

# **Sustaining U.S. Commercial Nuclear Power with Innovative Security Technologies**

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## **Abstract**

In this paper I will discuss the benefits of engaging with commercial nuclear power utilities, the U.S. Nuclear Regulatory Commission and DOE National Laboratories to explore the use of innovative security technologies to sustain the commercial nuclear power industry. While the U.S. commercial nuclear power industry is among the most robust and well protected critical infrastructures in the world, increased costs of regulation in Nuclear Security since the terrorist attacks of 9/11 threaten the long-term operation and future of the existing fleets. America's current operating nuclear reactors provide roughly 60 percent of the nation's zero-carbon electricity generation in an age where clean electricity generation is believed to be fundamental in the fight against climate change. There is one nuclear power plant under construction in a nation that has not seen a nuclear power plant built in over 40 years. This indicates the only way to sustain nuclear power generation in the U.S. is through sustaining the current operating fleets, which continue to see plants being shut down due to high operating costs. The nuclear industry and NRC have been successful in establishing guidance necessary to renew a nuclear reactor license for up to 80 years of operation through subsequent license renewal (SLR) with three applications submitted in 2018 and further data indicating over half of the industry will follow. Recent milestones have been achieved to initiate digital innovation needed to replace dated analog controls and increase efficiencies of systems used to operate the plants. Implementation of innovative security technologies could also decrease operating costs. Past industry and NRC disagreement on increasing use of innovative security technologies without decreasing the overall effectiveness of plant security has historically produced zero results. The results and conclusions of this research validate why now is the ideal time to pursue the implementation of innovative security technologies needed to sustain the commercial nuclear power industry in the U.S.

## **1. Introduction: State of Sustaining Nuclear Industry**

The commercial nuclear power industry in the United States currently provides 20% of the nation's electricity generation through the operation of 99 reactors, most of which are located on the east coast. Within this 20% of electricity generation, nuclear power is also providing roughly 60% of the nation's zero-carbon electricity. On both sides of Congress, zero-carbon electricity generation continues to be a topic of discussion and necessity in the fight against climate change as well as the U.S. meeting its own clean-energy generation objectives. Be that as it may, recent years have shown the struggle of nuclear power to maintain its foothold in American's energy portfolio by the rate of premature plant shutdowns occurring and the nation will continue to see occur as demonstrated in Figure 1.

Premature Nuclear Power Plant Closures and Announced Shutdowns					
Plant	MWe	Closure Year	Reason	Final Year Generation (billion kWh per year)	Final Year CO2 Avoided (M tons/year)
Crystal River 3	860	2013	Mechanical	7.0	3.8
San Onofre 2 & 3	2,150	2013	Mechanical	18.1	8.0
Kewaunee	566	2013	Market	4.5	3.8
Vermont Yankee	620	2014	Market	5.1	2.4
Fort Calhoun	478	2016	Market	3.4	3.3
<b>TOTAL</b>	<b>4,674</b>			<b>38.1</b>	<b>21.3</b>
Oyster Creek	610	2018	Policy	5.4	4.0
Three Mile Island 1	803	2019	Market	6.9	5.0
Pilgrim	678	2019	Market	5.1	2.3
Davis-Besse	908	2020	Market	7.9	5.7
Duane Arnold	619	2020	Market	5.2	5.0
Indian Point 2 & 3	2,061	2020-2021	Market & Policy	15.3	7.1
Beaver Valley 1 & 2	1,872	2021	Market	15.3	11.1
Perry	1,268	2021	Market	9.8	7.1
Palisades	789	2022	Market	6.1	5.3
Diablo Canyon 1 & 2	2,240	2024-2025	Policy	17.9	6.9
<b>TOTAL</b>	<b>11,848</b>			<b>94.9</b>	<b>59.5</b>

Source: NEI 2018 Survey

Figure 1. Premature Nuclear Plant Closures and Announced Shutdowns. [1]

Nuclear power generation has maintained its place in the nation’s energy portfolio for decades, producing clean, reliable baseload power. Nuclear power plants operate under stringent safety standards as mandated by the U.S. Nuclear Regulatory Commission (NRC), the Institute for Nuclear Power Operator (INPO) safety and human performance standards and the Occupational Safety and Health Administration (OSHA). Overall, the level of safety and human performance at nuclear power plants serves as a model for other critical infrastructures, not only within the U.S., but throughout the entire world. Even after the occurrence of the Fukushima-Daichi incident following the March 11, 2011 earthquake and tsunami off the coast of Japan, which the entire world watched unfold on television, the U.S. nuclear industry was able to weather the storm of fear and doubt clouding nuclear power after the incident. Following Fukushima-Daichi, the U.S. nuclear industry worked with the NRC to implement additional policies and safety measures to significantly reduce the possibility of a Fukushima-type incident ever occurring in the U.S. For the Fukushima-Daichi incident, as with the disasters at Three-Mile Island in 1979 and Chernobyl in 1986, the U.S. nuclear industry was able to survive and continue to maintain its place in U.S. electricity generation.

The U.S. nuclear industry’s safety reputation, baseload electricity generation capacity and ability to remain resilient through the implementation of changes following nuclear-related catastrophes, either due to human error or even natural events are not enough to withstand the impacts of a changing energy-market environment within the U.S. as illustrated in Figure 1. Falling energy prices due to the abundance of cheap natural gas from fracking, the increased interest in moving toward renewable energy generation from wind and solar, as well as a reduction in electricity demand due to increased energy efficiencies has resulted in a significant drop in energy prices in various regions of the country (Figure 2).

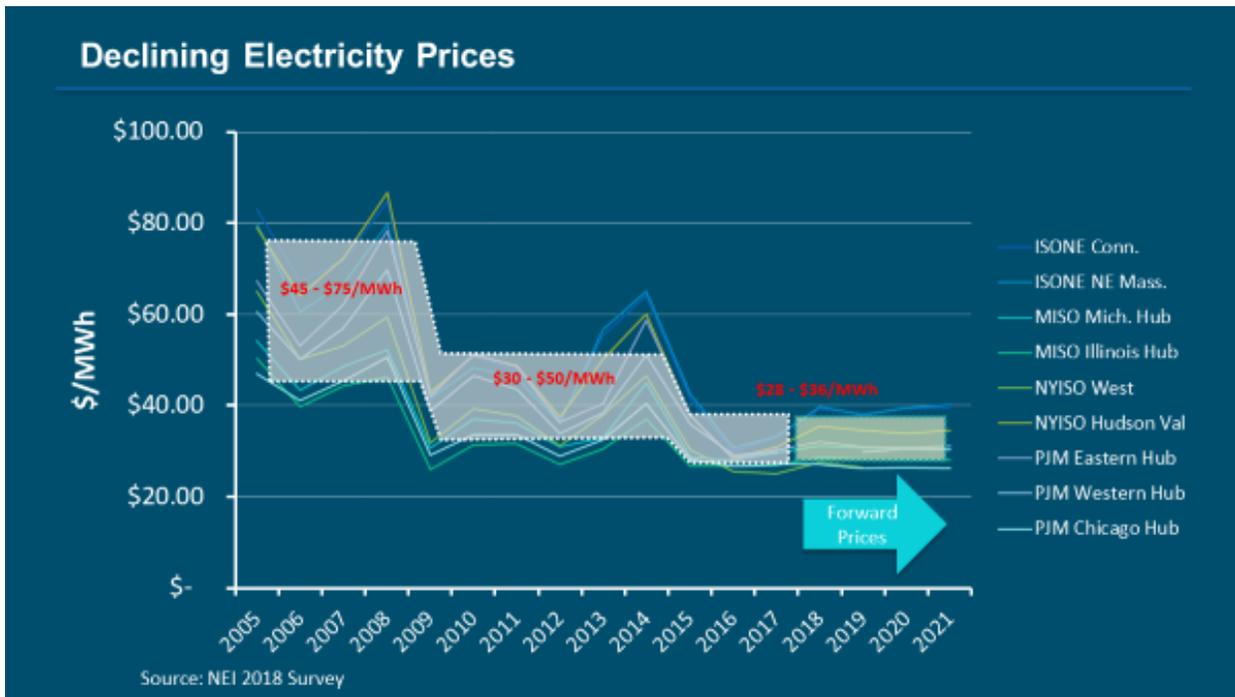


Figure 3. Declining Electricity Prices. [2]

The U.S. nuclear industry must adopt a renewed or revised method of resiliency to sustain the existing operating fleets, maintain its current position in the nation’s energy portfolio and ensure a steady platform remains for licensing and construction of advanced nuclear technologies of tomorrow. There is a mindset and perhaps even a culture shift beginning to take place within nuclear power in the U.S., being shaped by the acceptance of the need to ensure the long-term operation of the nation’s existing fleets, as well a validated concern regarding the aging and obsolescence of instrumentation and control systems currently used to operate the plants, some of which are remnants of World War II era technology in use since a plant’s initial construction and start-up. The succeeding sections of this paper will expand on the current direction in extending the licenses of the existing nuclear fleets, efforts to initiate digital transformation and spur technological innovation within the nuclear industry, as well as the significant impact nuclear security technology innovations could also have in reducing what is widely considering within the nuclear industry as the most significant financial burden impacting nuclear power in the U.S., due to increased nuclear security requirements since the terrorist attacks of 9/11.

## 2. Challenges in Nuclear Security

Maintaining security of commercial nuclear power plants to protect against deliberate acts of terrorism has always been a concern but was significantly elevated to a national security issue following the terrorist attacks of September 11, 2001. [5] Congress subsequently enacted new security requirements for commercial nuclear power and has repeatedly focused attention on regulation and enforcement by the NRC. The NRC and industry approach to maintaining effective security at a plant includes various security programs, each with its own individual objectives that when combined provide a holistic approach to maintaining effective security of a plant.

Since the terrorist attacks of 9/11, there has been a continued build-up within these various security programs for commercial nuclear power producing what is widely considered to be the most robustly fortified and protected commercial critical infrastructure in the entire world. The increased level of security of nuclear power generation over the past 17 years has resulted in a commercial critical infrastructure that is nearly impenetrable. 17 years after the 9/11 attacks, security at nuclear plants remains an important concern for the NRC, the commercial nuclear power industry and the nation. This has come at a very high cost for the nuclear power industry that cannot be sustained in the current energy situation impacting our electricity generation, particularly in consideration of the recent and pending nuclear power plant shutdowns our country has continued to see over the past several years as shown in Figure 1.

The Force-on-Force Triennial Inspection Program was once described by the Director for the Office of Nuclear Security and Incident Response (NSIR) at the NRC, Jim Wiggins, as the most complex and complicated inspection program in the entire NRC. [11] An NRC Force-on-Force inspection occurs every three years at a plant and is designed to test the effectiveness of the site's security programs, procedures, protective strategy, and competency of the security force in protecting the plant against a terrorist attack intent on causing radiological sabotage. The mock adversary force used by the NRC and the industry to conduct these simulated assaults is referred to as the Composite Adversary Force (CAF), which is made up of Security Officers from the industry that have been selected to perform as a CAF team member for a designated period, generally not to exceed three years. The CAF conducts an assault on the plant in accordance with the Design Basis Threat (DBT) established for the nuclear power industry by the NRC in consideration of terrorist activities which have occurred throughout the world. The DBT establishes the weapons, equipment, knowledge, capabilities, level of training and tactical expertise the CAF may use in developing scenarios used to conduct a simulated attack on the plant. The DBT is also used by the NRC and the nuclear industry to determine the overall level of security required to effectively protect a plant. [12]

Although the Force-on-Force inspection has been described by the NRC as complicated and complex, as well as being referred to by nuclear power industry security professionals as "career week," there have been considerable accomplishments made in recent years to relax some of the dynamics of this inspection program. A prevalent reason nuclear why security professionals have referred to this inspection as "career week" has been due to the extreme approach used over the years in grading each Force-on-Force exercise. In the past, if the CAF team was able to reach a scenario objective designed to cause radiological sabotage successfully, it would be deemed a failed exercise and essentially paint the entire Force-on-Force inspection for that plant as a failure. Extreme measures had been considered and even taken in the past, such as notifying the governor of the state where the nuclear power plant is located and calling on the National Guard to augment the plant security force, all due to a failed exercise.

In 2014, members of the NRC and the Nuclear Energy Institute (NEI) developed a white paper to provide an alternate approach to conducting the Force-on-Force Triennial Exercise Program. [7] In consideration of the robust nature of the security programs at the plants since 9/11, the white paper provided recommended changes to the exercise program, based on a holistic approach to a nuclear plant's overall security program effectiveness and grade the exercises more consistently with the inspection programs throughout the rest of the NRC Reactor Oversight Process (ROP).

In doing so, the NRC proposed revising the security significance determination process (SDP) to reflect this new approach. Rather than deem an exercise a failure, the utility would conduct an evaluation on the cause of an issue identified during an exercise and implement corrective actions through internal site programs. The NRC may issue an inspection finding based on the severity of the issue and conduct follow-up inspections if deemed necessary.

An additional benefit of this holistic approach was recognition and credit to industry for the numerous site-conducted Force-on-Force exercises throughout the year, referred to as annual exercises. The new approach required a regional NRC inspector to observe an annual exercise at least once during an 18-month period. This would provide a licensee credit for the conduct of an effective NRC-observed exercise and would subtract one graded exercise from the triennial inspection, resulting in two NRC graded exercises conducted once every three years. The white paper also included additional recommendations to justify reducing the number of NRC graded exercises to one NRC exercise every three years. This is scheduled to be implemented in 2020 and should certainly serve to reduce the amount of site resources dedicated to an FOF inspection and will predictably change the industry's perception of a FOF inspection as "career week."

As positive a direction as this may be for nuclear security, reduced site resources dedicated to a FOF inspection that only occurs once every three years combined with an improved industry perception of the program does not equal the reduced costs that are needed in security to help sustain the nuclear power industry. What this does establish is the NRC's receptiveness to new concepts that can be implemented to demonstrate a licensee's ability to successfully protect the plant against radiological sabotage and protect the health and safety of the public, while recognizing other areas within a licensee's security programs that demonstrate its overall effectiveness in protecting the plant.

### **3. NRC Commission Overview**

The Honorable Kristine Svinicki was designated Chairman of the NRC by President Donald J. Trump on January 23, 2017. Last year, she was sworn in for her third term as a Commissioner to a term ending on June 30, 2022. She began her service on the Commission in 2008. The Honorable Jeff Baran was sworn in as a Commissioner on October 14, 2014. He is currently serving a term ending on June 30, 2023. The Honorable Stephen G. Burns was sworn in as a Commissioner on November 5, 2014, to a term ending June 30, 2019. He served as the 16th Chairman of the NRC from Jan. 1, 2015, through Jan. 23, 2017. The Honorable Annie Caputo was sworn in as a Commissioner on May 29, 2018 and is currently serving the remainder of a five-year term ending June 30, 2021. The Honorable David A. Wright was sworn in as a Commissioner on May 30, 2018 and is currently serving the remainder of a five-year term ending June 30, 2020. [3]

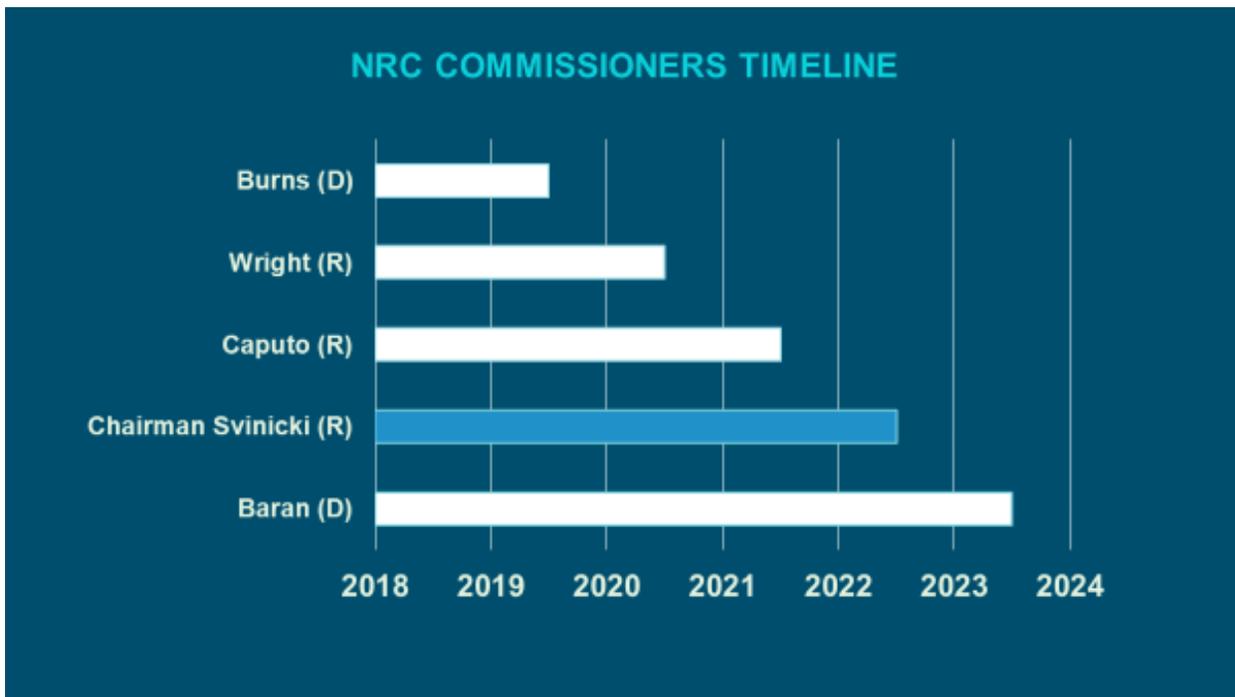


Figure 4. NRC Commissioners Timeline. [3]

The NRC as currently staffed is at a full five Commissioners under the leadership of a Chairman with an extensive history in promoting national policies related to nuclear energy technology. Before joining the NRC, Chairman Svinicki spent over a decade as a staff member in the U.S. Senate advancing a wide range of policies and initiatives related to national security, science and technology, energy and the environment. She also served as a professional staff member on the Senate Armed Services Committee where she was responsible for the Committee's portfolio of defense science and technology programs and policies, and for the atomic energy defense activities of the DOE, including nuclear weapons, nuclear security, and environmental programs. She previously worked as a nuclear engineer in the DOE's Washington, D.C. Offices of Nuclear Energy, Science and Technology, and of Civilian Radioactive Waste Management, as well as its Idaho Operations Office, in Idaho Falls, Idaho. [3]



In consideration of Chairman Svinicki's extensive background related to promoting nuclear energy policy, her history and experience as an NRC Commissioner, as well as the history and experience of the other four Commissioners, the NRC staff is operating under a full Commission with exceptional leadership. Further, the NRC Commission, particularly the Chairman, has demonstrated support on the importance of success in Subsequent License Renewal (SLR) to license and operate U.S. reactors from 60 to 80 years. There are currently three nuclear power plant licensees with SLR applications (SLRA) submitted to the NRC: Florida Power & Light's Turkey Point submitted in January, 2018, Exelon's Peach Bottom submitted in July, 2018, and Dominion Energy's Surry submitted in October,

2018. Recent industry surveys indicate more than half the existing fleet of nuclear reactor licensees in the U.S. intend on submitting SLRAs, as demonstrated in Figure 3.

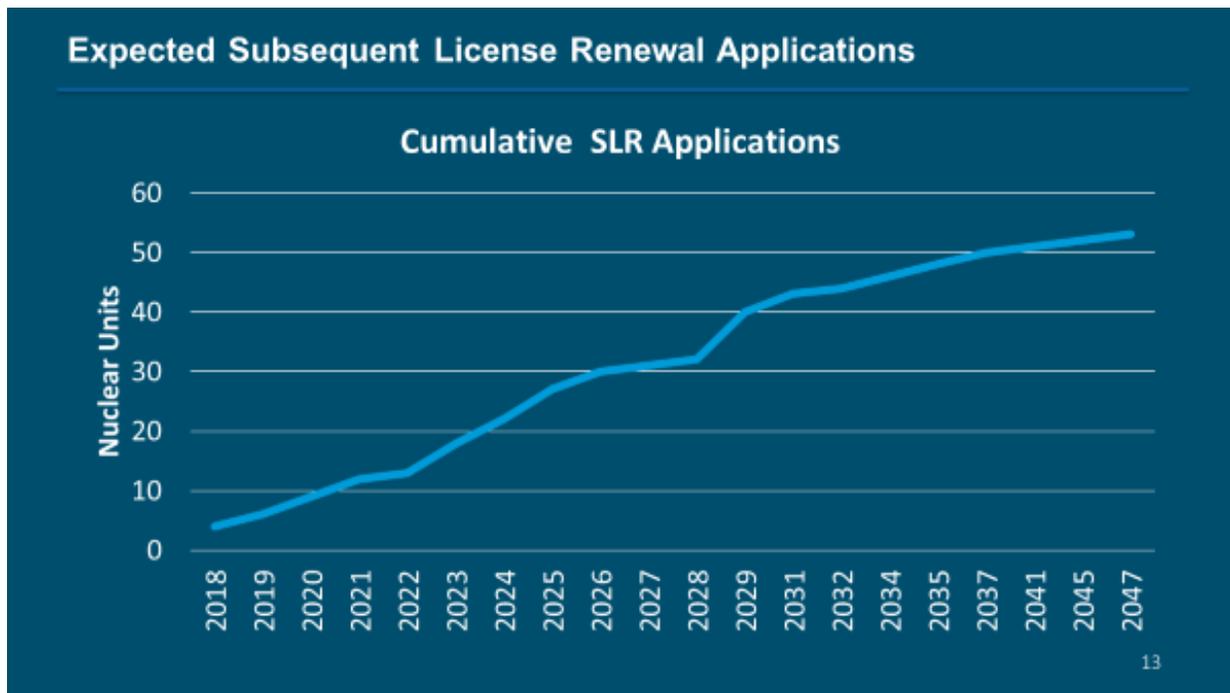


Figure 4. 2018 NEI Subsequent License Renewal Industry Survey. [4]

Chairman Svinicki has also shown a keen interest in the success of the Digital Instrumentation and Control initiative (DI&C) to initiate digital transformation and modernize the existing plants. Recent data collected by NEI through a series of 12 DI&C implementation workshops demonstrates a significant number of planned digital upgrade projects for both safety and non-safety related systems are both planned and currently taking place across the nuclear industry. Based on this information, the NEI/industry lead for both SLR and DI&C at the time, and individual responsible for both facilitating and conducting the workshops, concluded that digital transformation of the nuclear power industry was actively underway. Although the full series of workshops had not been completed yet, he had collected data of over 60 planned digital upgrades scheduled across the industry, some of which were scheduled to both begin and be completed within 2018. On the day these workshops were scheduled to kick off, the current Chief Nuclear Officer (CNO) at NEI, Bill Pitesa, met with Chairman Svinicki and discussed at length the purpose and intended objectives of these workshops. [9], [10]

This data is significant due to the relationship between SLR and DI&C. As was validated through interactions between the NEI representative and industry members attending the workshops, success in DI&C has a direct correlation with success of SLR. Although NRC and industry guidance is available to successfully renew the license of a reactor from 60 to 80 years, due to the uncertainty of energy markets impacting the commercial nuclear power industry combined with the high costs of operating a plant, successful operation to 80 years is not guaranteed even though the renewed license has been approved and granted by the NRC. The onus falls on the nuclear industry to solve the problem of how plants will continue to operate safely and efficiently while continuing to reduce costs over the extended life of the plant. The

answer to solving this problem lies in plant modernization through digital innovation. Both the NRC Commission and the nuclear power industry realize that regardless of the U.S. nuclear industry's exceptional safe operating history, the current operating fleets in the U.S. fall far behind other critical industries in terms of digitalization, automation and more efficient, modern technology. All indications are the NRC Commission supports this direction.

#### **4. Security Technology Innovation**

In consideration of how nuclear security and even security in other critical infrastructures has evolved through the years, particularly with the expedited rate in security and defense innovation since the terrorist attacks of 9/11, advancement in security concepts and equipment is not such a novel idea. Majority of equipment used to perform tasks that were once required to be performed by a person have become so commonplace that the idea of having a person perform that task now seems absurd and completely unnecessary. Some examples of these types of security technologies are the explosive and metal detectors, X-Ray machines, Intrusion Detection Systems (IDS) and closed-circuit television systems (CCTV) that are fixed and can provide playback of occurrences. Consider advancements made in the weapons and equipment Nuclear Security Officers and Responders are using today. Not 20 years ago, nuclear plant security personnel were using revolver pistols and shotguns as the sidearm and response weapon. In present day, most utilities have mimicked law enforcement with use of the Glock and AR-15 assault rifle equipped with advanced optics and laser/light technology.

Advancements in technology and how quick the human mind is to forget when or how humans were performing tasks these technological devices are used to perform for us today can be seen far beyond the security and defense arena. The average 20-year old of today essentially cannot imagine life without a smartphone or tablet; a world of information and technological capability fitting within the palm of one's hand that at one time took up enough space to fill an entire warehouse. At least for advanced countries, technology has changed everything about how we conduct our lives from shopping, entertainment, education and social media to fighting our wars. As our world moves forward with pending technological innovations such as Artificial Intelligence (AI), automation and robotics, how we perform the tasks we are performing ourselves today will be forgotten as a result of the technological innovations of tomorrow.



Technological advancements needing to be pursued in nuclear security most immediately are those innovations with a proven track record of reliability and effectiveness either in other critical infrastructures or the theatre of war. The tasks these technologies perform in these other areas are either very similar to, identical, or far exceed the requirements needed to maintain protection of a nuclear power plant. A typical responsibility of a Security Officer or Responder similar to that of

the military is patrolling designated areas of land or property either via foot patrol or vehicle patrol. Advancements in drone technology have gone so far beyond satisfying this requirement that our military and federal agencies are even using this technology to fight our wars by

surveilling and launching hellfire missiles to destroy our enemies. The use of drone technology combines the familiarity the younger generation has with video gaming with the need to remove a human or multiple humans from conducting assigned duties in a hazardous environment, whether that environment be the battlefield or an environment such as a Security Officer's where a person is expected to walk, sit or stand for hours on end while being equipped with over 30 pounds of gear and equipment. Not to mention the fact that the use of drones to conduct security patrols could potentially eliminate the need for multiple humans performing that task all while maintaining the effectiveness of plant protection.

The proper design and implementation of remotely operated weapons systems (ROWS) could be used to maintain the effectiveness of the site protective strategy by replacing armed responders in fixed and elevated positions at the plants. Comparable to drone technology and as the name implies, these systems are remotely operated from an operator who could be responsible for multiple response positions each equipped with a ROWS system. Returning to the previous point of how difficult it can be to imagine performing certain tasks without the use of technology, a nuclear security professional should attempt to imagine life overseeing protection of a nuclear plant without the

technology used in the Central Alarm Station (CAS) or Secondary Alarm Station (SAS) now. How did nuclear security responders and supervisors



perform the tasks that the CAS and SAS are used to perform now, before the advancements in IDS and CCTV technology? This would be hard to imagine in consideration of the capabilities a plant security force now has in responding to a threat with the assistance of technology. The key comparison to make between a qualified CAS/SAS operator and a qualified ROWS operator is that the functions of a ROWS operator are nearly identical to that of a CAS/SAS operator; the operator is controlling a piece of plant equipment used to perform a security-related function from an enclosed, fixed position. Further, the technology used to operate the ROWS is nearly identical to the CAS/SAS technology.

Significant technological innovations have been achieved in AI, robotics and automation to date. Today, we can walk into a McDonalds to order, pay for and pick up a meal without any interactions with another human being. This has been achieved successfully, effectively and efficiently with the intention of using AI to take the place of a person that for years performed a mundane, repetitive task. Regardless of the limited skill sets needed to perform this function, it was a necessary function in order to deliver fast food to another person as efficiently as possible. Comparably, most airlines now use similar AI kiosks to check passengers for flights reducing the human-to-human interactions at an airport while significantly increasing the effectiveness, efficiency and timeliness of air travel. This process may even be augmented through use of airline smartphone apps resulting in even more efficient air travel. There are opportunities within nuclear security to increase efficiency of certain security processing responsibilities while decreasing manpower currently required to perform these simple functions. In consideration of



the tasks being effectively performed by these two AI technologies in two different industries, the task of visitor processing by security officers at a nuclear power plant could potentially be eliminated through implementation of similar AI technology.

What should be realized in consideration of these three examples is the fact that although these are only three examples,

they are three conceptually very different examples of technology innovation that could resolve three conceptually different challenges across nuclear power plant security. All three technology innovations could be used to improve and enhance the effectiveness of plant security while adding efficiencies and improving performance of the security force without the need for additional manpower. Any nuclear power plant security manager or nuclear industry fleet security director would likely conclude that a security program moving in this direction would result in less staffing needed to maintain the effectiveness of site security programs. Someone in this position would likely conclude that an industry moving in this direction could continue to see numerous security technology innovations and significant staff reductions for long-term operations, all while maintaining effective plant security programs.

## **5. Initiating Technology Innovation in Security**

Challenges to achieving technological innovation and efficiencies to improve performance of security at nuclear power plants can be overcome through facilitating the active engagement of impacted stakeholders. These stakeholders being the commercial nuclear power industry, the NRC and DOE national laboratories. The nuclear power industry obviously being the end user and stakeholder most impacted by the benefits of innovation in security and responsible for the ultimate implementation of new security technologies at nuclear power plants. The NRC as the regulator responsible for ensuring the safe operations through policy development and inspection of nuclear power plants across the U.S. The DOE national laboratories due to the extent of cutting-edge research and development being performed at certain DOE national labs focused on national and nuclear security technology innovation. This research and development could prove fundamentally helpful in establishing initial NRC policies and regulations for new security technologies in the nuclear power industry, as well as the national labs assisting and partnering with the nuclear industry in the piloting, testing and implementation of new security technology throughout the commercial nuclear industry.

## **6. Security's Impact to Sustaining Nuclear Power**

Years of discussion among the members of NEI's Nuclear Strategic Initiatives Advisory Committee (NSIAC), which consists of the CNOs of NEI's member utilities that meet quarterly to discuss regulatory initiatives impacting nuclear power, has revealed plant security to be among the largest, and possibly the single largest cost currently impacting operating budgets at a nuclear power plant. Since the terrorist attacks of 9/11, the cumulative impacts of regulation related to enhancing security programs to address an elevated threat have been substantial. Whether due to issues with the Force-on-Force Inspection Program, enhancements to plant physical security or

implementation and inspections related to Cyber Security, the budget required to maintain the security department at a nuclear plant often exceeds that of the Operations Division. Along with these security program enhancements has brought the need for additional security staffing. An example of staff build-up of security to meet NRC requirements is that of Southern California Edison's (SCE) San Onofre Nuclear Generating Station (SONGS) after 9/11. The Security Division at SONGS went from a full staff of about 140 in 2001 to a full staff of over 500 by 2005. This nearly 300% increase in security staffing and costs for SONGS is a typical example of the intense and immediate increase in resources that was placed on the commercial nuclear power industry after 9/11 with no easing of security requirements since and by all indications, no end in sight.

If good news is to be found in the current situation impacting the commercial nuclear power industry, it is to be found in the current direction of the NRC and nuclear industry in SLR and DI&C. The SLR and DI&C initiatives illustrate the industry and regulator's pursuit of not only renewing operating licenses for up to 80 years, but to establish a framework that will finally allow the nuclear power industry to pursue technological innovations needed to help it remain in operation and remain relevant in the U.S.'s diverse energy portfolio for up to 80 years. These two initiatives combined help to sustain the nuclear power industry and essentially prevent it from going extinct within the U.S.; however, it will take more than the success of these two initiatives alone to sustain the nuclear power industry. Technological innovation should not and cannot be limited only to safety and non-safety plant operating systems through the SLR period. In pursuing SLR and DI&C, utilities should look to other areas within a plant where technological innovation could serve to ensure the long-term operational success of a plant. There is no better area to look to improve efficiencies than an area where the level of innovative research and development (R&D) has soared due to elevated terrorist activities and threats, as well as the need to save lives on the battlefield. Not only has the R&D in this area soared, but the technological advancements have been tested against real-world threats and have proven effective in delivering the intended results. This is an area where technological innovation could serve to ensure the commercial nuclear power industry's success of SLR and innovative modernization that is essentially untouched at this point. Not to mention the psychological effects that proactive innovation to reduce costs in the most expensive operating requirement could have on an industry that has continued to struggle and see plants repeatedly decommissioned for no other reason than the fact that it has become too expensive to either build or operate a nuclear power plant in the United States. Make no mistake about it, this industry needs hope just as equally as it needs sound regulation if it is going to survive.

## **7. Conclusion**

The sections of this paper and purpose of this research are intended to provide an overview of the current state of the commercial nuclear power industry in the U.S., leadership at the NRC, current initiatives being pursued to sustain nuclear power, the impact Nuclear Security technology innovations can have to sustain the nuclear industry, but most importantly, why now is the ideal time to initiate engagement on this. The reason now is the ideal time to pursue technology innovations in Nuclear Security is due to everything that has just been listed and described, is currently happening all at once. All things considered, this is very positive and quite amazing. The commercial nuclear power industry and the NRC together are at a crossroads.

However NRC and the industry decide to do business will either prolong the existence of nuclear power or bury it.

Let us evaluate this a little further. Through the industry and NRC's pursuance of SLR and DI&C for extended operation and plant modernization, all indications seem to be in the direction of prolonging the nuclear industry's existence. The NRC's senior leader has an extensive background in promoting nuclear power and policy not only related to generation, but also nuclear defense and security, and as we all know, the senior executive sets the tone and culture for the entire organization. To touch back on plant modernization and the DI&C initiative again, the NRC is warming up to the idea of using advanced technology to replace safety-related systems needed to operate the plant. If the NRC is open to licensing and implementation of innovative technology to operate the plant (systems needed to ensure safe shutdown of the reactor), a compelling argument can and should be made to allow the industry to use advanced, innovative technology to help protect the plant, which is fundamental to maintaining health and safety of the public. Let us not forget the milestones that have been achieved in Nuclear Security related to reducing the Force-on-Force Triennial Inspection Program from three down to two exercises in 2014, with an intended outcome of one exercise every three years by 2020. This also demonstrates an NRC Commission and technical staff open to new ideas and concepts in security inspections and programs so long as the effectiveness of security programs and site protective strategy are not decreased.

All this information considered in addition to the extensive, cutting edge R&D for nuclear security and defense being conducted at DOE's national laboratories provides the perfect opportunity for a partnership between the commercial nuclear power industry and the DOE national labs in pursuing and implementing innovative security technologies. This partnership and joint engagement with the NRC is needed to develop the very security technologies that will help sustain and modernize commercial nuclear power generation in the U.S. for up to and potentially beyond 80 years of continued operation.

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