NUCLEAR POWER STANDARDIZATION

By Robert Zuppert

INTRODUCTION

> America has not ordered a new nuclear power plant since the 1970s. France, by contrast, has built 58 plants in the same period. And today, France gets more than 78 percent of its electricity from safe, clean nuclear power.[1]

America's production of nuclear power plants in the United States has been stagnant for nearly 30 years. On the forefront of the failure of the government and private sector to revitalize the nuclear power industry has been the lack of standardization within the licensing, construction and operation of nuclear power plants. The failure to standardize all facets of nuclear power prevented the industry from being able to continue its licensing process following the nuclear accident at Three Mile Island in 1979. "After Three Mile Island (TMI), plants already designed and built, or partially built, incurred additional costs and delays associated with changes resulting from TMI."[2]

Throughout this research paper, I will analyze the history of nuclear power and how the lack of a formal standardization process significantly affected the licensing process of nuclear reactors by the Nuclear Regulatory Commission (NRC). From the early licensing process, I will present why standardization was needed in the nuclear power industry and how the NRC implemented their new standardized licensing process for all nuclear reactors. Following my analysis, I will offer recommendations to help improve the current status of standardization in

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[1] Bush, George W. "A Secure Energy Future for America." *Nuclear Plant Journal*. Vol. 23, Iss. 3 (May/Jun 2005), 42.
[2] Blankinship, Steve. "Standardized Design/Streamlined Licensing Will Pave Path for New Nuclear Units." *Power Engineering*. Vol. 110, Iss. 4 (Apr 2006), 8.

the industry and suggest future areas of research to assist in the promotion of the revitalization of nuclear power within the United States and throughout the world.

WHY ARE NUCLEAR POWER STANDARDS IMPORTANT

> The United States has brought nuclear power technology to the world, and it has the opportunity to become an industry training leader because its nuclear power plant standards, government regulations and practices are followed by the majority of nuclear power plants worldwide.[3]

With the United States operating nuclear reactors safely for over 30 years, the world has always looked to the U.S. for guidance and advice on how to better improve their processes and programs. However, the current standardized process for the operation of nuclear reactors was not as formalized as it is today. With the development of nuclear power industry in the early 1960s, the U.S. lacked a formal standardized process for licensing nuclear reactors, approving equipment for operation, implementing procedures and training operators, the nuclear power industry needed a process that addressed all safety, technical and public concerns.

From the early NRC licensing process, "licenses were issued and construction begun before the design was finalized, resulting in many changes and multiple Nuclear Regulatory Commission (NRC) approvals."[4] This informal and haphazard process caused significant delays in the construction process and proved to be very costly to utility companies attempting to bring new nuclear reactors into the market. The parallel process of issuing licenses and reviewing the reactor design at the same time did not allow nuclear power to flourish in the U.S.

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[3] Agnithotri, Newal. "Training Standardization." *Nuclear Plant Journal*. Vol. 21, Iss. 5 (Sept/Oct 2005), 20.
[4] Hansen, Teresa. "Nuclear Energy's 'Brilliant' Future." *Power Engineering*. Vol. 110, Iss. 7 (Jul 2006, 30.

To counteract this inefficient and ineffective process of developing new nuclear reactor plants, the NRC and private utilities looked to a standardized process that would address the need for standardization, while preparing the industry for the future. As many utility executives and government officials at the NRC and Department of Energy began to realize following TMI, "standardization is a key to the economics of nuclear power, and economics will drive nuclear revitalization in the U.S."[5]

HISTORY OF NUCLEAR POWER IN THE UNITED STATES

> Nuclear energy. The thought of it all too often conjures up frightening images in the public's mind of deadly combination or even total annihilation of our planet. Major accidents at the Chernobyl nuclear plant in Ukraine in 1986 and the Three Mile Island Unit 2 (TMI-2) facility in Middletown, Pennsylvania, in 1979 have further reinforced these terrifying images.[6]

These two key nuclear reactor accidents have shaped the view of nuclear power in the U.S. Before analyzing the early NRC licensing process, it is important to acknowledge important historical events in the nuclear power industry. The first accident occurred at TMI-2 during the peak of nuclear power development in the U.S. The accident at TMI-2 did not injure any worker or members of the surrounding community; however it did bring about "sweeping changes involving emergency response planning, reactor operator training, human factors engineering, radiation protection, and many other areas of nuclear power plant operations."[7]

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[5] Bruschi, Howard J. "Standardization: The Key to Nuclear Revitalization." *Public Utilities Fortnightly*. Vol. 127, Iss. 11 (Jun 1, 1991), 23.
[6] Kurland, Orin M. "Risk mitigation in the atomic age." *Risk Management.* Vol. 40, Iss. 6 (Jun 1993), 34.
[7] NRC Office of Public Affairs. "Fact Sheet on Three Mile Island Accident." March 2004. Nuclear Regulatory Commission. 21 July 2007. < *http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html*>

This accident was the impetus for change at the NRC and a shift in focus on enhancing safety at and increasing oversight at all nuclear power plants in the U.S.

The second accident occurred at Chernobyl nuclear power plant. "The accident at the Chernobyl nuclear power plant in 1986 was the most severe in the history of the nuclear power industry, causing a huge release of radionuclides over large areas of Belarus, Ukraine and the Russian Federation."[8] The nuclear reactor meltdown at Chernobyl not only had a dramatic impact on the health and economic status of the Soviet Union, Belarus, Ukraine and the Russian Federation, but it also damaged the public view of nuclear power throughout the world. American citizens began to ask if a Chernobyl type accident could occur in the U.S.

TMI and Chernobyl had a damaging impact on the progression of nuclear power in the U.S. Today, only 19.4 percent of U.S. electrical power is provided by nuclear energy compared with France's 78.1 percent nuclear fuel share. Appendix A provides a synopsis of the major countries throughout the world and the percentage of electric power provided by nuclear energy in their respective country.[9] It is alarming that the United States does not fall in the top 12 of nuclear power production. The map below created by the International Nuclear Safety Center provides a worldwide map of the current operational nuclear reactors.[10]

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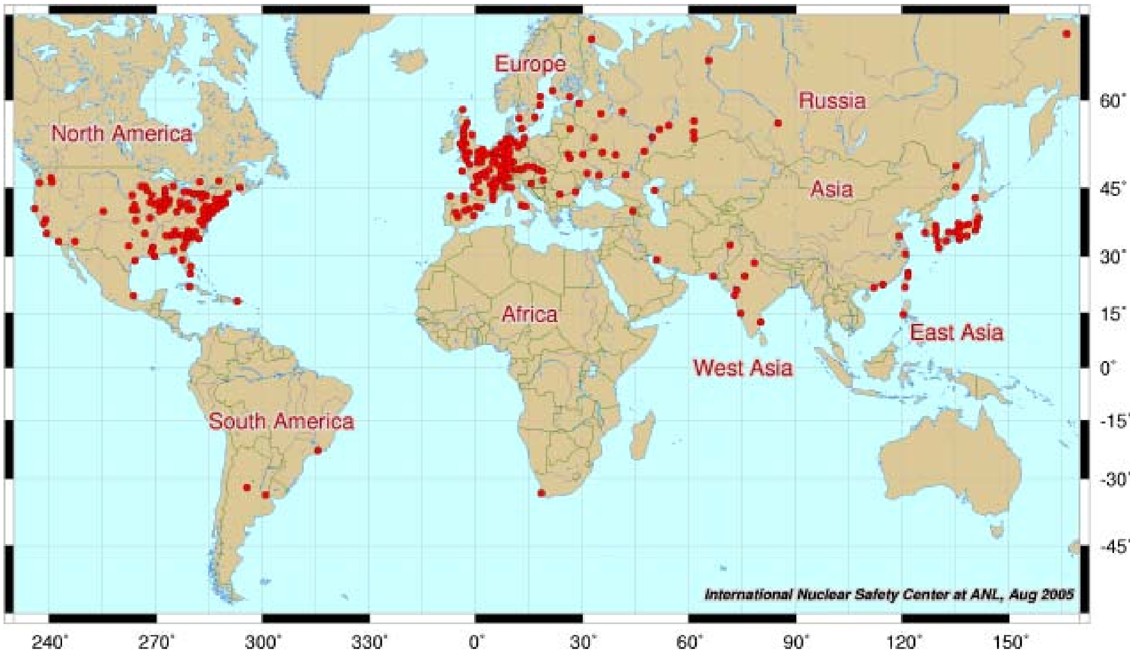
[8] Chernobyl Forum. "Chernobyl's Legacy: Health, Environmental, and Socio-Economic Impacts and the Recommendations to the Governments of Belarus, the Russian Federation and Ukraine." April 2006. International Atomic Energy Agency. 20 July 2007. <http://www.iaea.org/Publications/Booklets/Chernobyl/chernobyl.pdf>

[9] International Atomic Energy Agency and World Nuclear Association. "World Nuclear Power Generation and Capacity." May 2007. Nuclear Energy Institute. 21 July 2007. <http://www.nei.org/resourcesandstats/documentlibrary/reliableandaffordableenergy/graphicsandcharts/worldnucleargenerationandcapacity/>

[10] International Nuclear Safety Center. "Maps of Nuclear Power Reactors: WORLD MAP." August 2005. Argonne National Laboratory for the Department of Energy. 21 July 2007. < http://www.insc.anl.gov/pwrmaps/map/world_map.php>



It is important to note that the majority of the nuclear reactors worldwide are located in the eastern U.S. and the western part of Europe. In the next ten years, the worldwide nuclear reactor inventory will see additions in the U.S., China and India.

The development of nuclear power in the U.S. has been widely influenced by the history of nuclear power throughout the world. Following TMI, "35 plants were stopped at various stages of planning and construction because of bureaucratic obstacles."[11] The construction of the last nuclear reactor, Watts Bar Unit 2, in the U.S. was started in 1974 and was completed 23 years later in 1997. Watts Bar Unit 2 illustrates that the industry needed to review its current processes and determine how to proceed in the development of nuclear power.

[11] Bush, George W. "A Secure Energy Future for America." *Nuclear Plant Journal.* Vol. 23, Iss. 3 (May/Jun 2005), 42.

EARLY NRC LICENSING PROCESS

> Safety issues were not fully resolved until the plant was essentially complete – a process flaw that has substantial financial implications.[12]

Throughout the 1960s and 1970s, the NRC licensing process proved to challenge utility companies attempting to receive a license to operate their built nuclear reactor. During the emergence of nuclear power in the U.S., NRC lacked a rigorous formalized process for submitting applications and determining if reactors that were being built were safe for operation. By using a parallel process to determine if the submitted reactor design was safe for operation, companies were incurring large financial expenditures on a project with an uncertain outcome.

During this time period of standard development in licensing process at the NRC, utility companies wishing to gain a license for a new nuclear reactor would submit a preliminary safety analysis report (PSAR). Following the issuance of the PSAR, companies would then be granted a license by the NRC and begin to construct their new nuclear reactor plant. At this point in the licensing process, the NRC did not make the determination if the submitted reactor design was safe for operation. During the construction phase, the NRC would begin to analyze the reactor design and present questions to the respective company regarding the safety and technical standards. Companies that submitted plans "invested millions, and in some cases billions, of dollars to build the plant, and hoped one day you would get a license to operate it."[13] Once the review of the reactor design was completed by the NRC and the company completed the

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[12] Nuclear Energy Institute. "Licensing New Nuclear Power Plants." October 2006. Nuclear Energy Institute. 21 July 2007. <http://www.nei.org/resourcesandstats/documentlibrary/newplants/factsheet/licensingnewnuclearpowerplants>

[13] Blankinship, Steve. "Standardized Design/Streamlined Licensing Will Pave Path for New Nuclear Units." *Power Engineering*. Vol. 110, Iss. 4 (Apr 2006), 8.

construction of the reactor, a decision was made by the NRC to either grant an operational license for the reactor or determine the reactor unsafe for operation and require the company to scrap its construction.

This primitive NRC licensing process presented numerous problems for NRC, DOE, utility companies and the public. Utilizing an uncertain process, safety issues were not brought to the attention of the company or the public until the reactor was nearly built. This process limited the ability of the public to view the current reactor design prior to its construction.[14] Without public involvement early in the licensing process, it created a significant uncertainty to the company of the probability of gaining an operating license. This uncertain and costly process was further delayed following the nuclear reactor meltdown at TMI. TMI caused significant increases in schedule projections, which resulted in companies incurring significant additional costs.

This early NRC licensing process continued until the NRC established new process for licensing nuclear reactors under Title 10 of the Code of Federal Regulations (10 CFR) in Part 50.[15] The focus of this new licensing process was to remove the uncertainty described above and ensure that the licensing process was efficient and effective. The NRC licensing process used in the birth of nuclear power in the United States lacked a formal standardized process that contained transparency, validity and public acceptance. The issues and concerns regarding the old NRC licensing process helped the NRC and private sector to shift their focus to

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14 Nuclear Energy Institute. "Licensing New Nuclear Power Plants." October 2006. Nuclear Energy Institute. 21 July 2007. <http://www.nei.org/resourcesandstats/documentlibrary/newplants/factsheet/licensingnewnuclearpowerplants>

15 NRC Office of Public Affairs. "Backgrounder on Nuclear Power Plant Licensing Process." July 2005. Nuclear Regulatory Commission. 15 July 2007. <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-bg.html>

standardization. I believe that if the NRC had standardized nuclear designs, processes and procedures prior to the TMI disaster, construction of nuclear power plants would have continued in the U.S. if there were no flaws with the standards being utilized.

STANDARDIZATION OF THE NRC LICENSING PROCESS

> Continued investment in new technologies and processes and the ongoing trend toward operator-supplier alliances should further drive down these operating costs while improving worker safety statistics and further reducing the already-small risk of an accident.[16]

To accomplish the goals mentioned above, the NRC created a new licensing process in 1989 under Title 10 of the Code of Federal Regulations (10 CFR) in Part 50.[17] After the NRC issued their new licensing process, Congress issued the 1992 Energy Policy Act which provided more support for the new licensing process.[18] The focus of the new NRC licensing process was to lower the initial costs of construction through standardization and assist in reducing that small risk accident by utilizing a standard process and reactor design. To make the new nuclear reactor licensing process more efficient and effective, while increasing nuclear power safety standards in the United States, the new licensing process allowed the NRC to "precertify the designs and make sure that they're standard in uniform."[19] By focusing on an efficient licensing process combined with a preapproved standard design, the NRC created the possibility of constructing

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[16] Tritch, Stephen. "Committed to the Growth of the NP Industry." *Nuclear Plant Journal.* Vol. 22, Iss. 2 (Mar/Apr 2004), 17.

[17] NRC Office of Public Affairs. "Backgrounder on Nuclear Power Plant Licensing Process." July 2005. Nuclear Regulatory Commission. 15 July 2007. <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-bg.html>

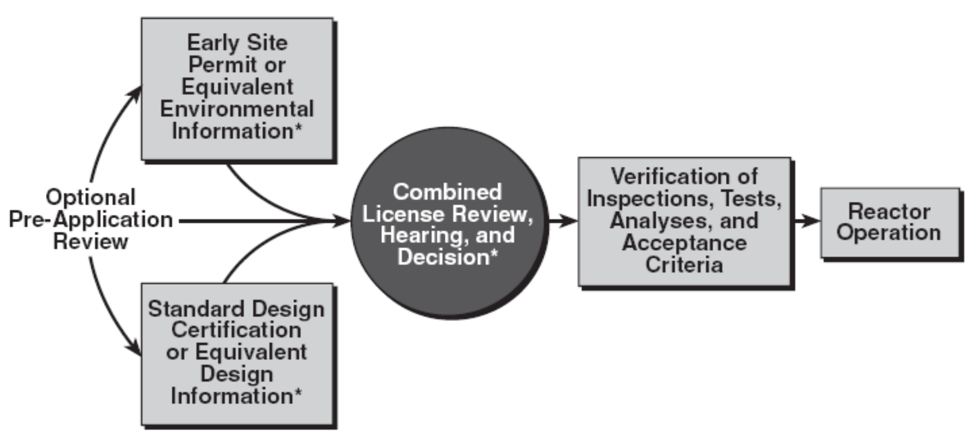
[18] Nuclear Energy Institute. "Licensing New Nuclear Power Plants." October 2006. Nuclear Energy Institute. 21 July 2007.

[19] Klein, dale E. "Three Proposed COLs Expected in 2007." *Nuclear Plant Journal.* Vol. 25, Iss. 2 (Mar/Apr 2007), 28.

more reactors and allowing them to begin operation in a shorter amount of time. This reduction in time will reduce the financial burden on utility companies, while allowing for a rapid increase in nuclear power plants in the U.S.

The new NRC standardized licensing process consists of a design certification review, early site approval, and an issuance of a combined license for operation. Following the issuance of the combined license for operation (COL), the new nuclear reactor must pass the inspections, tests, analyses, and acceptance criteria (ITAAC) to verify that the nuclear reactor is built to the design specification that was approved by the NRC in the design certification stage. Figure 1 below created by the NRC provides a brief overview of this process.[20] One key difference from the early NRC licensing process is that this new process allows for the NRC to review the design of the reactor prior to construction to ensure that any safety or technical concerns regarding the reactor design or nuclear power plant site are addressed prior to construction.

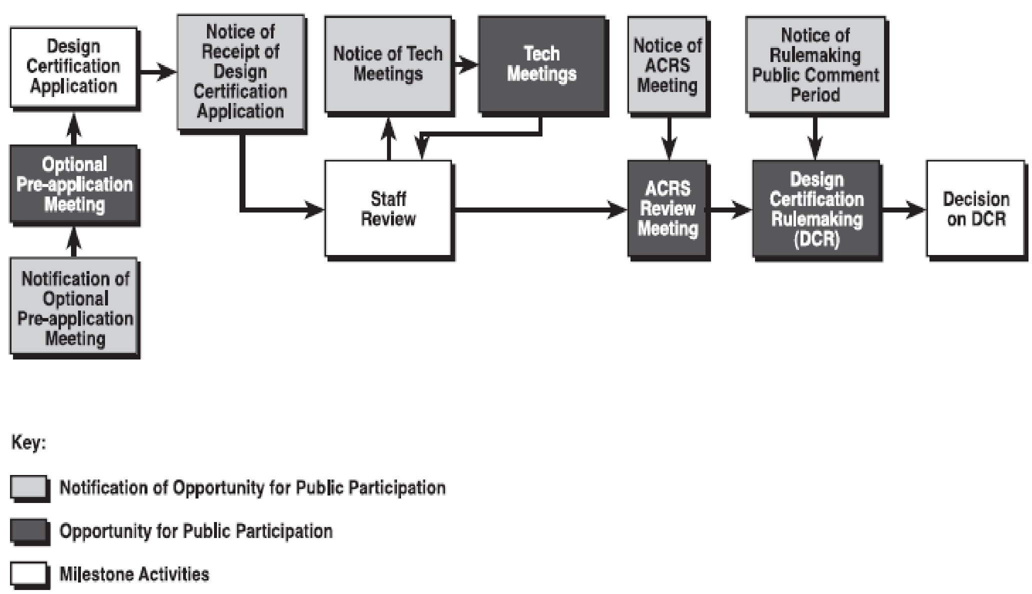
Figure 1 - Relationships Between Combined Licenses, Early Site Permits, and Standard Design Certifications



[20] Office of Public Affairs NRC. “Nuclear Power Plant Licensing Process.” July 2005. U.S. Nuclear Regulatory Commission. 17 July 2007. < http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0298/br0298r2.pdf>

One of the key areas of improvement in the new standardized licensing process is the design certification review. During the design certification review, the NRC conducts a detailed safety and technical review of the reactor design taking approximately 36 to 60 months. During this review, the NRC will determine any safety and technical issues to be raised in a public forum and allow the public, NRC staff and the applicant to respond to the issues that were identified. One major change in the review process is the public involvement in the entire application process. As depicted in Figure 3[21], the NRC has ensured that the new standardized licensing process included the public at all stages. By including the public throughout the licensing process, the nuclear power industry will gain greater public acceptance if issues and concerns can be brought forward and addressed in a public forum.

Figure 3 - Opportunities for Public Involvement During the Review of Standard Design Certifications



21 Office of Public Affairs NRC. "Nuclear Power Plant Licensing Process." July 2005. U.S. Nuclear Regulatory Commission. 17 July 2007. < http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0298/br0298r2.pdf>

The design certification review has proven to add significant benefits to the new licensing process. Currently only four nuclear reactor designs are pre-approved for use including the Advanced Boiling Water Reactor (ABWR) by General Electric Nuclear (1997), System 80+ by Westinghouse (1997), AP600 by Westinghouse (1999), and AP 1000 by Westinghouse (2006). By having all nuclear reactor designs standardized, the NRC wants "the pumps in the same location, switches in the same location, the characteristics to be the same."[22] By standardizing the designs of new nuclear reactors, costs reductions in construction and operations have occurred and efficiencies across the entire nuclear power business have increased dramatically. The approval of pre-approved standardized nuclear reactor designs has also reduced the risks associated with the design certification review process.

The NRC has made significant strides with the issuance of early site approval permits (ESP). ESPs allow companies to gain NRC permission to build a plant on a specific site before gaining permission to actually build the plant. The use of ESPs has significantly reduced the time required to bring a nuclear reactor on-line. Companies can start building upon completion of the reactor design certification review, after receiving an ESP. An ESP consists of a site safety analysis, environmental report and emergency planning information.[23] This stage of the licensing process has been very effective due to the involvement of all government officials and the public throughout the entire process. In Figure 2[24] below, the public has numerous

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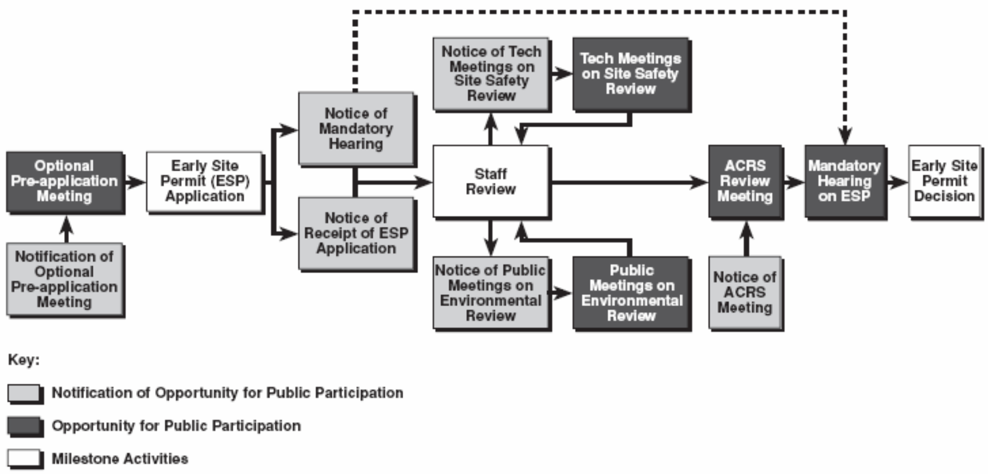
[22] Klein, dale E. "Three Proposed COLs Expected in 2007." *Nuclear Plant Journal.* Vol. 25, Iss. 2 (Mar/Apr 2007), 31.
[23] Nuclear Energy Institute. "Licensing New Nuclear Power Plants." October 2006. Nuclear Energy Institute. 21 July 2007.
[24] Office of Public Affairs NRC. "Nuclear Power Plant Licensing Process." July 2005. U.S. Nuclear Regulatory Commission. 17 July 2007. < http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0298/br0298r2.pdf>

opportunities during the ESP process to raise environmental concerns or possible emergency planning problems not considered prior to the approval of a new future reactor plant site.

Figure 2 - Opportunities for Public Involvement During the Review of Early Site Permits



Under Title 10 of the Code of Federal Regulations (10 CFR) in Part 52, the NRC may issue a construction and operating license called a combined license (COL)[25]. The safety, technical, environmental and emergency planning problems that may have been raised during the design certification review or ESP are determined to be resolved and the COL will only focus on the outstanding issues. Once a company receives a COL, the NRC has determined that the new nuclear reactor can operate safely. Prior to the reactor beginning operation, the NRC must verify that the ITAAC criteria are met and conform with the approved design specification prior to granting permission for the reactor to begin operation. At any time during the COL process, the

[25] Nuclear Energy Institute. "Licensing New Nuclear Power Plants." October 2006. Nuclear Energy Institute. 21 July 2007.

public may request that the NRC hold a hearing to address any concerns or safety issues that may have not been address previously.[26]

> Imagine a nuclear plant design developed with international technology, built by a national manufacturer, adopted by a large customer, approved by the government, and licensed in a cost-effective and orderly fashion. Imagine further a standardized design that is duplicated two dozen times, constantly improved upon, and then referred back to the government before moving ahead with a new generation.[27]

The new licensing process designed by the NRC will control the future success of the nuclear power industry in the U.S. Crafting a process that consists of three defined stages and allows for public involvement at all stages is a significant improvement over the process utilized in the early 1960s. Customers, utility companies, governments, and the world will receive the ability to participate in an efficient and cost-effective licensing process that focuses on delivering safe nuclear reactors to the marketplace in a timely fashion.

However, there are many risks to the new NRC process. The NRC must able to quickly change based on input from companies, staff and government officials on what areas need improvement for future licenses processes. The future success of this process will be dependent upon the ability of utility companies and government agencies to market the possible benefits of a surge in nuclear power in the U.S. It is important to note that no applicant has completed the new NRC licensing process; therefore more potential problems may exist in the current process.

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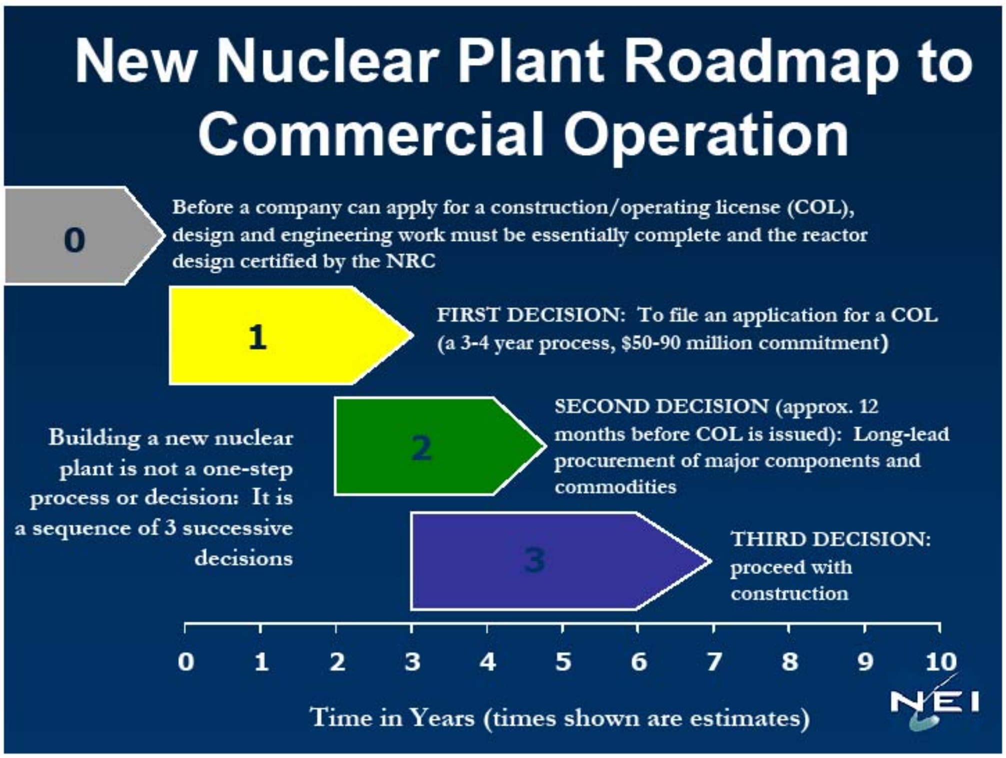
[26] Office of Public Affairs NRC. "Nuclear Power Plant Licensing Process." July 2005. U.S. Nuclear Regulatory Commission. 17 July 2007. < http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0298/br0298r2.pdf>

[27] Bruschi, Howard J. "Standardization: The Key to Nuclear Revitalization." *Public Utilities Fortnightly*. Vol. 127, Iss. 11 (Jun 1, 1991), 23.

As illustrated below in “New Nuclear Plant Roadmap to Commercial Operation”[28] by NEI, the new process is well defined and goals for the completion of each step have been established, however it will be important to track how well most new nuclear reactor plant applications adhere to the estimated timeline. The ability to navigate this three step process will be dependent upon a developed relationship between NRC and the respective utility company to ensure that concerns and recommendations are addressed in a timely manner.



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28 Nuclear Energy Institute. “New Nuclear Plant Roadmap to Commercial Operation.” NEI. 16 July 2007. < http://www.nei.org/filefolder/new_nuclear_plant_roadmap.pdf>

FUTURE DESIGNS OF NUCLEAR POWER REACTORS

> The goal is to make nuclear power cost-competitive with other resources and to enhance safety to a level that no evacuation outside a plant site would be necessary. It should also generate less waste, prevent materials diversion for weapons production and be sustainable.[29]

The standardization process has not only affected the NRC licensing process, but also the development of new reactor designs throughout the world. The focus of the development of new nuclear reactors is to ensure that the reactors would be cost-effective and could be installed anywhere throughout the world for operation. To accomplish this lower cost with more applicability has been the focus of the AP1000 design by Westinghouse. "The AP1000 design incorporates structural as well as equipment modules that allow a significant amount of fabrication and construction efforts to take place in shop environments, with products being sent to the site for installation as assemblies."[30] While AP1000 is on the cutting edge of technology, executives at General Electric believe that their ABWR design meets current demands regarding the need for more safety from terrorists; however future designs should focus on future problems and concerns that may arise.[31]

Because of this need for more reactors throughout the world, the U.S. Department of Energy (DOE) has started the discussion on research and development of a new family of

[29] Majumdar, Debu. "Advanced Reactors Around the World." *Nuclear Plant Journal.* Vol. 21, Iss. 5 (Sep/Oct 2003), 21.
[30] Poirer, Bill. "New Plants with High Safety & Availability." *Nuclear Plant Journal.* Vol. 25, Iss. 1 (Jan/Feb 2007), 25.
[31] Redding, John. "Work on New Designs Should Continue." *Nuclear Plant Journal.* Vol. 20, Iss. 3 (May/Jun 2002), 50.

reactors called Generation IV reactors.[32] These new reactors are going to be designed to address the needs of the citizens of all countries, while reducing waste. The new standardized worldwide designs of nuclear reactors will have a significant impact on the world nuclear power market, but also directly affect the entire licensing process at the NRC.

RECOMMENDATIONS

Based on my research, I have formulated three recommendations to assist in the further standardization and development of nuclear power in the U.S. and the world. These three recommendations will focus on education, International Atomic Energy Agency (IAEA) standardization and forward-looking nuclear reactor designs.

The most lacking aspect of the development of nuclear power in the U.S is a comprehensive marketing plan. This marketing plan should focus on explaining the numerous benefits and minimal risks associated with nuclear power. Amazingly enough, "the public favoring nuclear energy is 64 percent – close to an all-time high"[33] The public must become knowledgeable regarding the actual safety statistics of nuclear reactors in the U.S. because I believe that most people would be shocked at its excellent track record.

Secondly, the IAEA must standardize nuclear reactors worldwide to gain further public acceptance of nuclear power and create economies of scale for the production of nuclear reactors. DOE is currently moving the standardization of nuclear reactors forward with the Generation IV reactors; however IAEA has access to the entire world and can provide a much larger impact for the worldwide nuclear power industry.

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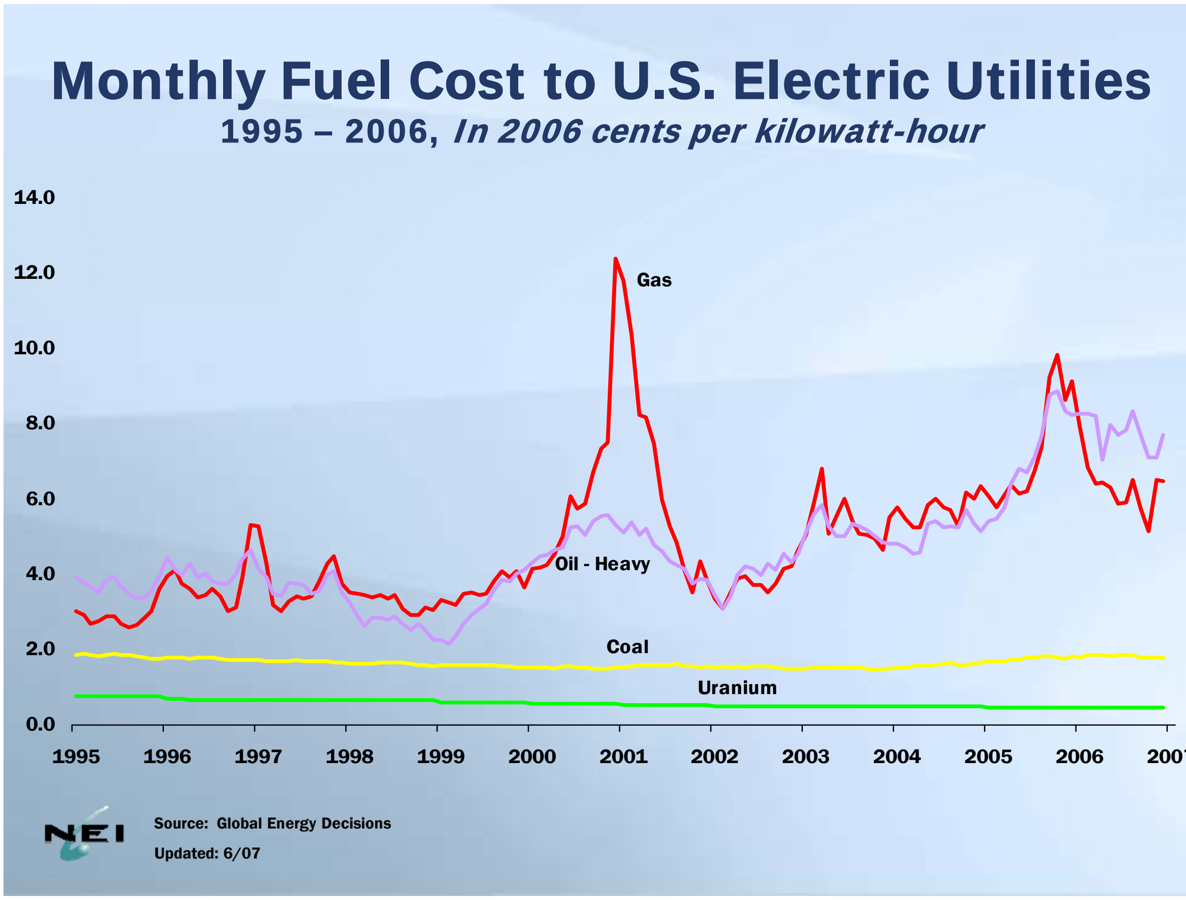
[32] Majumdar, Debu. "Advanced Reactors Around the World." *Nuclear Plant Journal*. Vol. 21, Iss. 5 (Sep/Oct 2003), 22.
[33] Hintz, Donald C. "The Nuclear Energy Industry: The Importance of Nuclear Energy in the Future." *Vital Speeches of the Day*, Vol. 69, Iss. 18 (Jul 1, 2003), 561.

Lastly, companies and government agencies must remain focused on forward-looking nuclear reactor designs to combat possible global warming effects on already approved nuclear reactor sites and future advancements by terrorists to attack nuclear power plants. Developers must ensure that new reactor designs have the ability to readily upgrade their containment and safety features to mitigate the effects of a possible terrorist attack. These new reactor designs must also focus on increasing safety standards of all reactors. An increase in safety standards will lower the risk of failure to an even smaller possibility, while gaining further public acceptance due to the measures being taken to ensure safety.

FURTHER RESEARCH

Future research regarding the standardization of nuclear power should focus on illuminating the benefits of a reduction on oil, lower construction costs and lower greenhouse gases. An increase in nuclear power production would reduce worldwide dependency on oil and have numerous political and economic impacts throughout the world. A nuclear power surge would also lower production costs by creating economies of scale and allow more countries the opportunity to purchase nuclear reactors. Lastly, nuclear power revitalization would result in a reduction in the production of greenhouse gases due to a reduction in the use of coal, oil and gas. A reduction in greenhouse gases would have a positive effect on global warming and result in a significant benefit for the entire world and future generations.

Looking at this graph[34] created by NEI, a surge in nuclear power would result in a worldwide economy that is less dependent upon the fluctuation in the price of gas and oil which would have a positive economic and political impact for the entire world. The research of this effect on the political and economic framework of the world could have significant impact on the decisions made by political and government leaders regarding the future of nuclear power.



34 Nuclear Energy Institute. "Monthly Fuel Cost to U.S. Electric Utilities." June 2007. NEI. 15 July 2007. <http://www.nei.org/resourcesandstats/documentlibrary/reliableandaffordableenergy/graphicsandcharts/monthlyfuelcosttouselectricutilities/>

CONCLUSION

The future of nuclear power in the U.S and the world depends upon the standardization of all facets of nuclear power including the licensing process, reactor designs, operating procedures and training. The early NRC licensing process failed to provide a standard format for new nuclear reactors to be reviewed, licensed and delivered to the marketplace. Following TMI, the public opinion regarding nuclear power waned due to a fear for safety. The new NRC licensing process contains a detailed process for new nuclear reactors to be reviewed for technical and safety issues.

To revitalize nuclear power in the U.S., citizens, executives and government officials must be educated on the benefits and risk of nuclear power and the plan for the future. The NRC must be ready to address all concerns regarding the licensing process in a timely manner to ensure that there is continuous process improvement. With the NRC working closely with political leaders and company executives, the new licensing process will become an open exchange of ideas and recommendations which will allow all stakeholders to plan and prepare to combat problems of the future.

The future of the United States is dependent upon its ability to effectively manage its energy resources to accomplish the goals of the country. U.S. is currently focused "to ensure that nuclear energy continues to be a part of the nation's energy future – to use nuclear energy as a mainstay in improving our nation's energy security."[35] Nuclear power executives and regulators must ensure that the standards of all facets of nuclear power are correctly established to allow nuclear power the opportunity to provide the energy of the future.

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[35] Hintz, Donald C. "The Nuclear Energy Industry: The Importance of Nuclear Energy in the Future." *Vital Speeches of the Day,* Vol. 69, Iss. 18 (Jul 1, 2003), 561.