries or adverse health effects documented as a result of the incident by the U.S.' Departments of Public Health, Energy, and the Environmental Protection Agency, nor have there been any lawsuits brought before a court against the company that operated Three Mile Island plant when the incident occurred.

A. SUCCESS OF NUCLEAR POWER PLANTS IN THE UNITED STATES

Indeed, the story of Three Mile Island is actually one of success. In 1997, Three Mile Island Reactor 1 "completed the longest operating run of any light water reactor in the history of nuclear power worldwide—616 days and 23 hours of uninterrupted

[26] Phillip L. Cantelon and Robert C. Williams, *Crisis Contained, The Department of Energy at Three Mile Island*, (Carbondale Ill: Southern Illinois University Press, 1982).

operation."[27] In 1998, "Three Mile Island employees completed three million hours of work without a lost-work day due to accident."[28] In addition, the United States and the nuclear industry learned important lessons from the incident that have led to continued improvements in the operation and performance of nuclear power plants.[29] Nonetheless, because of its impact on public perception of nuclear power, the Three-Mile Island incident had long-term negative results on the nuclear industry and the employment of nuclear energy in the United States, including a loss of confidence in and fear of nuclear energy and a subsequent decline in nuclear power plant construction. The effects of the forestallment of the development of the nuclear industry in response to the Three Mile Island incident are still being felt today.

B. THE FAILURE THAT SHAPED UNITED STATES PERCEPTION OF NUCLEAR POWER PLANTS

The second watershed incident in terms of shaping American attitudes toward nuclear power was the accident at the Ukrainian Chernobyl Power Plant during the eighties, when the Ukraine was still a member state of the Soviet Union. According to the Environmental Protection Agency and the Department of Energy, the number four reactor at Chernobyl exploded and burned on April 26, 1986.[30] At first the Soviet Union released little information on the origin or consequences of the accident or the extent of radioactive fallout. What happened at Chernobyl was a large scale accident that resulted from unauthorized testing in a facility whose reactor and reactor buildings had not been built, and were not being operated, according to industry safety standards. In the United States and other western nations, however, nuclear plants are built and operated in accordance with these safety precautions; had the precautions conventionally applied in

27 Canadian Nuclear Association, "Nuclear Power Accidents." http://www.cna.ca/curriculum/cna_safety/nuclear_accidents-eng.asp?bc=Nuclear Power Accidents&pid=Nuclear Power Accidents.

28 World Nuclear Association, "Three Mile Island: 1979," http://www.world-nuclear.org/info/inf36.html.

29 Ibid.

30 World Nuclear Association, "Chernobyl Accident," http://www.world-nuclear.org/info/chernobyl/inf07.htm.

the United States been in place at Chernobyl, then the Chernobyl accident would not have occurred.[31] For example, the United States and other western nations require that a containment facility or "shell" be built around a nuclear reactor in a nuclear plant. The plant at Chernobyl did not have such a containment shell. Later simulated reenactments of the accidents revealed that the reactor explosion and the radiation released as a result would have been contained if a containment shell had been constructed.[32] Moreover, in addition to the fact that unauthorized testing was being conducted in the Chernobyl facility, the reactor that exploded itself had a design flaw. One of the greatest contributing factors in the events leading up to the accident was poor training, Internet resulted in the mismanagement of the emergency situation that evolved in the aftermath of the reactor explosion. This mismanagement was reinforced by the consequences of the Cold War isolation. At the time, there were no required safety measures for the workers or the public.[33]

C. KEY DIFFERENCES BETWEEN THREE MILE ISLAND AND CHERNOBYL

The difference in the magnitude of the Three Mile Island incident and Chernobyl is substantial. While there were no deaths or injuries from the Three Mile Island incident, 47 individuals died as an immediate result of the Chernobyl accident, and 210,000 people were required to be relocated as a result of radioactive contamination stemming from the reactor explosion. The aftermath of the Chernobyl accident was complicated by the fact that Ukraine depended heavily on nuclear electricity to get them through its typically brutal winters. As soon as reactor 4 was contained, the rest of the plant was brought back on line and remained on line until 2005. The well-documented negative effects of the accident include physical and genetic damage to humans and wildlife as a direct consequence of excessive and prolonged radiation exposure. However, the accident had at least one positive result that is often overlooked by

31 World Nuclear Association, "Chernobyl Accident."

32 Richard Rhodes, and Denis Beller, "The Need for Nuclear Power," *Foreign Affairs* 79 no. 1, 2000, 40.

33 World Nuclear Association, "Chernobyl Accident."

westerners. After Chernobyl, the Soviet Union sent scientists, engineers, and workers to European and American nuclear power plants to observe so that they could learn new technologies, operating techniques, and training methods for future use in Soviet facilities. Following the dissolution of the Soviet Union, many satellite nations kept their nuclear power plants and have maintained and operated them with very few accidents or incidents. Many of these plants have passed regular inspections by various domestic and international nuclear agencies.

D. CHOICES IN ENERGY SECURITY

At this point in time, the United States has choices regarding its use of fuel sources for critically needed energy. If the United States allows itself to remain dependent on foreign oil, choices in fuel sources may not be available in the future. Today, electricity is still relatively cheap, but another "oil crisis" could change the energy picture very quickly. Because the United States is a highly industrialized nation intent on maintaining its position as an economic, scientific, and technological leader on the world stage, its energy requirements and demands, will continue to grow. Keeping in mind the domestic and national security welfare and benefits of the United States, it is better that the nation make changes now on its own terms pursuant to a well-planned energy strategy rather than wait to do so at a point in time when its status as a hostage to the direction of foreign governments and entities forces it to do so in order to respond to a short-term or long-term energy crisis. Currently, Middle East nations that control the production rate of the oil that the U.S. imports, and, to some degree, they control the price as well. Armed conflict almost anywhere in or connected to the Middle East will drive up the cost of oil imports on the international market. Moreover, even small upward fluctuations in the price of oil will cause American consumers to start paying more money for oil just to maintain their standard of living and economic stability. Further developments in nuclear power can only help lead the United States to achieve further technological breakthroughs as it strives to create a "clean energy economy." France has already made progress in the use of nuclear energy, and they have been able to develop newer and safer methods for nuclear energy production. It is time that the United States followed suit.

E. SUMMARY

This chapter gave historical background on two incidents that shaped the nuclear power industry in the United States, Three Mile Island and Chernobyl. Both of these incidents illustrate success and failure of operating a nuclear power plant. Then, it laid down the foundation of key differences between the two events. The chapter closes with choices that the U.S. has today in energy sources. The next chapter will cover current thoughts of nuclear power plants as terrorist targets.

III. NUCLEAR POWER PLANTS AS TERRORIST TARGETS

In this chapter, it will describe the possibilities of a physical attack on a nuclear power plant in the U.S. Then, it will discuss the Nuclear Regulatory Commission (NRC) and utility companies' involvement in defending nuclear power plants, as well as the shortcomings in their defense against potential attacks. The NRC and utility companies who own the nuclear power plants must follow a formula called the Design Based Threat (DBT), Internet outlines training and defensive measures required that will be explained in detail. The threat to nuclear power plants is not only in the physical plane, but also that of the cyber realm, whose possibilities of exploitation resulting in compromise of control systems will be examined.

A. THE THREAT

In 2006, the Government Accounting Office wrote in its report GAO-06-388, dated March 2006:"…to the Honorable Christopher Shays, Chairman of the House Subcommittee on National Security, Emerging Threats, and International Relations: "Dear Mr. Chairman, The nation's 103 operating commercial nuclear power plants, located at 65 sites in 31 states, are potential targets for terrorists seeking to cause the release of radioactive material." The Nuclear Regulatory Commission (NRC) also advised there is a realistic threat of attack by Al Qaeda or other terrorist elements against the U.S. nuclear power system.[34]

Since 2001, the NRC's strategy for deterring and defeating threats to nuclear power plants has been under increased scrutiny. The methodology used to evaluate plant preparedness to respond to terrorist attacks is laid out in a document known as the Design Basis Threat (DBT), Internet "characterizes the elements of a potential attack, including the number, of attackers, their training, and weapons and tactics they are capable of employing."[35] In the same report, new licensees for structuring a nuclear power plant

[34] U.S. Government Accountability Office, Report to the Chairman, Subcommittee on National Security: GAO-06-388, March 2006, 1.

[35] Ibid., 2.

must demonstrate the ability of the future plant to defend against attacks presented in the DBT. The NRC tests each nuclear plant's ability to respond to threats laid out in the DBT through no-notice inspections and simulated exercises known as "force-on force exercises." However, not all plants that undergo this testing meet the criteria set forth in the DBT.

Furthermore, the DBT was revised with input from the Nuclear Energy Institute (NEI) industry stakeholders, who objected to a number of the NRC's proposed changes to the hypothetical threats that form the basis of the DBT, including the size of potential vehicle-born explosives and other weaponry. The NEI objected to several of the NRC's proposed changes because the hypothetical threats constituted attacks by an "enemy of the United States, Internet (nuclear power plant) sites are not, required protecting against under NRC regulations."[36]

In the years since the 9/11 terror attacks, the possibility of a terrorist attack against nuclear power plants has been discussed in media outlets and legislative chambers.[37] In September 2002, the Arab television station Al-Jazeera aired a taped interview that indicated a nuclear plant to be damaged by Al Qaeda on September eleventh.[38] The reaction to this tape and concerns about dirty bombs made with black-market radioactive materials caused the specter of nuclear terrorism to seem all too real to the American public. The United States General Accounting Office ("GAO") has officially acknowledged in several government reports that commercial nuclear power plants in the United States could be targets of potential future terrorist attacks.[39] In

[36] GAO-06-388, March 2006, 20–21.

[37] David Bodansky, *Nuclear Energy, Principles, Practices, and Prospects* (New York: Springer-Varlac, 2004), 501.

[38] Mark Holt and Anthony Andrews, Nuclear Power Plant Security and Vulnerabilities, Report Prepared for Members and Committees of Congress (Washington D.C. Congressional Research Service, January 18, 2008), 3.

[39] Roland M. Frye, Jr., The Current "Nuclear Renaissance" in the United States, Its Underlying Reasons, and Its Potential Pitfalls, *Energy Law Journal*, 29 no. 2 (2008): 279.

addition, the GAO issued a report concerning the possibility of terrorist attacks on government research reactors and nuclear research labs and the dangers such attacks could pose.[40]

Along with concerns about unaccounted-for plutonium and uranium falling into the hands of Muslim extremists and nightmares about jets crashing into a nuclear plant's containment shell, comes the uneasy sense that the American government is not doing enough to anticipate and prevent a deadly nuclear attack, that, as Stephen E. Flynn puts it, "[t]he United States is living on borrowed time—and squandering it."[41] However, despite this preoccupation with nuclear power plants as the targets of terrorist activity, there are no hard facts or figures regarding the likelihood of such an attack or there could be prospects of it to be thriving. There are no comprehensive and methodologically rigorous studies compiling estimates of the number of human casualties or of the environmental damage, if such an attack were to occur. Indeed, there seems to be no consensus among the major stakeholders in the nuclear debate regarding the plausibility of a terrorist attack or activity against a nuclear power plant or regarding the dangers that such an attack would cause.

B. KNOWN WEAKNESSES

Weaknesses exist in the physical security of nuclear power plants. Although physical barriers are erected, and stand-off distance exists between the facilities and intruders' possible points of entry, these security measures remain prey to human error and negligence on the part of the persons operating these systems. For instance, in 2007, security forces at the Peach Bottom nuclear power plant in Pennsylvania were found asleep while at their work place. [42] These guards constituted an armed response force that would respond in case of emergency, whatever that may be. However, because they were sleeping, they were not ready and able to respond to such an emergency. A video tape

[40] Roland M. Frye, Jr., The Current "Nuclear Renaissance" in the United States, Its Underlying Reasons, and Its Potential Pitfalls, *Energy Law Journal*, 29 no. 2 (2008): 280.

[41] Stephen E. Flynn, "The Neglected Home Front," *Foreign Affairs*, 83, no 5 (2004): 20.

[42] "Exelon taking over security at its plants," Daily Herald http://www.dailyherald.com/story/print/?id=96049.

was smuggled out of the nuclear plant showing the guards asleep and was provided to CBS News in New York. From there, the NRC obtained the tape and opened an investigation. The NRC's subsequent investigation uncovered several additional instances of the inattentiveness of the guards at the Peach Bottom plant. The NRC leveled a fine against Exelon Nuclear, the owners and operators of the plant. "The fine was issued as a Severity Level III in accordance with Nuclear Regulatory Commission enforcement policy and carries a minimum fine of $65,000."[43]

Most political and media discourse on the use of terrorist-hijacked airliners used kamikaze weapons to destroy the plant's physical structure in a scenario similar to the one that unfolded on 9/11. Moreover, even when other forms of armed physical attacks against nuclear plants are addressed, discussion of the issue has proceeded from the assumption that any terrorism against nuclear reactors in the United States would be perpetrated by Al Qaeda, or a well-organized Islamic fundamentalist group that shares Al Qaeda's philosophies and operational strategies.

With the focus on overt terrorists' physical attacks, both politicians, as well as the media have overlooked the possibility of cyber attacks on the operational computer systems that run modern nuclear power plants. To the extent that cyber-terrorism against nuclear plants has been discussed, the issue has been raised by commentators and experts in the fields of cyber security. Moreover, little of the speculation regarding terrorism against nuclear power plants has focused on the likelihood of attacks by domestic terrorists, let alone the possibility of domestic cyber attacks.

C. TWO CATEGORIES OF ATTACKS

Potential attacks against nuclear power plants fall into two categories: attacks against the physical structure of the nuclear power plant and cyber attacks that could be launched against a plant's computer systems without intruding into the physical space of the plant itself. In addition, such attacks could be perpetrated either by international terrorists, including Islamic extremist groups, or by domestic groups within the United

[43] Angela M. Hill, "Sleeping Security Guards Cost Nuclear Plant $65, 000," ABC News online, January 8, 2009, http://abcnews.go.com/Blotter/story?id=6597151&page=1.

States without ties or sympathies with foreign terrorist organizations. The current literature on nuclear power plants as potential targets of terrorist attacks varies in its theories and conclusions regarding the threats posed by each of these types of attacks.

1. The Possibility of a Physical Terrorist Attack on a Nuclear Power Plant

Even prior to the 9/11 terrorist attacks, federal regulations required all Nuclear Regulatory Committee (NRC) licensed power plants to implement security measures. These include physical barriers and trained security personnel in order to respond to potential physical attacks on nuclear plants.[44] Accordingly, in the United States, nuclear plants have been constructed in such a way that they form three zones: a manipulated "buffer" region, a "protected" zone, and a "vital area," wherein is the actual nuclear reactor. [45] Plant employees and escorted visitors are the only people allowed access in the protected area through the use of physical barriers and other security measures. The vital area's admittance is subject to even more stringent restrictions than the "buffer" or "protected" areas. Plant security forces must be screened, investigated, and trained according to NRC requirements.[46] In the U.S. all nuclear power plants are privately owned. Therefore, private owners must also absorb the cost of training, screening, hiring, equipping and arming security personnel.[47]

Even though the plants are federally regulated, the training of security personnel is of inconsistent quality. For example, guards at the Shearon Hills nuclear power plant based in the Raleigh-Durham, North Carolina metropolitan region made numerous complaints that plant management was not advocating or enforcing proper security measures or reporting violations to the NRC. It was not simply that plant management

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[44] Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 3.

[45] Ibid.

[46] Ibid.

[47] U.S. GAO -06-388, Report to The Chairman, Subcommittee on National Security, Emerging Threats and International Relations, Committee on Government Reform, House of Representatives, *Nuclear Power Plants: Efforts Made to Upgrade Security but the Nuclear Regulatory Commission's Design Basis Threat Process Should be Improved* (Washington, D.C.: Congressional Research Service 2006), 3.

was declining to implement additional security measures beyond the bare minimum requirements. Rather, the guards' complaints were based on multiple violations of minimum regulatory requirements resulting from plant management's attempts to cut costs. The guards at Shearon Harris are employed by a privately owned contractor, Securitas Security Services USA. However, although the security officers work for Ameritas, the guards' supervisors at Shearon Hills work directly for Progress Energy, Internet owns and operates the Shearon Hills plant.

Two guards interviewed by the Raleigh Durham Independent refused to provide their full identities, out of fear of reprisals from Progress Energy and their supervisors. Progress Energy has a track-record of retaliating against employers who complain about security issues. Progress terminated the employment of Richard Kester, "a former high-ranking security official at Shearon Harris who was fired in 1999 after refusing to lie to the NRC about improper security officials."[48] One of the Ameritas guards told the Independent that he had repeatedly contacted the NRC, but, after NRC failed to respond, the guards decided to take their case to the media and other watch-dog groups. The guards alleged that routine searches of vehicles entering plant premises were suspended in order to minimize delays in the plant's operations and that security doors had broken locks and could be opened merely by pulling on the handles forcefully. When guards brought the broken locks to the attention of plant management, they were instructed to not so forcefully pull on the doors, and the locks were not replaced. One of the guards says the other guards are scared as "they get fired right and left."[49] In response to the above allegations, the Employment Discrimination Bureau of the North Carolina Department of Labor opened investigations into Shearon-Harris' alleged unlawful retaliatory action, including firings of guards who complained about security breaches.

A non-profit organization called The Project on Government Oversight (POGO) alleges further lapses in security at nuclear power plants. In Tennessee, evidence of the failure of guards to properly inspect cargo entering the plant's compound was revealed.

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[48] Sue Sturgis, "Guards sound alarm over security at Shearon Harris nuclear plant," *The Independent Weekly*, December 14, 2005, http://www.indyweek.com/gyrobase/Content?oid=oidpercent3A25778.

[49] Ibid.

A shipment of M-4 assault rifles was delivered to the Sequoyah Nuclear Plant, and the Tennessee Valley Authority had the responsibility of managing it and should have been sent to the Sequoyah Nuclear Plant's armory. The boxes were not labeled correctly and passed through four search locations where the cargo should have been discovered. The boxes were not opened, as they should have been, and subsequently were sent to a plant warehouse. The point of concern is not that the M-4s were improperly placed, but that the cargo was not inspected after passing through multiple checkpoints.

> This incident highlights the vulnerabilities of the nation's nuclear power plants, said Peter Stockton, a spokesman for POGO. "There are really terrible procedures allowing this to happen," he said in a telephone interview Wednesday. Stockton said if disgruntled insiders knew about this vulnerability and were able to bring weapons and explosives into the nuclear facility, there may be irreparable damage. 'We're talking a whole lot worse than Three Mile Island," he said. "If an insider knows where the target sets are, in other words, the way to damage the reactor or to blow a hole in the spent fuel pool, it would be a hell of a lot worse than anything we've ever seen in this country before.[50]

Frank von Hippel, who is ex assistant director for national security in the White House Office of Science and Technology, says the companies who own the nuclear power plants are unwilling to spend the money needed to maintain the proper protection levels.[51]

The question that should be asked, "is how well trained the guards at nuclear power plants really are? Plant security guards routinely qualify on the firing range with assault-weapons such as the Israeli Uzi or the U.S.-made M-4. The director of the Bay City Texas nuclear plant, known as the South Texas Project, says their guard force is well trained in preventing armed attackers from gaining access to the facility. Mark Burnett, South Texas Project Vice President, said "We train for armed intruders. Basically, it's paramilitary fashion to stop these people from getting into the plant."[52] Burnett says the

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[50] Ben Lando and Donna Borak, "Lapse allows guns into Tenn. nuke plant," United Press International, 17 August 2006, http://www.upi.com/Science_News/Resource-Wars/2006/08/17/Lapse-allows-guns-into-Tenn-nuke-plant/UPI-82821155845636/.

[51] Steve Hargreaves, CNN, "The threat of nuclear meltdown," CNN, November 12, 2009, http://money.cnn.com/2009/11/12/news/economy/nuclear_security/.

[52] Ibid.

training consists of simulated attacks with ex-special forces members as the attackers. The plant's security force defends against and delays the attackers while local and federal law enforcement response teams come to their assistance.[53]

The NRC calls this training exercise force-on-force exercises and conducts and observes such exercises as part of its evaluation of a plant's compliance with the DBT. These exercises are more than simple gun-play with blank ammunition; they entail 350 hours of inspections in conjunction with the simulated assault on the plant. For the attacking force to "win" the exercise, it must reach specific targets within the power plant compound. These targets are facilities or components, whose sabotage or destruction would result in a release of radioactive material.

Local law enforcement would coordinate the emergency response to an actual attack. However, participation of law enforcement or federal agencies in the local area is not incorporated into the NRC's official force on force exercises.[54] In December 2009, DTE Energy, the managers of the Michigan Fermi plant in Newport, Michigan, along with local and federal officials, held a training exercise to repel armed attackers trying to gain access to the facility. The training scenario not only employed responders from the plant's personnel and security forces, but it also included local emergency departments, the FBI, the Michigan State Police, the local Sheriff's department, and other local law enforcement agencies. A detailed details and information on the conduct of the exercise and quality of the participants' performance was not released, but DTE claimed the exercise was "an outstanding success."[55] However, Steve Stockton, an investigator with POGO, argues that these simulated exercises are conducted under conditions that are not sufficiently similar to those that would exist in the event of a real attack. He asserts that the exercise scenarios generally only use a team of five hostile attackers, rather than twelve, Internet he believes would be more realistic. Also, there are limitations on weaponry used by the attackers in force-on-force exercises, "they don't allow the

[53] Steve Hargreaves, CNN, "The threat of nuclear meltdown," CNN, November 12, 2009, http://money.cnn.com/2009/11/12/news/economy/nuclear_security/.

[54] GAO-06-388, March 2006, 10.

[55] "DTE: Fermi security drill a success," Monroe News Michigan, December 12, 2009, http://www.monroenews.com/apps/pbcs.dll/article?AID=/20091212/NEWS01/712129961.

'terrorists' to use automatic weapons or high-powered explosives."[56] The DBT does dictate restrictions on what the conditions under Internet force-on-force exercises are conducted. However, in 2006, the NRC began allowing plants that successfully pass their first two force-on-force exercises to conduct subsequent simulations using more open parameters.[57]

Planning for the force-on-force exercises based on the DBT requires several steps. The DBT was first implemented in the 1970s and revised in 2003. Prior to the 2003 revision, criteria were formulated to determine the characteristics of the attackers who would simulate the assault on a nuclear plant. The first step entailed review of current intelligence reports to assign attack characteristics to the adversary force based on a given terrorist organization. The next step involved determining whether the given terrorist group had ever operated in the United States or was only active overseas. It was then ascertained whether the terrorist group needs to operate in a more or less secure environment. "NRC considers that terrorists planning to attack a nuclear power plant in the United States would face greater operational security and logistical challenges than terrorists operating in countries where there is an internal insurgency."[58] The last two steps for assigning characteristics to the attacking force involve examining how often the terrorist group that is being used as a model has used the given attack characteristic, Internet targets that characteristic has been used against, and the purpose for attacking those targets. For example, would a terrorist group use a certain weapon in an attack against a soft target or against a more secure, better-defended target?

In 2003, the NRC reviewed this multi-step process and recommended revising the DBT to include suicide bombing among the potential modes of attack against nuclear plants. However, after the NRC initiated the process of expanding the DBT's list of potential weapons used by potential attackers and elicited comments from stakeholders, members of the nuclear industry objected to the addition of suicide bombs. The industry also resisted the NRC's recommendation that the DBT encompass the possibility of an

[56] Steve Hargreaves, CNN, "The threat of nuclear meltdown."

[57] GAO-06-388, March 2006, 11.

[58] Ibid., 14.

attack initiated or assisted by a plant insider, an employee who knowingly or unknowingly compromises security in some way, to the benefit of the attackers. The NRC acceded to the industry's request that inside threats be omitted from the DBT based on the rationale that personnel screening programs would eliminate the possibility of such an attack. However, as demonstrated in the section on the cyber threat, it is possible for an employee or contractor to compromise a plant's security measures without intending to do so.

After the World Trade Center bombing, Senate Hearings were held to determine whether there was a threat to nuclear power reactors in light of the penetration of Three Mile Island's security. Phillip Clark, the chairman of General Public Utilities Nuclear Corporation, Internet owned the Three Mile Island facility, was called to testify before the Senate hearings. Clark stated that "[t]he fence he went through is designed to detect intrusion, not stop it. I keep hearing or seeing things in print that say security was breached. I don't think that is a correct characterization."[59] At the Senate hearings other groups testified, including non-government agencies:

> Eldon V. C. Greenberg, representing two watchdog groups, the Nuclear Control Institute, Internet is concerned with weapons proliferation, and the Committee to Bridge the Gap, a safety group, said that for years the commission [NRC] had assumed that truck bombs were not credible and that if they became credible, there would be warning. "In a span of less than three weeks, both those pillars have been demolished," he said. [60]

It is not the first time security has been breached at a nuclear plant nor the first time a vehicle entered a supposedly secure area. The picture below illustrates the route a station wagon was driven without detection. It went past the initial security gate at the top right, and eventually into the Turbine Bldg where his vehicles topped, however, the intruder was never found or charged.

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[59] Scott Portzline, *Nuclear Plant Terrorism*" (New York) 5.

[60] Matthew Wald, "Nuclear Plants Said to Be Vulnerable to Bombings," New York Times, 21 March 1993, http://www.nytimes.com/1993/03/21/us/nuclear-plants-said-to-be-vulnerable-to-bombings.htm.

Figure 1. The illustration was taken from "Another Nuclear Threat-Nuclear Plant Terrorism" p. 46. Author: Porzline, Scott D. Harrisburg, PA, 3/28/1994. The overhead photo comes from Google Map. "3 Mile Island" (Satellite View).

At this time, nuclear power plants' physical defense was a low priority. During these same hearings, the then-NRC Chairman Ivan Selin stated that NRC did not have the responsibility to provide safety and security against terrorist attacks. He stated that terrorism was the responsibility of the FBI and other law enforcement agencies. "If somebody drove a bomb into the parking lot, blew it up, killed a hundred people at a power reactor, that's not our problem" he said.[61] At the time Selin made this statement,

[61] Scott Portzline, *Nuclear Plant Terrorism*" (New York), 14.

regulations had not yet been drafted and enforced requiring plants to construct physical vehicle barriers as a defense against vehicle bombs.

Following the 9/11 attacks, further regulations were implemented with the specific purpose of preventing the theft of nuclear material from plant premises. The Office of Nuclear Security and Incident Response were established by the NRC in April 2002 in order to fortify and strengthen the security of the country's nuclear reactors in the aftermath of 9/11. In addition, the NRC mandated that plants expand their overall security protocols to defend against potential attacks implemented through water vehicles and ground vehicles other than four-wheel drive automobiles and to account for the possibility of combined attacks involving both a vehicle bomb and another form of external assault, such as an intrusion by armed terrorists.[62] The cost of security enhancements to American nuclear power plants since September 11, 2001, including additional physical security barriers, increased security forces, and improved detection equipment now exceeds $1.2 billion.[63]

However, the final rule formulated by the NRC excluded attacks by aircraft; thus, power companies that operate private nuclear plants are not required to implement security measures that specifically address the possibility of an attack in Internet a passenger jet is used as the primary weapon of assault.[64] This omission caused quite a stir in both the scientific and political communities. A group of scientists who called themselves the Union of Concerned Scientists had submitted a proposal, ultimately rejected by the NRC, Internet called for the construction of "beamhenge" barriers, barriers made of steel beams and cables that would surround nuclear plants and prevent intrusion of aircraft. In rejecting the proposal, the NRC countered that the threat of attack by large aircraft was more adequately and appropriately addressed by the military and other government agencies and organizations, such as Department of Homeland Security,

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62 Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 4.

63 GAO-06-555T, Nuclear Power Plants, 5.

64 Ibid., 10.

the Federal Aviation Administration and the Federal Bureau of Investigation.[65] The NRC insisted that it was not exempting plants from defending themselves from terrorist attacks. It instead was recognizing the reality that defense against certain terrorist threats, such as hijacked airliners used as kamikaze weapons cannot be defended against by private security forces.[66] The GAO-06-388, dated March 2006, went on to address different types of attacks. Arguing that protocols were already in place to address attacks by air and that private companies should not be expected to defend themselves against incursions that were more properly construed like national security threats, the NRC chose to concentrate on physical attacks perpetrated by ground and water vehicles.

The NRC requires each licensed nuclear power plant to carry out security tests and measures after a period of three years in order to strengthen security against any forthcoming terrorist attacks or threats posed in scenarios outlined the Design Basis Threat (DBT). The DBT requires plants to prepare for defense against "an attack by several well-trained and dedicated individuals armed with hand-carried weapons and equipment and assisted by a knowledgeable insider who participates in a passive or active role."[67] The NRC tests plant readiness to counter the attacks hypothesized in the DBT through simulated exercises as documented by GAO-06-388, March 2006, 11. In these "force-on-force" attack exercises administered by the NRC, attacks by outside adversaries attempting to infiltrate and damage the plant's vital area are simulated. A number of simulations, each presenting a different attack scenario are conducted over several days under NRC supervision and observation.[68] Before a company obtains a license for building and setup of a nuclear power plant, it must develop a security plan specifically designed to safeguard towards the threats outlined in the DBT and obtain the NRC's approval of the plan.[69]

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[65] GAO-06-555T, Nuclear Power Plants, 8.

[66] Ibid.

[67] Ibid.

[68] Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 4.

[69] GAO-06-555T, Nuclear Power Plants, 8.

As of November 2005, the NRC had carried out force-on-force inspections at only 20 of 65 sites and projected that inspections of all sites would not be completed until 2007. In addition, some sites have consistently failed to meet the requirements set forth by the DBT and NRC regulations.[70]

However, the United States General Accountability Office (GAO), while recognizing that the NRC has enhanced security regulations for nuclear plants, has also been critical of the NRC and urged it to do more. For instance, the GAO raised concern in testimony before Congress that almost 50 percent of the nuclear plants in the United States were all using the security company Wackenhut. The GAO raised the possibility of conflict of interest and observed that Wackenhut organization was charged of cheating on brutal exercises, Internet were observed and controlled by the Department of Energy. Moreover, critics have continued to criticize the NRC's failure to address nuclear plants' vulnerability from attack by aircraft. At the time when nuclear power plants were constructed in the United States, they were built to withstand hurricanes, earthquakes, and other natural disasters, but no additional design in the plant accounts for a deliberate airliner crash such as those perpetrated on 9/11. Some experts contend that an aircraft deliberately crashed into a nuclear plant containment shell could trigger a reactor meltdown and widespread exposure to radiation among the public.[71] However, the NRC and the nuclear industry itself contend that nuclear plants would be difficult attack targets for large aircraft and that, even if a deliberately crashed airliner penetrated the containment shell, it is unlikely that it would reach the actual reactor vessel. They also argue that such an attack could not achieve a sustained, super-hot fire, such as the one that led to the demise of the Twin Towers, unless the plane's body, including the wings that carry its fuel completely penetrated through the containment shell.[72]

Nils Diaz, former NRC Chairman, has stated on record that the possibility of an aircraft crash harming the reactor core, resulting in the release of radiation at levels that

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[70] GAO-06-555T, Nuclear Power Plants, 8.

[71] Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 5.

[72] Ibid.

negatively influence public health and safety, is exceedingly low. However, no matter how unlikely it is that such an attack would be successful, political pressure has had some effect in directing NRC and industry policy. On a forward-looking basis, newly constructed nuclear plants will be required to design and construct containment shells with the aim of protecting the reactor core from the impact of a large commercial aircraft, Internet will drive up construction costs.

Concerns about physical attacks on nuclear power plants should extend beyond airborne attacks. Because there is no central depository for nuclear waste in the United States, all spent fuel is stored on a plant's physical site. One of the most vulnerable and least protected points at nuclear power plants is the storage area for spent fuel, Internet is generally kept in cooling pools or, less frequently, in dry casks. For example, in April 2005, the National Academy of Sciences stated that "successful terrorist attacks on spent fuel pools, though difficult, are possible, and that "if an attack leads to a propagating zirconium-cladding fire, it could result in the release of large amounts of radioactive material."[73] The study recommended that, when stored in pools on plant premises, the most recently spent, and thus hottest, of used fuel rods are intermingled with cooler spent rods in order to decrease the possibility of fire and that sprinkler systems are set up in case pool water is lost.[74]

In his discussion of nuclear terrorism, David Bodansky points out that it is "not clear how high a place nuclear terrorism occupies in planning by terrorist groups."[75] Targets exist that are both easier to attack and more symbolic than nuclear plants. Such targets include the Statue of Liberty, the Washington Monument, and high-value political targets, such as the Capitol Building and the White House. In addition, attacks on softer targets, such as movie theaters, sports stadiums, and shopping malls promise terrorists an opportunity to inflict mass casualties on a greater scale. This is in comparison to the resources and logistical hurdles a terrorist group would have to overcome to successfully

[73] Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 5.

[74] Ibid., 6.

[75] Bodansky, Nuclear Energy, Principles, Practices, and Prospects, 502.

attack a nuclear power plant.[76] If terrorists intend to disrupt the American economy or its infrastructure, mass transit systems, tunnels, and bridges pose more desirable targets. Among other options available to them, terrorists could disrupt energy transmission by attacking electrical transmission lines, gas and oil pipelines, or oil tankers. The tainting of food and water supplies and the use of weapons of mass destruction, if they are available, would result in more immediate casualties across a wide swath of the United States than an attack on a single nuclear plant.[77]

Nuclear plants have little symbolic value and terrorist attacks on nuclear plants are not likely to result in high death toll of some other types of attacks because of the physical security measures and evacuation plans in use at American power plants. As Bodansky points out in his book, *Nuclear Energy, Principles, Practices, and Prospects*, nuclear plants offer two potential targets for terrorists: the physical reactors and the used fuel, Internet stored on plant grounds, either in pools of water or dry casks. He also notes that a physical attack on a nuclear power plants could take one of two forms: an attack by armed terrorist intruders or a deliberate aircraft collapse directly into a nuclear power plant.

Bodansky deems the airliner crash scenario that has so captured the public and political imagination to be the least likely path to a victorious radical assault on a nuclear plant. He points out those American nuclear plants are subject to regulations that require the construction of a containment shell to enclose the plant. These containment shells are constructed with the plan of it surviving the impact of a small plane crash. Although Bodansky concedes that these containment structures might not withstand the impact of a large passenger plane, he points out that nuclear power plants make particularly challenging targets. Because a nuclear power plant is relatively small—when compared to large sized targets such as the World Trade Center and the Pentagon, it is constructed at low level ground, this would be cumbersome for yet a skilled pilot to achieve the desired impact. Moreover, as Bodansky notes, to produce the intended catastrophic

[76] Bodansky, Nuclear Energy, Principles, Practices, and Prospects, 511.

[77] Ibid., 502.

effect, the impact would have to disable the plant's cooling system and not only breach the containment shell but reach the reactor vessel inside.[78]

As for attacks by armed intruders, Bodansky points out in the same book that nuclear plants are heavily guarded by private security forces and that existing security protocols would result in the immediate shut-down of the plant at the first indication of an attack "with no option for restarting." According to Bodansky, the accomplishment of such an assault

> …would depend on the ability of the intruders to overcome the guards and disable the normal and emergency cooling systems in such a manner that they could not be restored in time to avert an eventual reactor meltdown. The worst case scenario is a serious one, but evacuation of the surrounding population could mitigate the harm and the chances of success are dubious.
>
> —*Bodasnky, Nuclear Energy, Principles, Practices, and Prospects*

Bodansky does admit that the spent fuel stored at nuclear plants also poses a risk in the event of an armed attack. He points out, however, that "the heat output of the spent fuel is low relative to the heat output of fuel in a reactor that has just been shut down" in *Nuclear Energy, Principles, Practices and Prospects*. He concludes that even if a cooling pool in Internet spent fuel rods are stored were breached by armed terrorists, they would face a serious challenge in creating a blast that will result in a dangerous dispersion of the bits contained in the rods. On the other hand, Bodansky does concede and describes in his book that a dangerous condition could arise if a cooling pool was breached and the fuel rods inside were allowed to heat to dangerous levels. In such an event, no explosion would be necessary to release radiation into the atmosphere because, due to limited air circulation, the densely packed fuel rods could begin to melt. While Bodansky does not suggest that nuclear plants are impervious to attack or that an attack on a plant poses absolutely no danger, he argues that, because of the security measures in place and the

[78] Bodansky, Nuclear Energy, Principles, Practices, and Prospects, 512.

difficulty of attacking a nuclear plant, such attacks are likely to fail and that competent and well-organized terrorists will turn to the myriad "softer rich targets" that exist elsewhere on U.S. territory.[79]

2. The Possibility of Cyber-Terrorism Against a Nuclear Power Plant

In the popular consciousness, an attack against a nuclear power plant could involve a deliberate plane crash into a facility, a bomb, or some form of physical sabotage to the reactor itself. However, in his compelling article "The Current 'Nuclear Renaissance' in the United States, Its Underlying Reasons, and Its Potential Pitfalls," Roland M. Frye points out that terrorist attacks on nuclear plants could very well take the form of cyber sabotage. Frye's concern is a rational and well-supported one. Although there has been no known, deliberate cyber attack on an American nuclear power plant, Frye's article highlights some recent incidents that suggest the damage cyber terrorism could cause. In one particularly alarming instance in August 2006, the Browns Ferry Unit 3 nuclear power plant in Alabama suffered a partial shut-down of two pumps after its computerized control system was overwhelmed by a broadcast storm. Systems failures at nuclear power plants could have devastating consequences: In January 2003, a partial failure of the computer system at the Oak Harbor, Ohio Davis-Beese nuclear power plant resulted in the five-hour shut-down of the plant's safety monitoring system, as well as the shut-down of the plant's processing computer, Internet remained off-line for six hours.[80]

Moreover, in a simulated cyber attack orchestrated by the Department of Energy, a nuclear generator was induced to self-destruct. Computer security experts retained by private power companies to test the safety measures in place at their nuclear reactors have found it disturbingly easy to hack into company computers, sometimes managing to infiltrate informational and operational systems in less than twenty-four hours. In addition, terrorists with hacking and computer expertise could use these skills to gather information or facilitate other types of attacks; in 2007, it was discovered that hackers

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[79] Bodasnky, Nuclear Energy, Principles, Practices, and Prospects, 513.

[80] Frye, The Current "Nuclear Renaissance," 288.

had compromised databases containing personal identifying information of visitors to three national research labs that work with nuclear material and nuclear power: the Los Alamos National Laboratory, the Oak Ridge National Laboratory, and the Lawrence Livermore National Laboratory.[81]

Although U.S. nuclear power plants have been built to endure natural calamities, such as earthquakes, cyclones, and tornados, there has been little attention paid to new vulnerabilities that have come with the dawn of the digital age. As Joe Weiss notes in "Cyber Security in the Control Room," many, if not most, of the nuclear power plants currently in operation in the United States are still functioning based on analog technology, because they were built long before the advent of the Internet and the advanced computer applications of today.[82] However, any new plants constructed in the United States will be built using state-of-the-art digital computerization, and existing plants are being slowly but gradually updated with the introduction of digital technology, Internet enables superior operational capability but also creates vulnerabilities to cyber attacks.[83] Many power companies believe that they have protected themselves against cyber attacks through encryption, firewalls, or the segregation of plant operational systems. However, both Frye and Weiss point out that the routine linking of power companies' corporate computer systems with the dedicated computer systems used to control, maintain, and operate nuclear plants and reactors results in definite and dangerous security weaknesses. Because certain external computer systems will typically be less secure than the plant's operational systems, especially given the use of e-mail and the World Wide Web, infiltrating corporate computer systems could enable hackers to more easily penetrate plant systems. [84]

> Several companies are thinking breaking up their multiple networks (including control system networks) into a single network to minimize cost and maximize widespread proficiency. Though, this plan can have a

[81] Frye, The Current "Nuclear Renaissance," 290.

[82] Joe Weiss, Cyber Security in the Control Room, *Power Engineering* 111, no.98 (2007): 38.

[83] Ibid., 39.

[84] Weiss, Cyber Security in the Control Room, 39; Frye, The Current "Nuclear Renaissance," 295.

> number of latent cyber implications. But, following these plans, the result would be the less secured systems would be attached with more secure systems.[85]

Moreover, intra-company divisions between informational technology (IT) and plant operations groups may create conflicts or result in members of both groups acting at cross purposes due to lack of communication or unawareness of each other's security needs and protocols. [86] As Weiss explains, "The issue Internet resides is that the technique is totally different from IT control systems. This resulted in a clash between operations and IT departments. Surely, due to this we have to compromise on security guidelines. In order to streamline all these factors the coordination between and IT and operations is vital."

Weiss underscores a problem that is perhaps more difficult to resolve and more dangerous in its ramifications. The operators of plant computer systems themselves do not always have a complete and thorough grasp of the intricacies of plant control and operational systems. Even when they do, they rarely, if ever, understand supervisory control and data acquisition (SCADA) security, the measures required to properly secure these systems.[87]

Some are familiar with these Internet security measures and some who are acquainted with the nuclear plant securities must know these cyber ones. These types of securities normally host the people who are shifted from IT securities. Surely, the people who are required should be well versed with additional feature of nuclear licensing experience along with these securities. [88]

Cyber security in nuclear plants is truly and thoroughly understood by only a handful of specialists. Cyber security in general is focused largely on the protection of

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[85] Weiss, Cyber Security in the Control Room, 39.

[86] Joe Weiss, Cyber Security in the Control Room, *Power Engineering* 111, no. 98 (2007): 40.

[87] Ibid.

[88] Ibid.

information. The science of protecting systems responsible for the actual processes and operations of nuclear plants has not been studied or developed as well as standard IT technology. [89]

Weiss indentifies even most computer security experts have only a limited knowledge of nuclear plant controls systems and related security technologies and protocols. Moreover, there is little incentive for this knowledge to be developed and disseminated. Power companies, Internet are in direct business competition with one another, rarely share information on security measures with their peers and often bind their employees with agreements that forbid the sharing of such knowledge.[90]

D. SUMMARY

Whether the potential threat is construed as physical or cyber in nature, nuclear plants do bear some vulnerabilities and these vulnerabilities spring from the same sources. The nuclear industry currently has no incentive to invest heavily in matters of security, whether it is cyber security or physical plant security. [91] Implementing security measures, particularly new and innovative security measures, can be costly. Businesses, including the power companies that run nuclear power plants, worry that investing too deeply in costly security measures will put them at a competitive disadvantage with respect to their peers in the energy market.[92] Moreover, as Bodansky points out, the NRC has relied too much on the nuclear industry's point of view when constructing regulations and requirements, and likely even the parameters of the DBT.[93]

According to many experts on nuclear power plant security, security at nuclear power plants primarily "concerns the threat of radiological sabotage, a deliberate act against a plant that could directly or indirectly endanger public health and safety through

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[89] Weiss, Cyber Security in the Control Room, *Power Engineering* 111, no.98 (2007): 40.

[90] Ibid., 40.

[91] Flynn, The Neglected Home Front, 24.

[92] Ibid., 28.

[93] Bodansky, Nuclear Energy, Principles, Practices, and Prospects, 501.

exposure to radiation."[94] However, given the difficulties of perpetrating an airborne attack against a nuclear plant, the deliberate aircraft crash method of assaulting a plant seems unlikely. Moreover, even though the physical defenses of America's nuclear plants could no doubt be improved, the chances of a more conventional physical attack succeeding or of causing a widespread threat to public health and safety are minimal when compared to the potential catastrophic consequences that would ensue as a result of terrorist attacks on softer and richer targets.

Cyber terrorism is clearly a more pressing concern when considering nuclear power plant security. Nuclear power plants have demonstrable cyber vulnerabilities. However, political discourse on nuclear plant security still centers on physical security rather than cyber security, and NRC regulations and "force-on-force" exercises focus primarily, even exclusively, on physical attacks, even though a cyber attack presents a more likely scenario. Moreover, the most frequently discussed scenarios of terrorist attacks on nuclear power plants involve Islamic fundamentalist or other international terrorist groups. Minute notice has been thrown to the chances of domestic attacks, and even less to domestic cyber-terrorism. In subsequent chapters, this thesis will attempt to remedy these gaps in the current thinking on nuclear power plants as terrorist targets.

[94] Holt and Andrews, Nuclear Power Plant Security and Vulnerabilities, 6.

IV. THREATS TO NUCLEAR PLANT CONSTRUCTION

A. DOMESTIC THREATS TO NUCLEAR PLANT CONSTRUCTION

This chapter will explain the history of the U.S. citizens in their initial acceptance, then rejection of nuclear power development. Examples will be given of groups who have been active in the U.S., protesting development and employment of nuclear power for energy. Some of these protest groups still exist today and have found some effective means of slowing development and expansion of nuclear power. These incidents will be highlighted. In closing, the hypothetical threat of international threats, those external to the U.S., further research needs to be done in this area, since it is hard to validate the actual threat as viable.

In the 1950s and 1960s, it was believed that the United States and the world were entering an age of nuclear power. By the mid-1980s, new construction of nuclear plants had halted, and it was widely believed that the prospects of nuclear power as the primary American energy source were dead. The rapid fall in the nuclear industry's fortunes is traditionally attributed to incidents such as Three Mile Island and Chernobyl, Internet fueled rising public fears of nuclear power and spurred organized political protests and law suits against new plant construction.

1. Environmentalists' Role

However, many experts have concluded that environmentalists played little to no real role in nuclear power's fall from favor in the United States.[95] Some even go so far as to call environmentalists of the 1970s and 1980s as "uniformly ineffectual," noting that "government policies at both the federal and state levels continued to favor nuclear power" even as they staged their protests.[96] The same school of thought disputes the

[95] Craig A. Severance, "Business Risks and Costs of New Nuclear Power," http://climateprogress.org/wp-content/uploads/2009/01/nuclear-costs-2009.pdf.

[96] Ibid.

conventional wisdom that the Three Mile Island accident brought about the end of the nuclear industry, given that "a wave of cancellations of new nuclear plant orders was already underway."[97] From this perspective, the environmentalists did not halt the further development or employment of nuclear power by turning public opinion against nuclear plants; rather, the fall of the nuclear industry is attributed to economic factors. For instance, according to Craig A. Severance, "Utility executives and Wall Street financiers were the ones who stopped nuclear power's expansion in the 1970s. As more evidence of the business risks and the costs associated with nuclear power became clear through utilities' own experiences, utility boards across the country and the financial houses that fund them, stopped considering nuclear power a serious future option.[98] Orders for new plants that had already been advanced were quietly withdrawn. The nuclear industry simply failed to compete against other available options, whose risks and costs were significantly lower."

Severance believes, while political activists are often credited with the demise of the original "nuclear renaissance" of the 1950s and 1960s, it is impossible to deny the role played by economic factors, including the large upfront costs associated with plant construction and the financial losses incurred through plant shutdowns and inefficiencies.

Nonetheless, other commentators insist that, even if public and political opposition may not be solely responsible for curbing the expansion of nuclear power, it can still serve to slow plant construction, interfere with plant operation, and add to the costs incurred by the nuclear industry in opening and maintaining nuclear power plants. As Severance points out even those who believe that the primary threats to future plant construction are financial and economic, not political, recognize that organized political and public protest against plant construction can raise associated costs, particularly in the form of legal fees required to defend against lawsuits and requests for injunctions.[99] He

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[97] Craig A. Severance, "Business Risks and Costs of New Nuclear Power," http://climateprogress.org/wp-content/uploads/2009/01/nuclear-costs-2009.pdf.

[98] Josie Garthwaite, "Nuclear Energy More Expensive Than Some Clean Power, Study Says," Earth2tech. http://earth2tech.com/2009/01/05/nuclear-energy-more-expensive-than-some-clean-power-study-says/.

[99] Severance, "Business Risks and Costs of New Nuclear Power."

even states as the next "Nuclear Renaissance" begins to dawn in America, many fear that associated litigation could cause delays in plant construction and thus increase exponentially the costs incurred by plant owners and operators. For instance, Moody's Investor Services asserted that "[it] believe[s] the first COL filing will be litigated, Internet could create lengthy delays for the rest of the sector."[100]

2. The American Public's Role

However, the attitude of the public towards nuclear power has evolved over the past twenty years or so. Stanley Rothman and S. Robert Lichter discuss in Elite Ideology and Risk Perception in Nuclear Energy Policy. They asserted that while nuclear power was once seen as a looming threat to environmental integrity, it is now viewed by many as a form of clean energy that could help halt the insidious effects of global warming. Many observers have linked the fate of nuclear power to popular opinion of nuclear plants and their safety with respect to the community and the natural environment. The American public shifted from widespread, unhindered acceptance of nuclear power in the years following World War II to a conviction that "wide-ranging laws protecting . . . against risks [of] environmental degradation [posed by nuclear power] [we]re absolutely necessary," in the 1970s and 1980s.[101] They also illustrate that some right-leaning political thinkers believe that, at least when it comes to nuclear power, "leftist" public interest groups, in concert with the "liberal" media, wield more power than either the private business sector, the mainstream scientific community, or the federal government in determining the direction of the nation's technological development. They also talk about those who emphasize the role of public opinion in steering such technological decisions concede that "cost overruns and the abandonment of many partially completed nuclear facilities in United States have probably played a role in the development of negative attitudes" toward nuclear power. However, they point out that "for the average person, fears about the safety [of nuclear plants] are far more important." From this point

[100] Severance, "Business Risks and Costs of New Nuclear Power," http://climateprogress.org/wp-content/uploads/2009/01/nuclear-costs-2009.pdf.

[101] Stanley Rothman and S. Robert Lichter. Elite Ideology and Risk Perception in Nuclear Energy Policy, *The American Political Science Review*, 81 no. 2 (1987) 383–404.

of view, events such as the Three Mile Island incident and the Chernobyl meltdown had a more detrimental effect on nuclear plant construction and operation than did ballooning construction costs and other unforeseen cost overruns.[102]

For instance, in 1987, Rothman and Lichter concluded that "nuclear development [was] not, at [that] time, a viable energy option in the United States" because, even though the scientific community believe that nuclear power posed little threat to the environment, "[t]he view that nuclear plants are unsafe [was] shared by a significant number of citizens in positions of social influence or responsibility."[103] Rothman and Lichter credit organized antinuclear groups with a great deal of power and influence in the national political debate over nuclear power that raged in the latter part of the twentieth-century.

However, other analysts dispute the notion that the antinuclear movement was sufficiently organized and powerful to have a deep effect on the prospects of nuclear power. Author Gary L. Downey in "Ideology and the Clamshell Organizational Dilemmas in the Anti-Nuclear Power Movement, Social Problems" uses the example of the Clamshell Alliance, Internet emerged in New England in the 1970s. He illustrates how it spawned imitators across the United States, Internet shows the organizational and philosophical weaknesses that plagued most anti-nuclear protest groups and ultimately undermined their effectiveness. Downey explains that the Clamshell Alliance based itself on a philosophy of non-violent civil disobedience, as exemplified by their peaceful occupation of a nuclear power plant in Seabrook, New Hampshire and their subsequent incarceration in National Guard armories, where they continued their protest by refusing bail, an attitude that attracted much attention from the media and the public. For a time, the Clamshell Alliance became the model for effective political protest against the construction of nuclear power plants. Soon, similar organizations sprung up all over the United States, wherever new plant construction was planned or contemplated.[104]

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[102] Stanley Rothman and S. Robert Lichter. Elite Ideology and Risk Perception in Nuclear Energy Policy, *The American Political Science Review*, 81 no. 2 (1987) 383–404.

[103] Ibid.

[104] Gary L. Downey, "Ideology and the Clamshell Organizational Dilemmas in the Anti-Nuclear Power Movement," *Social Problems* 33 no. 5, 357–373.

However, Downey reveals that the Clamshell Alliance, as well as its imitator organizations, was vulnerable to internal strife over long-term goals and the appropriate strategies for meeting them. Part of the difficulties faced by groups that embraced direct action through peaceful protest lay in their organizational design; most such organizations made decisions by consensus, Internet worked when group members were more or less in agreement but Internet rendered concrete action almost impossible when opinions began to diverge.[105]

As Downey has noted that especially as the membership rolls of the Clamshell Alliance and other groups began to escalate, the consensus method of decision-making was no longer practical. As the consensus process was gradually abandoned, group members became disillusioned and angry, resulting in internal organizational conflict. These groups, Internet originally appeared to be models of efficiency, began to splinter into opposing factions.[106] The resulting dissolution of these protest groups greatly diminished their ability to disrupt plant construction and performance and, more important, their potential to influence government and public opinion according to Downey. He says, in addition, state and local governments further undermined the influence of such groups, ironically, by taking steps to accommodate their protests and displays of civil disobedience. Having learned of a planned Clamshell Alliance protest or peaceful occupation, state and local governments would issue permits for rallies and officially sanctioned political protests. He concludes that this governmental cooperation with the group's political protest undermined its success by robbing it of its aura of disobedience and political opposition. It also opened a rift within the group over whether the Alliance should participate in the rally.

B. INTERNATIONAL THREATS

Americans have long worried about nuclear power plants as a focus of international terrorism, a fear that has only intensified in the years following the World

[105] Downey, "Ideology and the Clamshell Organizational Dilemmas in the Anti-Nuclear Power Movement," *Social Problems* 33 no. 5, 357–373.

[106] Ibid.

Trade Center and Pentagon 9/11 attacks. Experts and commentators differ on the risk of an international radical assault on the nuclear power plant and the seriousness of the consequences if one should occur.

Danger of catastrophic radiation release from a nuclear power plant is posed by the potential loss of reactor core coolant and subsequent "melt down."[107] However, NRC studies have confirmed that the possibility of eradicating the reactor centre and discharging radiation in levels significant enough to affect public health is poor.[108]

1. Plant Structure

In David Bodansky's Nuclear Energy, Principles, Practices, and Prospects, today's nuclear power plants, built in a pre-9/11 era, were built to withstand natural disasters such as hurricanes but not the strength of a collision with an airliner. Nonetheless, it has been asserted, based on research performed at the Sandia National Laboratory, that the likelihood of an airplane, even a large passenger jet, penetrating the reinforced steel hull of a nuclear reactor is very unlikely.[109] Moreover, a nuclear power plant, because of its low physical profile, would present a daunting challenge for a terrorist pilot attempting to strike it. In order to make the sustained fire that would cause significant radiation release, a plane, including its fuel-bearing wings, would have to penetrate the containment shield completely. The possibility that an airliner, flying a relatively small, low-lying target, could accomplish this is extremely small.[110]

However, the others point out that a nuclear power plant is vulnerable to attack not only at the reactor site but the site of its spent fuel storage as described by Frank N. von Hippel, *Revisiting Nuclear Safety*, here he explains that spent fuel rods are typically stored in pools of water to cool in an area protected by a 5-foot thick concrete wall. The Nuclear Regulatory Commission (NRC) has concluded that a large aircraft could

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[107] Mark Holt and Anthony Andrews, *Nuclear Power Plants: Vulnerability to Terrorist Attack*, CRS Report for Congress, October 2006.

[108] Ibid.

[109] Bodansky, *Nuclear Energy,* 510–512.

[110] Holt and Andrews, Nuclear Power Plants, October 2006.

potentially penetrate this protective wall, possibly damaging the pressurized water reactor and resulting in the rapid drainage of the pools. In such a scenario, the spent fuel rods could heat up to the point of fire leading to a large fission product release. The NRC estimated a fire of such magnitude would result in the release of about 10 times as much radioactive materials as that of the 1986 incident at Chernobyl.[111] The National Academy of Sciences (NAS), found a small, but significant, possibility that if one were to attack a spent fuel cooling pool, dependent on the attack results, it could affect the rods' zirconium cladding catching fire. NAS recommended the installation of water-spray systems in spent fuel areas to replace lost pool water and the interspersing cooler rods with hotter, more recently used rods to lessen the likelihood of a dangerous zirconium fire.[112]

Others have pointed out that, while a direct attack on a nuclear core reactor is unlikely to meet with success, plants are vulnerable to operational failures, such as station blackout events that could result in damage to a plant's nuclear core within a matter of hours.[113] Thus, while a successful airborne assault on a nuclear plant seems unlikely, an armed terrorist attack on a plant could have potentially disastrous consequences. In mock attack exercises staged at American nuclear plants by DHS, armed terrorists were able; one-half of the simulations, to breach the plant's containment shell and destroy enough equipment to lead to a core meltdown.[114] While nuclear plants are guarded by trained security forces, some argue that they are insufficient to meet the threats and expertise that would probably be demonstrated by an armed terrorist attack squad.[115]

2. Plant IT Systems

The concern about physical attacks on nuclear plants threatens to overshadow attention merited by a more likely, and potentially more dangerous, form of assault—a

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[111] Von Hippel, Revisiting Nuclear Safety, 201.

[112] Holt and Andrews, Nuclear Power Plants, October 2006.

[113] Edwin S. Lyman, Revisiting Nuclear Plant Safety, Science, New Series, 299 no. 5604 (2003), 202.

[114] Lyman, Revisiting Nuclear Plant Safety, 202.

[115] Ibid.

cyber-attack on a nuclear plant. The GAO has noted the "potentially devastating impact" or a cyber-attack on the nation's computer systems to the functioning of crucial networks and concluded those cyber security vulnerabilities and its defenses needs to be better addressed by DHS.[116] The GAO's recommendations include conducting cyber-attack exercises and improvement of control systems at critical infrastructure sites.[117] While none of these recommendations were focused specifically towards nuclear power plants, it makes sense for both DHS and the nuclear industry to consider these recommendations seriously when considering issues of plant security. In particular, DHS's design basis threat and the simulated exercises that it conducts to assess plant readiness to handle a terrorist attack, should be amended to include a cyber-security and cyber-attack component.

C. SUMMARY

This chapter explained the domestic and international threats to nuclear power plants. It presented the environmentalists and American public's role in the early development of the nuclear power industry. Then it discussed the plant physical structure in its role of protection against a physical threat and then keyed in on the weakness of the plant IT systems. These measures have a significant monetary cost that will be looked at in the next chapter.

[116] David Powner, Critical Infrastructure Protection, DHS Needs to Better Address Its Cyber security Responsibilities, GAO Testimony Before the Subcommittee on Emerging Threats, Cyber security, and Science and Technology, Committee on Homeland Security, House of Representatives, September 16, 2008.

[117] Ibid.

V. COSTS TO THE NUCLEAR INDUSTRY OF SAFEGUARDING PLANTS AGAINST TERRORIST THREATS

This chapter will examine the relative costs of building new nuclear power plants, in relation to non-nuclear energy costs. The evidence will be in an the United States' open economy and the desires of nuclear power plant owners to extend their operating licenses can find funding to build the new plants. Nuclear power plants' cost effectiveness is then examined, along with the costs of fossil fuels in comparison.

A. FUNDING

There is much debate over exactly how much nuclear-generated electricity, nuclear plant operation, and new nuclear construction in the United States will cost in the much-heralded and anticipated "Nuclear Renaissance." Utility companies keen to invest in nuclear power argue that nuclear electricity is the least expensive option for the production and distribution of energy to American consumers and businesses. Supporters of nuclear energy claim that nuclear-generated electricity will be cheaper. This is due to lower fuel costs and the added benefit of clean energy and reduced carbon-dioxide emissions.[118] Skeptics, however, argue that these estimates and claims are exaggerated, if not entirely unreasonable. They point to the nuclear industry's history of construction delays and cost overruns and its tradition of passing its unexpected expenses on to the American public in the form of high electricity rates. One factor that is not discussed in regular discussions of the costs of nuclear energy is the role of plant security measures. Although many argue that nuclear plants are attractive targets to international and domestic terrorists, none of the leading economic studies use the additional costs of protecting against that threat into account when calculating the construction costs of new nuclear plants or the pre-tax levelized cost of nuclear-generated electricity (LCOE).

[118] Richard Meserve and Ernest Moniz, "The Changing Climate for Nuclear Power in the United States," Bulletin of the American Academy of Arts and Sciences, 55 no. 2 (2002) 57–72.

Nuclear power plants are notoriously expensive to construct and operate. [119] This reputation is based primarily on cost overruns on nuclear power plant projects in the 1960s and 1970s, Internet, always took longer and cost more to build than expected.[120] In addition, this first generation of nuclear power plant was often less than reliable in its functioning; shut-downs and malfunctions meant plant downtime and facility repairs and, ultimately, an intense drain on the financial resources of both nuclear power companies and their investors.[121] In McLellan's, *The Economics of Nuclear Power,* cost overruns and construction delays continued into the 1980s, a period of high interest rates, Internet further complicated the prospect for nuclear power companies and nuclear plant construction projects. He discusses the efficiency and reliability rates of early nuclear power plants were much lower than hoped and promised. In 1975, the average nuclear plant operating in the United States was working at only 55.9 percent capacity. Performance had barely improved a decade later in 1985, when the amount hovered at 58.0 percent capacity. He also believes that scares such as the 1979 Three-Mile Island accident spurred the passage of additional safety regulations, many of Internet were expensive to implement.

B. LEGAL ISSUES

He clearly outlines that this concern over safety also turned many members of the American citizenry, Internet had been largely supportive of nuclear power in the 1950s, against the construction of new nuclear plants. He further explains that announcements of new plant construction projects were met with neighborhood protests and legal fights. The time, effort, and legal resources necessary to thwart such public and ground-level political opposition also drained the coffers of the nuclear industry. The resulting delays extended the expected operation start date of nuclear plant construction projects. It further meant that early investments in such projects took years longer than expected to

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[119] David McLellan, The Economics of Nuclear Power: Current Debates and Issues for Future Consideration, Nuclear Energy Futures, Paper No. I, February 2008, Center for International Governance Innovation.

[120] Ibid.

[121] Ibid.

start paying off. The additional, unpredicted expenses suffered by the nuclear energy industry were often passed on to the consumer in the form of higher electricity rates. Decades after the resolutions of these struggles, the notion of nuclear plants as bottomless money pits lingers in the public consciousness, especially among those in the all-important business community, the source of potential investors in nuclear power.

C. COST EFFECTIVENESS

McLellan also states, however, proponents of nuclear power argue that modern plants are proving more cost-effective in recent years, even to the point of attracting significant private sector investment. This is attributed mainly to improved performance and effectiveness of current nuclear plants. There has been a financial turnaround in the nuclear energy industry founded on the increased efficiency of nuclear reactors. By 2004, nuclear power plant capacity had increased to over 90 percent. Between 1994 and 2004, the combined electricity production of U.S. nuclear plants increased from 640 billion to 789 billion kilowatt hours. He gave details on astoundingly, this increase occurred despite an overall decrease in the number of nuclear power plants in operation, in the United States. Meserve and Moniz claim that the average production cost for nuclear-generated electricity is somewhere in the neighborhood of 1.71 cents per kilowatt-hour, a figure that supposedly takes into account all costs except for plant amortization and makes nuclear power possibly the cheapest form of electric power available in the United States, cheaper even than coal. They also point out that the cost of nuclear energy remains fairly stable and is not subject to the fluctuations that often roil the natural gas market.[122]

Meserve and Moniz point to the recent consolidation in the nuclear industry as evidence of the attractiveness of nuclear power to both providers and consumers. Utility companies, betting that nuclear energy is the power of the future as concerns over foreign oil and carbon emissions grown, began buying up existing nuclear plants and investing in

[122] Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

nuclear research and development in the mid 1990s.[123] As utility companies purchase older nuclear plants in anticipation of a nuclear renaissance, it is anticipated that, before the end of the next decade, all 104 of the nation's currently existing nuclear plants in a few years time will be held in the hands of a select group of about ten power companies.[124] Nuclear energy proponents point to this trend towards consolidation as evidence that the utility industry has begun to realize that nuclear power will, in the long run, be better for its bottom line. They argue that this is further evidenced by the flood of 20-year license renewals for existing nuclear plants.[125] As of October 2006, 44 operators of 44 nuclear power plants had applied for and received operating license renewals, 10 other renewal applications were pending and 17 additional requests were predicted to be presented by the end of 2010.[126] Current reactors whose licenses were expired had been certified in Internet 10 were under evaluation, and 17 more requests were predicted to be received, by 2010.

D. INDUSTRY BOOM

In addition, applications to build new power plants are soaring.[127] The nuclear industry seems to believe that it can learn from the mistakes and missteps of the past. It also believes it can take advantage of new technological advancements and shorter licensing processes to build plants more quickly for less money. While plants used to take as long as fifteen years to build, the projected construction period is now between

[123] McLellan, The Economics of Nuclear Power. Current Debates and Issues for Future Consideration, Nuclear Energy Futures.

[124] Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

[125] McLellan, The Economics of Nuclear Power. Current Debates and Issues for Future Consideration, Nuclear Energy Futures.

[126] Nathan E. Hulton, Jonathan G. Koomey, Daniel M. Kammen, "What History Can Teach Us About the Future Costs of U.S. Nuclear Power", *Environmental Science & Technology,* April 1, 2007.

[127] Ibid.

three and five years.[128] In addition, the NRC licensing process for nuclear power plants has been streamlined so as to address the delay in plant construction that typically resulted from the regulatory process.[129]

Nuclear power plants are still expensive to build, especially when compared to natural-gas-powered plants. The upfront capital costs of nuclear plant construction are indeed daunting, especially to investors. Again, McLellan shows, nuclear energy proponents argue that nuclear power plants have become increasingly cheaper to operate. Despite the high up-front investment required to build a nuclear plant and bring it online, it is far less expensive to operate than a plant powered by gas. This is due primarily to the fact that fuel costs account for up to 65 percent of the cost of generating electricity from a natural-gas plant, while fuel costs account for only 15 percent of the costs of nuclear-generated electricity.[130]

Meserve and Moniz, *The Changing Climate for Nuclear Power*, point to the Nuclear Regulatory Commission (NRC) in its regulatory role as an indirect gatekeeper on costs. They note that, while NRC used to concern itself only with plant design and construction, it has turned its attention more and more toward operations and maintenance as concerns about health, accidents, and terrorist attacks have mounted. According to Meserve and Moniz, increased regulation will be effective at keeping prices down because safer, well regulated plants are more efficient, more reliable, and less prone to accidents, break-downs, and other expense-generating incidents.[131] Moreover, "great strides have been made in methods of quantifying the risk associated with reactor accidents. This technique, called probabilistic risk assessment (PRA), is a systematic evaluation of the plant to determine potential accident consequences and evaluate their

[128] McLellan, The Economics of Nuclear Power.

[129] Paul L. Joskow, The Future of Nuclear Power in the United States: Economic and Regulatory Challenges, Center for Energy and Environmental Policy Research, December 2006.

[130] McLellan, The Economics of Nuclear Power.

[131] Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

frequencies by looking at the probabilities of failure of systems and components" and was developed by the NRC in concert with the Atomic Energy Commission (AEC).[132]

Ultimately, according to Meserve and Moniz, *The Changing Climate for Nuclear Power*, the appeal of transitioning to nuclear power for utility companies will depend largely upon the perceived cost-efficiency of constructing nuclear plants and using nuclear energy in comparison to the costs of building utility plants that use natural gas and the cost of natural gas. The attractiveness of the American consumer will depend largely on the notion of cost-savings, with concerns over global warming playing a tangential role. However, investors shun uncertainty and want to see immediate results. Thus, in a deregulated energy market such as in the United States, even given the improvements in nuclear plant construction and operation realized in recent years, investors will probably prefer projects that require less upfront money and promise to deliver on investment more rapidly than nuclear power plants.[133] In addition, the projected costs savings of advanced nuclear power plants are just that—projections. Construction time estimates and predictions of cost-efficiency may be the result of over-optimism. A number of factors, both foreseen and unforeseen, could eventually drive the price tag on both nuclear plant construction and nuclear energy much higher than the pundits are currently preaching. For instance, much of the projected cost-efficiency of nuclear power lies in the cheapness of nuclear fuel relative to coal, oil, and natural gas. However, the price of uranium has experienced a run-up in recent years, and events of an uncontrollable nature could raise its price even higher.[134]

E. OTHER INCENTIVES

David McLellan, in an article addressing nuclear power in the United Kingdom, recommends the use of government regulation and legislation to make tax and other incentives, such as a tax on carbon-emissions, that will make "nuclear power economics"

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[132] Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

[133] Joskow, The Future of Nuclear Power in the United States: Economic and Regulatory Challenges," Center for Energy and Environmental Policy Research, December 2006.

[134] Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

more attractive and agreeable and inspire construction of new plants and transition to nuclear power.[135] Many of McLellan's suggestions have already been considered or implemented in the United States, either at the state or federal levels. The Energy Policy Act of 2005's (EPACT) passage created strong financial incentives for power companies to invest in nuclear energy. In addition to production, it results in 1.8 cents per kilowatt-hour tax credits. Further, for the first eight years of operation, EPACT offers "standby support" to power companies and plant operators of up to $500 million to cover cost overruns liable to demanding holdups for the first two new nuclear reactors built and an amount equal to half of the cost of regulatory delays, or the lesser of $250 million for each of the next four plants built.[136] Taken together, these are incredibly strong financial incentives for utility companies to move into nuclear power. As Paul Jaskow of MIT notes, "[c]learly, a subsidy of about "$20/mwh plus insurance against the cost of regulatory delay is a significant incentive for nuclear plant investment s that are eligible to receive the subsidy. It is equivalent to placing a price of about $25/ton of carbon dioxide emissions from pulverized coal plants."[137]

Despite the power of these financial incentives, some analysts are more pessimistic about the future success of nuclear energy and critical of the industry's claims of cost-effectiveness. For instance, Craig Severance notes that cost overruns and construction delays led to the cancellation of more than 130 nuclear construction projects in the 1970s and 1980s. He sees little evidence that nuclear plant design and associated technology has changed so substantially as to prevent history from repeating itself.[138] Severance views the current optimistic fervor over nuclear energy to be the product of wishful thinking at best and a willful distortion of the economic realities at worst. Pointing out that "[e]stimates for new nuclear power place these facilities among the costliest private projects ever undertaken," Severance cautions that power companies are exploiting concerns over global warming, arguing that utility companies have an

135 Meserve and Moniz, The Changing Climate for Nuclear Power, 57–72.

136 Joskow, "The Future of Nuclear Power in the United States."

137 Ibid.

138 Craig A. Severance, "Business Risks and Costs of New Nuclear Power," 4.

"incentive" to sell nuclear energy to the American public because of the until-recently high price of natural gas as well as the fact that new state regulations (and potential federal regulations) restricting or taxing carbon emissions have made it more difficult effectively to operate coal-powered energy plants.[139] As Severance notes, federal authority was granted in 2007 for federal loan guarantees of $18.5 billion for nuclear plant construction, in addition to the other financial incentives included in EPACT.

Severance further disputes the notion that natural-gas-generated electricity is more costly than nuclear electricity. Indeed, he counters the claims of utility companies that nuclear energy is the least expensive clean energy option available, asserting that

> Independent studies have concluded new nuclear power is not economically competitive. Given this discrepancy [between the claims of utility companies and independent studies of nuclear energy], [the nuclear industry's] history of cost overruns, and the fact new generation designs have never been constructed anywhere, there is a major business risk nuclear power will be more costly than projected.
>
> —*Craig A. Severance, Business Risks and Costs of New Nuclear Power*

On the other hand, Severance argues, natural gas plants have come close to perfecting cost-efficiency in energy delivery. Furthermore, the answer to the current energy debacle may not be nuclear plants but rather plants that run on both natural gas and some form of bio-or recycled fuel. Severance cites plants that operate "through a combination of aggressive load reduction incentives to customers, better grid management, and a mixture of renewable energy sources supply zero-fuel-cost kilowatt hours backed by the kilowatt capacity of natural gas turbines where needed" in his book.

Severance warns that construction delays would reduce power company credit rates and generate funding shortfalls. He predicts that, if the nuclear industry does experience shortfalls, it will be passed on to the consumer in the form of high electricity costs, resulting in negative economic pressure, in those regions of the United States whose energy needs are serviced by nuclear plants. According to Severance, the utility companies have little to lose by transitioning to nuclear efforts because their expenses in

[139] Craig A. Severance, "Business Risks and Costs of New Nuclear Power," 4.

doing so will be heavily subsidized by federal grants, loans, and tax breaks and their interests will be protected by the ability to pass costs on to the American citizenry in the form of more expensive electricity. He also claims that various estimates of the cost of nuclear energy do not take into account such costs as property taxes, regulatory compliance, and, especially, the expenses entailed in waste management and disposal. He predicts that, if nuclear-generated electricity is much more expensive than anticipated for the consumer to purchase, it will meet with low demand, and that the nuclear industry, as a business concern, will find itself in jeopardy, much as it did in the 1960s, 1970s, and 1980s.

While many of Severance's criticisms may be reasonable, the true future of nuclear power lies somewhere between his dark assessment and the rosier prospects envisioned by McLellan and Meserve and Moniz. Paul Joskow, of MIT, predicts that the nuclear industry will grow but more slowly than the optimistic forecasts. While he recognizes the impact of the financial incentives provided by EPACT, he expects that certain parts of the country will be more welcoming of nuclear than others.[140] Specifically, Joskow foresees areas of the country with a significant amount of already-existing nuclear infrastructure to be the first to embrace the Nuclear Renaissance.
However, he points to "[u]nresolved trash removal guidelines and regional resistance to new nuclear plants as "likely . . . barriers to investment in new nuclear power plants in some areas of the country."[141]

Joskow explains the consolidation in the nuclear industry and the scramble for license renewals as a consequence of substantial increases in the performance of nuclear plants and in the cost of alternative fuels and electricity costs. He also notes the cost of constructing a coal or natural gas plant from scratch costs more than the principal expenses needed for continuing the life of existing power plants. However, Joskow makes a distinction between acquiring and operating already-existing nuclear plants and constructing a new plant. While the capital costs of acquiring an older but still working

[140] Severance, Business Risks and Costs of New Nuclear Power," 4.

[141] Joskow, "The Future of Nuclear Power in the United States."

nuclear power plant are minimal, the upfront costs of constructing a new power plant can be staggering. Joskow points out that, until recently, there was very little investment interest in nuclear energy and that most of the current interest, shown by industry consolidation and license renewals, has been manifested not by investors, but by the energy industry itself.[142] In a competitive, deregulated market, it is the investor who has the greatest power. He notes that,

> …on a going forward basis private investors in new nuclear plants must expect to recover both their operating costs and the much higher capital costs of building a new plant from revenues earned from electricity produced by the plant. The necessary revenues must come either from sales of power at market prices in states that have adopted competitive market models or through regulated retail prices determined through the regulatory process in states where generation investments are still subject to regulation.
>
> —*Joskow, The Future of Nuclear Power in the United States*

While there has been some recent investor interest in nuclear energy, Joskow attributes this to the passage of EPACT with its overall financial package for plant owners and operators, as well as to the widely held expectation that the federal government will eventually pass a carbon-emission tax or other disincentives that will result in a large-scale abandonment of coal in the industry. He says, despite EPACT, however, investors in nuclear plants will still carry risks of construction cost overruns, market price variations, and plant shut-downs. Jaskow, also notes that the effects of EPACT on long-term business and investor incentives are uncertain because the subsidies phase out after the first few years of plant operation.

Moreover, Jaskow concludes, based on a life-cycle cost comparison that a nuclear plant is not competitive with coal-powered plants in terms of production costs and is only competitive with natural-gas-powered plants when the price of natural gas is high. He estimates construction costs for a new nuclear plant need to drop by 25percent and financing costs need to drop to the levels of those currently prevailing for the

[142] Joskow, "The Future of Nuclear Power in the United States."

construction of new coal and natural gas plants in order for nuclear energy to be viable with natural products in the energy markets as a cheap fuel source.

F. THE MARKET

However, Jaskow is not entirely negative in his outlook on nuclear costs. He expects that nuclear energy will not immediately thrive in a deregulated, competitive market environment. He notes that, in some statistics the energy market has not been effectively deregulated; some utility companies hold regional monopolies on electricity and their prices must therefore be regulated or capped by state commissions and governmental authorities. In these areas, investors will have less influence than state governments and regulatory bodies in steering the direction of utility companies.[143] He expects nuclear power plants to flourish in those areas, as well as in areas where the populace is used to nuclear power or is suffering under extremely high electricity rates. He also thinks in these latter areas, new nuclear plant construction is less likely to meet with local resistance.[144]

The directors of a study at the University of Chicago concluded, just as Jaskow does, that the popular claims for cheap nuclear electricity are inaccurate.[145] The study calculated a pre-tax LCOE for nuclear energy ranging from $47 to $71 per megawatt-hour compared to $33-$41 for coal plants and $35-$45 for natural-gas plants.[146] The authors of the Chicago study also noted that upfront capital costs were the most important determining factor in a nuclear plant's later profitability and production costs. For nuclear plants, upfront capital costs of construction account for one-third of LCOE, while interest rates on construction capital make up another quarter of LCOE.[147] Furthermore,

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[143] Joskow, The Future of Nuclear Power in the United States.

[144] Ibid.

[145] George S. Tolley and Donald W. Jones, *The Economic Future of Nuclear Power: A Study Conducted at The University of Chicago* (2004), 5.

[146] Ibid.

[147] Ibid.

construction costs for nuclear plants will undoubtedly be difficult to determine and incorporate because so little nuclear construction has recently taken place in the United States.

As the authors of the Chicago study argue,

> [a] case can be made that the nuclear industry will start with very little learning from previous experience when the first new nuclear construction occurs in the United States. The paucity of new nuclear construction over the past twenty years in the United States, together with the entry of new technologies and a new regulatory system, has eliminated much of the applicable U.S. experience.

Furthermore, as the Chicago study notes; early plants will undoubtedly be more expensive than later-built plants. The authors of the Chicago study estimate that first-of-a-kind engineering costs (FOAKE) could increase the construction costs of the first plant built by a particular energy company by as much as 35 percent. On a positive note, the study concludes that nuclear power plants will become more cost-effective as time goes on. It will also be more effective as experience is gained in constructing and operating them while federal incentives and concerns about global warming could provide nuclear power a boost in the United States.[148]

G. SUMMARY

Despite the optimistic projections of the power industry, the profitability of nuclear energy, at least in the short run, is uncertain. Improvements in technology, plant design standardization, concern over global warming, streamlined regulations, federal loans, subsidies, and other financial incentives are all expected to play a role in spurring growth in the nuclear sector, as well as support cost containment in the creation and maneuvering of nuclear plants. However, the complexity of plant design and operation, the fickleness of investors, and the high upfront costs of plant construction all counsel towards caution when it comes to predicting the prospect of the nuclear industry in the United States. Perhaps most troubling is the failure to account for specialized plant protection, both physical and cyber-oriented, in calculating the cost of constructing and

[148] Tolley and Jones, *The Economic Future of Nuclear Power*, 12.

operating a nuclear power plant. If nuclear plants are, indeed, attractive terrorist targets, more-so than other power plants, then some specialized security measures must be implemented. These measures will not likely be inexpensive; however, it appears that no serious evaluation of their potential price has been attempted or performed. The next chapter will explain DHS's role in the nuclear power industry.

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VI. DEPARTMENT OF HOMELAND SECURITY ROLE

This chapter explains, using recent attacks on the U.S. infrastructure, DHS' role to respond to these threats. Threats that have taken place have occurred in the form of cyber-threats, such as malicious software and have been seen in the U.S. current nuclear infrastructure. The warning of these attacks has existed for many years, but as this chapter outlines, DHS has been re-occurring slow to respond. Further research also needs to be done in this area as it has been under recent cyber attack.

A. NATIONAL SECURITY

The danger posed to national security by potential cyber-terrorists has been underscored by events such as the May 2007 denial-of-service attack on the nation of Estonia, Internet resulted in the widespread debilitation of government and business Web sites and channels of communication.[149] The attack on Estonia was only the most frightening and high-profile of a number of cyber-incidents, some intentional cyber-attacks and others unintentional cyber-related disruptions that have highlighted the susceptibility of the nation's infrastructure to cyber-terrorism.

Intentional cyber-assaults comprise the 1997 disabling of the air-traffic communication systems in Worcester, Massachusetts, the use of a radio-transmitter to violate the control system of an Australian sewage treatment center by a disgruntled former employee in 2000, the disabling of train signaling systems throughout the eastern United States as a result of the Sobig computer virus Other attacks contain the hindering of a secure observing system through the blocking of control system communication at the Oak Harbor, Ohio Davis-Besse nuclear power plant as a result of the infection of the plant's private computer network by the Microsoft SQL Server worm "Slammer," and the disruption of control systems at thirteen Chrysler manufacturing plants in the mid-

[149] U.S. Government Accountability Office, GAO-07-310, January 2007, "High Risk Series, An Update," 45.

western United States in August 2005 by the Zotob Worm.[150] Almost all of these deliberate attacks were domestic with no evidence of international terrorist involvement.

Incidents that were not part of a deliberate attack or disabling of a plant or system but Internet nevertheless resulted in the disruption of critical operations include the August 2003 blackout that affected much of the northeastern portion of the United States. This is also attributed in part to the failure of a control system alarm processor and a June 1999 gasoline pipeline failure in Bellingham, Washington, the results of Internet were exacerbated by the inefficient monitoring by control systems.[151] All of the above incidents occurred in part due to weaknesses in the security measures and protocols protecting the control systems of the affected facility.

Despite the overwhelming evidence that the nation's infrastructure is particularly vulnerable to breaches of cyber-security, discussions of terrorist attacks centered on power plants and other critical facilities tend to focus on potential defenses against physical attacks. The DHS and related federal agencies lag disturbingly in their implementation of measures necessary to make certain the cyber-security of this nation's crucial networks.

B. DHS AND THE PROTECTION OF CRITICAL INFRASTRUCTURE

When specifically addressing security at the Department of Homeland Security (DHS), in the "High Risk" report, the GAO noted that the very foundation of DHS posed certain security vulnerabilities because it entailed assimilating twenty-two formerly independent agencies and offices into one fully functioning government department. Although it praised DHS for the progress it had already made, the GAO noted that the agency was still in mid-transition and thus remained highly vulnerable. Based on its previous assessments of merged agencies and departments, the GAO voiced that "successful transformations of large organizations, even those faced with less strenuous

[150] U.S. Government Accountability Office, GAO-07-310, January 2007, High Risk Series, An Update," 45.

[151] Ibid.

reorganizations than DHS, can take years to achieve."[152] In particular, the GAO noted in this report that DHS had not implemented a "corrective action plan that includes a comprehensive transformation strategy" and that its management systems were "not yet integrated and wholly operational." The result is a state of management and operational disruption that, as of January 2007, was still hindering the efforts of DHS to fulfill its primary functions much less develops advanced security measures.[153] Again, the failure of DHS, the agency committed to protecting national security, to adequately address its own security concerns are disheartening. Among the most concerning of GAO's comments on the DHS was its finding that DHS had not yet performed extensive risk assessments in the area of critical infrastructure. Although GAO does say so specifically, critical infrastructure would presumably include the nation's nuclear power plants.[154]

With respect to the nation's critical infrastructures, the GAO emphasizes the importance of developing cyber-security measures to the successful fulfillment of DHS's responsibilities and those of its National Cyber-Security Division (NCD). According to the GAO, the DHS and the NCD still needed to complete the following tasks: "developing a national plan for critical infrastructure protection, including cyber-security; planning for and coordinating cyber-incident response and recovery; and identifying and assessing cyber-threats and vulnerabilities."[155] In this same report, the GAO, reviewed the progress of DHS in these areas, Internet included establishing a U.S. Computer Emergency Readiness Team, and "developing high-level plans for infrastructure protection and incident response" and orchestrating emergency response exercises involving simulated cyber-attacks and cyber-crises so that federal agencies and corporate entities could evaluate and improve their readiness. However, the GAO concluded, quite alarmingly, that "DHS has not yet completely fulfilled any of its key responsibilities," noting in particular that DHS had, as of reporting time, failed to achieve national

[152] U.S. Government Accountability Office, GAO-07-310, January 2007, "High Risk Series, An Update," 45.

[153] Ibid.

[154] Ibid.

[155] Ibid.

assessments of vulnerability to cyber-threats or initiate recovery plans for cyber-security systems in either the public or the private arenas.[156] The DHS faces admittedly stubborn opposition from private sector infrastructure-sensitive industries when it comes to making security assessments and implementing security measures. As the GAO explained, private industry is notoriously reluctant to provide information to governmental agencies, and the current lack of departmental unity at DHS further undermines the agency's authority in the eyes of private actors. However, GAO's ultimate conclusion concerning DHS's cyber-readiness is a chilling one: "Until DHS fulfills its cyber-security responsibilities, our nation's critical infrastructures will remain at risk" in its "High Risk Series" report.

In congressional testimony in 2009, David Powner, Director of Information Technology Management Issues at GAO, argued that DHS had insufficiently addressed its responsibilities with respect to securing critical infrastructure and key federal operations against cyber-threats.[157] Powner argued that current cyber-security breaches and attacks in the United States and elsewhere highlighted both the need to protect infrastructure and operations from such events as well as the lack of DHS's efforts to develop a meaningful and useful security protocol.[158] As Powner noted in the GAO Report, Critical Infrastructure Protection, the DHS is "the focal point for coordinating cyber-security, including making it responsible for protecting systems that support critical infrastructures, a practice commonly referred to as cyber critical infrastructure protection." He went on to state that the GAO has been asking the DHS to improve its cyber-security measures since 2005. In its capacity as the agency responsible for preserving national security, the DHS has been designated as the frontline responder and coordinator for U.S. cyber-security efforts.[159] Given the DHS's leadership role in cyber-

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[156] U.S. Government Accountability Office, GAO-07-310, January 2007, "High Risk Series, An Update," 45.

[157] David Powner, GAO Report, Critical Infrastructure Protection: DHS Needs to Better Address Its Cyber security Responsibilities, Testimony Before the Subcommittee on Emerging Threats, Cyber security, and Science and Technology, Committee on Homeland Security, House of Representatives, 2009, 3.

[158] Ibid., 5.

[159] Ibid., 8.

security, the fact that the DHS has been so slow to meet minimum requirements regarding security measures points to national vulnerabilities in key areas. Most notable are the nation's power supply and power distribution infrastructure, Internet includes nuclear power plants.

In July 2008, the GAO found that the Computer Readiness Team assembled by the DHS had failed to address fifteen "key cyber-analysis and warning attributes." according to Powers. Specifically, the GAO noted that warnings and notifications issued by the Computer Readiness Team were "not consistently actionable or timely."[160] He also documents the GAO also reported that DHS had not established a viable, coordinated plan for improving the security of key control systems. Further review by Powers as of 2009, the DHS had not fully addressed the deficiencies noted in earlier GAO reports.

C. AREAS OF CONCERN

The GAO reviewed and reported weaknesses in six major areas of concern with respect to cyber-security: 1) bolstering cyber-analysis and warning capabilities; 2) reducing organizational inefficiency with respect to implementing cyber-security measures, 3) the successful implementation and completion of cyber-exercises, 4) developing sector-specific plans addressing cyber-security concerns, 5) improving cyber-measures and protocols protecting the control systems of critical national infrastructure, and 6) improving the ability of the DHS to recover from cyber-attacks and other Internet-service disruptions.[161] Powers spends a lot of his writing on the GAO concluded that, while the DHS had taken steps to fulfill its mission in all six areas, it had not yet fully met its responsibilities in any one of them. While the DHS has managed to achieve some cyber-security measures, the sophistication and effectiveness of those measures is uncertain. For instance, the GAO concluded that, while the DHS had the ability to identify the characteristics of events constituting cyber-threats or attacks, it had not taken

[160] Powner, GAO Report, Critical Infrastructure Protection: DHS Needs to Better Address Its Cyber security Responsibilities.

[161] Ibid.

the progressive step of developing systems of prediction and analysis that could warn of possible attacks or respond to and analyze various, simultaneous threats to cyber-security. He states, according to the GAO, the DHS "d [oes] not possesses the resources to handle multiple [cyber] events across the nation."[162]

Without specifically mentioning nuclear power plants, the GAO made special note of the deficiencies in the DHS's cyber-readiness with respect to the nation's critical infrastructure. Specifically, Powner writes that the GAO found that the plans that the DHS had drafted for infrastructural cyber-security were not fully inclusive of relevant and necessary cyber-security factors and considerations. He explains in, *Critical Infrastructure Protection*, some of these key factors and considerations included a method for identifying potential consequences of a cyber-attack and the development of incentives for the implementation of voluntary risk assessments by private actors in certain industrial sectors related to infrastructure. Of special concern is the security and protection of infrastructure control systems. In addition, Powner writes that the GAO noted that the DHS "had not established a strategy to coordinate the various control systems activities across federal agencies and the private sector."

Although the GAO expressed concern about the implementation of cyber-security measures for control systems, disproportionately more attention has been paid to protecting information systems than to protecting control systems. Control systems have been addressed almost as an afterthought, and only after information security have been addressed. When the importance of control systems to the nation's infrastructure is acknowledged, the nuclear energy industry is rarely, if ever, specifically identified as a critical concern for cyber-security concerns. For instance, in December 2007, the Computer Security Division of the National Institute of Standards and Technology (NIST), an office of the U.S. Department of Commerce, issued recommendations for the

[162] Powner, GAO Report, Critical Infrastructure Protection: DHS Needs to Better Address Its Cyber security Responsibilities, 8.

implementation of security controls for federal information systems.[163] The NIST's recommendations in 2007 focused exclusively on developing and implementing security measures for information systems in accordance with the Federal Information Security Management Act (FISMA).[164] NIST did not issue a statement or recommendations on cyber-security for industrial control systems until almost a year later.[165] The NIST report on control systems noted their critical role in infrastructure such as electric power, the water supply, oil and natural gas distribution, the transportation system, the food supply, and the nation's manufacturing industry.[166] However, the report makes no specific mention of the nuclear industry.

The lack of rigorous attention to the cyber-security of industrial control systems for critical infrastructures in general, and the nuclear energy industry in particular, highlights glaring weaknesses in the cyber-security measures implemented thus far by the DHS. As NIST notes, control arrangements are crucial to the operating of important organizational industries in the United States.[167] From Stouffer's, *Guide to Industrial Control Systems Security,* the NIST also points out a fact that heightens the problem that the DHS and its affiliated agencies face in ensuring the cyber-security of the nation's infrastructure: He also states that private industry manages nearly 90 percent of the nation's most critical infrastructures. Further, he indicates that NIST accurately pinpoints the potential vulnerabilities that are arising as more and more corporate industries in the area of critical infrastructure improve their control and operations systems and being able to connect them to the information systems.

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163 Ron Ross, Stu Katzke, Arnold Johnson, Marianne Swanson, Gary Stoneburner, George Rogers. Recommended Security Controls for Federal Information Systems. Information Security, Computer Security Division, Information Technology Laboratory, National Institute of Standards and Technology, U.S. Department of Commerce, December 2007, 10–38.

164 Ibid., 12–45.

165 Keith Stouffer, Joe Falco, Karen Scarfone. Guide to Industrial Control Systems (ICS) Security, Supervisory Control and Data Acquisition (SCADA) systems, Distributed Control Systems (DCS), and other control system configurations such as Programmable Logic Controllers (PLC) Recommendations of the National Institute of Standards and Technology, September 2008, 5–28.

166 Ibid.

167 Ibid.

Stouffer notes, as NIST notes, the cyber-security measures related to information systems are often entirely inappropriate and ineffective for control systems. Indeed Stouffer's work shows that NIST acknowledges that brand new security measures designed specifically for control systems may be needed for proper protection of the nation's infrastructure. Additionally, in Stouffer's, *Guide to Industrial Control Systems Security,* the following pages are clearly detailed on NIST's report on industrial control systems painstakingly details the different types of control systems and their differences from traditional information systems. NIST also catalogues potential cyber-threats and cyber-incidents that could damage, disable, compromise, disrupt or destroy the functioning of an industrial control system, including blocking the flow of information through control system networks, rewriting of control system commands and instructions and modifying software and configuration settings, and feeding inaccurate information into the control system. Indeed, NIST makes a number of sensible suggestions for enhancing control system security, including the establishment of firewalls and the use of independent authentication mechanisms for control systems, restricting physical access to computer components critical to the control system performance, and creating redundant counterparts for control system components so as to maintain functionality during cyber-attacks and other incidents.

Stouffer explains factors that complicate the linking of control systems with information systems include the differing goals of the departments that utilize information systems and those that handle control systems. While confidentiality is of utmost importance in information security, plant safety and system availability and functioning are the priorities with respect to control system security. Information and control systems also differ in terms of standards and thresholds that they apply in terms of reliability, performance, communication protocols, and system design and functioning.[168]

Although NIST acknowledges that private industry manages most of the nation's critical infrastructure, it offers only cursory recommendations for resolving the inherent

[168] Stouffer, Falco, Scarfone, Guide to Industrial Control Systems (ICS) Security, Supervisory Control and Data Acquisition (SCADA) systems,, 13–45.

tensions that arise between these private owners and federal regulators when it comes to formulating and enforcing security requirements in general and cyber-security requirements in particular. NIST recommends developing a "compelling business case" for the implementation of an effective cyber-security program for industrial control systems.[169] Stouffer feels that such a business case would involve presenting cost and damage scenarios in the event a control system is insufficiently protected during a cyber-attack. Such a business case would probably necessitate drawing upon the resources and expertise of industrial trade groups and consulting firms with both experience and an established reputation in the relevant industry. An effective "business case" would also include accurate and reasonable cost estimates for implementing the recommended or required cyber-security measures. However, these suggestions for creating a "compelling business case" do little to solve the fundamental question of lack of incentives to private owners of critical infrastructures, such as nuclear power plants to voluntarily adopt vital security protocols and solutions.

D. THE NUCLEAR REGULATORY COMMISSION AND PLANT SECURITY

In its investigations of the Nuclear Regulatory Commission and nuclear power plant security, the GAO has identified corporate influence on federal regulators and the regulatory process as a factor that compromises efforts to improve plant protection with potentially severe consequences. Wells in, *Design Basis Threat Process Should be Improved*, the GAO reviewed the NRC's process for amending the Design Basis Threat (DBT), the document that sets forth the hypothetical terrorist attacks and security threats, Internet are used to safeguard against the nuclear plants. As the GAO explains, "[t]he DBT characterizes the elements of a potential attack, including the number of attackers, their training, and weapons and tactics they are capable of employing."[170] The GAO concluded that the NRC's process for revising the DBT was insufficient. In particular,

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[169] Stouffer, Falco, Scarfone, Guide to Industrial Control Systems (ICS) Security, Supervisory Control and Data Acquisition (SCADA) systems, 13–45.

[170] Jim Wells, "Nuclear Power Plants, Efforts Made to Upgrade Security, but the Nuclear Regulatory Commission's Design Basis Threat Process Should be Improved, "GAO-06-555T, March, 2006, 1–5.

the GAO found that many of the changes that the NRC implemented in the DBT were instituted in response to the suggestion, influence, and pressure of representatives of the nuclear industry.[171] Wells states that in April 2003, the DBT was revised following concerns raised after of the 9/11 terrorist attacks. He is critical that while the GAO approved of many of the changes to the DBT, including an increase in the number of attackers and a growth in the range of resources that could be employed during an assault on a nuclear plant, it noted that other changes, including what weapons attackers could assault a plant with, were influenced by industry feedback.

He writes in *Design Base Threat Process*, again the GAO noted that the NRC made initial recommendations for revising the DBT and then sent the draft DBT to industry leaders for discussion. According to the GAO and Wells, "NRC specifically sought and received feedback from the nuclear industry on what is reasonable for a private security force to defend against and the cost of and time frame for implementing security measures to defend against specific adversary characteristics" in the "High Risk Report" also accounts how the GAO also noted that, in many cases, the NRC altered its initial proposal after considering industry commentary on the draft. For instance, the NRC excluded some of the arms from the catalog of the protection of nuclear power plants that should be required to protect against after industry representatives complained that effectively defending against these weapons would be prohibitively expensive. Another example given by Wells, Internet industry representatives argued the vehicle bomb was too large in the draft-revised DBT. Industry representatives reportedly contended that the possibility of terrorists using a vehicle bomb of such magnitude was extremely small. Further, Wells explains that such a powerful bomb would be detected by federal authorities before reaching the nuclear plant. Numerous plants would be unable to effectively defend themselves against a bomb of such magnitude because they lacked the land required to install effective vehicle barrier systems. In addition, Wells

[171] Wells, "Nuclear Power Plants, 1–5.

shows that industry stakeholders objected to the inclusion of a specific proposed weapon in the DBT because each plant would incur annual costs of up to $2 million in order to defend against it.

In addition, the NRC removed from the DBT a number of other weapons to Internet the industry representatives voiced objections.[172] The GAO concluded that, in a number of instances, the NRC altered the DBT based not on its best judgment regarding the form a likely terrorist attack would take but rather "based on what industry considered reasonable and feasible to defend against."[173] Wells writes the GAO recommended that the NRC improve its DBT revision process by segregating the NRC department or services directly responsible for soliciting and reviewing industry feedback on the DBT from that responsible for approving changes to the DBT.

Moreover, the rate of plant inspections and observations of DBT-based force-on-force exercises is extremely slow. As of November 2005, Wells documents in, *Design Basis Threat Process Should be Improved,* only 31 percent of the sites had completed NRC inspections. At this rate, Well's criticizes, the NRC would be able to assess the security measures implemented at each plant only once every eight years. The NRC has since promised to increase the amount of plant inspections from once every eight years to once every three years.

E. INDUSTRY INFLUENCE

The issue of industry influence on regulatory requirements could be of paramount consideration when it comes to requiring private owners of critical infrastructures, especially nuclear power plants, to achieve effective cyber-security measures. Many of the vulnerabilities currently facing nuclear plants have arisen due to rapid evolution of cyber-technologies. Plants transitioning from outdated analog control systems to new digitized control systems are interfacing with already existing corporate information technology systems. Cyber-technology, especially the technology related to cyber-security measures, is subject to sudden and drastic change. Moreover, while cyber-

[172] Wells, Design Basis Threat Process Should be Improved, 6–10.

[173] Ibid.

security for information technology systems is a well-developed field, control systems' cyber-security is still an emerging discipline. Implementing effective security measures for new digitized control systems in nuclear plants will require not only the purchase and configuration of software and the installation of new systems but also the hiring and training of employees who will be able to understand and apply the latest security protocols. Because control system cyber-security is a nascent field, the nuclear energy industry may be required to engage in a significant amount of research and subsequent development in order to obtain an acceptable level of cyber-protection. It will most likely be required for individual plants to maintain control security experts as consultants, and, since so few of these experts currently exist, these consulting services will probably be very costly to plant owners and operators.

Achieving cyber-security, particularly with respect to plant control systems will, at the least, prove inconvenient to owners of nuclear power plants. The nuclear energy industry will almost certainly incur substantial costs through the development and implementation of the necessary security protocols. The DHS and the NRC will almost certainly encounter resistance on the part of the nuclear energy industry to adopting recommended control system security measures. Any suggestion for improving the security of nuclear power plants must, therefore, also include specific steps for motivating and incentivizing the commercial plant owners who will be required to make the upfront capital investments necessary to achieve the necessary cyber-security measures and protocols. In addition, because control system security is such a new field, frequent testing of the cyber-security measures implemented by nuclear power plants will initially be required in order to ensure their success. During this period—when the industry and the relevant agencies are themselves just beginning to explore the technology required to achieve cyber-security for nuclear power plants, it must be the current state of the technology and the compelling need to protect the nation's critical infrastructure that sets the tone and defines the standard. This is especially the case when the need for cyber-security may conflict with the financial interests of private plant

owners, the DHS, the NRC, and related agencies must be immune from industry pressure if the federal government is to successfully prepare for and protect against terrorist threats against nuclear power plants.

F. SUMMARY

This chapter focused on the many aspects of the role that the Department of Homeland security has with nuclear power plants. It has highlighted areas of concern by GAO reports. It also reviewed the role of the Nuclear Regulatory Commission and plant security, Internet is evaluated by the Design Base Threat Process. Furthermore, it explains the industry's influence of the protection of the physical plant and the IT systems. The next chapter takes a look at Europe and its issues with nuclear power plants. Europe has had to deal with much larger protest groups against nuclear power than have been experienced in the U.S. Yet, European nations continue to expand their nuclear power generation, and nations such as France continue to develop new nuclear power generation technologies that have put it ahead of the U.S. in power generation capabilities.

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VII. EUROPE'S ISSUES WITH NUCLEAR POWER PLANTS

This paper's primary focus has been on the United States issues with nuclear power plants. However, energy is a complex issue that all states must deal with and find long-term solutions. This chapter explains how the European Union has made long-term goals in energy distribution. The dissolution of the Soviet Union has complicated the energy supply and distribution between many European states in sharing energy resources in both fossil fuels and nuclear energy. To complicate matter due to expansion of the EU, one of the EU's membership requirements was decommissioning of older nuclear power plants, mostly in the former Soviet states as these plants are deemed unsafe but they have few financial resources to decommission or build new ones. The challenges of the newer EU states are demonstrated in examination of three members, Bulgaria, Hungary, and Lithuania.

> Since Europe is dependent on imports of energy and most of its raw materials, it can be subdued, if not quite conquered, without all those nuclear weapons the Soviets have aimed at it simply through the shipping routes and raw materials they control.
>
> —Barbara Amiel [174]

A. ENERGY IS A COMMODITY

Since energy is a commodity, there are four significant distinctiveness of power marketplaces that need to be understood: (1) transportation in the United States and Europe is essentially extremely oil based, and the worldwide demand for worldwide oil has increased due to the expanding economies of China and India; among others; (2) carbon-based energy provides most of the non-transportation energy such as electricity production, heating, and commercial power; (3) governmental spending is insignificant in terms of energy research and development; (4) a global revolution is required in energy

[174] Barbara Amiel, Quotes, http://www.brainyquote.com/quotes/quotes/b/barbaraami341568.html.

production to support energy that is sufficient, economical and sustainable.[175] These characteristics do not let the energy market self correct by supply and demand. It cannot self correct because demand is a certainty that drives the economic activity of each country. Therefore, it becomes a "must pay" bill.

B. THE ENERGY SYSTEM IN EUROPE

European countries are challenged by the system that they must use in addressing energy issues since various departments of government organize separate divisions of energy policies and regulations. There are many moving pieces from different actors in the government and economic process such as the European Union's Council of Ministers, the European Commission, and state governments, Internet all set goals that must be implemented through directives from the Commission, legislation from the European Parliament, and then national legislation.[176] In January 2007, the European Commission published "An Energy for Europe". It focused on three goals: (1) combating climate change, (2) encouraging expansion and jobs, and (3) offering safe and reasonable energy to clients.[177]

In November 2007, the European Commission published "A European Strategic Energy Technology Plan" that identified technology that would help the European Union to achieve its stated energy goals. The primary concern was to strengthen research to lower costs and improve the performance of the current infrastructure and to promote business opportunities to stimulate market development. This plan outlined two notable things for nuclear power in Europe. First, it urges the European Union to utilize a single electric grid supplying renewable energy sources; second, it calls for the EU to remain competitive in fission technologies combined with long term waste solutions. [178]

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[175] Franklin Kramer & John Lyman, "Transatlantic Cooperation for Sustainable Energy Security A Report of the Global Dialogue between the European Union and the United States" (Washington D.C., 2009) http://acis.org/Energy Security: Transatlantic Cooperation and Sustainability.

[176] Ibid.

[177] William Nutall, "European Supply Security and Nuclear Power "(CESSA Policy Brief) September 5, 2008. www.energypolicyblog.com/?p=187.

[178] Kramer and Lyman, "Transatlantic Cooperation for Sustainable Energy Security A Report of the Global Dialogue between the European Union and the United States."

1. European Union Policy on Nuclear Power Plants

Energy supply security and nuclear power has become a focused interest item in the EU in order to secure energy supplies and also to reduce greenhouse gas emissions.[179] The EU expanded from 12 to 27 states, yet reduced the percentage of member countries with antinuclear stances. This is because many of the newer members are experiencing energy shortfalls. The issue of electricity security varies across the EU. Western European states have a robust and flexible electricity system and stabilized markets.[180] For them, nuclear power plants are just one option to consider as a future source of energy. Many Central and Eastern European states, however, depend on Russia for natural gas. These countries have a reasonable apprehension of their dependence on Russian natural gas to provide for their electricity requirements. In addition, many of these same countries have limited electrical interconnections, gas distribution pipeline problems, and increased policy pressure from western EU states to decommission Soviet-era legacy nuclear plants. [181]

European nuclear power is formed by two predominant regulations—one, the regulation of electricity markets; second, the safe regulation and handling of dangerous and politically controversial technology.[182] At the heart of the matter is economics. Western European states have enough electricity from current sources to meet their economic and public needs. Although Central and Eastern European states' economies and populations have been shrinking in recent years, they still need a continuous secure electrical power grid. Moreover, these states aspire to support growing economic and populations in the future.

On June 23, 2009, the EU established a Community framework for the safety of nuclear installations.[183] The primary focus established of this community framework is

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[179] Nutall, "European Supply Security and Nuclear Power "(CESSA Policy Brief).

[180] Ibid.

[181] Ibid.

[182] Ibid.

[183] Eurotom Supply Agency, EU Energy Policy Diary 2009, http://register.consilium.europa.eu/pdf/en/09/st10/st10667.en09.pdf.

the national responsibility of member states for the nuclear safety of nuclear installations. Each member state may decide on its energy mix in accordance with relevant national policies. While the document addresses the importance of safe management of spent fuel and radioactive waste, there is no clear objective as to when this subject should be readdressed and solutions agreed upon. Furthermore, the European High Level Group on Nuclear Safety and Waste Management was established, but there does not seem to be an enforcement authority for this organization.[184] In the EU, there is a question as to whether there should be a central nuclear waste disposal site for all member states. [185] As in the United States, one of the serious obstacles to expanding nuclear power is the requirement for investments from public and private sources to fund the energy sector. [186] Currently, Bulgaria is the only EU member that has two new nuclear power plant units under construction (since September 2009) that are fully funded projects.[187]

The EU has worked to establish uniform safety standards for nuclear power plants. Article 2 of the Euratom Treaty provides for the establishment of the European Atomic Community (Euratom). However, the EU struggles with the legal issues concerning nuclear safety and requirements, since it is an individual state's right and responsibility to safeguard its nuclear program.[188]

Another contentious issue within the EU is the proposed model of decommission financing. This is particularly problematic for newer EU members that have to give up their nuclear power plants because they do not meet the safety requirements outlined in the treaties.[189] Currently there are 152 reactors spread over the EU providing 30 percent

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[184] Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations.

[185] Nutall, "European Supply Security and Nuclear Power "(CESSA Policy Brief).

[186] Energy Charter, "Investment." http://www.encharter.org/filadmin/user_upload/conferences/2009_may/LUX2009-report.pdf.

[187] "Nuclear power plants in Europe," European Nuclear Society, http://www.euronuclear.org/info/encyclopedia/n/nuclear-power-plant-europe.htm.

[188] "European Commission to Revise "Nuclear Package," European Nuclear Society. http://www.euronuclear.org/info/nuclearpackage.htm.

[189] Debra Johnson, "Nuclear Energy Policy in the European Union: Meltdown or False Alarm?" *Journal of International Affairs* 53. New York: Columbia University, 1999.

of EU electricity. The planned or required phase out of reactors will reduce the level of electricity currently utilized.[190] The essence of the problem is the upfront investment of two to three billion euros to build new plants. Most recent EU members do not have the resources to finance new plants on their own or to decommission their old nuclear plants.

C. NUCLEAR POWER PROGRAMS IN NEWER EU MEMBERS

This section reviews the nuclear power plant programs in Bulgaria, Hungary, and Lithuania. These countries were chosen for the following reasons:

(1) Bulgaria had to shut down two nuclear power plants under duress. Although Bulgaria needed the electricity that the plants generated, shutting them down was a requirement for EU entry. Nuclear power provides 35 percent of its electrical grid. Bulgaria is dependent on Russian gas.

Indeed, Russia provides 90 percent of Bulgaria's supply, though Bulgaria is looking for other options for energy. [191]

(2) Lithuania depends on its Soviet-designed nuclear power plant for 70percent of its electrical requirements. For its natural gas power plants, it depends on Russian suppliers for 90 percent of its gas. The EU is subsidizing the decommissioning of the remaining Soviet-era reactor. This nuclear power plant is a Soviet-built RBMK-2 nuclear power plant. This is the same design as was in Chernobyl, Ukraine, and met with a nuclear disaster. However, Lithuania has entered into a partnership with Estonia, Latvia and Poland to construct a new nuclear power plant. Financial support will be given by the government of Lithuania and privately held companies in Estonia, Latvia and Poland. [192]

(3) Hungary operates four Soviet-designed reactors at one operating nuclear power plant, Paks. It has no plans to shut down its power plant and continues to invest in

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[190] "A European approach to nuclear power, safety and security"-EUROPA Memo/07/10 dated 10 January 2007. http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/10.

[191] World Nuclear Association, Nuclear power in Bulgaria, http://www.world-nuclear.org/info/inf87.html.

[192] World Nuclear Association, Nuclear power in Lithuania, http://www.world-nuclear.org/info/inf109.html.

training and safety programs. It has operated one nuclear power plant successfully since the mid 1970s. Its reactors produce 40 percent of its electrical power grid's needs. These reactors' output does not provide enough electricity, so it also uses gas and coal powered electrical plants. This results in high energy costs for consumers in Hungary and in neighboring states who share some of the nuclear-generated power. [193]

1. Bulgaria

Although Bulgaria was forced by the EU to shut down two of its aging nuclear power plants, it has not had assistance from the EU to replace them. Only two 1,000 mega-watt units are now in operation, resulting in a substantial lack of electrical energy supplies in the region.[194] The German power company RWE was chosen to co-build a 2,000 mega-watt nuclear reactor in Belene, Bulgaria, in conjunction with the Bulgarian government-owned company BEH. However, RWE cannot now provide the money to invest in other projects due to the overall poor global economic situation. RWE has backed out of other nations' projects as well. "This was also the third project in Central and Eastern Europe that RWE had pulled out of in as many weeks—it ended talks to buy a stake in the Polish utility Enea and withdrew from an LNG project in Croatia."[195] This has opened the door to the most probable investor—Russia. This takes jobs away from the EU and also takes regulation of the construction out of the EU's control. "The financial difficulties of Belene may turn out to be an excellent opportunity for Russia to realize its objective of entering the EU nuclear power sector."[196] Bulgaria will not want to wait too long searching for investors, as it has already invested 1.2 billion euros in the

193 World Nuclear Association, Nuclear power in Lithuania.

194 "Bulgaria mulls new reactor at Kozloduy nuclear plant", *China View News*, November 26, 2009, http://news.xinhuanet.com/english/2009-11/27/content_12547904.htm.

195 Nicholas Watson, "Russian into Europe's nuclear power sector," November 6, 2009, Business New Europe, http://businessneweurope.eu/story1854/Russian_into_Europes_nuclear_power_sector.

196 Ibid.

project. Russia has been the only serious investor, Internet is ironic as Bulgaria's reactors, Internet were ordered to be decommissioned by the EU, were originally built under the Soviet empire.[197]

2. Lithuania

Lithuania shares much the same current fate as Bulgaria. The co-op energy consortium of Estonia, Latvia, Lithuania, and Poland to build a new nuclear reactor lacks a strategic investor to front the majority of the funds.[198] All of these countries are reliant on Russia for electricity and natural gas, raising the costs of energy. Shutting down the Ignalina power plant, ordered by the EU, has caused an energy deficiency in the region. "The Ignalina nuclear plant closure will deepen the recession, more than double power-generation costs and force Lithuania and the region to import electricity. At present, Ignalina supplies about 80 percent of Lithuania's electricity."[199] Five billion euros are needed for the consortium project, and according to Lithuania's energy minister, whoever the strategic investor may be will have to front up to half of the cost.[200] The EU has driven these states to comply with the EU directives on greenhouse emissions and nuclear safety, but has not provided them with the financial support needed to construct new nuclear power plants to meet their energy needs. Sharing the costs of the construction, as well as the energy provided by the nuclear plants is, one of the few options available to these states.

Energy sharing is partly driven by being a signatory to the European Energy Community Treaty, Internet entered in force on July 1, 2006. However, all EU members

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197 Watson, "Russian into Europe's nuclear power sector."

198 Lithuania in the World**:** "A Simple Approach Delve deeply, but keep it simple, is the philosophy of the foreign minister," http://www.liw.lt/archive_vid.php?shid=1173277290&id=1173275944.

199 "NIB: Baltics need unified energy plan to attract investors," *The Baltic Business News*, November 26, 2009, http://balticbusinessnews.com/article/2009/11/26/NIB_Baltics_need_unified_energy_ plan_to_ attract_ investors.

200 Petras Vaida, "Sekmokas: nuclear power plant in Lithuania might cost 3-5bn euros," *The Baltic Course*, November 27, 2009, http://www.baltic-course.com/eng/energy/?doc=2076.

have the right to participate since the language is unclear at any interpretation.[201] The original purpose of the treaty was to promote cross-border sharing of energy resources.

3. Hungary

Hungary, as one of the principal producers but yet under-producing for its region, is one of the central states expected to participate. The government has proposed to expand capacity in its existing plants, and its parliament has already voted largely in favor of building and maneuvering of a new nuclear power plant by around the year 2020.

When Peter Honig spoke at the 53rd General Conference of the IAEA in 2009, he explained Hungary's nuclear power plan.[202] Hungary remains committed to the parameters laid out by the IAEA and remains a strong supporter of its programs. Hungary has extensive use of nuclear energy and endorses only peaceful use of nuclear energy in general. He urged all members of the EU to sign, ratify, and implement a Comprehensive Safeguards Agreement and Additional Protocols, Internet will include a layer of safeguards against manmade disasters. Furthermore, he acknowledged that more countries need to implement safeguards for nuclear energy, that there are budgetary issues that must be dealt with for nuclear power, and that security in terms of energy and physical plant security needs continued work and improvements.

To meet Hungary's need for energy and hedge for energy for its economic and social needs Hungary's Parliament has passed a decision paving the way to build new units at the Paks nuclear power plant.[203] The resolution mandates the government to execute an environmental assessment, study energy markets and then contract for units to increase capacity. For the time being, Hungary's current four units that are in the Paks nuclear power plant were given a lifetime extension by the Hungarian Atomic Energy

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[201] The European Energy Community Treaty. http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY/Legal/About_the_Treaty.

[202] H.E. Mr. Peter Honig, Minister, Ministry of Transport, Telecommunication and Energy, Republic of Hungary, 53rd, General Conference of the IAEA, http://www.iaea.org/about.policy/GC/GC53/statements/hungary.pdf.

[203] Ibid.

Authority. In addition, by the end of this year the power upgrade should be completed, bringing Hungary closer to meeting its domestic requirements.

Hungary has taken the first steps in meeting the responsibility of its radioactive waste. It has identified a site for the National Radioactive Waste Repository for low and intermediate waste.[204] The above ground facility opened in September 2008, and the underground disposal chambers should be operational at the end of 2010. This will affect Russia, since before the repository completion all radioactive waste was sent back to Russia for disposal. To further support nuclear power the government of Hungary has offered its nuclear experts to EU member states to share its knowledge and reinforce cooperation among the member states for nuclear energy.

D. ENERGY SHARING

The EU favors energy sharing. It has recognized that it will have a steady increase in energy needs and that the current energy model based on fossil fuel has two crucial flaws. The first flaw is that the European Union imports almost all of its oil requirements from Russia, Internet forces it to be dependent on Russian oil. The second flaw is that the alternative to gas and oil from Russia is dependence on oil from the Middle East. In addition, the volatility of rising prices and world competition for the oil resources from either Russia or the Middle East cause a financial burden on member governments and businesses, Internet hampers economic growth and development.

Nuclear power is currently viewed by the EU as an alternative to integrate the energy market, and to encourage development in the energy sector and initiatives in areas such as infrastructure expansion, investment financing, and research and development.[205] The long-term goal would be that member states would have access to modern and affordable energy that offers secure supply and reliability options and that nuclear power would be acceptable to European social and environmental concerns.

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[204] Honig, Minister, Ministry of Transport, Telecommunication and Energy, Republic of Hungary.

[205] George Joffe, Samir Allal and Houda Ben Jannet Allal, "10 Papers for Barcelona 2010 Energy and Global Economic Crisis: The Chances for Progress," October 2009. http://www.iss.europa.eu/uploads/media/10papers-02.pdf.

E. ENERGY SECURITY

The EU's primary concern, in terms of energy security in today's current structure, is the potential interruption to gas and oil pipelines. A secondary concern is the world demand for oil, followed by the third concern of the pumping stations. The last concern is resource nationalism that always has the potential to emerge, particularly in politically difficult or economic downturns. The EU is in the process of hedging against the first threat of potential interruption. The EU has asked member states to store the oil and gas reserves that are outlined in the European Energy Charter. It has been recognized by all member states that this plan is a short term solution at best, and that the long term solution has to be a renewable energy source that the EU can manage and sustain on its own. The EU has recognized that to counter the second-order concern of world demand for oil it simply must find alternate methods for energy sources.

The third concern of pumping stations is an issue that the EU is still struggling with currently since the pumping stations constitute a twofold problem. The first hurdle it must overcome is most of the pumping stations are national assets owned and run by the governments, so as long as each government is following the treaty or bilateral agreement then all is well. However, if a government chooses not to honor its obligations, there is no other course of action than diplomatic resolutions to resolve the turmoil-- there is remarkably little the other countries can do. The other problem is that pumping stations are security vulnerability. If they come under a terrorist attack and become nonoperational, not only does it affect the primary state running the pump; it also affects other countries that depend on that pumping station, therefore, having a cascade effect on the whole system.

The fourth concern of nationalism of resources is an issue that the EU must contend with across the board on a variety of issues. The purpose of the EU is to work together to succeed and take the comparative advantage of membership. The EU as a collective group is working hard to solve the issue of energy, and it will undoubtedly require a long time to work through, but since the EU was able to persuade many its members to give up their national currency there is nothing to deem that it will not be able to solve its energy dilemma. Adopting the euros was decision for the member states

of the EU. As this paper points out, the energy questions involve parties outside the EU, including Russia and states in the Middle East.

Nuclear power plants provide some long-term solutions for the EU energy outlook. They help alleviate the security threats that stem from concerns about shipping choke points and pumping stations. Nuclear plants could provide an alternative energy source so that the EU would not have to import as much oil from Russia or the Middle East. However, nuclear power plants would not solve two issues of state's owned assets or vulnerability to terrorist attacks, Internet could have a cascade effect on the members depending on the energy that particular nuclear plant would provide.

F. OTHER CONSIDERATIONS

Energy is a critical requirement for every state, Internet is why each state evaluates its nuclear power plants in terms of national security, economics, and security against manmade disasters. Energy drives several security factors that are more sensitive in the European Union in comparison to the United States since the European Union has few resources of its own and limited options to choose from as well.[206]

Even though the European Union must solve its own energy problem, it has embraced the Transatlantic Cooperation for Sustainable Energy Security: A Report of the Global Dialogue between the European Union and the United States.[207] This report dealt with[208]: (1) the dilemmas of climate change, (2) the hazards of energy shortage and policies for existing energy sanctuary, (3) confronts in the world financial system and latest scenes of global economic governance and, (4) the requirement for logical junction and the establishment of a Euro-Atlantic Strategy.[209] Understanding the goals of the EU is necessary since it will affect each member state's national security and economy,

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[206] European Environment Agency, "Energy-Introduction," http://www.eea.europa.eu/publications/92-826-5409-5/page019new.html.

207 CSIS, Center for Strategic& International Studies, "Brzezinski Chair in Global Security and Geostrategy," http://csis.org/program/brzezinski-chair-global-security-and-geostrategy.

208 Franklin Kramer and John Lyman, "Transatlantic Cooperation for Sustainable Energy Security A Report of the Global Dialogue between the European Union and the United States," 2009.

[209] Kramer and Lyman, "Transatlantic Cooperation for Sustainable Energy Security."

Internet in turn affects the EU as a whole including the cost of protecting the assets. The global economy is in a downturn, Internet causes national budgets to be restricted, and it will be difficult to fund the goals stated above.

The EU has taken initial steps to reduce its own dependence on oil but there needs to be a transatlantic community to focus on energy strategies, markets, institutions, study and progress, standards and regulations, security of infrastructure, and reaction to distractions. [210] This could help launch the international organizations that the EU could work with to support efforts for utilizing alternative energy sources.

A regular forum still needs to be established that would include the United States and the member states of the EU and NATO. It would focus on the issues of energy safety, improvement of weather alteration, and financial viability and entire energy sources to comply with those points. Under consideration is the Transatlantic Forum on Energy Cooperation (TFEC).[211] It is under this arm with the partnership with the International Atomic Energy Agency (IAEA) that the EU could rebuild and spread its nuclear infrastructure, fund works to promote safe nuclear power, and provide incentives and tax policies to promote nuclear power.

Then there is the point of the EU's dependence on Russia for natural gas. Even if the EU strengthened its member states' nuclear energy programs, the Central and Eastern European states would still rely on Russia for enriched uranium and waste disposal since there are treaties in place already. If EU members agreed to an electrical depository, who would supervise the management and distribution of members' deposits and withdrawals and pay for the electricity? Further research is needed.

If the EU managed its own electrical grid and was not as dependent on Russian oil and gas, would this action alienate Russia even more? There are implications since Russia maintains the world's largest deposits of natural gas and is a chief exporter of

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[210] Atlantic Council, "Energy Security: Transatlantic Cooperation and Sustainability,",http://www.acus.org/publication/energy-security-report.

[211] Ibid.

other fossil fuels to most of Europe. Today, Russia has the natural gas that most of the EU needs; therefore, it has a strong influence.

If the EU can work through the issues and complexity of nuclear power for electricity, it will gain independence in many other areas. When a community has a secure, reliable and economical energy source, it can then divert its attention to other things. When it breaks its dependence on importing foreign oil, it has different choices to make in the international forum of diplomacy.

G. IMPACT ON EUROPE'S DOMESTIC REALM

While nuclear power can be one of the components of energy to meet Europe's electrical needs, it may bring domestic disturbance, undermining national security interests. Europe has seen protests against nuclear power, with volumes of people protesting, and accompanying violence, that the U.S. has not yet witnessed in recent years. The difference of protest groups between the U.S. and Europe is evident. In the U.S. there was a protest regarding the re-licensing on one of Vermont's nuclear power plants. Two anti-nuclear organizations, Greenpeace USA and Earth First, targeted the Vermont complex. Earth First protestors entered the Vermont Public Service Board offices in Montpelier, Vermont, dressed like Santa Clause and elves, demanding that the Vermont Public Service Board not renew the nuclear plant license. They were not arrested but fined $800 for damages caused to the offices.[212] The protest garnered a dozen or so people, dressed in costumes.

1. Protestors

In Europe, there have been protests of transportation of nuclear waste in Germany and France. This has not been a new protest since "The German government suspended transports in 1998 out of safety concerns. Part of the security concern is of the contentious protests and fights between protestors and police in connection with the

[212] "Green Mountain Earth First! Take Action Against Nuclear Energy," EarthFirst! http://www.earthfirstjournal.org/ article.php? id=437.

transportation activities."[213] However, in 2001 transportation of Germany's nuclear waste began again. This was also marked with protests, including protestors vandalizing railway facilities in Berlin.[214] Again, in November 2008, there were protests against the transportation of nuclear waste but with significantly larger numbers of protestors. One of the flashpoints of the protest is near the city of Gorleben, Germany; this location stores German nuclear waste before movement to the French reprocessing center. The protestors tried to suspend the train's schedule, presumably to terminate the shipment entirely from the initial departure from Germany to France.

Amid various methods, protestors even chained themselves to the tracks. "Police used water cannons, tear gas and batons to break up the protestors; and riot officers carried them away one by one."[215] Although the train did eventually make it to its initial French destination in La Hague it was delayed by 13 hours.[216] After its departure for Gorleben, Germany, protesters were able to suspend the train's travel by 20 hours through various means. These methods used by the Protestors included placing wooden barricades across the tracks and setting fire to them. Tractors blocked the entrance to the storage facility with people chained to cement barriers made by their fellow protestors. In an earlier section of the train tracks protestors had sealed their arms in cement blocks under the tracks.[217] One protestor was killed in the protests. He chained himself to the railroad tracks along with approximately 12 others. When the train rounded a corner, at a

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213 "Vandals smash railway building windows in nuclear protest," Associated Press, March 21, 2001, http://www.independent.co.uk/news/world/europe/vandals-smash-railway-building-windows-in-nuclear-protest-688383.html.

214 "Vandals smash railway building windows in nuclear protest," Associated Press, March 21, 2001, http://www.independent.co.uk/news/world/europe/vandals-smash-railway-building-windows-in-nuclear-protest-688383.html.

215 Stephanie Kennedy, "Protest to Stop Nuclear Waste in its Tracks," ABC News, http://www.abc.net.au/am/content/2008/s2415984.htm," November 11, 2008.

216 Ibid.

217 "Nuclear Waste Arrives at German Dump," *Nuclear Power Daily.* http://www.nuclearpowerdaily.com/reports/Nuclear_waste_arrives_at_German_dump_after_fierce_protests_999.

much slower speed due to a bend in the track, the group moved off of the tracks with the exception of one person who was killed when the train struck him.[218]

These protests are in the wake of political wrangling in recent years, in Germany, regarding the phasing out of Germany's 17 nuclear reactors. In 2001, The Atomic Exit Law was passed, whose aim was to phase out the 17 nuclear reactors by 2021. The political landscape has changed since German Chancellor Merkel is leaning toward stopping the shut-down of the nuclear reactors, Internet currently provide 25 percent of Germany's electricity. Chancellor Merkel "argues it is unrealistic in the face of high oil costs, [it] will endanger renewable energy goals and will leave Germany vulnerable to the whims of its largest gas supplier, Russia."[219] One of the goals of the law was to reduce greenhouse gas emissions by 80 percent. However, with few alternative choices to power Germany's electrical needs, nuclear power may exist longer.

2. European Neighbors

Germany's neighbors have already faced similar prospects. "Countries such as France, Finland, Italy, Sweden, and the UK are already eyeing nuclear power to help them meet emissions reductions targets, leaving Germany isolated among its EU and G-8 partners."[220] Despite the realities of Germany's future energy woes without nuclear power, not all German citizens are in favor of changing the Atomic Exit Law. In September 2009, 50,000 people and more driving 400 farm tractors flocked to the German Reichstag in Berlin, in protest of the potential roll-back of the bill.[221] Also demanded by the protestors was closure of the proposed nuclear waste storage facility at Gorleben, Germany.[222] The protestors were not stationary, even in their vast numbers.

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[218] Jarrett Murphy, "Anti-nuclear protester killed by waste train," CBS News http://www.cbsnews.com/stories/2003/09/25/national/main575060.shtml.

[219] Rachel Nolan, "Nuclear-Power Debate Reignites in Germany," *TIME*, July 9, 2009. http://www.time.com/time/world/article/0,8599,1909228,00.html.

[220] Ibid.

[221] "Thousands in Berlin to Protest Nuclear Energy," *Deutsche Welle*, available online via commondreams.org, September 5 2009, http://www.commondreams.org/headline/2009/09/05-1.

[222] "Anti-nuclear protest march against German U-turn," France 24 International News. http://www.france24.com/en/20090905-anti-nuclear-protest-march-against-german-u-turn.

The protest began at the Berlin train station and traveled 2 kilometers to the Brandenburg Gate.[223] That the protest organizers were able to move 50,000 protestors and 400 tractors that distance, in central Berlin, shows the European antinuclear protestor leadership's strong organizational abilities.

The other states mentioned are also not without their fair share of protestors. Greenpeace released a press release on 19 November 2009, titled "Nuclear Madness Reaches Finland." Greenpeace activists had unlawfully boarded a cargo ship, sailing from France to Finland. On board the ship, its cargo contained steam-powered generators built in France that were to be used in construction of a nuclear reactor in Olkiluoto, Finland. Six Greenpeace activists boarded the ship on 16 November, and two more boarded the ship the next day, 17 November 2009. Their goal was to gain media attention for their cause, Internet was protesting the construction of the nuclear reactor in Finland. The Greenpeace activists were from Finland, France, Germany and Sweden.[224]

In July 2008, Greenpeace activists climbed the Eiffel Tower in Paris, France, and attached onto the Eiffel tower a large banner with a nuclear symbol. This was in direct correlation to Paris hosting the EU members. Furthermore, on the Eiffel Tower were the EU stars, Internet signified "France's six-month term as EU president."[225] Greenpeace believes that France's President Nicholas Sarkozy was using the EU summit to promote his agenda of more nuclear-generated electricity. Sarkozy was hosting over 40 heads of state and government in Paris for a summit on the partnership between the European Union and countries from the Mediterranean region.[226] Greenpeace accused Sarkozy of selling Areva (France's nuclear power company) nuclear power abilities to the UN and G8.[227] According to Greenpeace, Sarkozy's government has signed agreements with

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[223] "Anti-nuclear protest march against German U-turn," France 24 International News. http://www.france24.com/en/20090905-anti-nuclear-protest-march-against-german-u-turn.

[224] Greenpeace Press Release, "Nuclear Madness Reaches Finland," *Media-Newswire.com*, http://media-newswire.com/release_1106272.html.

[225] Estelle Shirbon, "Greenpeace climb Eiffel Tower in nuclear protest," Reuters UK, July 13, 2008, http://uk.reuters.com/article/idUKL1327148920080713?sp=true.

[226] Ibid.

[227] Ibid.

nine other nations in the Mediterranean region, to build Areva nuclear reactors in their nations.[228] In early July 2008, Sarkozy announced that France would build a second-generation European Pressurized Reactor (EPR).[229] Other EPRs are under construction in Finland and France. The Finland EPR is located at Olkiluoto, where the steam-powered generators were headed when their ship was boarded by Greenpeace enroute. [230]

Europe's monumental number of protestors converged on a single objective as a nuclear power plant in the spring of 2009. They targeted France's oldest nuclear power plant, Internet is located in Colmar, France. People, from France, Germany, Italy, Spain, and Switzerland rallied outside the Colmar nuclear power plant, insisting that it is too old to maintain safe operations. Over 10,000 people from these countries attended the rally.[231] While this group of protestors was outside the Colmar plant, 3,500 persons protested the Fessenheim nuclear power station. The Colmar protest was met by 3,000 police officers, along with "dozens of anti-riot police vehicles and trucks with water cannons."[232] Protestors alleged that police agencies prevented them from boarding their trains while en route.[233]

The examples listed previously, except for Finland, were the Western states with a reliable electrical grid that currently meets it requirements. The potential for protests and violence is greater in the newer eastern states that do not have reliable electrical grids that cannot meet their electrical requirements to begin with and that must make tough choices. The decision may force these states to both not meet their treaty requirement of decommissioning their Soviet-era reactors and do nothing to replace them leaving, them entirely dependent on Russia for oil and coal to run other electrical plants or provide electricity using the reactors keeping domestic stabilization. The implications for these

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[228] "Greenpeace hangs nuclear banner on Eiffel Tower," Greenpeace International, July 13, 2008, http://www.greenpeace.org/international/press/releases/greenpeace-hangs-nuclear-banne.

[229] Shirbon, "Greenpeace climb Eiffel Tower in nuclear protest."

[230] "Greenpeace hangs nuclear banner on Eiffel Tower."

[231] "Thousands protest against France's oldest nuclear plant," Expatica.com, April 10, 2009. http://www.expatica.com/fr/news/french-news/Thousands-protest-against-France_s-oldest-nuclear-plant-_56920.html.

[232] Ibid.

[233] Ibid.

states could be that not having nuclear power electric plants reduces their national security, Internet will reduce growth in their domestic economies due to high energy costs and could even destabilize governments through domestic turmoil and unrest of their own citizens.

H. SUMMARY

In closing, the EU and the rest of Europe face difficult problems of energy that vary from the ones tackled by the United States and will lead to a different solution set for them. They have taken the first step and identified the problem; they are beginning to work at the EU level on strategic plans to meet energy goals and objectives. They are looking at solutions based on known technology and electrical output, and they have started to consider protecting those assets that cross boundaries, treaties, and governments.

The conclusion chapter focuses on policy recommendations that United States can focus on today in the areas of energy strategy, streamlining the levels of bureaucracy, and create incentives to build new plants and expand the nuclear power industry. There are two areas that need further study, as they are too broad in scope to address in this paper. The first, potential attacks against nuclear power plants; the second area of in depth study would be DHS's plan to secure critical infrastructure against cyber-threats.

VIII. CONCLUSION

> Whether it's nuclear energy, or solar or wind energy, if we fail to invest in the technologies of tomorrow, then we're going to be importing those technologies instead of exporting them. We will fall behind. Jobs will be produced overseas, instead of here in the United States of America. And that's not a future that I accept.
>
> —President Obama, February 16, 2010 at Remarks by the President on Energy in Lanham, Maryland

This thesis was written to help understand that all nuclear reactors are inherently dangerous but can be used safely and the industry is growing outside of the United States. This paper hopes to establish that nuclear power plants can both satisfy the U.S.' energy needs and do so in a way that reduces or eliminates the security risks posed by its current reliance on fossil fuels.

A. POLICY RECOMMENDATIONS FORMAT

In Chapter VII, The Difference of the Europe's Issues with Nuclear Power Plants, a first step for at least the European Union was to start planning at a strategic level on an energy strategy. President Obama has taken the initial steps in creating such a strategy but the strategy will need to continue and grow and be refined by future executive administrations.

1. Well-planned Energy Strategy

The United States has taken key steps in creating a viable energy strategy. The American Recovery and Reinvestment Act included $80 billion dollars for energy invest and job creation. [234] Then, there is the investment of $150 billion into energy

[234] "The American Recovery and Reinvestment Act," The White House Office of the Press Secretary Energy & Environment, http://www.whitehouse.gov/issues/energy-and-environment.

technologies and loan guarantees on new nuclear power reactors in Georgia creating a business partnership between the private sector and the federal government.

The federal government plays a key role in domestic energy policy. President Obama focuses on breaking the U.S. dependence on oil. Policies are now focused on producing more energy within the U.S. and linkage to promoting energy efficiency in all sectors of American society.[235]

One of the indicators of a successful government is good bureaucracy. The concept of Department of Energy, Department of Homeland Security, the Nuclear Regulatory Commission, and private sector working together and overlapping in many ways beneficial to the industry and the safety of the American public.

2. Level of Bureaucracy

Based on the research conducted for this paper it would seem the role and responsibly of key agencies will require streamlining. This will limit the problems between government regulatory enforcement and the private sector. It also reinforces the concept that it is all agencies responsibility to ensure the physical and IT sectors are protected, accounted for, and congressional oversight that only strengthen the long term goals of security of the plants.

The European Union has already shown that it can promote growth in the industry through regulation and agreement. However, the EU's weakness is that it has no money to assist members in upgrading, decommissioning, and regulating nuclear power plants. The United States may consider some of the incentives that the EU created and then follow suit with federal funding to expand the nuclear power industry within the U.S.

[235] "The American Recovery and Reinvestment Act," The White House Office of the Press Secretary Energy & Environment, http://www.whitehouse.gov/issues/energy-and-environment.

3. Create Incentives

There needs to be government regulation, legislation, and taxation to generate revenue to finance incentives to encourage new competition in the industry. The long term benefits should be more companies providing electricity, lower costs to the consumer, and new technologies developed.

B. AREAS FOR FURTHER STUDY

1. Potential Attacks Against Nuclear Power Plants

This paper has indentified the two categories: attacks against the physical structure of the nuclear power plant and cyber attacks. Each of these areas deserves further research and analysis to counter each attack.

2. DHS

DHS had been strongly criticized by the GAO and others that it has not addressed its responsibilities with respect to securing critical infrastructure and key federal operations against cyber-threats. Further study needs to be conducted to access a reasonable plan and execution of that plan to ensure that cyber security goals are met.

C. SUMMARY

The short-term goal of nuclear energy should be to break the United States dependency on foreign oil imports. The long-term goal is to create several alternative energy sources that will enable the U.S. to continue to grow economically and yet ensure National Security.

Energy is vital to any industrialized nation and with competition of new and upcoming economies of other nations, oil will continue to be an important commodity; but by diversifying energy sources the U.S. can remain a world leader in clean energy and economics.

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