MARCH 30 – APRIL 1, 2016 • WASHINGTON, D.C., USA

NUCLEAR INDUSTRY SUMMIT 2016

enhancing nuclear security www.nis2016.org

The Role of the Nuclear Industry in the World

and How It Manages the Security of its Materials and Technologies

Nuclear Industry Summit 2016

Working Group 3

March 30, 2016

Preamble

This paper was commissioned by the Advisory Board of the Nuclear Industry Summit 2016. It firstly highlights the immense societal benefits provided by the International Nuclear Industry (not only in the area of nuclear power and so therefore the mitigation of climate change but also in the fields of medicine and industry). Secondly it explains how we provide necessary security for our materials and technologies. This paper may be complemented by an exhibition area(s) at NSS/NIS 2016. Thirdly, in order to remain accessible to the general reader, the paper has not utilized extensive footnotes, but has drawn from a number of authoritative and international sources; a selected listing of these sources is provided at Appendix A2.

Executive Summary

Most people go about their business not spending a lot of time reflecting on the technical origins of the things they see, use and enjoy in their everyday lives. However, what they do presume, and insist upon, is that these things – whether consumer products, techniques for making food safe, or sources of energy and electricity – are secure. And, in the case of nuclear technology, that the civil nuclear industry takes the appropriate measures to ensure they are secure.

For those who are not nuclear physicists and engineers, or specialists in nuclear medicine and radioisotopes, there is little discussion about the nuclear industry. As a result, they are often unaware of the incredible breadth and diversity of how nuclear technology and materials are actually used. Therefore, the onus is on the industry to provide a simple but effective understanding of the vital contribution of this technology to humanity.

This presentation attempts to do just that. It provides a short, accessible insight into the vital contribution of this technology to peaceful uses that benefit our societies and our well-being. The nuclear industry's role in securing the radiological technologies and materials it uses is also described. Three key messages can be drawn from the pages that follow:

> Nuclear technology is vital for more than just providing reliable, low-carbon energy. It also has life-saving medical application; improves manufacturing, mining, transport and agriculture; and help us discover more about the planet we live on and how we can sustainably live with it.
>
> Maintaining the security of facilities and radioactive materials is fundamental to all well-managed operations in the nuclear industry. Industry works closely with governments and regulators at the national and international level to ensure the public is protected.
>
> People of all countries deserve access to the many benefits of nuclear technology, but the security challenges must be addressed. To this end, the international nuclear industry will, as it has done for decades, work towards improving governance, exchanging information and learning from good practice. Enhancing public confidence in the effectiveness of the industry's security practices will help to sustain the public's awareness of – and support for – the myriad and everyday peaceful uses of nuclear technology.

1.0 Introduction

The vital contribution of nuclear technology and materials to modern society

The recent COP21 Paris Agreement on combating climate change set ambitious targets for the reduction of greenhouse gases and emissions from fossil fuels. The world is facing the global challenge of obtaining energy for life, food, warmth, health – in short, for the betterment of humanity – and doing so from low-carbon energy sources. A transition is under way, and all low-carbon technologies must be brought to bear. Nuclear energy – a clean, powerful source of electricity – is one of them. At the same time, nuclear technology also brings additional benefits to humanity that are not always well understood or recognized, even by the people whose lives are directly and positively enhanced as a result.

As the Joint Statement of the 2014 Nuclear Industry Summit noted:

> "Nuclear technology and materials provide a vital contribution to modern society, as do the radioactive sources used in industry, medicine, agriculture, research and other fields. Nuclear power currently provides 12% of the world's electricity and has one of the smallest carbon footprints of any major energy source. Tens of millions of patients are treated with nuclear medicine each year and 90% of these support clinical diagnosis; there are over a 100 different nuclear imaging procedures in use at the thousands of medical centres that use nuclear medicine for the benefit of human health.
>
> Continued public confidence is essential for the application of nuclear technology, and the extensive benefits that it brings. Participants commit to enhance public and stakeholder confidence through high standards of transparency, integrity, ethical behaviour and social responsibility."

As in 2014, the 2016 Nuclear Industry Summit participants acknowledge that public confidence is essential if the public is to continue to reap the benefits of nuclear technology. They are committed to building the desired confidence and carrying it beyond the 2016 NIS Summit. To do so, it is important to provide clear information on the vital contribution made to modern society by nuclear technology and to openly discuss the types (but not necessarily the details) of the security and safety controls that are integral to all facets of the nuclear industry.

That is the aim of this paper.

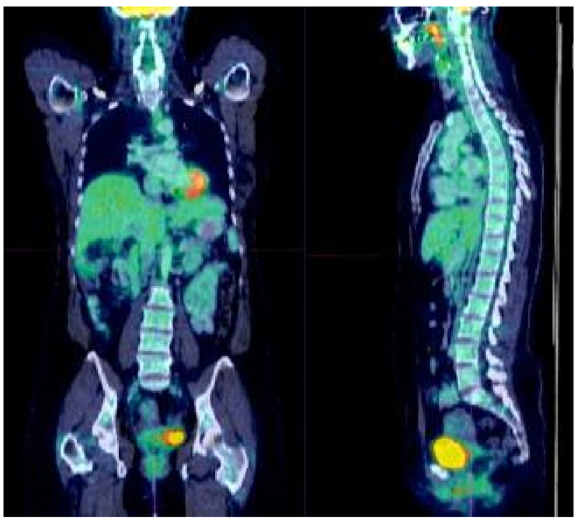
2.0 Context

Building public awareness of the benefits and confidence in the safety and security of nuclear technology and material

Public acceptance of nuclear technology is dependent on both public knowledge of the benefits that nuclear technology provides to society and the economy, and their confidence that materials and technologies are being managed in a responsible manner.

2.1 OVERARCHING COMMENTS ON THE BENEFITS OF NUCLEAR TECHNOLOGY

Many benefits derive from the peaceful uses of nuclear technology. Our industry is a proud and responsible provider of these benefits.



The public are often unaware of the extent to which aspects of their everyday life involve products and processes originated from the application of nuclear technology via the nuclear industry. Many are surprised to learn of how their quality of life is positively enhanced by this technology – and in a multitude of ways ranging from medical treatment through to better health and clean air, to food safety, electricity generation, advanced manufacturing – and beyond, even to such ordinary products as exit signs.

Modern society could not operate without the contribution of nuclear technologies. Our homes and offices would not have smoke detectors. Bridges would not bear weight as reliably, aircraft would not fly as safely, pipelines would leak more often, and more of our friends and neighbours would die of undiagnosed heart disease and untreated cancers.

For emerging economies and countries on the road to economic development, the contribution of nuclear science and technologies takes on additional importance. As the IAEA Director General said, these technologies "can make a major contribution to economic growth and have an important role to play in support of sustainable development".

Section 3 of this paper gives detailed descriptions of the benefits provided by nuclear technology to a variety of societal endeavours.

2.2 OVERARCHING COMMENTS ON THE MANAGEMENT OF NUCLEAR MATERIALS AND TECHNOLOGIES

"Nuclear security" is shorthand for the security of nuclear or other radioactive materials associated facilities, or associated activities. The overarching objective of nuclear security is generally understood as ensuring that nuclear materials are secure from unauthorized access and theft and that nuclear facilities are secure from sabotage.

For governments, the primary purpose of nuclear security is to protect against illicit or malicious acts of theft, sabotage, terrorism or deliberate public harm involving nuclear or other radioactive material (e.g. sources).

For the nuclear industry, the security of nuclear and other radioactive materials is a very important facet of good management. The nuclear industry fully understands the importance of adequately securing radioactive materials for the public good. As a heavily regulated industry, it also understands that effective security is vital to business success.

3.0 Benefits

The Benefits to Humanity of Nuclear Technology and Material

The WNA recently described the impact of nuclear technology on our daily lives.

> "From the moment we get up in the morning, until we go to sleep, we benefit unknowingly from many ingenious applications of radioisotopes and radiation. The water we wash with (origin, supply assurance), the textiles we wear (manufacture control gauging), the breakfast we eat (improved grains, water analysis), our transport to work (tire rubber polymerization, thickness gauges for checking steels and coating on vehicles), the bridges we cross (neutron radiography), the paper we use (gauging, mixing during production processes), the drugs we take (analysis) not to mention medical tests (radioimmunoassay, perhaps radiopharmaceuticals), or the environment which radioisotope techniques help to keep clean, are all examples that we sometimes take for granted."

The benefits to humanity comprise human health (diagnostics and treatment; combating communicable and non-communicable disease); food & nutrition (safe food and better crops); environment and sustainability (tackling climate change; adding fresh water resources);

electricity and power (the path to a better life); consumer and industrial products (for daily life and economic growth); and public safety (radiological detection).

The IAEA notes the "clear links" between the United Nations' new Sustainable Development Goals and the contribution of civil nuclear technology, notably in the areas of energy, food security, nutrition, human health, environmental protection, and the management of water resources.

3.1 HUMAN HEALTH

Many people do not realize the importance of radiation and radioisotopes for screening, diagnosis and therapy of various medical conditions. According to the WNA, over 10,000 hospitals worldwide use radioisotopes. The use of radiopharmaceuticals in diagnosis is growing at over 10% per year. It has been estimated that almost 100 different diagnostic nuclear medicine procedures are available today – and almost every major organ system can be imaged using these techniques.

Diagnostic nuclear medicine help to determine the cause of health problems based on the function of the organ, tissue or bone. Radioactive isotopes are widely used to indicate tumours and to study the heart, lungs, liver, kidneys, blood circulation and volume, and bone structure. Radiopharmaceuticals are also administered to patients for imaging purposes. These images are captured by equipment such as a PET (positron emission tomography) scanner or a gamma camera.

An advantage of nuclear over x-ray techniques is that both bone and soft tissue can be imaged very successfully. Lung scans use radioactive materials to detect presence of blood clots; bone scans can detect the spread of cancer 6-18 months sooner than x-rays. Technetium-99m, the most widely used diagnostic radioisotope, gives the patient a very low radiation dose. It is used in some 40 million diagnostic procedures per year. Imaging with radioactive technetium-99m can help diagnose bone infections in young children at the earliest possible stage.

Radioisotopes are used in therapy to control and damage cancerous growths. Iodine-131 is used to treat thyroid cancer; Phosophorus-32 to treat leukemia. The Word Health Organization (WHO) considers radiation therapy to be "fundamental to the optimum management of cancer patients".

The importance of nuclear medicine to people all over the world cannot be over-estimated. It is a factor for saving and extending human life. It is also a factor in economic development because it is a technology available to nearly every country regardless of income levels.

The IAEA points out: “In developing countries, malnutrition, communicable and non-communicable diseases, particularly cancer, threaten health and cut short productive lives. Health problems and diseases can be detected and treated using nuclear techniques.” Radiation medicine technology allows a country to develop cancer control capacity through the introduction, expansion and improvement of infrastructure, services and workforce.

On the medical research side, nuclear materials are widely used in biotechnology to follow the fate of specific molecules in the body; they are an essential part of biomedical research on diseases like AIDS, cancer and Alzheimer’s disease. Radionuclides are essential for genetic research.

Many medical products today are sterilised by gamma rays from a cobalt-60 source, such as disposable syringes, surgical gloves, heart valves, bandages, plastic and rubber sheets, and surgical instruments. It is estimated that gamma radiation technology is used to sterilize up to 40 per cent of all single-use medical devices in the world.

In the absence of the cobalt-60 isotope, cost-effective radiation sterilisation would not be possible on a global scale. Moreover, sterilisation by radiation makes the manufacturing and distribution process safer and cheaper because it can penetrate products while sealed in their final packaging, ensuring full sterility of the product. It is also used for implantable devices – i.e. orthopedics (e.g. hip and knee joints), stents, heart valves and more.

3.2 FOOD AND NUTRITION

A terrible statistic tells us that one out of every ten children born in developing countries will die before their fifth birthday as a result of malnutrition. According to the World Bank, investing in infant and young child nutrition can save one million lives each year, and can help 260 million more children and their mothers have a healthier future by preventing stunted growth and impaired brain development.

The IAEA points out the “hidden hunger” of micronutrient deficiencies – and what nuclear isotopes can do to help identify such deficiencies and combat malnutrition.

Micronutrients – e.g. pro-vitamin A, iron and zinc – are key building blocks for development in infants of a strong immune system against infectious disease. Stable isotope techniques using a specific stable isotope of the element or molecule under study can assess the availability of micronutrients in a young child's food as well as the child's ability to absorb them.

Knowing what is taken up and what is not helps to identify the source of malnutrition and thus the means to treat it. Such methods are non-radioactive and non-invasive. In addition, nuclear techniques are used for neonatal screening for sickle cell disease, hypothyroidism and cystic fibrosis, as well as childhood cancers.

Radioisotopes can also be used in a similar manner to find out the effectiveness of different types of fertilisers; by labelling a fertiliser with a particular radioisotope, one can discover how much of it is taken up by the plant and how much is lost. This leads to more efficient agriculture that is both less costly to the farmer and friendlier to the environment.

Radiation is used to preserve seeds and food products and breed disease-resistant plants. In plant breeding, some 1800 new crop varieties have been developed through mutation induced by ionising radiation. New genetic lines of root and tuber crops, cereals and oil seed crops have been produced; while new kinds of sorghum, garlic, wheat, bananas, beans and peppers have been made more resistant to pests and more adaptable to harsh climatic conditions.

A worldwide standard on irradiation to preserve food was adopted in 1983 by a joint committee of the WHO, IAEA and the UN Food and Agriculture Organization (FAO). It is estimated that 25-30% of food harvested in many countries is lost as a result of spoilage by microbes and pests. Irradiation technology is increasingly being used to preserve food – spices, grains, fruit, vegetables and meat. It avoids the use of potentially harmful chemical fumigants and insecticides. Moreover, radioisotopes reduce post-harvest losses by suppressing sprouting and contamination.

Food irradiation uses gamma radiation to kill bacterial pathogens and other harmful organisms without affecting the nutritional value of food itself – or making it radioactive. This technique is used in over 60 countries to help protect food from contamination.

Gamma rays are highly effective at killing micro-organisms, yet there is no residue or radioactivity on or in the products and packaging. This means no quarantine is required and the product is immediately available for shipment or use after processing. For example, radiation is used to sterilise the packaging of milk products.

Irradiation of food products is increasingly regarded in many countries as a healthy and preferable alternative to chemical treatments. Smaller radiation doses to kill insects and their larvae are increasingly used as a phytosanitary precaution to prevent the spread of insect pests in international trade. The method's success in the United States, Latin America, South Africa and other regions has allowed resumption of the export of cash crops like grapes.

To illustrate the worldwide role of nuclear technology and applications in food production, the FAO/IAEA lists the following compelling statistics:

30 countries use nuclear science methods for improved irrigation and crop production.

48 countries use nuclear tracer techniques and FAO/IAEA soil and water management guidelines to protect their farmlands.

95 countries use isotopic and nuclear techniques to identify land and water management practices to improve nutrient and water use efficiency for crop productivity and environmental sustainability.

100 countries use radiation-based plant breeding techniques to improve food and industrial crops. Worldwide, over 3000 new varieties of crops have been officially developed and released by countries using mutation-assisted plant breeding techniques. Contrary to genetic engineering of plants, these nuclear-based plant breeding methods are working inside a specific genome and are nature, in the sense that the same process happened in nature over billions of years on a much slower scale by natural radiation.

64 countries use the carbon isotope discrimination technique to assess crop genotypes for tolerance to drought and salinity.

70 countries use disease diagnostic and monitoring tests to assist their animal disease prevention, control and eradication programmes.

30 countries are using the Sterile Insect Technique, which releases sterile but still virile male insects to prevent further offspring of insect pests. It is environmentally friendly on two important levels. First, it does not introduce any toxic agents into the environment; second, it is highly specific, in that it only affects a single species and not the many harmless or even beneficial insects living in the same place.

3.3 ENVIRONMENT AND SUSTAINABILITY

Crop and livestock losses caused by insects – such as the tsetse fly, screwworm, medfly and Codling moth – are considerable. Use of the IAEA's Sterile Insect Technique irradiates the eggs of these insects to sterilise them before hatching. As a result, no offspring are produced and the insect pest population in the area can be drastically reduced or even extinguished in an island situation.

The IAEA estimates that, by suppressing insect pest populations with SIT, pesticide use worldwide has been reduced by 600,000 litres annually. Since 2006, the insect pest control programme has generated benefits to farmers of more than $100 million and created thousands of rural jobs.

Water resources are essential to human life and development. A number of nuclear technology applications help us know the size and dynamics of underground aquifers, which is essential for the sustainable use of these resources. Other applications allow us to understand phenomena such as ocean acidification and its impact on marine ecosystems; find new sources of fresh water in the form of groundwater aquifers; identify pollutants and their sources in oceans and fresh water; and provide the necessary energy to power large-scale desalination operations.

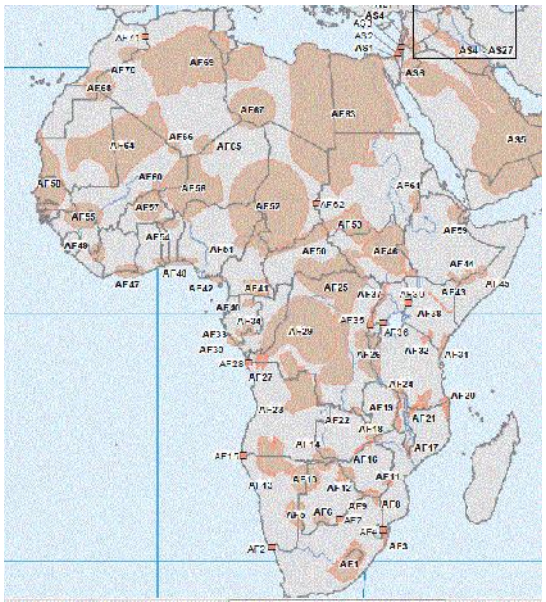
Ocean acidification occurs as oceans absorb the rising quantities of atmospheric carbon dioxide, which converts into a weak acid – dihydrogen carbonate – in contact with water. Corals and other marine organisms, particularly those with exoskeletons, have problems to build and maintain their acid-sensitive calcium carbonate structures. Radiotracers track the effects of acidification on ocean chemistry and marine life. Nuclear techniques monitor the oceans' shifting chemical balance cause by ocean acidification – vital information if we are to protect the marine environment, which supplies almost a third of all protein consumed by humans.

Fresh water resources underground can be traced and measured by isotope hydrology techniques. Through this, existing supplies of water can be conserved and new renewable sources of water found. The isotopic composition of water has been described as a "fingerprint" that allows one to identify the origins of underground aquifers, how big they are, and how this water moves underground. It is estimated that some 60 countries have used this sustainable management techniques to investigate their water resources.

Isotope tracking also helps to detect sources of pollution in reservoirs and coastal aquifers; detect toxins produced by harmful algal blooms in marine foods; and monitor and assess marine pollutants like heavy metals and pesticides. Solid wastes and sewage can be treated with radiation techniques instead of through the use of toxic chemicals.

Fresh water is a major priority in sustainable development. For many countries, desalination of salt water is a means of obtaining this precious resource.

Nuclear technology can help in desalination by using low-pressure steam from the turbine and hot seawater feed from the cooling system of small or medium-sized nuclear reactors. Other desalination plants use reverse osmosis and power from the grid. However, by co-locating desalination plants with nuclear power plants, the cogeneration potential can be better exploited. This is a technique supported by leading international water experts. There is already over 150 reactor-years of experience in the feasibility of using integrated nuclear desalination plants.



Turning to climate change, radioactive materials are essential in climatological investigations to determine the extent to which the earth's climate is warming. Isotopic records are preserved in marine sediments, corals and polar ice. Such information about the oceans' temperature, salinity, acidity, humidity, biodiversity and circulation in the past helps to verify the accuracy of today's ocean and climate models. Radionuclides also help to determine plant and sea assimilation of greenhouse gases.

A sustainable environment also requires stopping the spread of disease among animals. Nuclear techniques are used to diagnose livestock diseases and improve livestock growth and resistance to disease. Radioimmunoassay methods are essential in stopping the spread of trans-boundary animal diseases, such as rinderpest. Thanks to the role played by nuclear technology, rinderpest is now an animal disease of the past, having been completely eradicated worldwide.

3.4 ELECTRICITY AND POWER

Sustainable development relies upon access to clean, sufficient and affordable energy. Access to affordable energy directly improves human welfare. Yet globally about 1.3 billion people have no access to electricity.

Electricity is therefore the single most important contributor to human development and the betterment of humanity. Little wonder that access to energy – largely in the form of electricity and power generation – is rightfully considered the enabler for achievement of the UN's Millennium Development Goals.

As the IAEA describes it:

> “Essential to all human activities, energy fuels social and economic development. Energy is the engine for the production of goods and services across all economic sectors: agriculture, industry, transportation, commerce, public administration, among many others. Lack of energy is a contributing factor in individual, community, national and regional poverty. In contrast, access to energy opens many new opportunities. Meeting the UN Millennium Development Goals cannot be accomplished without access to affordable energy services.”

Without access to electricity, people are deprived of the opportunities that energy enables in education, agriculture, business, industry, and healthcare. Moreover, the use of fossil fuels for basic necessities like cooking and heating becomes a deadly hazard for many in developing countries. Half of the world’s population has no access to clean cooking fuels. Consequently, according to WHO estimates, the diseases caused by the resulting indoor air pollution kill 2 million people annually.

Current IAEA projections foresee electricity demand increasing by 60 to 100% between today and 2030. What will be the energy source for generating sufficient electrical power to meet this huge growth in demand? Will it be a clean, no-emissions energy source?

Nuclear energy minimizes the amount of CO_2 and other noxious gases produced in the generation of electricity. It therefore mitigates the impact of climatic disruption on development. By including nuclear power in its energy mix, a nation reduces harmful air pollution and GHG emissions, expands electricity supplies, and increases technological and human capital.

The nuclear industry is also pursuing innovative research and development in the area of nuclear energy options for the future. These involve more efficient fuels and new fuel cycles, Generation IV reactors, hydrogen production, small modular reactors, fusion energy. These innovative technologies focus on achieving dramatic improvements in flexibility, safety, cost, environment footprint, construction time, as well as on applications in remote or off-grid areas without local affordable or reliable sources of energy.

In short: nuclear technology contributes to development and growth through its production of clean, effective and affordable electricity. This in turn has a substantial positive effect on the environment and sustainability by being one of the tools we have today for combatting climate change and air pollution – for the benefit of humanity.

3.5 INDUSTRY AND CONSUMER PRODUCTS

The industrial and consumer product applications of nuclear technology surprise many people. These applications are largely unknown to, or pass unremarked by, the general public.

Applications in the industrial sector include the measurement of density, moisture content and geological composition in civil engineering; material analysis in industrial engineering; and level and flow rates in oil & gas exploration and production. In industrial radiography, nuclear substances are used for the non-destructive examination and testing of advanced materials. Radiation from the substances passes through the material and allows defects in welds or constituency to be recorded on film or a digital imager.

Gauges containing radioactive sources are used in industries where levels of gases, liquids and solids must be checked. These gauges are most useful where heat, pressure or corrosive substances make it impossible to use direct contact gauges. For example, radioisotope thickness gauges are used in the making of continuous sheets of material including paper, plastic film, metal and glass. Manufacturers of cans use radioactive materials to obtain proper thickness of tin and aluminum. Radiation gauges are used to regulate blast furnaces and liquid metal in moulds.

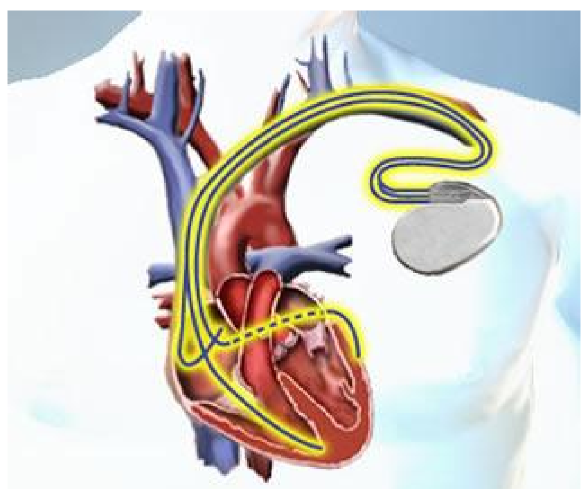
Moreover, radioisotope gauges are more portable than x-ray machines and can be used to check welds of new gas and oil pipeline systems and examine the structural integrity of bridges. Other forms of radiography can be used to locate components of materials not visible by other means.

Industrial radioisotope tracers are created by adding small amount of radioactive substances to materials used in various processes. This technique allows examination of mixing and flow rates of materials, liquids and gases, as well as the location of leaks. Radioisotope tracers are extensively used in metallurgical research to identify metal alloys and purify metals.

In advanced materials research, neutron beam scattering is giving new insights into how to treat infant respiratory distress syndrome; how to protect materials from corrosion; building better computer models of materials; superconductivity; hydrogen storage; creating lighter, more reliable car engines; and adding value to steel products.

Other applications come more directly into the realm of consumer and industrial products. For example:

- The paper industry uses radioactive materials in producing coated paper.
- Radioactive materials are used in luminous paint and products, including exit signs, airport runway lights, dials, gauges and watches.
- Radiation is used to toughen the rubber in radial tires and to align the steel belts in those tires.
- Non-stick pans are treated with radiation to ensure that the plastic coating adheres.
- Cosmetics, hair products and contact lens solutions are sterilized with radiation.
- Textiles are treated with radioactive materials to give them desirable qualities, like the ability to repel water.
- Smoke detectors rely on a tiny radioactive source to function.
- Radiation is used to measure the correct amount of air whipped into ice cream.
- Radioisotopes that emit energy are used in heart pacemakers and to power navigation beacons, satellites and space vehicles.



Nuclear energy provides process heat for industrial applications including desalination, synthetic and unconventional oil production, oil refining, and biomass-based ethanol production. Looking to the future, nuclear energy would be a natural source for large-scale hydrogen production.

3.6 PUBLIC SAFETY

Radiation is used to scan luggage at airports to detect explosives and concealed weapons, and to check packages for illegal narcotics.

Nuclear techniques are used to locate hidden radiological sources, including those which may be contrived as radiological dispersal weapons (so-called "dirty bombs").

The use of nuclear techniques (neutron beams) in materials research has direct significance to public safety. In addition to assisting inspection techniques for oil and gas pipelines, such R&D is used for assessing ship hull integrity and railroad track failure analysis as part of accident investigations.

4.0 Nuclear Security and Industry

Governments, with the full support and engagement of industry, have committed to the prevention and suppression of acts of terrorism, sabotage and theft by becoming parties, and to implementing various international treaties and UN Security Council Resolutions aimed specifically at enhancing and assuring nuclear security.

From a corporate perspective, good practice for the security of nuclear and other radioactive materials is comprised of a number of inter-related components: security culture (vetting of staff, training and involvement of all staff in security etc.); physical security (guards, gates, fences, intrusion detectors etc.); information security (including cyber security) and response.

4.1 SECURITY AND SAFETY – THE NUCLEAR INDUSTRY'S COMMITMENT

Nuclear security and nuclear safety have in common the aim of protecting persons, property, society and the environment. Security measures and safety measures have to be designed and implemented in an integrated manner to develop synergy between these two areas and also in a way that security measures do not compromise safety and safety measures do not compromise security. However, there are some differences.

Safety is enhanced through transparency. Greater openness and awareness of procedures, measures and facilities designed to strengthen safety can reinforce public confidence in the industry and the public's willingness to accept nuclear technology as beneficial.

Security relies more on reducing openness and access in order to protect sensitive facilities, sources and operational procedures from possible interference or attack by criminal or terrorist entities. Security is therefore dependent on the extent to which specific measures and information are kept from wider exposure. Some detail nevertheless must be communicated and made transparent in order to reassure the public and build confidence in the industry.

The nuclear industry is an active supporter of the Nuclear Security Summit process and its professional organisations (NEI, WNA etc.) undertake public and political outreach. The industry has also committed itself to principles of conduct to strengthen security. These principles of conduct are actively implemented by industry in everyday operations, processes and research that utilize nuclear technology and materials.

Each part of the industry will have a different balance to achieve between the openness of safety and the assurance of security. Some measures must stay confidential and protected in order to be effective in enhancing nuclear security. There is also recognition that the source of transgression could come internally within a facility and its operations, as well as externally. Moreover, the range of threats, risks, impacts and so forth will be different, depending on the nature of the nuclear technology and its applications.

What they share is that, as a licensee accountable for the possession, production, storage, safety, security and application of nuclear technology and material for peaceful, civilian purposes, each industry participant has legal and regulatory obligations regarding nuclear security for which compliance is enforced by national authorities and law. Industry may also be liable for any third party damage caused by a security incident.

The objective of nuclear security is to protect persons, property, society, and the environment from harmful consequences of a nuclear security event. With the aim of achieving this objective, industry seeks to establish, implement, maintain and sustain effective and appropriate nuclear security measures to prevent, detect and respond to such nuclear security events.

With any human activity come risks. This is as true of other energy industries as it is of the nuclear industry. Despite the low risk of deliberate release of radiation through criminal or terrorist intent, security measures are designed and implemented to protect the public and industry personnel as well as to mitigate the impact of a security breach should it occur.

4.2 THE INTERNATIONAL CONTEXT

The international nuclear security legal and policy framework is comprised of many components including: the resolutions of the UN Security Council and UN General Assembly; the Statute of the IAEA; international conventions; the resolutions of the IAEA Board of Governors and the General Conference; in IAEA Nuclear Security Guidance Documents and other IAEA standards.

However it is internationally accepted that responsibility for nuclear security rests with States.

A State ensures nuclear security by creating a nuclear security regime comprised of legislative and regulatory frameworks, institutions that oversee the implementation of these frameworks (i.e. regulators) and nuclear security systems and measures that prevent, detect and respond to nuclear security events.

The industry willingly complies with relevant international and national standards for the security of their nuclear and other radioactive materials and associated facilities and activities.

4.0 Conclusion

Enhancing Public and Stakeholder Confidence

Participants in the 2014 Nuclear Industry Summit committed to enhance public and stakeholder confidence through high standards of transparency, integrity, ethical behaviour and social responsibility, and we are doing so.

At the same time, performance alone is not enough. The world's nuclear industry has an excellent story to tell about how our technologies improve human lives.

Each of our organizations alone, whatever its particular contribution, may not have a full perspective on this narrative. This document represents an effort to paint the broader picture.

Public attitudes change. There is an opportunity to create a more positive popular view of nuclear by telling our story. While we continue to perform with transparency, integrity, ethical behaviour and social responsibility, this story of benefits also has a great contribution to make to enhanced confidence.

A1 APPENDIX

HOW THE NUCLEAR INDUSTRY PROVIDES FOR SECURITY OF RADIOACTIVE SOURCES

Government, industry and citizens often need to keep information and materials secure. Information, financial assets, medicines, cleaning fluids, and flammable liquids and gases need to be secured on a daily basis. Nuclear facilities, activities and materials are just one category of this problem. When safety and security systems work well, relatively little effort is required to maintain security – it becomes in-built and, to some extent, automatic.

According to the IAEA:

> "Nuclear security focuses on the prevention of, detection of, and response to, criminal or intentional unauthorized acts involving or direct at nuclear material, other radioactive material, associated facilities, or associated activities.
>
> Nuclear security and nuclear safety have in common the aim of protecting persons, property, society and the environment. Security measures and safety measures have to be designed and implemented in an integrated manner to develop synergy between these two areas and also in a way that security measures do not compromise safety and safety measures do not compromise security.
>
> Nuclear security, together with nuclear safety and applicable safeguards, is essential for enjoying the many benefits of nuclear material and other radioactive material in industrial, agricultural and medical applications, nuclear energy and many other areas."

At the Nuclear Industry Summit 2014, the nuclear industry identified six principles which set out the key responsibilities and activities through which the industry ensures secure operations and contributes to a robust national security culture. [See: "Nuclear Industry Participants Principles for Secure Operations"] Following are some of the undertakings by industry participants.

> <u>Regulatory Oversight</u> – Through development and maintenance of infrastructure and regulatory policies and principles, industry is committed to, inter alia: "a security response capability sufficient to counter the level of threat and risk appropriate to a facility".
>
> <u>Corporate Governance</u> – High-level corporate governance is established which, inter alia: "clearly designates accountability for security, including physical protection, cyber-security, and information security." Such governance also establishes "independent oversight accountable to or performed by the facility senior executive to monitor security operations."

Industrial Security Program and Operations – Industry will design and operate security systems to protect nuclear material and technology from theft or illicit use and facilities from damage that meet all the applicable requirements of the IAEA's Convention on the Physical Protection of Nuclear Materials and its 2005 Amendment; United Nations' International Convention for the Suppression of Acts of Nuclear Terrorism; national laws of the state; and international best practices and standards. Industry also will ensure that security provisions "provide for efficient facility operation, safety, and general emergency response".

Industry Experience and Cooperation – Industry commits to learning from each other in the area of best security practices and, in this regard, to the sharing of operating experience, to international cooperation, and to peer reviews.

Emergency Response – Industry commits to ensure an effective emergency response is in place where required.

Use of Highly Enriched Uranium (HEU) and Radioactive Sources – Industry commits to minimize civilian use of HEU to the extent possible, and to ensure effective control of high activity radioactive sources with appropriate security systems.

In addition to the undertakings and assurances conveyed in the principles identified by the Nuclear Industry Summit 2014, there are other security-related measures and systems which govern all aspects of how industry handles radioactive sources.

The IAEA's 2004 Code of Conduct on the Safety and Security of Radioactive Sources characterized all sealed sources according to an internationally accepted risk profile. The Code requires all signatory nations to implement certain security measures to ensure the safety and protection of persons and the environment resulting from the use of these sources. One of the requirements is the implementation of a tracking system to monitor the movement of the high-activity sealed sources as identified in the Code of Conduct.

National regulators are responsible for the regulation of the use, possession and storage of all nuclear substances, including those devices referred to as sealed sources. Sealed sources are radioactive substances encased in a sealed capsule or in a cover to which the substance is bonded. They are used for a variety of activities such as medical, industrial, academic and research, and commercial applications.

Most importantly, a strong licensing and compliance system will have safety and security provisions for nuclear substances and devices commensurate with the risks associated with the substance or device.

Licensees are accountable for any radioactive sealed sources in their possession, and must maintain an inventory of them. Licensees also report the movement of radioactive sources via a Sealed Source Tracking System and a National Sealed Source Registry.

Other means by which industry ensures the security of radioactive material:

Access Control – limiting access of individuals so that the risk of theft, sabotage or unauthorized use is minimized. When transporting radioactive material, access control is maintained when the transport vehicle is stopped while en route to its destination.

Detection and Assessment – Monitoring is used to detect unauthorized access to radioactive material via intrusion alarms, electronic devices for intrusion detection, or visual monitoring via video surveillance cameras and visual inspection. Systems are put in place to facilitate the notification of law enforcement agencies if actual or attempted theft, sabotage or division of material should occur.

Physical Barriers – These include physical controls – such as locked containers, storage facilities or other locations – that form barriers to prevent unauthorized removal of mobile or portable devices.

Information Protection – Information on how radioactive material is secured from unauthorized removal or access when it is in storage or how the licensee controls and maintains surveillance of the material is protected and stored securely.

Transportation of Nuclear Material – With respect to transportation of certain categories of nuclear material, a licence is required from the regulator. To obtain the licence, a transportation security plan must be provided that sets out, inter alia, proposed security measures. These security measures take into account, for example, the category of nuclear material to be transported, the size and type of the shipment, the distance and type of terrain to be covered, the mode of transport, whether the nuclear material is sealed or unsealed, and any provision for support of response forces along the transport route.

Transport security measures derive from regulatory requirements, national practices and international arrangements – such as the IAEA's Convention on the Physical Protection of Nuclear Material, which calls upon nations to cooperate in providing protection of nuclear material during its transport across national borders.

Other principles adhered to by industry in the transport of nuclear material include providing physical protection to prevent theft or acts of sabotage; minimizing the time the nuclear material remains in transport; varying transport routes; and restricting information on transport schedules and data about the movement of the nuclear material.

A2 APPENDIX

GOVERNANCE TEMPLATE

NUCLEAR SECURITY GOVERNANCE REPORTING TEMPLATE

This Template can be used by organisations that operate nuclear facilities and by those that use other high activity radiological materials such as in medical institutes. It can be modified for the specific circumstances in the organisation but, ideally, the 10 key questions should be addressed in the annual report published by the organisation, without disclosing sensitive information. An illustrative report for the fictional company RuriPower is provided to give guidance on suitable reporting language.

	Question	Notes and Suggestions
1	What is the *published policy* for nuclear security in your organisation?	If you don't publish a security policy, why not? If you do, how does it compare to your safety policy? Does it refer to performance, oversight and accountabilities?
2	How does your Board of Directors implement effective *governance and oversight* of the nuclear security programme?	Boards of Directors are usually required by law to oversee risk, including security. Does your Board have a mechanism to review security policy and performance? If not, why not? Do your Board Directors have the security clearance to see security assessments and reports? If not how can they discharge their responsibilities?
3	How do your Executive Directors *manage and control the implementation* of the nuclear security programme?	Executive management are responsible for security implementation. How do they achieve this? Is there an Executive Committee that defines policy and oversees security performance across the business including the supply chain?
4	What specific steps have you taken to encourage a *positive and effective nuclear security culture*?	Do you engage employees and seek their feedback? How does your security culture and efforts to improve it compare to your programme for nuclear safety?
5	Have you clearly *defined the managerial accountabilities for nuclear security*? What can you say about this?	Security is not just the job of the Security Director and Department. Do all Executives and Business Units have specific responsibilities and targets for security performance, including the Human Resource Director, Engineering, Technology, Operations, etc.?
6	Are all managers and personnel with accountabilities for nuclear security *demonstrably competent* by establishing appropriate standards for selection, training and certification? How do you achieve and evaluate this?	How do you assess whether managers and personnel are "demonstrably competent" in your organisation? Do you have certified professional development training with tests of competence? Do you require your staff to complete external certified training? Does this training extend to *all* managers and personnel with accountabilities for security
7	Is your nuclear security programme *performance based*? What can you say about your use of leading and lagging indicators?	Have you established meaningful performance metrics for the full range of security policies and procedures? Are there both leading and lagging indicators? Are these compiled and reported to the Executive Directors and the Board? Has the Regulator had reason to criticise your security arrangements and if so, how can you address this in your report?

8	Do you regularly assess the *effectiveness of your nuclear security programme, including cyber security*? What can you say about this?	Do you conduct exercises for physical security and penetration/other testing for your IT&IC systems? Is there a structured programme of testing? Who reviews the results and how do you learn from experience?
9	Do you take part in industry *peer reviews* of your nuclear security programme?	Are peer reviews completed jointly with other organisations in your country to identify best practice and provide feedback for improvement. Since they are done within a State there should be no problems associated with security clearances. It is also possible to conduct reviews with international specialists if either the reviews are limited to corporate oversight arrangements or if security clearances are obtained.
10	Have you taken measures to *ensure proper coordination between safety, security (including cyber security) and emergency response arrangements* and have you adopted an all hazards approach to risk management?	How do you manage these interfaces and avoid "gaps"? Do you have an integrated approach to risk management that includes the elements described opposite and if not, why not?

RURIPOWER

ANNUAL REPORT ON NUCLEAR SECURITY IMPLEMENTATION

INTRODUCTION

At RuriPower we hold sensitive materials, technology and information that must be protected from the threat of sabotage, theft or misuse. For that reason, we have always been very security conscious and have in place a complex system of security measures. Some of these, such as the perimeter fences, cameras, guard patrols and external access control systems are evident to the public. Others, including measures to protect certain sensitive areas from attack by explosives, are not.

While we want to provide public reassurance about our security arrangements, we obviously must ensure that we do not release information that could be of use to terrorists or others with malicious intent. This report provides information about our corporate oversight arrangements for nuclear security, how we approach risk management and review security performance and promote a strong security culture. We welcome comments and feedback, and encourage our employees and civil society to support the nuclear security arrangements by remaining vigilant and reporting any concerns through established channels or to the Police.

THE ROLE OF THE BOARD

Our Board recognises that there is a fundamental link between economic, environmental and social performance and that our long-term success depends on our ability to manage all three. Security is no different and is considered to be an integral part of our governance arrangements and operations. Our policy, published on the RuriPower website, is that:

> *"Effective security is an essential contributor to our business success at international, national and local levels, and is implemented through a performance-based security programme that is reviewed by the Board and implemented through our Executive Management Team".*

The Board receives performance and policy review information on a bi-annual basis and each year invites the National Security Regulator to attend a Board meeting to discuss current and future regulatory matters, including its assessment of our performance and attitudes to security.

THE EXECUTIVE COMMITTEE ON SECURITY (ECS)

The ECS is an integral part of our risk management arrangements and reports through to the RuriPower Executive Team and to the Board Audit Committee. Its Terms of Reference are to review security policy and performance across the organisation, to implement findings and recommendations, and to keep the Board informed of relevant developments. It is chaired by the Chief Operating Officer and attended by seven Operational and Functional Directors, each of whom have clearly defined responsibilities for aspects of the Security Programme.

The Director of Health, Safety and Environment, and the Group Director for Security have essential roles to ensure that the interfaces between safety and security are managed effectively and efficiently. The ECS meets quarterly and in the last year has taken specific measures to improve the management of physical protection and cyber security, appointing an Executive Coordinator to strengthen liaison between these professional teams. The ECS has also introduced an improved performance management system following a peer review by other nuclear operators and from the aviation sector in Ruritania.

SECURITY PERFORMANCE FOR THE YEAR

On the basis of our security performance programme, including the testing and exercise arrangements, we are confident that our systems are effective against the government defined Design Basis Threat. The Nuclear Security Regulator and our own Corporate Security Assessment Teams have conducted 21 scheduled and no-notice inspections and audits of our programme. Minor deficiencies were identified and all were corrected within the agreed timescales. However, it is our own internal oversight programme that provides us with the most robust assurances and we see external inspection as a supplement to our own management arrangements.

In the last year, we have revised our Memorandum of Understanding with the Ruritanian National Police Service, which has led to improved arrangements for off-site armed response and for incident command and control, including the opening of a new integrated command centre. These changes have improved operational integration and our resilience to attack.

From next year onwards, we will organise a yearly full-scale incident management exercise to strengthen synergies and complementarities of our security, safety and emergency preparedness teams.

We are also pleased to report that the programme to ensure that all managers with accountabilities for security are demonstrably competent was implemented during the last year. We have worked with independent experts to provide us with a job task analysis and competency framework for all accountable management personnel, and through a combination of in-house and external training 75% of the identified managers have now achieved certified status. The integrity of these certifications is backed by internationally recognised ISO standards for systematic training and proctored examination. The remainder of the managers will complete their training and assessment in the next 6 months, and recertification will be an on-going requirement. The training programme has led to significant improvements in understanding the need for the implementation of security across the business and supply chain and has proved to be a highly successful investment of time and resources.

RuriPower conducted its annual Employee Attitude Survey and for the first time included a survey of employee views on security. This identified some important issues relating to security communications and delays being experienced by staff and contractors when accessing certain areas of the site. Consequently, we have established employee forums for security at which we will explore further these issues and take steps to address employee concerns. Overall, however, the survey demonstrated that the security programme is both understood and supported (81% of respondents responding positively) but we will continue to promote a strong and inclusive security culture across RuriPower.

A3 APPENDIX

SELECTED REFERENCES AND SOURCES

Barrett, John – "Summary of Selected IAEA Activities Related to Maternal and Child Health" (2010, unpublished)

Burkart, Werner – "Nuclear Science: a Unique Contribution to the Betterment of the Human Condition" in: Environmental Radioactivity: New Frontiers and Developments (Bologna, Italian Physical Society, Conference Proceedings, 104)

Canadian Neutron Beam Centre – Probing Materials for Science and Industry 2014 (http://cins.ca/reports.html#cnbc)

Canadian Nuclear Safety Commission – "The Importance of Maintaining Control of Sealed Sources" in: DNSR Newsletter (Special Inventory Control Edition 2014)

Canadian Nuclear Safety Commission – National Sealed Source Registry and Sealed Source Tracking System – Annual Report 2014

Canadian Nuclear Safety Commission – Nuclear Substances in Canada: A Safety Performance Report (2013)

Canadian Nuclear Safety Commission – "Packaging and Transport of Nuclear Substances Regulations" in: DNSR Newsletter (Summer 2014)

Canadian Nuclear Safety Commission – Transportation Security Plans for Category I, II or III Nuclear Material (Regulatory Guide, March 2003)

FAO/IAEA – Contribution to Global Food Security (Joint Division of the FAO and IAEA)

IAEA – Atoms in Industry: Radiation Technology for Development (IAEA Bulletin, September 2015)

IAEA – Climate Change: Making a Difference through Nuclear Technologies (IAEA Bulletin, June 2015)

IAEA – Contributing to the Achievement of the Millennium Development Goals

IAEA – Designing Better Nutrition Programmes: the Role of Nuclear Technology

IAEA – "Essential Elements of a State's Nuclear Security Regime", Nuclear Security Series

IAEA – Incident and Tracking Data Base – Fact Sheet (2014)

IAEA – Nuclear Security Plan for 2014-2017

IAEA – Nuclear Technology Review 2015

IAEA – Nuclear Technology for a Sustainable Future (June 2012)

IAEA – Sealed Radioactive Sources (October 2013)

Management Information Services – The Untold Story: The Economic Benefits of Nuclear Technologies (Organizations United for Responsible Low-Level Radioactive Waste Solutions, Washington D.C. 20035)

Nordion and Bruce Power – Clean Nuclear Power: Safe Hospitals (www.cleannuclearpowersafehospitals.ca)

Nuclear Energy Institute – Fact Sheet on Nuclear Technology Applications: Consumer Products; Food and Agriculture; Industrial Uses; Medicine and Scientific Research; Space Exploration; Water Desalination (2014)

Nuclear Energy Institute – Fact Sheet on Nuclear Power Plant Security (September 2014)

Nuclear Regulatory Commission – "Implementing Guidance for Licensees that Possess Radioactive Material Quantities of Concern"

Nuclear Threat Initiative (NTI) – Strengthening the Global Nuclear Security System (July 2012)

WORLD Institute for Nuclear Security – Facilitating Accountability for Nuclear Security: a Model National Assurance Programme for Nuclear Security (May 2013)

World Nuclear Association – Radioisotopes in Industry (December 2014)

World Nuclear Association – The Many uses of Nuclear Technology (March 2014)