PROJECT AIM 2020

DELIVERING OUR FUTURE

# Appendix E – Landscape Assessment and Scenarios
# July 18, 2014

*If we could first know where we are, and whither we are tending, we could then better judge what to do, and how to do it.* President Abraham Lincoln

*Change is the law of life. And those who look only to the past or present are certain to miss the future.* President John F. Kennedy

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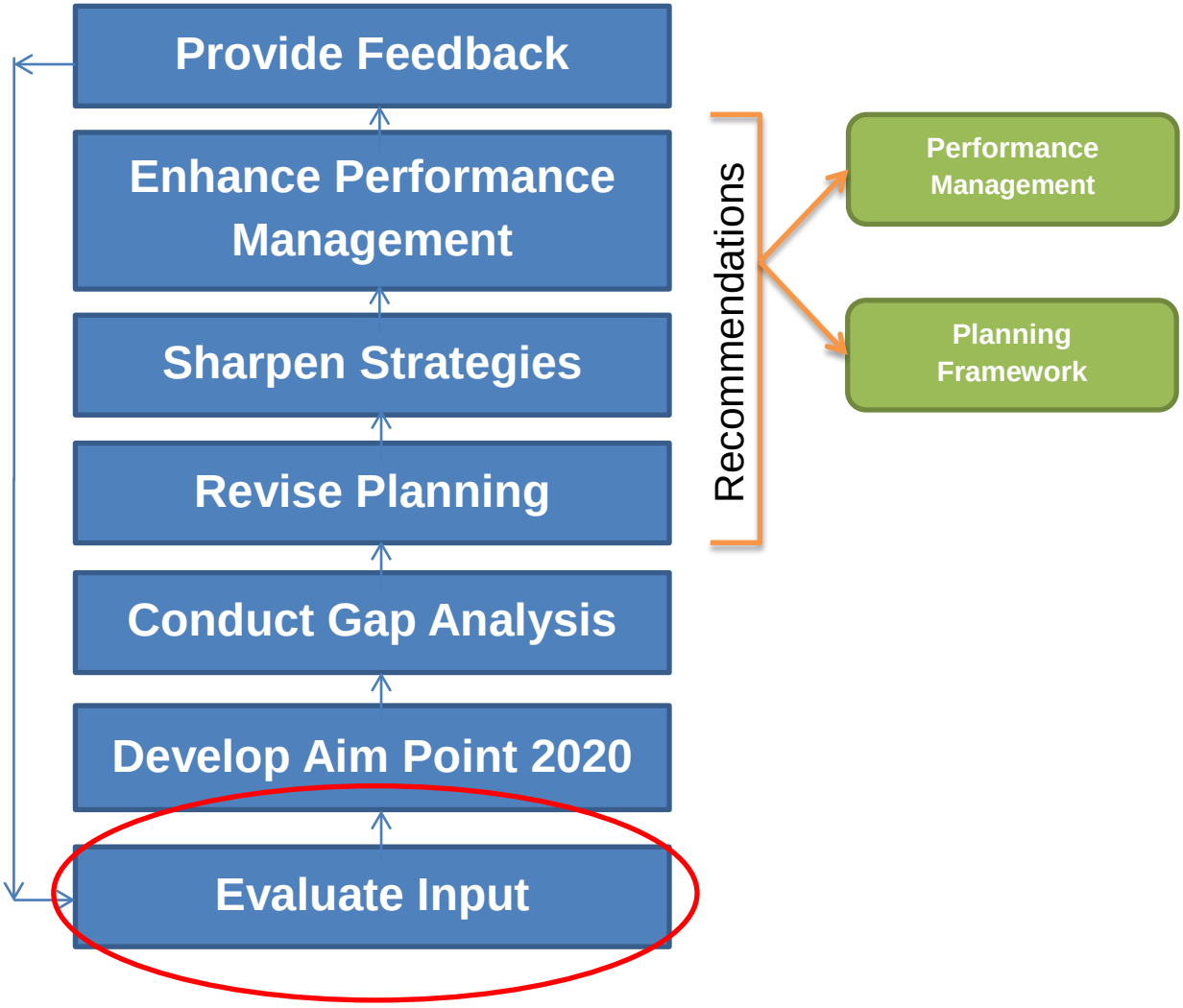
## I. Purpose:

The purpose of the landscape assessment is to provide context for the Nuclear Regulatory Commission's consideration of alternative future scenarios, in support of the development and use of scenario analysis as part of Project Aim 2020. As depicted in the figure below, the Landscape Assessment is part of the input considered in developing the alternative scenarios.

Figure 1 – Project Aim 2020 Approach and Input (Red Circle)




## II. Landscape Assessment:

### Overview

The world is experiencing change at an unprecedented pace, as reflected in social, cultural, economic, and technological advances around the globe. Experts on societal change have noted that the first decade of the twenty first century has experienced as much change as the

previous century combined. "Game-changing" products and services that historically appeared every five or more years now roll-out every few months. Mobile devices, communications software, and other tools to support the demands and pace of modern society are constantly being refreshed and enhanced. This rate of change is unlikely to slow down any time soon. Consequently, it is important for government agencies like the NRC to monitor the changing environment, consider the implications of these changes on its operating environment and workload, and prepare the agency to achieve high confidence in fulfilling NRC's safety and security mission.

This landscape assessment identifies key societal. The trends are categorized into Technology, Security, Society and Demographics, Economics, and Politics. Some of the changes driving these trends are readily evident and recognized. Other changes are occurring more subtly or may not have been widely recognized, accommodated , mitigated, or leveraged by existing NRC programs, processes, and strategies. Each of the changes has the possibility of driving significant change within the NRC, but present even more compelling cases for change when they converge with each other. Individually and collectively, broad trends are rapidly transforming the world that NRC operates in and will impact NRC's workload and operating environment. Rapidly evolving technology across multiple disciplines, increasingly unpredicted global changes, shifting societal and demographic changes, and tighter fiscal constraints together require the NRC to rethink, adapt, and refine our plans and strategies to meet tomorrow's mission in the most effective and efficient manner.

**Technology**

Technological advancement around the world is rapidly transforming the majority of human activities. The influence of technology is likely to increase and become more pervasive over the next 20 years. In the past 20 years, technology has reshaped governments and entire industries, including retail, communications, financial, entertainment, and publishing. Social media sites such as Facebook and Twitter have transformed the way we communicate. They also contributed to governmental reform, especially in the Middle East, Africa, and some of the former Soviet republics. The world is becoming increasingly connected, with critical functions in government, industry, and nonprofit organizations depending more on secure and reliable networked information systems and devices. The following influences will play a major role in shaping the technological landscape over the next 20 years.

Mobile Devices and Social Media

Increasingly widespread use of mobile devices and the adoption of social media represent a major shift in how humans connect and communicate. According to Gartner, a leading information and technology research and advisory company, there were about 5.6 billion mobile devices in worldwide use in 2011. Within the next 20 years, the use of mobile devices is expected to grow to around 50 billion, with the highest growth in the areas of medicine and supply chain management. About 60% of the global population has access to social media. As more devices are connected, social media will play an increasingly significant role in marketing, delivery, and consumption of services. Social media will provide greater growth in services to areas of the United States where traditional access to services was previously denied due to locality or other factors.

**Implications**: The demand for virtual interaction will continually transform face-to-face transactions into virtual interactions. Mobile remote monitoring applications could replace site visits for monitoring and reporting. The NRC will require more flexibility and elasticity with anywhere/any time services and employees will need expertise in how to use social media and mobile devices to streamline redundancy, enhance customer service, and keep pace with latest technological innovations.

## Computing Power and Data Analytics

Computing power continues to increase rapidly, with size and cost of technology decreasing. In 1965, Intel co-founder Gordon E. Moore predicted that semiconductor capacity would double every 18-24 months. This phenomenon continues today and is recognized as "Moore's Law." If this trend continues as expected, the computing power of machines could exceed that of the human brain by 2027, and the average home computer could operate a million times faster than today's computers. By 2020, a typical home computer would be capable of downloading today's entire holdings of the Library of Congress (16 terabytes) in just over two minutes.

Given the increase in the amount of data society generates and consumes, the ability to analyze this information quickly and accurately and derive critical insights and knowledge is increasingly important. It will have the potential to revolutionize both government and industry. Computers, such as IBM's Watson, have already shown the ability to make sense of extremely large data sets in reasonable time. Over the next 20 years, data are expected to increase our capacity to utilize predictive modeling, particularly in areas such as risk management, finance, and health care.

**Implications**: Computer systems will increasingly be capable of pulling, assimilating, and processing large quantities of data from archives, databases, and other online repositories while interfacing with individuals. With increasing use of computers for transactions and storage of data, expectations rise for individuals and organizations to quickly access information and anticipate needs based on previously entered information, interests, and behaviors. The NRC will need to collect, store, and quickly analyze information across its mission from a single authoritative data source, with a single verification system to provide the highest quality and most efficient service to the public and licensees.

## Research and Development

3D printing (or "Additive Manufacturing") is a technology that has the potential to revolutionize manufacturing, as we know it. 3D printers build things by depositing material, typically plastic or metal, layer-by-layer, until the object or final product is "built" to exacting specifications and tolerances. The technology has existed for the last 20 years and has been used for rapid prototyping in the automatic and aeronautical fields. Over the past few years, as a result of advances in processing power, storage, and bandwidth, applications of 3D printing have advanced considerably. For example, in the medical field, experimental knee cartilage, heart valves, and bone implants are being fabricated and pharmaceutical companies are exploring use of the technology for drug manufacturing.

**Implications**: Technological advances are transforming organizations. The American public, licensees, and employees will expect previously labor intensive and expensive inventory to be

affordable, available in mass, rapidly produced, and promptly delivered. The use of the technology will also allow for more personalized services, such as customized products and personalized medicines. Expanded use of this technology will also challenge conventional NRC approaches for vendor inspection and protection against counterfeit, fraudulent, and suspect items.

**Security**

As the trend toward globalization of the world economy continues, the influence of non-state actors will increase. This will give rise to a multi-polar world, characterized by increased global instability and persistent conflicts. As wealth and power transfer, the power of individual countries to single-handedly dominate international markets will wane. U.S. military and economic power will remain strong, but there will be increased competition and influence from growing powers, including China, India, and Brazil. The future U.S. national security landscape is likely to be more dynamic and diverse, encompassing a full spectrum of threats and conflict. The expected future threat will be a hybrid, meaning that it will be a blend of conventional and unconventional warfare. Both state and non-state actors will utilize military and non-military tactics and tools to achieve their objectives. Even non-state actors are likely to develop high-end capabilities traditionally associated with states, while state actors will adopt modern military technologies for use in more urbanized areas and non-traditional battlefields, such as cyber space. The following factors will play a central role in the security landscape of the next 20 years.

Cyber Security

Cybercrime, committed by state and non-state actors, has thrived over the past ten years and expanded double-digit percentages annually. In one year, McAffee assessed the daily emergence of 60,000 new pieces of malware. It is increasingly more difficult to protect computer systems that are relied upon to enhance connectivity and communications from such malware. A successful cyber-attack on the nation's communications infrastructure would have severe implications on the federal government. Such an attack could cripple the nation's financial system, power grid, and other critical infrastructure that would adversely impact NRC's ability to provide services and disrupt the mission. Smaller-scaled, undetected cyber-attacks could have far-reaching implications. They can cause greater havoc because they are unnoticeable at the time of the attack and inflict longer-term damage if they remain undetected and unmitigated.

**Implications**: Adversaries are becoming bolder in their intent and more sophisticated in their capability. Government and private sector reliance on cyberspace (Internet, social media, mobile applications, etc.) will present continued challenges for safeguarding information and providing services while at the same time promoting connectivity. While the expectation will be for "seamless one source, authoritative data" across agencies and organizations, NRC and partner agencies who provide services will need to protect sensitive information. The world is becoming more virtual and cyberspace is becoming more vulnerable to malevolent actors. NRC must be able to provide information securely from anywhere at any time.

Proliferation of Weapons of Mass Destruction

Hostile state and non-state actors are seeking to acquire, or have recently acquired, nuclear, radiological, biological, and chemical Weapons of Mass Destruction (WMD). The rapid spread of knowledge and technology likely will increase the ability of hostile states and non-state actors to access and, potentially, deploy these weapons. Future U.S. military and intelligence operations likely will focus increasingly on detecting, intercepting, and destroying WMD and precursor materials. US military and civilian personnel will likely increasingly operate in potentially hostile environments that expose them to radiological, biological, chemical, and non-conventional explosives.

**Implications**: The Federal government is becoming more connected and promoting interagency collaboration as a pillar in national security governance. As a result, agencies that had not been viewed as part of the national security agencies, such as NRC, will be relied upon more to support national detection, interception, mitigation, destruction, and response actions. In addition, because some of the same materials that are used in the WMDs are also regulated by the NRC, greater involvement of nuclear or radioactive material in attacks or disasters, manmade or natural, will heighten public concern about the civilian uses and controls on these materials.

Robotics and Unmanned Systems

Warfare over the next 20 years is likely to become more lethal because of advanced weapons systems and enabling technologies. The proliferation of precision-guided rockets, artillery, missiles, mortars, and improvised explosive devices will pose a significant challenge to U.S. forces. A significant number of countries are making and selling guided munitions, and U.S. forces likely will be a target subject to their deployment. Proliferation of directed energy weapons (e.g., laser systems and other systems involving thermobaric and nanoenergetic technologies are expected to increase over the next 20 years. The pace of development of robotics and unmanned systems has rapidly accelerated over the last decade. These systems have given U.S. forces an enhanced ability to conserve combat power and to extend surveillance reach and offensive strike capabilities. However, in future conflicts, the U.S. will no longer have as much of a monopoly on robotics and unmanned systems. Both state and non-state actors are beginning to develop and field their own capabilities, which pose a greater threat to U.S. forces.

**Implications**: Because of these rapidly developing and more lethal systems, their availability and deployment by non-state actors will need to be closely assessed by the US government and NRC. Some of them may be included in future revisions of the Design Basis Threats for Radiological Sabotage and Theft and Diversion of Strategic Special Nuclear Material, as well as reference threats assumed for other categories of nuclear facilities and material. This could drive future enhancements to NRC security requirements and require expanding the critical skills of NRC security specialists to keep pace with these trends.

## Society and Demographics

Persistent social and demographic trends indicate that the nation's population will become more diverse over the next 20 years. Today's minority populations – particularly Hispanics/Latinos

and Asian/Pacific Rim – will account for a large share of the U.S. population, and the current Caucasian population is expected to decrease becoming a minority by 2042. Urban areas will grow faster in population than rural areas, which will bring new challenges for Federal, State, and local governments. The following factors will play an important role in shaping the societal and demographic landscape of the next 20 years.

### Gender and Minority Shifts in the Workforce

The number of females in the U.S. is predicted to exceed the number of males in the next 20 years. U.S. Census Bureau trends show that women make up the majority of the population and will continue to do so for the foreseeable future. In 2010 non-Hispanic Whites accounted for 80% of the population over 65 years of age. Projections indicate that by 2050 this same group is expected to account for only 58% of the population. Such a shift in population will cause greater diversity in the workforce. Within the next 20 years, Federal employees will be more ethnically diverse, more technologically advanced, and less committed to life-long jobs than today's employees. They will increasingly expect greater flexibility, less traditional and constraining work schedules, and the ability to work from anywhere and at any time.

**Implications**: In the next 20 years, NRC employees will reflect the gender and minority shifts similar to that of the general population. This will require the NRC to better understand and provide for the needs of its employees, while becoming a more flexible and agile organization. Understanding the diverse needs of its employees will help the NRC attract a competitive workforce sufficient to fulfill the agency's mission. In addition, these trends may also affect the availability of qualified employees, particularly in the science, technology, engineering, and mathematics (STEM) degree fields that NRC relies extensively upon to accomplish its mission. These changes could also affect the perceived attractiveness of the government and NRC as an employer.

### Shifting Geographic Patterns

Population migration trends indicate that US citizens are moving out of larger U.S. urban centers. Areas such as Los Angeles, Chicago, and New York will lose a large share of the population over the next 20 years to other areas, such as San Antonio, Washington, Phoenix, Houston, and Las Vegas.

**Implications**: Geographic trends in the US are contrary to global trends increasing populations in major urban areas. The US public is increasingly moving to smaller cities and rural areas rather than megacities and densely populated urban areas. These trends will likely affect the distribution of certain licensees, as well as the political influence of certain less developed areas as Congressional seats are adjusted to reflect the changes in population. More sparsely populated areas currently considered favorable to host higher risk and less attractive facilities (e.g., waste disposal and treatment facilities, prisons, power generation facilities) may become more desirable locations for residents. The distribution of population within the US may also impact energy demands across the country with higher demands in the Southeast, Southwest, and Western Coast. The redistribution may also be more compatible with greater use of renewable sources of energy, such as solar and wind, which are more distributed. However, stable and reliable sources of baseload energy, such as nuclear power plants, will be needed.

## Economics

The world economy is expected to remain fragile, volatile, and a key determinant of international influence over the next 20 years. The evolution of the U.S. economy will be one of the most critical factors determining the strength of the nation. The current U.S. economy is expected to recover slowly from consecutive years of recession and debt growth. Entitlements such as Social Security and Medicare for aging populations are projected to reach 50% of the U.S. budget by 2030. Health care spending will continue to grow due to the aging of the population and the increasing costs of medical intervention and innovation. Given these trends, the following are important factors in determining the economic landscape of the next 20 years.

### International Economy

Within the next 20 years, China and India are projected to have the world's largest economies and number of energy consumers. Countries such as Indonesia, South Africa, and Turkey will grow in economic prominence. The Asian region will have strong economic influence since over half of the world's population will be concentrated in that region. Combined domestic banking assets of emerging economies such as China, India, Brazil, Russia, Mexico, and Indonesia are expected to exceed those in the U.S., Japan, Germany, the United Kingdom, France, Italy, and Canada.

**Implications**: Countries having the largest populations and demanding the most energy consumption will have significant influence over world events, either causing these events or responding to them. The U.S. will be called to respond through a combination of diplomatic and military measures. Additionally, the demands of these growing countries and economies on energy and other scarce resources will likely prompt conflicts and undermine energy security, while increasing competition, which may affect the balance of energy resources and future development. As their influence grows, so too will their demands for reliable, safe, and secure energy production, thus driving increased reliance on nuclear power generation. This, in turn, will give them greater prominence in nuclear safety and security and non-proliferation initiatives, which could further undermine the influence of the US Government and NRC. Alternatively, if NRC is successful in forging and maintaining strong cooperation with these ascending countries, it could strengthen NRC's influence and global nuclear safety, security, and safeguards.

### National Debt

As our nation's debt increases, it will become increasingly difficult to finance the national debt with U.S. Treasury bonds at low interest rates. The national debt can have devastating effects on the American public as interest rates continue to rise and foreign investors demand higher interest rates for repayment of Treasury bonds. These negative effects include slow economic growth, weaker job markets, higher taxes, reduced consumer confidence, higher inflation and possible unsustainability of national commitments such as Social Security and other entitlement programs and services. Over the next 20 years, the Social Security Trust Fund may not have enough to cover the retirement benefits promised to the Baby Boomer generation.

**Implications**: The Federal government's unsustainability of national commitments will have a significant impact on Federal programs. Some services and programs within NRC may change

in response to increasingly constrained Federal spending, as the nation makes difficult decisions with respect to priorities. Cuts or reductions in some Federal programs may also prompt broader changes in the U.S. economy. NRC will need to rethink the way it meets its mission, such as requiring adjustments and greater flexibility to accomplish the mission through greater collaboration, technology, or contracting.

**Politics**

The political tides are changing domestically and internationally. The trend carries significant areas of concern such as shifting attitudes of people toward government, as well as global and political instability. Political leaders are supporting starkly contrary views from one another, creating an environment with strong polarization and partisanship. Elected officials are experiencing varying success, leading many citizens to examine where to place their trust and confidence. Financial realities are dictating new paradigms and reshaping existing social contracts for countries, and will have direct and immediate impacts on citizens. Rogue leaders in rapidly unstable countries or ungoverned areas are pushing new boundaries with respect to their methods of governance. This instability will begin to increasingly spill over onto the international stage, as adjacent countries are impacted by citizens seeking refuge and more stable conditions. The world is becoming a place where those in power are doing so with less while co-existing within a world that grows increasingly unstable. Reduced government budgets and political instability will be commonplace for the foreseeable future. The following are important factors to consider when determining the political landscape over the next 20 years.

Attitude toward Government

Sentiments of broad dissatisfaction, frustration toward the Federal government, and distrust in large institutions are expected to remain or grow over the next decade. Historically, during hard economic times and broad dissatisfaction with the state of the nation, the American public has a diminished trust and confidence in the U.S. government and its institutions.

**Implications**: As attitudes toward government shift, use and reliance on the government will wane, raising the prospect for changes in conventional institutions, such as government regulation of the civilian use of nuclear material and facilities. The NRC must remain a trusted partner to ensure that it meets the needs of the public with ever increasing expectations and the nation.

Global Political Instability

Concerns about global political stability have most recently been highlighted by the Arab Spring, increases in sectarian fighting in Iraq, instability in Ukraine, and other hot spots around the world. One of the most volatile conflicts in the Middle East is the current Syrian Civil War. A multitude of diverse groups is banding together to overthrow the current Syrian government. This and other conflicts have highlighted the undertones of religious and regional powers jockeying for control and influence. Over the next 20 years, instability can be expected in other parts of the world, including South America and Asia, as old grudges and resentment resurface and spawn new or resumed conflict.

**Implications**: Global political instability has the potential to involve U.S. military, diplomatic, and other capabilities. The resulting conflicts and change in governments can also complicate, disrupt, and wipe out safety and security enhancements facilitated through assistance and cooperation with NRC. In addition, they can also prompt new or resumed fears of the American public in the safety and security of nuclear facilities and materials, if they cause or result in manmade or natural disasters and emergencies involving nuclear technology. Further, instability provides ample opportunities for non-state actors to learn new skills and tactics that can later be used in more stable countries to the detriment of nuclear safety and security, as well as society at large.

## III. Intended Use:

The Landscape Assessment is intended to provide input for the development and refinement of the alternative future scenarios in Aim Point 2020 (attached). Based on the utility of this assessment, it may be updated in future years to reflect new or modifications of the trends and changes reflected in this assessment.

## IV. Reference:

This landscape assessment is largely based on a comparable product developed by the U.S. Department of Veterans Affairs (VA), Office of Policy and Planning, which is the *Strategic Environmental Assessment for Fiscal Year 2013*, September 2013. VA developed the assessment as part of a multiple year initiative to adopt and implement a more forward-leaning, proactive, long-term strategic plan. The VA Strategic Environmental Assessment describes broad trends in society. Because these trends are strategic and cross-cutting for all government agencies, the landscape assessment presented in this document stimulates thinking and awareness about the implications of these trends for NRC in developing and considering alternative future scenarios and strategies.

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DELIVERING OUR FUTURE

# V. Aim Point Scenarios
# August 29, 2014

*If we could first know where we are, and whither we are tending, we could then better judge what to do, and how to do it.* President Abraham Lincoln

*Change is the law of life. And those who look only to the past or present are certain to miss the future.* President John F. Kennedy

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## I. Introduction

Project Aim 2020 is using scenario analysis and focus groups in identifying key strategies and recommendations to improve programs and processes during the next five years. These strategies and recommendations are intended to provide high confidence in the Nuclear Regulatory Commission (NRC) accomplishing its safety and security mission, while enhancing operational excellence, agility, responsiveness, and efficiency.

Your participation in one or more focus groups will help the agency prepare for the future by considering the future scenarios, their implications for the agency, and how the agency could best prepare itself to succeed in the future. We are not attempting to predict the future, but rather are preparing the agency for change and considering how the NRC should change.

## II. Scenario Analysis

Aim Point 2020 provides a set of scenarios for the projected agency workload and operating environment over the next five years. The Aim project team followed the approach described in *Building Higher Performance Government through Lean Six Sigma – A Leader's Guide to Creating Speed, Agility, Efficiency*, 2011, by Price, Mores, and Elliotte as a guide. A variety of leading private and public sector organizations use this approach as a key element of planning and enhancing operational excellence, agility, and efficiency. The basic premise of scenario analysis is that it is better to get the future imprecisely right in our planning than precisely wrong. Therefore, rather than choosing one definitive future scenario and planning for that future, scenario analysis considers multiple futures. The scenario analysis helps the NRC anticipate and prepare for change, rather than reactively responding to unexpected changes when they occur. The scenarios described in this document are hypothetical and will not actually occur as described. However, some combination of the elements of these scenarios will likely occur. Because the future is dynamic and changing, the probability of occurrence of these elements has not been established. This approach builds on the experience of the past and the strengths of the present, to deliver future success.

> "It is better to be imprecisely right in our planning than precisely wrong."

Price, Mores, and Elliotte strongly urge all government agencies to include scenario analysis in the planning process. They note that this approach is particularly useful in situations where agencies desire to deal with challenges proactively and where changes in the agency's operating environment are recognized, but not understood, let alone controlled by the agency. Scenario analysis offers three desirable attributes to planning by governmental organizations:

- **Long View** – Looking beyond the immediate demands far enough into the future to identify new strategies to overcome

challenges, barriers, and leverage opportunities, which cannot be readily seen from today's perspective.

- **Outside-in Thinking** – By focusing on the big picture, agencies "bring the outside in" to inspire innovative and creative strategies for a range of potential changes.
- **Multiple Perspectives** – Without a single "right" scenario (i.e., most likely or best estimate), scenario analysis encourages consideration of multiple points of view, expanding the agency's peripheral vision and awareness of threats and vulnerabilities while promoting a more inclusive approach to preparing for the future.

The use of the scenario analysis enables participants in the planning process to understand and visualize what the future could be like based on key drivers of change that will most affect the agency. The Project Team developed these scenarios based on a forecast range of workload and operating conditions. The team developed this of Aim Point 2020 by:

- Reviewing industry conditions
- Interviewing external and internal stakeholders
- Considering Government initiatives
- Researching economic conditions and predictions
- Exploring technology forecasts
- Studying potential work/life forecasted conditions
- Collaborating with Federal foresight community

## III. Current State

In the current state in 2014, the mission of the NRC is to license and regulate the Nation's civilian use of radioactive materials to protect public health and safety, promote the common defense and security, and protect the environment. The NRC principles of good regulation – independence, openness, efficiency, clarity and reliability, guide how the NRC reaches decisions on safety and security issues. The NRC has two strategic goals, Safety – ensure the safe use of radioactive materials and Security – ensure the secure use of radioactive materials.

Historically, about 75% of the NRC's budget and employees support the Nuclear Reactor Safety Program (54% Operating Reactors and 20% New Reactors). The Nuclear Material and Waste Safety program requires about 22% of the NRC's resources (6% Fuel Facilities, 8% Nuclear Materials Users, 4% Spent Fuel Storage and Transportation, and 3.5% Decommissioning and Low-Level Waste). By law, the NRC recovers about 90% of our budget authority through fees for service and annual fees.

In the current state, our budgeted resources are as follows:

- Nuclear Reactor Safety - $811 Million and 2908 FTE
  - Of which $297 Million and 623 FTE are corporate support

- Nuclear Materials and Waste Safety - $232 Million and 843 FTE
  - Of which $ 86 Million and 181 FTE are corporate support

These resources include both the direct resources (e.g., licensing, inspection, investigation, assessment, enforcement, research, incident response, rulemaking), as well as indirect resources, such as agency overhead and other corporate support functions (e.g., acquisitions, administrative services, financial management, human resource management, outreach, information technology, policy support, training and travel). The budgeted resources are not the same as expended resources because the agency makes adjustments while executing the budget to reflect fact of life changes and changes in work priorities.

## IV. Future Scenarios

Now fast forward to 2020 as you think about and "live" in the future scenarios. Think about what opportunities and challenges the NRC may face in each of these scenarios and identify strategies and changes that the NRC must pursue to accomplish our mission. As you identify these strategies and changes, think about the ability of the agency to change and the capabilities that will be most important to implement the necessary changes and operate in a more timely, effective, efficient, nimble, and sustainable way.

## Scenario A – New Dawn

In 2020, the U.S. is a good place to live and work. The recession of 2008-2010 is a distant and fading memory. The U.S. economy is moderately strong. Electricity demand is about 5% higher than it was in 2014, with power being provided by a mix of large generating plants, a larger fraction of renewables, and many small independent generators contributing power to the grid. Growth in nuclear power continues following the Fukushima Daiichi nuclear accident. The public has greater confidence in nuclear power as a safe, secure, reliable, and sustainable energy source. However, a significant percentage of the public remains uneasy about all things nuclear. The new nuclear power plants at Vogtle, Summer, and Watts Bar are now operating. Two more large light water reactors are under construction in the southeast. The NRC has an appropriate balance of corporate and technical programs and has robust confirmatory and anticipatory research programs that support its regulatory programs. NRC is once again a best place to work.

As part of the "all the above" U.S. energy strategy and consistent with constraints on $CO_2$ emissions, continued operation of nuclear power plants beyond the initial operating period of 40 years and the 20-year extension remains desirable. In 2020, the NRC is reviewing four applications for subsequent license renewal with a forecast that most operating plants will seek subsequent renewals during the next decade.

The U.S. nuclear industry is more competitive globally and is benefiting from the expansion of nuclear energy worldwide. American companies are exporting equipment and services. Along with the exports come the expectations that the safety of nuclear exports is "certified" by the U.S. and at the highest level of safety ("world gold standard"), even though the technology is used in nuclear power plants exported from other countries like Russia, Korea, and China. Significant interest exists in building small modular reactors because of their lower cost and the flexibility that they provide, including remote use, desalination, process heat, and stabilizing the grid. The NRC has already certified two small modular reactor designs and has two more applications under review.

Despite the progress in operating and building nuclear power plants, the country remains in a stalemate without a viable geologic repository for spent fuel and high-level waste disposal. Relatively low cost uranium remains abundant on world markets and is projected to meet demand for many decades. The NRC has two applications under review to construct and operate regional interim consolidated spent fuel storage facilities. In addition, all operating nuclear power plants are storing spent fuel in both dry casks and wet pools.

The National Materials Program now has 39 Agreement States programs. As a result of continued perceived lapses in safety and financial constraints, the Congress expanded the NRC's mission and responsibilities to regulate the safety and security of Department of Energy's non-defense nuclear activities. The NRC assumed these new responsibilities in 2018 without a significant change in agency resources and is now working through initial implementation of external regulation of these facilities and activities.

## Scenario B – Heartrending

In 2020, the U.S. economy is moderately weak, electrical demand is reduced, and interest in nuclear power has diminished. The weakened economy, competitive sources of power, and continued public concerns about safety following the nuclear accident at Fukushima-Daiichi have contributed to a large number of premature shutdowns of existing operating nuclear power plants. America's 80 operating nuclear power plants now generate less than 15% of the Nation's electricity. Except for the five new nuclear power plants that were constructed and began operating in the 2016-2018 timeframe, no new nuclear power plants are under construction. The additional new plants licensed by the NRC since 2014 have been placed on hold pending a significant change in the economy or generating environment.

The U.S. nuclear industry has lost its international prowess and influence. New countries have emerged as the dominant technology suppliers, and with their ascension, the regulatory agencies in these countries have also risen in global prestige. All work by the nuclear energy industry to develop innovative small modular reactor designs has been reduced to a crawl, with global markets shaped by exports from other countries. The NRC has no design certification applications under review for either SMRs or large light water reactors. Based on industry forecasts, the projected reactor licensing workload for the next decade is composed primarily of modest uprates of existing reactors and amendment reviews needed to address safety or security issues or to support decommissioning.

Regarding the backend of the fuel cycle, there is a surplus of uranium due to diminished demand. The momentum to site and construct a geologic repository for spent fuel or regional interim storage facilities has diminished. The spent fuel remains safe in wet and dry storage facilities. Due to financial constraints that have been particularly severe in States, several Agreement State programs have terminated and returned regulatory responsibilities to the NRC; no new States are seeking to establish Agreements with the agency. Additionally, alternate technologies have emerged to safely and economically replace about half of the Category 1 and 2 radiation sources licensed by the NRC.

The NRC does not have the appropriate balance of corporate and technical programs and has suffered reductions in its research programs as a result of cost cutting. Budgets are constrained, employee benefits have decreased, and few IT improvements have been deployed. NRC's annual attrition has doubled to about 10% and the agency is facing significant challenges in attracting and retaining talented employees with critical skills to accomplish the NRC's mission, particularly among the newer employees from the so-called "Millennial" generation (born in 1982-2000).

## Scenario C – Steady Ahead

In 2020, the workload for the NRC remains fairly consistent with where we were in 2014, with about 100 operating nuclear power plants generating 20% of the Nation's electricity. Continued uncertainties, weak economic growth, and public concerns about the safety of nuclear power have constrained growth in new nuclear generation, but the operating environment remains favorable for continued operation of existing nuclear power plants. The NRC has robust confirmatory and anticipatory research programs to support is regulatory programs.

Despite the emergence of new nuclear exporting countries, the American nuclear industry has remained competitive in the global market and is benefiting from slow expansion abroad. These U.S. nuclear exports prompt expectations from trading partners and multi-lateral organizations for greater (+20%) cooperation and assistance from the NRC with our international counterparts. Although domestic interest has waned, international interest in US certified Small Modular Reactor designs remains high, with two applications currently under NRC review.

No significant changes have occurred in the status of the spent fuel management and high-level waste disposal programs since 2014. There is no significant national program for siting and developing a geologic repository. Distributed interim storage of spent fuel continues at nuclear power plant sites in both wet and dry configurations, including stranded sites where the reactors have been decommissioned. The fuel cycle facilities in the U.S. continue to operate consistent with historical levels. Although the NRC has licensed new fuel facilities, abundant global supplies and competition, coupled with economic uncertainties and constrained growth in nuclear power, have undermined commercial incentives to invest in constructing new nuclear fuel facilities in the U.S., preferring instead to build and operate overseas closer to growing nuclear markets in China, India, Middle East, and Africa.

The National Materials Program has constricted since 2014, with fewer NRC licensees and Wyoming and Missouri becoming Agreement States for a total of 39 Agreement States. As a result of technology substitution and growing concerns about NRC fees, the number of NRC materials licensees has decreased to about 1200.

In an effort to cope with ever increasing Federal requirements and to maintain the high level internal controls and quality of working conditions at the NRC, the agency has attempted to control corporate spending, but with only limited success. Internal processes, both regulatory and corporate, are ponderous, opaque to stakeholders, and untimely. The ratio of mission direct to overhead has decreased to a level of 40/60 with more of NRC resources devoted to overhead than to supporting the direct mission. Fees for service and annual fees have continued to increase, while the level of service provided by the NRC has decreased, creating greater dissatisfaction among the remaining licensees. Although the NRC is doing better in controlling the cumulative effects of regulation across all classes of licensees and vendors, it has come at higher administrative costs than originally projected. Licensees and the NRC are reluctant to launch new regulatory initiatives because of their fee and cost ramifications.

## Scenario D – Compression

In 2020, the workload for the NRC remains fairly consistent with where we were in 2014, with about 100 nuclear power plants generating 20% of the Nation's electricity. Continued uncertainties, weak economic growth, and public concerns about the safety of nuclear power have constrained further growth in new nuclear generation. The operating environment remains favorable for continued operation of existing nuclear power plants.

Despite the emergence of new nuclear exporting countries, the American nuclear industry has remained competitive in the global market and is benefiting from slow expansion abroad. These U.S. nuclear exports prompt expectations from trading partners and multi-lateral organizations for greater (+20%) cooperation and assistance from the NRC with our international counterparts. Although domestic interest has waned, international interest in US certified Small Modular Reactor designs remains high, with two applications under current review by the NRC.

The status of the spent fuel management and high-level waste disposal programs has not changed since 2014. There is no active program for siting and developing a geologic repository. Interim storage of spent fuel continues at nuclear power plant sites in both wet and dry configurations. The fuel cycle facilities in the U.S. continue to operate consistent with historical levels. Although NRC has licensed new fuel facilities, abundant global supplies and competition, coupled with economic uncertainties and constrained growth in nuclear power, have undermined industry commitment to invest in constructing new nuclear fuel facilities in the U.S., preferring instead to build and operate overseas closer to growing nuclear markets in China, India, Middle East, and Africa.

The National Materials Program has constricted since 2014, with fewer NRC licensees and a couple new Agreement States for a total of 39. The number of NRC materials licensees has remained about the same, less the licenses transferred to the new Agreement States.

As a result of upward spiraling corporate costs, the Commission mandated in 2016 that the NRC cut its corporate costs in half (about 25% of the agency's budget). As a result, the agency had to adjust the range and quality of services for human resource, financial, and information management. This change freed up about 15% of the agency resources to invest in longer term regulatory improvements and has reduced or substantially constrained the growth of fees for service and annual. In response to repeated requests from licensees, the NRC substantially improved the allocation and transparency of fee accounting for the various classes of licensees, which boosted stakeholder satisfaction and recognition of the fairness of NRC's fee policy. NRC is now seen as a leader in the Federal government for controlling its overhead costs; other agencies are seeking our advice and best practices to help them achieve comparable performance.

## V. Intended Use:

The alternative future scenarios described in this document will be used in the focus group discussions, as part of the gap analysis between the current state and future state, as well as in the identification of key strategies and necessary agency capabilities to close the gaps by 2020. They will also help the Project Team to identify "quick fixes" that can be readily implemented now to enhance the efficiency, effectiveness, agility, and performance of the agency. These quick fixes and longer term strategies and capabilities will be recommended and prioritized in a roadmap for agency transformation and implemented by the NRC following Commission review.