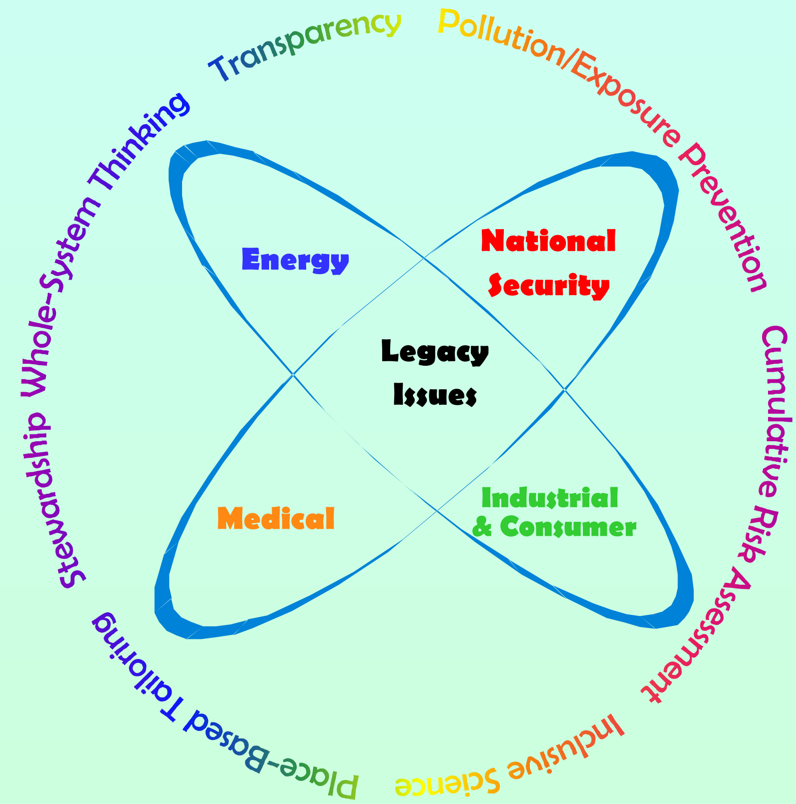
The Future of Radiation Protection: 2025

A Handbook for Improving Radiation Protection



A Project of the Institute for Alternative Futures
With Support from the U.S. Environmental Protection Agency

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Introduction

The Future of Radiation Protection: 2025 is a report on challenges the radiation protection community will confront over the generation ahead. It is also a handbook with exercises that people in the field of radiation protection can use to develop better responses to those challenges. It is a product of a project carried out by the Institute for Alternative Futures (IAF) with support from the U.S. Environmental Protection Agency. The project involved hundreds of people inside and outside the radiation protection community during a three-year period between late 1999 and early 2002.

The project reached conclusions that are themselves challenging. The bottom line is that the challenges ahead are so numerous and serious that they cannot be dealt with successfully through business as usual. A major shift in perspective and approach is needed.

FROM	TO
Exclusive focus on current issues, programs, budgets	Greater attention to the full range of radiation-related challenges facing society, leading to major changes in current priorities
Tacit assumption that the future will be much like the present	Realization that the future is likely to be much worse than the present if business-as-usual continues
Radiation protection defined primarily by a focus on "Legacy" issues	Assessment that Legacy issues will decline in importance and that future needs center primarily around developing more preventive approaches to 4 Key Sectors: Energy, National Security, Industrial & Consumer, and Health
Radiological attacks and other terrorist acts viewed as possible, but not given a high priority	Radiological attacks and other terrorist acts considered highly credible and a high priority
Reactive responses to problems after they become serious	More anticipatory, preventive approaches to problems
Conflicts between deeply entrenched positions	Emphasis on good science and shared principles for working toward better positions
Limited emphasis on public information and involvement due to habits of secrecy from the Cold War era	Primacy of transparency and public right-to-know; emphasis on public education and as much access as feasible to credible, usable information
Radiation protection as a community onto itself	Integration of radiation and environmental protection through shared principles for guiding action, combined databases, and risk harmonization

The first section of the report on *Challenges and Key Sectors* presents the results of an extensive set of interviews and focus groups exploring potential challenges the radiation protection community will need to deal with between now and 2025. It suggests that five ***Key Sectors*** – Energy, National Security, Industrial and Consumer, and Medical – can serve as a simple but comprehensive framework for assessing and prioritizing the challenges facing particular organizations and localities.

The second section on *Principles for Guiding Action* sets out seven principles that can help people working in radiation protection to adopt a more preventive and proactive approach, work through disagreements without blame or attack, and meet the challenges ahead. These principles emerged from a series of workshops designed to reach a full cross-section of the U.S. radiation protection community.

The third section contains discussion exercises that organizations and citizen groups can use to apply the principles. These discussion exercises can be used to develop a more comprehensive approach to virtually any problem or issue in radiation protection. The first exercise can be completed in two to three hours. A second exercise provides many options for deeper exploration. The exercises allow groups to apply the principles for guiding action in a systematic way and come to their own conclusions.

Challenges and Key Sectors

What are the most significant radiation-related challenges that will need to be dealt with between now and 2025?

The project began with a series of personal interviews and small group discussions that posed this question to over 125 thought leaders in the field of radiation protection. Discussions and interviews were conducted with professionals at an annual meeting of the Conference of Radiation Control Program Directors (CRCPD); an Association of State and Territorial Solid Waste Management Officials (ASTSWMO) Radiation Task Force meeting; a session at EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama attended by scientists, NGO, university and state officials; and an International Atomic Energy Agency (IAEA) International Symposium in Arlington, Virginia on the Restoration of Environments With Radioactive Residues.

The challenges that participants identified were grouped into 15 different categories shown in the Sectors image below in order to insure that no area was missed. Table 1 presents examples of challenges that participants judged to be both important and uncertain in their outcome.

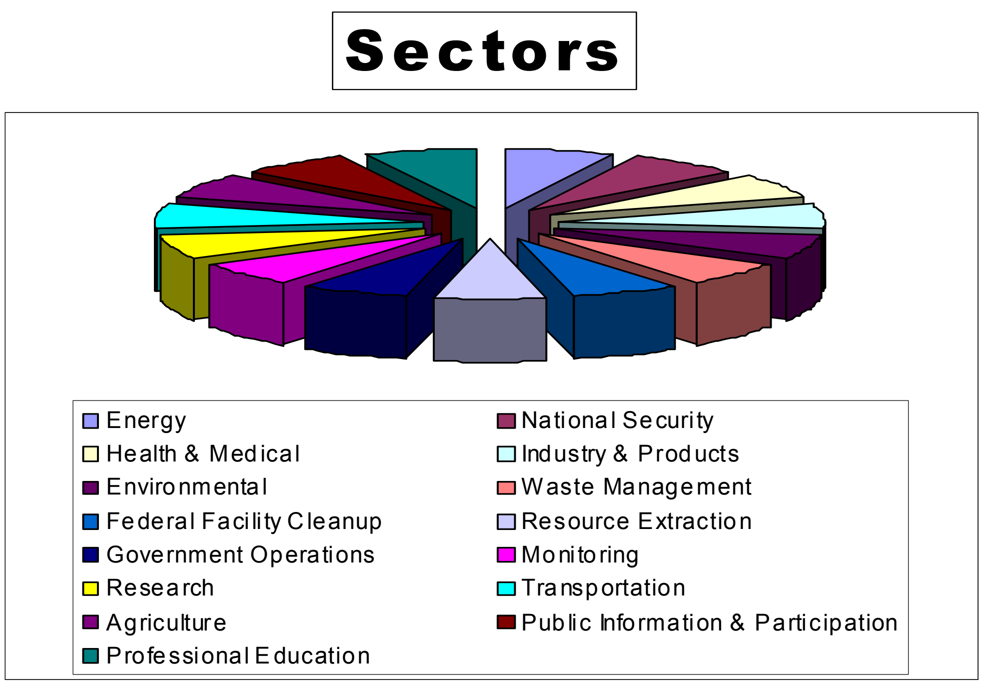


Table 1: RADIATION PROTECTION CHALLENGES – NOW TO 2025

Energy
▪ Next generation of nuclear power using smaller, standardized, safer reactors - yes or no ▪ Development of energy alternatives to nuclear power ▪ Shift to Hydrogen Economy – role of nuclear? ▪ Full benefit-cost accounting of nuclear & alternative energy options ▪ Potential slow phase out of nuclear power ▪ Change in sense of urgency about climate change as a result of new evidence, faster than expected warming, dramatic events, or political shifts ▪ Best investments for reducing greenhouse gas emissions – energy efficiency? nuclear? renewables? carbon capture and sequestration? ▪ Vulnerability of nuclear power plants & other energy sources to terrorism; grid vulnerability; potential for reducing vulnerability through distributed generation ▪ Economic costs of major security improvements ▪ Re-licensing current nuclear power plants ▪ Safe decommissioning and dismantling of nuclear plants ▪ Nuclear accidents ▪ Political impact of a Chernobyl-like event or wreck during the transport of high-level waste ▪ Breeder reactors and fuel recovery ▪ Radiation issues related to coal ash, TENORM from oil and gas, geothermal ▪ Potential breakthroughs in nuclear fusion ▪ Electric cars – could produce a large increase in electrical demand

Government Operations
▪ Public/community involvement in radiation protection issues ▪ Reversing a loss of trust, both from the public & from many in the regulated community ▪ Improving cooperation between federal agencies ▪ Growing role & responsibilities of states ▪ Increasing support for state radiation programs ▪ Improving accounting systems (total accounting) ▪ Setting standards over long periods of time, revising standards as new knowledge and models arise & assumptions change ▪ Environmental justice issues in radiation, e.g., Native American exposure patterns

Research
▪ Assuring good science amid controversy & influence of large funding from industry & government ▪ Understanding dose/ response at low levels ▪ Better assessment of cumulative risk ▪ Non-cancer radiation effects ▪ Hormesis

Agriculture
▪ Use of contaminated sewage sludge as fertilizer ▪ Food irradiation

Health & Medicine
▪ Radon concentrations in residential structures ▪ Radon progeny in cigarette smoke ▪ Unnecessary patient exposures/ overexposures to radiation in diagnosis & treatment ▪ Reaching agreement on “good practice” reference doses for different medical procedures ▪ Training & professional certification to reduce inappropriate medical uses ▪ Equipment calibration standards & guidelines ▪ Increasing exposures from new digital diagnostic technology ▪ Advances in radiation therapy that bring pluses but also unwanted consequences, e.g., labeled antibodies, CT interventional ▪ Explosion of radiation uses for both Dx and Rx ▪ Tracking cumulative medical exposures ▪ Progress in DNA arrays clarifies effects of low-level radiation, size of genetically sensitive population ▪ Preventive approaches & advanced modalities for diagnosis & treatment that can reduce uses of radiation ▪ Non-ionizing radiation issues: e.g., lasers, UV, EMF ▪ Disposal of radio pharmaceutical waste ▪ Control of cancer – would require changes in risk estimates ▪ Non-cancer effects of radiation, e.g., effects on fetuses of nucleotides that cross the placenta ▪ Exposures from flying in jet aircraft ▪ Cumulative exposures from varied additional sources not accounted for today

Environmental
▪ Assessment of ecological risks of radiation (eco-risk) ▪ Opportunity costs of environmental impacts ▪ Synergies between radioactive & chemical toxic wastes ▪ Groundwater contamination

Radiation Facility Cleanup
▪ Radiological assessment of DOE, Superfund, & other sites ▪ Improved clean-up technologies & strategies ▪ Clean-up standards ▪ Misallocation of resources – large funding to relatively unimportant Superfund sites, little funding for important things like low level waste sites, Hanford waste tanks ▪ Development of institutional controls (IC)

Professional Education
▪ Loss of talent entering the field ▪ Maintaining the professional/technical infrastructure for radiation protection, preventing a major gap between needs & capabilities ▪ Need for well-grounded professional generalists ▪ Shifting the focus toward prevention ▪ Increasing the emphasis on public health ▪ Harmonization of radiation and chemical risk management

National Security
▪ Nuclear terrorism – terrorist activity from small nations or terrorist networks with access to "loose nukes," bomb-grade materials, or materials for "dirty bombs" ▪ Preparing for the "unimagined but possible" ▪ Radioactive materials in the former Soviet Union ▪ Third World nuclear proliferation ▪ Possibility of "wild proliferation" ▪ Improving emergency response capability ▪ New generation of nuclear weapons, e.g., "bunker busters" ▪ Preventing radiation-related problems in any future weapons development ▪ Weapons decommissioning ▪ Elimination of nuclear weapons production ▪ What to do with & how to safeguard material from dismantled weapons ▪ Plutonium "spiking" to make it so hot that it is hard for terrorists to use

Industry and Products
▪ Orphan sources (radiation sources that end up in unexpected places) ▪ Occupational exposures ▪ Exposures from consumer products ▪ New industries using radioactive materials ▪ Substitutes, alternative technologies, and other trends away from the use of radioactive materials ▪ Product stewardship framework applied to industries using RAM ▪ Proliferation of low level sources – cumulative risks, impact on recycling ▪ Building construction ▪ Import of contaminated metals/materials ▪ Non-ionizing radiation exposures, e.g., rapid growth of wireless communication

Resource Extraction
▪ What to do with NORM (naturally occurring radioactive materials) and TENORM (technologically enhanced NORM) brought to the surface and accumulated or concentrated as a byproduct of industrial processes ▪ Source material for nuclear fuel ▪ Potential shutdown of uranium production, mining & enrichment, use of materials from dismantled weapons

Waste Management
▪ Finding a good solution for managing the increasing volumes of waste – not "saving money" or "blocking nuclear power" ▪ Lack of any system for low-level waste management ▪ High-level waste management & disposal, U.S. & abroad ▪ Aligning funding with real risks, avoiding pork barrel waste politics ▪ Local economic effects of waste sites ▪ Progress in robotics ▪ Progress in barrier/ containment materials ▪ Control of illegal mixing of radiation waste with other waste, & the preparedness to deal with such exposures

Radiation Monitoring
▪ Cheap, miniature sensor technology ▪ Expanded national monitoring system ▪ More efficient tracking systems ▪ Inexpensive RF tags ▪ Community monitoring ▪ Monitoring performance of repositories ▪ Real time monitoring information for licensees & regulators

Transportation
▪ Secure transportation of spent fuel ▪ Transport of other high-, mixed- and low-level wastes ▪ Political opposition & public protests

Public Information and Education
▪ Public right-to-know - availability of public information about sources & risks ▪ Balancing benefits of transparency with concerns for security ▪ Bringing public perceptions of radiation risks in line with scientific assessments of risks ▪ Education to increase public understanding of radiation protection issues

KEY SECTORS: A FRAMEWORK FOR APPROACHING THE CHALLENGES AHEAD

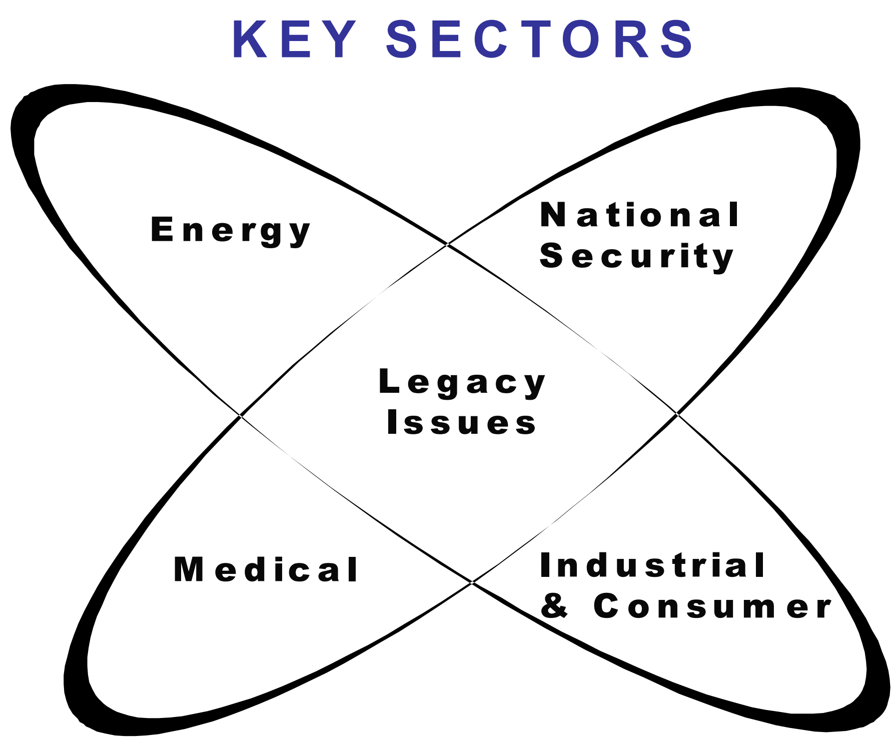
An analysis of the challenges identified by project participants led to several important findings.

Finding 1: Most Challenges Come From Four Sectors

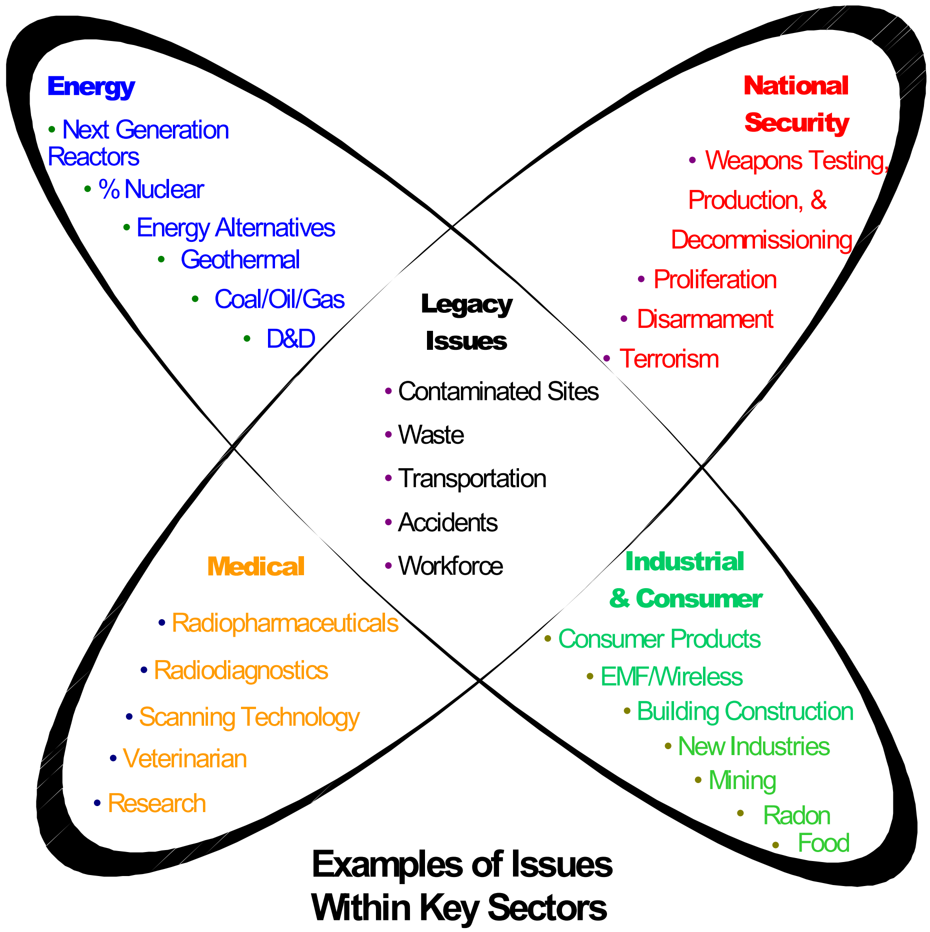
Most of the challenges that will need to be dealt with between now and 2025 arise from four sectors:

- Energy
- National Security
- Industrial and Consumer
- Medical

The Key Sectors images below represent these areas as four lobes within a simplified model of an atom. In the center, where the lobes intersect, is a fifth sector: Legacy issues. Wastes and other problems from the Energy, National Security, Medical, and Industrial and Consumer sectors eventually become the responsibility of people working in the Legacy Sector.



These five sectors appear to be the smallest number of categories into which nearly all of the challenges ahead can be placed and organized in a coherent way.



Finding 2: The Key Sectors Provide A Strategic Framework

The Key Sectors provide a simple, yet comprehensive framework for assessing and prioritizing the challenges facing particular organizations and localities. The Key Sectors can also be used as a framework for developing strategies that not only respond to individual problems, but also aim to address multiple problems within or across sectors.

Finding 3: Radiation Protection Currently Deals Primarily With Legacy Issues

Organizing the challenges ahead into five Key Sectors led to a realization that members of the radiation protection community primarily define their role as working within the Legacy Sector. In the larger community of environmental protection, the emphasis has been shifting for many years from dealing with wastes (pollution control, disposal) toward efforts to prevent wastes and other environmental problems from being created in the first place. In the radiation protection community, this shift has occurred much more slowly.

Finding 4: "Legacy" Challenges Will Decline, Future Needs Will Center on Prevention in the Four Key Sectors

Many participants believed that their organizations are likely to experience shrinking budgets and roles over the years ahead. For example, many CRCPD participants involved in the project foresaw shrinking resources for state radiation protection efforts, even as many problems worsen and new concerns emerge. At the Federal level, work on DOE and Superfund sites will reach a peak and then begin to decline.
While business-as-usual activities in radiation protection deal largely with Legacy issues, future needs center primarily around developing more proactive strategies to prevent wastes, security threats and other problems from arising in the four Key Sectors.

A central conclusion of this study is that developing more preventive approaches is the best strategy organizations in the radiation protection field can adopt to insure their continuing relevance and to have the greatest impact with limited resources.

Finding 5: Business As Usual Will Not Be Enough

Adopting a 2025 time frame encouraged participants to think beyond the limited number of issues currently occupying their attention, which led to a heightened sense of the scope and magnitude of future challenges. The collective discovery in each group discussion that "the challenges ahead are larger than we usually assume" led many participants to question current priorities. There was a widespread sense that business-as-usual will lead to worsening problems.

Implications of September 11th

The terrorist attacks of September 11, 2001 occurred in the midst of this project and strongly reinforced the conclusion that greater attention to preventive approaches is essential. Fresh thinking in all of the Key Sectors is required to address threats that were not previously considered likely.

In the Energy Sector, for example, security upgrades are already underway at nuclear power plants that go well beyond what were previously considered necessary. Security upgrades are also necessary at other less fortified parts of the nuclear fuel cycle, especially at stockpiles of spent nuclear fuel. There is about 40,000 tons of spent-fuel stored in cooling pools at operating and decommissioned power plants around the country. A report in 1997 for the NRC by Brookhaven National Laboratory estimated that a severe release of radioactivity from a pool could

render 188 square miles of land unfit for habitation and cause up to 28,000 cancer fatalities and $59 billion in damage.
To the extent that nuclear power proves essential for meeting future energy needs, vulnerability to acts of terrorism needs to be a major consideration in the selection of reactor designs. Several new designs are inherently safer than reactors in use today. The pebble bed modular reactor (PBMR), for example, is immune to the danger of a loss of coolant in the reactor core because the fuel is encased in billiard-ball-sized graphite "pebbles" that cannot get hot enough to melt down. But no options are without potential vulnerabilities. PBMR designs, for example, lack the thick, reinforced containment domes of conventional plants, making them more vulnerable as terrorist targets; their widespread use would require large numbers of reprocessing plants and produce large quantities of highly radioactive fuel waste.

To the extent that energy efficiency improvements, renewable energy sources, natural gas and coal with carbon sequestration, or other options prove able to meet future energy needs, the danger of terrorist strikes against nuclear facilities will be reduced. Lower use of nuclear energy in the U.S. and around the world would have security advantages. The materials, equipment and skills for constructing nuclear weapons would be harder to get, more conspicuous to try to get, and politically costlier to be caught trying to get – reducing risks of nuclear proliferation.

Radioactive isotopes such as cesium, cobalt, and americium are widely used in industry and health care. Applications range from food irradiation and radiation therapy to devices used to gauge and control the thickness of sheet metal, textiles, and paper napkins, or inspect metal parts for defects. The radioactive materials in these applications can be misused to build nuclear dispersion devices or so-called "dirty bombs" which use conventional explosives to disperse radioactivity over urban areas.

Radiological attacks using stolen or lost materials must now be considered a credible threat. They would cause some deaths, but nothing like the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon. However, they could contaminate tens of city blocks at a level that would require prompt evacuation. Since there are often no effective ways to decontaminate buildings exposed to the levels a dirty bomb would produce, long-term abandonment or demolition may be the only practical solutions. A single dirty bomb exploded in a major city could result in economic losses in the range of hundreds of billions to trillions of dollars.

Radioactive materials that can be used for such attacks are housed in thousands of commercial sites, medical facilities and research institutions around the country, few of which are adequately protected against theft by determined terrorists. The likelihood of abandonment or theft increases when technologies using radioactive materials break, become obsolete, or are no longer needed, and their owners face high costs for appropriate disposal.

A central conclusion of this study is that the threat posed by dirty bombs changes the situation facing the radiation protection community in

fundamental ways. Enhanced security measures are urgently needed at all sites that use potentially dangerous amounts of radioactive material. A thorough reevaluation of security regulations is needed to ensure that protective measures apply to all radioactive material that could potentially pose a security threat, not just those that present a threat of accidental exposure. Material recovery and storage programs need to be fully funded. Licensing requirements and inspection procedures for all dangerous amounts of radioactive material need to be reviewed.

Enhancing security measures will significantly increase the costs of using radioactive materials, which will stimulate the development and use of alternative technologies for many applications. Research programs and incentives to accelerate the development of inexpensive substitutes for radioactive materials in a wide variety of applications are potentially the most effective preventive strategy for responding to this threat.

The Challenge of *Whole System Protection*

The central challenge facing the radiation protection community is to go beyond business as usual toward a new ideal of *whole system protection*. Moving toward that ideal will require more preventive and proactive approaches in all of the Key Sectors. It will demand continuous innovation, rapid personal and organizational learning, flexibility to adapt to change, and movement beyond old conflicts that get in the way of progress.

"Principles for Guiding Action" toward whole system protection were developed in the next stage of the project. The principles that emerged, and exercises for applying them in decision-making, are described in the following sections.

Principles For Guiding Action

INTRODUCTION

Many of the challenges that the radiation protection community will need to deal with over the generation ahead involve disagreements between scientists, between environmentalists and industry, and among federal agencies like the Nuclear Regulatory Commission, the Department of Energy and the Environmental Protection Agency. One of the project's major objectives was to identify widely agreed upon principles for guiding action that members of the radiation protection community can use as a framework for resolving disputes and finding areas of common ground. It's easier to discuss problems and concerns without blame or attack when everyone agrees on basic principles. A set of seven principles emerged from the project's workshops:

1. Whole System Thinking
2. Transparency
3. Inclusive Science and Policy
4. Pollution and Exposure Prevention
5. Cumulative Risk
6. Place-Based Tailoring
7. Stewardship

This section of the Handbook provides a full description of these seven principles. Each principle is explained and then illustrated with several short case studies or examples of "the principle in action."

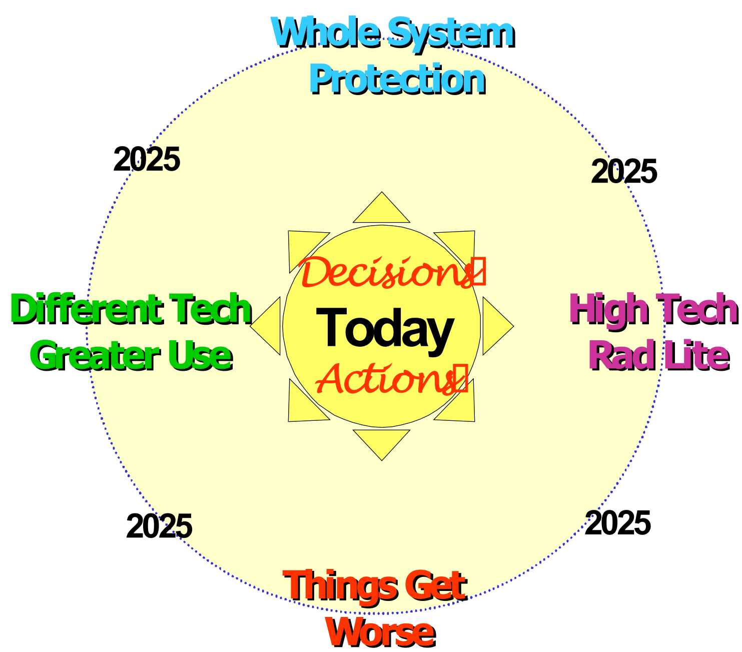
The following section of the Handbook contains exercises that anyone working in radiation protection can use to apply the principles to the issues that are most important to them. These exercises should only be undertaken after reviewing this description of the seven principles.

An Inclusive, Participatory Process for Identifying the Principles

All the trends and potential developments identified in IAF's initial interviews were compiled into four scenarios that explored different ways that radiation protection issues might play out between now and 2025. The scenarios were crafted to cover the whole range of future conditions that different interviewees saw as plausible, from a future dominated by problems to contrasting images of highly desirable futures. The purpose of the scenarios was not to predict the future, but to serve as a framework for a series of strategic discussions with different stakeholders in the radiation protection community. The discussions were designed to clarify participants' aspirations and identify principles appropriate for finding common ground.

In the first scenario, **Things Get Worse**, today's major controversies remain unresolved. Without decisive action, limited problems evolve into much bigger messes. In the second, **Different Technology**, **Greater Use**, the problems that dominate the first scenario are largely resolved by improvements in technology and management. A new generation of nuclear power is initiated. Expanding uses of radiation in industry and health care provide benefits that clearly outweigh risks. In the third scenario, **High Tech Rad Lite**, the market favors energy efficiency, natural gas, wind and other renewable resources over nuclear energy. Advanced technologies increasingly substitute for conventional uses of radioactive materials in industry and health care. Economics, national security concerns, and health concerns drive change.

The fourth scenario, **Whole System Protection**, was different in character from the other three. It did not describe "end states," such as whether medical uses of radiation increased or decreased by 2025. It focused instead on "process," describing a future of constant innovation and improvement, rapid personal and organizational learning, flexibility to adapt to change, and movement beyond old conflicts that get in the way of progress. It asserted that "principles for guiding action" widely agreed upon in the radiation protection community allowed people in the field to transcend some of their disagreements—but it did not specify what all of those principles should be. (The scenarios are described in more detail in the accompanying boxes.)



Things Get Worse
▪ Proliferation of nuclear weapons and weapons material and the enormous economic damage already caused by "dirty bombs" has made nuclear terrorism the primary national security threat. ▪ Global warming is accelerating rapidly because no substitutes for fossil fuels have been adequately developed or accepted by the public. ▪ Accidents related to nuclear energy generation have occurred in the U.S., Japan, France, the former Soviet Union, and the Third World. ▪ Environmental and public health scandals have occurred in the U.S. involving improper, transportation and storage of radioactive wastes. ▪ Huge expenditures for DOE and Superfund cleanups have often been boondoggles. ▪ Lawsuits for damages from medical and occupational exposures are on the rise. ▪ Concentrations of radon in residential structures have never been systematically addressed and remain an under-appreciated health danger. ▪ The waste management problem is still not solved. ▪ Many radiation protection programs have been cut and many personnel with appropriate training as well rounded generalists in radiation protection have retired; the number of people entering the field has declined.

Different Technology, Greater Use
▪ A new generation of smaller, standardized, inherently safer and more proliferation-resistant nuclear reactors is being built. ▪ Large-scale DOE and Superfund cleanup projects have been carried out efficiently, technical innovations have reduced cleanup costs, and costs of meeting unnecessarily high levels of protectiveness have been avoided. ▪ Important new uses of radioactive materials have been developed for medical diagnosis and treatment; the health benefits greatly exceed the risks. ▪ Many new industrial uses of radioactive materials have emerged, including some entirely new industries. ▪ A safe, acceptable waste storage and disposal program has been put into place for all forms of waste; the economic benefits generated by waste repositories overcame NIMBY resistances. ▪ Education programs for nuclear engineering and health physics are expanding rapidly to strengthen the technical infrastructure for dealing with radiation issues.

High Tech Rad Lite
▪ Total cost accounting has reinforced a global shift away from nuclear energy toward energy efficiency, natural gas, wind, and other renewable energy sources. ▪ Fuel cells using hydrogen are widely used in distributed generation and vehicles. ▪ All radiation standards have been set to protect the most vulnerable, genetically sensitive part of the population. ▪ Global treaties have banned all further production of nuclear weapons. ▪ All nuclear wastes, including materials from decommissioned nuclear weapons, have been placed in secure geologic storage. ▪ Advanced modalities for diagnosis and treatment have eliminated many uses of radiation in health care; improved training and professional certification have reduced inappropriate uses. ▪ Technological advances have provided substitutions for many uses of radioactive materials in industry and for all uses in consumer products. ▪ ·Professional training in radiation protection emphasizes prevention and public health.

The IAF scenarios were used as a framework for six scenario discussion sessions of twelve to fifteen people each. The six sessions were designed to reach a cross-section of the vast U.S. radiation protection community. At each meeting, a major objective was to challenge participants to identify what principles for guiding action the Whole System Protection scenario should include.

The first session, held at the EPA's Radiation and Indoor Environments National Laboratory (R&IENL) in Las Vegas, included state, tribal, university, and Federal laboratory officials. These participants tested the scenarios and a set of exercise/discussions based on them. The five other sessions were held in Washington, D.C. with different stakeholder groups.

The sessions used both high-touch (small group face-to-face conversations) and high-tech (a computer-based "groupware" tool). The groupware allowed everyone in the sessions to comment simultaneously, share their thoughts anonymously, react to each other's views, and participate in various kinds of ranking and voting exercises. The groupware also allowed discussion session facilitators to rapidly pull up graphs and charts to show areas of group consensus and disagreement, and to focus face-to-face discussions on topics the group as a whole assessed as important.

Each of the five Washington-based sessions was organized around a broadly defined stakeholder group:

1. **Federal agencies** – Department of Energy, Nuclear Regulatory Commission, Department of Defense, Department of State, Food and Drug Administration, Centers for Disease Control, National Institute for Science and Technology, Occupational Safety & Health Administration, and other agencies involved in radiation protection

2. **Industry and Science** – Nuclear Energy Institute, National Council on Radiation Protection and Measurements, American College of Radiology, Lawrence Livermore National Laboratory, Chevron Research and Technology, and other industry groups

3. **Environmentalists** – Environmental Law Institute, Public Citizen, Sierra Club, Institute for Energy and Environmental Research, National Safety Council, Nuclear Information Resource Service, Arlingtonians For a Clean Environment, and other non-governmental organizations

4. **EPA Radiation Professionals** – Staff and Managers from EPA's radiation programs

5. **Other Environmental Professionals within EPA** – Senior staff from many different parts of EPA beyond the radiation program

Input was also sought from state and local government officials at a board meeting and then an annual meeting of the Conference of Radiation Control Protection Directors (CRCPD) comprised of state and local radiation protection officials.

At the end of this series of discussion sessions, IAF analyzed the highest ranked suggestions participants had made for principles that members of the radiation protection community can use to reach greater agreement and achieve "whole system protection." The seven principles described here emerged from this highly participatory process that included virtually every part of the radiation protection community.

In a second phase of the project, IAF made Web and literature searches and conducted extensive interviews in order to characterize the principles and illustrate each of them with concrete examples and case studies. Staff members from EPA's Radiation Protection Division joined IAF on three trips – to Boston, Chicago and Denver – to conduct face to face interviews with experts and organizations whose work is closely related to one or more of the principles.

We believe that, taken together, the seven principles for guiding action are a powerful tool. Using this tool can help members of the radiation protection field solve problems and find greater agreement in areas where disagreements have blocked progress.

Over time, these principles can bridge the historical separation between radiation protection and the larger arena of environmental protection.

Summary of the Seven Principles for Guiding Action

1. **Whole System Thinking** – Strive to understand issues from a perspective broad enough to see the larger context from which the issues are arising. This requires multidisciplinary teamwork to look beyond specialties and organizational stovepipes. It entails striving to understand longer-term implications of actions and interconnections between issues.
2. **Transparency** – Operate in an open and accountable manner, providing the public with accurate, understandable information it can use to make decisions and evaluate the performance of organizations. Assure easy public access to up to date information on the state of chemicals and radiation in the environment. Avoid unnecessary secrecy, carefully balancing any risks to security that open access to information may pose with the social advantages of greater transparency.
3. **Inclusive Science and Policy** – Maintain a balanced approach that insists on the importance of sound science but also acknowledges the importance of inclusiveness. Engage a variety of disciplines, viewpoints and stakeholders, involve younger scientists, and bring to the table people with non-mainstream views as long as their approach is evidence-oriented. Employ alternative dispute resolution techniques to reach greater agreement on especially contentious issues.
4. **Pollution and Exposure Prevention** – Adopt practices to reduce at the source the amount of any hazardous substance or pollutant being released into the environment. Wherever feasible, eliminate the use of hazardous materials. Adopt practices that reduce exposures to hazardous substances and pollutants whose presence cannot be eliminated.
5. **Cumulative Risk** – Devote greater effort to understanding risks posed by cumulative exposures and by interactions between hazardous agents, including combined exposures to chemicals and radiation. Harmonize radiation and chemical regulatory approaches, based on a careful crosswalk between chemical and radiation models, parameters, risk calculations, and measurement techniques.
6. **Place-Based Tailoring** – In developing protection strategies, take full advantage of the human resources and capabilities of local areas. Where uniform policies are not necessary, avoid "one size fits all" approaches, tailor policies to local or regional circumstances, and encourage experimentation.
7. **Stewardship** –Take responsibility for providing the expertise and resources to maintain an adequate level of protection to human health and the environment across generations. Promote product stewardship as a major strategy in radiation and environmental protection

Principle 1

WHOLE SYSTEM THINKING

Whole system thinking involves approaching issues from a perspective broad enough to see the whole system from which problems or issues are arising. Traditional analysis decomposes issues and looks closely at parts of problems. The danger in this approach is that defining problems too narrowly in complex systems leads to narrow "solutions" that merely shift the problem or create new ones in its place. Whole system thinking, in contrast, aims at understanding the larger context in which a problem arises as well as its connections to other issues, which can lead to new views of the nature of the problem, new goals, and innovative solutions. Considering the "bigger picture" increases the likelihood of avoiding unintended consequences, finding solutions that provide multiple benefits, and targeting more detailed analysis in the most productive way.

Whole system thinking requires striving for better "peripheral vision": the ability to look beyond specialties and organizational stovepipes to consider the interconnections between your decisions and actions and other areas of activity. It requires striving to look beyond the immediate, local consequences of actions to consider their full potential benefits and costs—long term as well as the short term, global as well as local, environmental and social as well as economic.

When decisions are made without looking at this larger context, they are likely to sub-optimize and have unanticipated negative consequences. Unfortunately, as academic disciplines and professions become increasingly specialized, overspecialization often leads to a "trained incapacity" to see the interconnections between different areas. **Most of the current problems in the field of radiation protection are the result of past failures to adopt a broad enough perspective.** The waste problem is as large as it is, for example, because of a failure to do the kind of whole system thinking that would have led to more focus on waste minimization and volume reduction.

Multi-disciplinary teamwork is critical for avoiding the danger of trained incapacity. Individuals can seldom do good whole system thinking, not because it is so difficult, but because understanding any complex system requires many different perspectives and areas of expertise. Whenever a complex system needs to be designed or changed in a significant way, front-loaded planning done at the outset with the requisite variety of disciplines and stakeholders involved is the approach likely to achieve the most benefits at the least cost.

A whole system approach can avoid downstream costs for unanticipated consequences, expensive redesigns, litigation, delays, cleanups and other problems. It can often reveal how spending more for some things can reduce costs for other things, producing superior solutions without increasing costs.

An extensive theoretical basis for whole system thinking has been emerging from chaos and complexity theory, systems dynamics modeling, and other fields. A growing body of tools and practical applications is being developed in areas as diverse as engineering, futures studies and the organizational development work of Peter Senge and his colleagues at MIT. All of these diverse approaches share the goal of achieving a broader perspective capable of seeing the interrelatedness of elements within a system.

The Principle in Action

Operation Cat Drop
A Parable on the Folly of Failing to Consider the Whole System

In the 1950s, the World Health Organization (WHO) attempted to solve the problem of malaria afflicting the Dyack people in Borneo. Its simple solution was to spray DDT to kill the mosquitoes that spread the disease. The operation was considered a success, until the thatch roofs of people's houses started falling down. It was determined that the DDT killed wasps that had previously preyed on thatch-eating caterpillars. Without the wasps, the caterpillars were rampant and ate the roofs of the village houses.

WHO then discovered a worse problem: the DDT built up in the food chain, poisoning insects that were eaten by lizards, which, in turn, were eaten by cats. As the cats died, rats proliferated, and the area was faced with outbreaks of sylvatic plague and typhus. WHO eventually enlisted the Royal Air Force to parachute 14,000 live cats into Borneo. This fiasco might have been avoided if WHO had considered the implications of spraying DDT from a whole systems perspective.

Source: Rocky Mountain Institute
www.rmi.org/

Whole-System Nuclear Sub Design
Virtual Collaboration in the Design of Next Generation Nuclear Submarines

The Electric Boat Corporation of Connecticut is a sophisticated example of using interdisciplinary teamwork and front-loaded planning to build next generation fast-attack submarines for the US Navy. In a typical sub design process, engineers would draft the design plans, which would be passed along for construction by separate subsystem installation teams. Any design changes in the field would have to go though a time-consuming approval process involving each affected subsystem.

For these new nuclear subs, Electric Boat changed their design philosophy to bring all the stakeholders in the submarine together early in the design process. The entire design for the submarine was modeled by computer, with each of the tens of millions *of components virtually modeled in a massive computer database. This shared IT infrastructure gave all subsystem stakeholders the opportunity to give design feedback and propose corrections and enhancements early in the design process. Instead of using specialized subsystem teams, Electric Boat reconstituted its department structure into 11 cross-functional teams responsible for each different section of the sub. Each of these cross-functional teams contained a full range of stakeholders: piping experts, electricians, engineers, waterfront supervisors, key vendors, and Navy officers. Electric boat found that this collaborative approach reduces problems to such an extent that it is much faster and less expensive overall, despite higher costs at the outset.*

Source: Fast Company
www.fastcompany.com/online/38/submarine.html

The AAAS Building in Washington, D.C.
Whole System Thinking Applied to Building Design

The professions that contribute to the design of buildings are a good example of how over-specialization can lead to trained incapacity. Architects tend to think mainly about building shell design, mechanical engineers about HVAC systems, lighting designers about electric lighting, and so on. Many building professionals have lost the capacity to think about the interconnections between these building subsystems. Now, however, a new breed of designer/builders is emerging who bring interdisciplinary teams together at the start of projects to identify design improvements that can only be seen from a "whole building" perspective.

The new American Association for the Advancement of Science (AAAS) building in Washington, D.C. is an example. High-performance windows and energy-efficient lighting cut energy consumption to half that of a conventional office building of the same size, saving $150,000 to $200,000 per year. Looking at the interactions between building systems made it possible to install these advanced systems without adding significantly to the building's cost. Spending more on some building components allowed cost-cutting on others. For example, the increased cost for high-performance windows and insulation was offset by the lower cost for a smaller HVAC system. The cost for installing energy efficient lighting was offset by making extensive use of daylighting and eliminating over-lighting.

Source: Building designed by Pei Cobb Freed & Partners
http://www.jbb.com/interiors2.htm

The Natural Step
Four Whole System Conditions for Achieving Sustainability

The Natural Step (TNS) is an international organization whose purpose is "to develop and share a common framework composed of easily understood scientific principles *that can serve as a compass to guide society toward a just and sustainable future." The Natural Step model is being used by McDonalds, IKEA, and more than 100 other corporations worldwide as part of their framework for strategic planning.*

Dr. Karl Henrik Robèrt, a Swedish oncologist, began the work that led to The Natural Step in 1989. In the course of reviewing literature on health-related impacts of environmental contamination, Dr. Robèrt was struck by the degree to which effective action on environmental problems was being held back by endless scientific arguments over what seemed to him to be details. This insight led him to explore the possibility of addressing environmental issues as a "whole system" rather than as a series of separate media and disparate symptoms. As a cellular biologist, he had been trained to think in terms of the fundamental requirements that must be met for a cell to survive over time. This led him to try to formulate a set of fundamental system conditions for a sustainable relationship between human society and technology and the rest of nature.

Dr. Robèrt engaged 50 of Sweden's most prominent scientists in a consensus process to reach agreement on scientific principles on which these system conditions could be based. After circulating 21 drafts, consensus was reached on a document on principles. Then, in the early 1990s, Dr. Robèrt worked with Swedish physicist John Holmberg to define a set of four system conditions for sustainability based on the scientific principles. The ideas in the consensus document and the four system conditions constitute The Natural Step's framework.

The four system conditions are:

Substances from the Earth's crust must not systematically increase in concentration in the ecosphere. *Meeting this condition requires a reduced dependence on mined materials and fossil fuels.*

Substances produced by society must not systematically increase in concentration in the ecosphere. *This requires a greatly decreased production of naturally occurring substances that are systematically accumulating beyond natural levels and a phase-out of persistent human-made substances not found in nature.*

The physical basis for the productivity and diversity of nature must not be systematically deteriorated. *This requires sweeping changes in agriculture, forestry, fishing, and patterns of urbanization.*

Resources must be used fairly with the most resource-efficient means possible to meet basic human needs. *Ignoring poverty will lead the poor, for short-term survival, to destroy resources we all need for long-term survival. A just distribution of resources is necessary to ensure the social stability and cooperation needed for making necessary changes.*

No organization can fully meet these four system conditions in the current economic system with the present level of technological development. However, they are not *meant to be rigid rules. Rather, they are directional guidelines designed to guide decision-making in the direction of whole system sustainability. Because the core concepts of The Natural Step are based on scientific consensus, they can provide a common compass for people with different values, beliefs and political outlooks.*

Sources: "Taking The Natural Step." Paul Hawken, In Context
http://www.context.org/ICLIB/IC4/Hawken2.htm

"Combining ISO 14001 and the Natural Step." Susan Burns and Dorie Kranz
www.naturalstrategies.com/articles/kranz~1.html

Environmental Accounting
Whole System Thinking to Clarify Environmental Costs

The field of environmental accounting has grown rapidly around the world over the past five years. It uses words such as full or total, true, and life cycle cost to emphasize that traditional accounting approaches were incomplete in scope because they did not look at the whole system and so overlooked important environmental costs as well as opportunities for cost savings and revenues. Environmental accounting has two major dimensions: external or societal costs, the costs of impacts on the environment and society, and internal or private costs that directly impact a company's bottom line.

A comprehensive assessment of the external costs of a product or process involves looking at its full life cycle, from raw materials acquisition to manufacturing to consumer use/reuse/maintenance and ultimate recycling or waste management. Materials flow maps, a standard technique in chemical engineering, can be used as a framework for tracking flows of energy and materials, including pollution/waste volumes, types and fate. Assigning dollar values to external costs is inherently difficult and controversial, but a growing number of organizations are attempting to do it. (For an excellent example, see Full Cost Accounting at Ontario Hydro: A Case Study, EPA 742-R-95-00X.)

Internal assessment in the form of environmental management accounting is easier to do and is the aspect of environmental accounting that is growing so rapidly. Management accounting involves identifying, collecting and analyzing information to support a business's management decisions. It looks beyond the conventional costs typically addressed in cost accounting and capital budgeting to clarify the wide range of hidden costs, contingent costs, and image and relationship costs related to the environment that need to be taken into account because they affect the bottom line.

Bringing the full extent of internal environmental costs to attention motivates managers and other corporate stakeholders to find ways of reducing or avoiding those costs, which at the same time improves environmental quality. Companies with good management accounting programs are much more likely to undertake pollution prevention efforts than other companies because good accounting allows them to *see clearly that emissions create a wide variety of costs and represent wasteful "unsaleable production." Finding ways to improve efficiency and design out wastes can cut costs, and finding ways to use or sell by-products that were previously treated as wastes can generate revenue. A whole system perspective fosters the view that, "If we can't use it and we can't sell it, we shouldn't produce it."*

Source: Interviews at the Tellus Institute in Boston, a long-term partner of the EPA's Environmental Accounting Project.
www.tellus.org/

Principle 2:

TRANSPARENCY

Transparency involves operating in an open, accountable manner and providing the public with accurate, understandable information it can use to make decisions and evaluate the performance of organizations. It mandates assuring easy public—and public manager—access to up to date information on the state of chemicals and radiation in the environment. It requires avoiding all unnecessary secrecy. Growing pressures for greater transparency will challenge any vestiges of isolationism, "experts-know-best" paternalism, and habits of secrecy within the radiation protection community that remain from the Cold War era. To the extent that these behaviors persist, they now cause public distrust and prevent people involved with radiation protection from being exposed to new ideas and the scholarship in policy thinking occurring in the broader arenas of environmental protection and technology innovation.

Demands for greater transparency will keep increasing. The marketplace itself is driving them, as the corporate accounting scandals of the early '00s demonstrate. Financial markets can only function well when investors have the information they need to assess risks and make judgments about who will most productively use their capital. The digital revolution is emerging as another powerful force for transparency. Thanks to the Internet, it has become much easier to gain information about the actions of corporations and governments, share that information widely, and coordinate social action globally.

To develop appropriate transparency policies, organizations concerned with radiation protection need to weigh concerns about transparency's potential risks against an appreciation of its advantages. Organizations dealing with radioactive materials need to carefully balance any risks to national security that open access to information may pose against the benefits of openness. Private sector organizations must be able to protect information critical to their competitive advantage. Taking transparency too far could violate due process and infringe on reasonable protections of personal privacy.

Despite these potential risks, greater transparency usually offers enormous benefits. It empowers citizens to participate and to hold public and private sector organizations accountable. Transparency in an organization creates a reputation for honesty and integrity and increases trust among all parties who deal with it. It stimulates better performance and avoids spending energy covering up mistakes rather than solving problems. It draws people in who want to be part of an open and honest organization and changes an organization's internal culture, encouraging more knowledge sharing and collaboration.

The ultimate goal of increasing transparency is simple yet profound. The better we can see and evaluate the economic, environmental, and social behavior of all our institutions, the more incentives there will be for doing things in ways that work economically, environmentally, and socially. Transparency is a social technology for creating a sustainable future.

The Principle in Action

Overcoming A Legacy of Secrecy
Excerpts from the Conclusion of the ACHRE Report – The DOE Advisory Committee on Human Radiation Experiments

Openness—the public sharing of all information necessary to govern—has long been an ideal in American democracy and politics. Scientists, also, have traditionally embraced openness as the surest guarantee of continued progress. However, the ideal of openness has often competed of necessity with some measure of government-imposed secrecy….

[H]uman radiation experiments and intentional releases of radiation were often closely related to, if not directly a part of, some of the most closely held of secrets; including, most notably, nuclear weapons design and testing. The episodes we reviewed reveal the tensions underlying the necessarily delicate balance between openness and secrecy.

We found that decision making related to the secrecy of human subject research considered not only national security, but also other criteria. At its birth in 1947, the AEC determined to keep Manhattan Project experiments secret on the basis of concern for "adverse effects on public opinion" and possible "legal suits," even where national security itself was not expressly invoked. More generally, we also found that decisions to keep information secret were often accompanied by a concern that the public might not understand the information and thus overreact or that the public would understand the information but that its immediate reaction could undermine support for programs deemed essential by policymakers.

Significantly, we found that AEC and DOD discussions of Cold War human research policy were themselves conducted outside the realm of public debate. For example, the 1947 AEC declarations of requirements for human research involving patients were evidently given minimal distribution within the AEC research community itself...

[T]he assertion that programs will be jeopardized because of embarrassment or potential legal liability (or, worse, because of a lack of confidence in the American public's ability to understand) can be used to limit disclosure of precisely those matters that most affect us all and that would most benefit from informed public discussion.

If the boundary between openness and secrecy is inherently ambiguous, the public trust in those who define it on a daily basis requires a clear explanation of the principles that they will follow. However, we found that some of the basic principles *and rules by which this boundary was defined were themselves kept secret from the public….*

Since 1951, presidential executive orders have limited the use of classification stamps to matters of national security. Nonetheless, the keeping of secrets with reference to ill-defined reasons such as public relations, continued. Indeed, as recently as the early 1970s, adverse public relations was reportedly invoked as a reason for keeping secret details of the plutonium injections of the 1940s. In some cases, as we look back, the public relations rationale for secrecy appears to be more clearly documented than any national security rationale….

We also found instances where the keeping of secrets was accompanied by deception. The shades of deception ranged from outright denials by the AEC that it engaged in human experimentation, to the use of cover stories in the collection of human tissue, to incomplete information deliberately given participants in government-sponsored biomedical research….

In many cases, of course, some degree of secrecy was merited. We found that where secrecy was initially justified by reasons relating to national security, the classifying authority often gave too little attention to the likelihood that there would come a time when such information was no longer sensitive… the practical reality was that once information was "born secret" it often simply remained that way.

Similarly, we found that where a national security rationale for secrecy did exist, adequate attention was often not paid to ensuring that sufficient records would be created and maintained so that all affected individuals (and the public at large) could later know the possible health and safety consequences. As a result, "downwinders," as well as knowing participants in nuclear tests, today wonder whether the information given them represents the full story of these events….

Finally, we found that confusion, misunderstanding, and controversy still characterize public understanding of issues at the core of the Committee's work; for example, what is the nature of the risk from radiation? And to what extent can government statements about radiation….be trusted? It is important to reflect on the ways in which this state of affairs may, in part, be a consequence of past secret keeping….

As the Cold War recedes further into history, the issues of secrecy and openness it posed will undoubtedly continue to present themselves, although often in new settings. Our review of the past provides the basis for some specific recommendations about the future, but it also points to a more fundamental understanding of the wisdom of those leaders of the day who identified the long-term costs of secrecy and called for policies to minimize them. The shortcomings of past policies and actions confirm that even when principles are articulated by well-intentioned officials, the translation of principles into practice is not automatic and warrants careful attention by the public. At the same time, the present-day legacy of distrust confirms that too much secrecy in the short term will, in the long run, erode *the public's trust in government and the government's ability to keep the secrets that must be kept.*

Source: Department of Energy
http://tis.eh.doe.gov/ohre/roadmap/achre/report.html

The Toxics Release Inventory (TRI) Program
Informing Citizens and Communities of Chemical Hazards in Their Areas

Government-mandated reporting requirements are proving an important tool for promoting environmental transparency. With the passage of the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986, the U.S. became the first country to mandate that companies emitting certain toxic chemicals must publicly report on emissions that go "beyond their fence line." The law requires EPA and the states to annually collect data on releases and transfers of these chemicals, as well as the location and quantities of chemicals stored on-site, and to make the data available to the public in the Toxics Release Inventory (TRI). Other nations have followed suit, developing similar programs.

EPI makes the TRI data available through several data access tools, including the TRI Explorer, Envirofacts, and EnviroMapper. Other organizations take the data and make it available through their own web sites. Environmental Defense, for example, posts the data in an easy to understand "Scorecard" format. People can go to their web site, type in their ZIP codes, and find out to what degree industries in their areas are meeting EPA standards.

Easy access to data of this kind has empowered citizens and communities to hold companies and local governments accountable for the management of toxic chemicals. Simply collecting data and making it public has helped spur companies to improve their chemical management practices. Current TRI data show that chemical releases have decreased roughly 48 percent since 1988.

Sources: Environmental Protection Agency
www.epa.gov/tri/
www.epa.gov/enviro/
www.epa.gov/enviro/enviromapper.html

The Coming Revolution in Personal and Community Risk Awareness
Impacts of Advances in Monitoring

The RADITECT personal radiation alarm is being marketed on the Internet for $149. RADITECT has two alarm modes. A yellow LED pulses and an alarm begins to beep when radiation levels increase above normal background levels but are not harmful. The speed of the beeping increases as radiation levels increase in the *range of 75 microREMs/hr to over 200 microREMS/hr. Beyond 225 microREMS/hr the alarm goes into its second mode: a red LED pulses and a solid alarm sounds. Advertising for the RADITECT alarm describes a variety of potential nuclear emergencies, from loose nukes and nuclear power plant sabotage to dirty bombs, and warns that "Without a radiation detector, you will have to depend solely on the limited resources of the authorities to monitor your area, determine your risk level, decide the best protective action and then 'get the word out' to you."*

Source: www.homelandprotection.net/prodInfo.shtml/

Miniaturized sensors for chemicals and radiation will come into the range of individual affordability over the decade ahead. Progress in sensor development has been rapid, with roughly 10,000 research articles being published annually over the past few years. The new emphasis on homeland security will accelerate development further.

As examples of what is emerging, Cyrano Sciences, Inc. has developed a miniaturized, broad spectrum "nose on a chip" that can detect the presence of 32 chemicals. And researchers at the Cooperative Research Centre for Molecular Engineering and Technology in Canberra, Australia have developed a nanotechnology-based sensor with an artificial membrane filled with ion channels only 1.5 billionths of a meter wide that can detect a single molecule.

As sensor technology begins to spread, it will be a self-accelerating process. The liability problems that architects and building firms will face will expand the market. As in the case of cigarettes, if you know a problem exists but fail to deal with it, that is what creates a liability.

Sensors will make visible things like the "dust storms" created in schools when students walk between classes, creating a market pull for healthy, high productivity schools and offices. Community groups concerned about pollution from local industries, or an accidental release of radiation, or particulates from the demolition of nearby buildings will be able to use inexpensive sensors to take matters into their own hands. Garbage trucks equipped with sensors will be able to detect hazardous materials. Individuals with particular chemical sensitivities can be alerted immediately to exposures, creating a new kind of "individualization of environmental protection." Significant impacts like these will be occurring in 5 to 15 years.

The spread of sensors will have many positive impacts but will also pose novel problems. For example, in Chicago we estimate there is an 80 percent false alarm rate for CO detectors. People need to understand that when the alarm reacts to a brief episode, like a car starting in the garage, or the next door neighbor mowing his lawn, it is not really a problem. A major, continuing educational effort will be needed to prevent unnecessary anxiety by helping the public interpret the information sensors are providing.

Sources: Interview with Dr. Joseph Stetter, Illinois Institute of Technology
www.iit.edu/~stetter/
www.cyranosciences.com/

Cyber-Activism for Transparency
Fostering Economic, Environmental & Social Transparency Via the Internet

- *Activists among mutual fund shareholders are using e-mail and the Internet to coordinate their efforts urging the Securities and Exchange Commission to require mutual fund managers to disclose their proxy voting guidelines and their votes on particular issues.*

- *Global Forest Watch, a network of local forest protection groups linked by the Internet, monitors the world's old growth forests. Participants record on digital maps any illegal cutting or burning and post this information on the Web, naming specific violators.*

- *When information circulated on the Internet showing that Nike produced some of its athletic shoes under unhealthy and exploitive working conditions, first CNN and then media outlets around the world picked up the story. The company quickly instituted sweeping reforms to protect its brand value from permanent damage.*

The Global Reporting Initiative
Organizing A Common Global Approach to Transparency and Sustainability

The Global Reporting Initiative (GRI) is a long-term, multi-stakeholder, international undertaking whose mission is to develop and disseminate globally applicable sustainability reporting guidelines for voluntary use by organizations reporting on the economic, environmental, and social dimensions of their activities. Since its inception in 1997, the GRI has worked to design and build acceptance of a common framework for reporting on these three linked elements of sustainability as they apply to an organization:

Economic: *Wages and benefits, labor productivity, job creation, expenditures on outsourcing, R&D expenditures, investment in human capital. The Economic element includes, but is not limited to, financial information.*

Environmental: *Including impacts of processes, products and services on air, water, biodiversity, and human health.*

Social: *Including workplace health and safety, employee retention, labor rights, human rights, wages and working conditions in outsourced operations.*

The GRI cooperated with thousands of representatives from business, accountancy, investment, environmental, human rights, and labor organizations worldwide in designing a common framework called the Sustainability Reporting Guidelines. These sustainability guidelines are designed to be flexible yet provide a systematic framework for reporting and assessing sustainability measures. Organizations can report broadly across all three areas, in depth in a specific field, or follow a comprehensive and systematic approach. The flexible guidelines and voluntary nature of the reporting allows companies to take a gradual approach to adopting transparency practices, yet still preserve enough rigor to allow systematic comparison and tracking of critical measures of sustainability.

The GRI, first convened in 1997 by the Coalition for Environmentally Responsible Economies (CERES) in collaboration with the United Nations Environment Program (UNEP), has evolved into a permanent independent global institution. In April 2002, the GRI was formally inaugurated at a UN Meeting, which included leaders from government, corporate, labor, NGO and investment sectors. More than 110 pioneering companies from around the world have already undertaken sustainability reporting using the GRI Guidelines - including BASF, British Telecom, Bristol-Myers Squibb, Canon, Co-operative Bank, Danone, Electrolux, Ford, GM, Interface, KLM, NEC, Nike, Novo Group, Nokia, and Shell.

The GRI appears likely to become the framework for a common international approach to transparency standards for both public and private organizations throughout the world in the 21st century.

Sources: Interviews at CERES and the Tellus Institute in Boston
www.ceres.org/
www.tellus.org/
www.globalreporting.org/

CERES – Principled Transparency
Promoting Principles of Sustainability for Corporations

Since it's founding in 1989, the Coalition for Environmentally Responsible Economies (CERES) has emerged as a leader in promoting environmental reporting and the transformation of environmental management within firms. CERES grew out of an alliance between socially responsible investment funds and leading environmentalists to create a positive framework for changing corporate practices. In the wake of the Exxon Valdez oil spill, CERES formulated their "CERES Principles" – a ten-point code of corporate environmental conduct for public endorsement by companies.

Companies that endorse the CERES Principles commit to continual improvement in their environmental performance by acting in keeping with the Principles. CERES endorsers also agree to submit annual environmental performance reports and to engage with CERES in a major performance review at five-year intervals. They *agree to engage in dialogue with any experts and special interest groups concerned about their performance.*

While the first companies to adopt the CERES Principles had pre-existing "green" reputations, in 1993 Sunoco became the first Fortune 500 Company to endorse the principles. Today, over 50 companies – including 13 Fortune 500 firms – have endorsed the principles, and over 2000 companies worldwide are regularly publishing environmental reports. CERES members collectively represent over $300 billion in invested assets. CERES has grown around their Ten Principles to become the leading coalition of environmental, investor, and advocacy groups in the US.

Source: www.ceres.org

Principle 3:

INCLUSIVE SCIENCE AND POLICY

Inclusive science and policy is concerned with maintaining a balanced approach to public policy making that insists on the importance of sound science for resolving factual issues, but also acknowledges the importance of engaging a wide variety of viewpoints and stakeholders.

Rigorous, objective scientific methods that can stand up to public and peer scrutiny are essential in all areas of research dealing with radiation and environmental protection. Designing research to reach outcomes predetermined by ideology, political stance or financial self-interest undermines the integrity of science and the public's trust in the credibility of scientists. Falsifying data is the cardinal sin in science.

In formulating research agendas and informing public policymaking, scientific objectivity needs to be combined with inclusiveness. One reason for inclusiveness is that there is truth in the assertion that "experts do not always know best." Experts typically approach issues from their specialized disciplinary perspectives and underestimate the importance of other disciplines or perspectives. In radiation protection, for example, issues have most often been approached from the perspective of health physics, with less attention to other potentially valuable perspectives such as public health or ecology and eco-risk. Moreover, senior scientists often hold views that have become the dominant consensus in their fields and have an automatic skepticism toward non-mainstream views, even when they may contain valuable new insights.

These dangers can be limited by deliberately taking an inclusive approach that draws on a range of scientific disciplines, involves younger scientists, and brings to the table people with non-mainstream views as long as their overall approach is evidence-oriented. The traditional knowledge of native peoples is a striking example of non-mainstream views once dismissed as unscientific but now recognized as holding important insights for environmental policy-making.

Another reason for inclusiveness is that important policy decisions require public involvement and public acceptance. The problem of nuclear waste storage is a dramatic illustration of the problems that can arise when there is little public participation in the decision-making process. Involving a wide range of stakeholders, attending to public concerns and values, and exposing citizens to the best available scientific information is the best way to gain public trust.

The most contentious science-related disputes are often resolved through expensive litigation or behind the scenes deal-making, approaches that tend to produce lowest common denominator solutions. An inclusive approach can draw on methods of alternative dispute resolution to help parties in controversy make full use of available scientific findings, acknowledge uncertainties, develop broader research agendas, and invent new solutions.

The Principle in Action

NPC Principles of Scientific Integrity
Principles for Assuring The Credibility and Quality of EPA Decisions

In order for the U.S. Environmental Protection Agency to uphold its mission of protecting human health and the environment, it needs to have the public's confidence and trust in the credibility of its scientific and technical activities. To address this concern, the National Partnership Council (NPC), comprised of both management and union officials representing EPA employees, developed a statement of Principles of Scientific Integrity. The points below summarize the key ideas in the statement.

- *Work must be performed objectively*
- *No work should ever have predetermined outcomes*
- *Use the best, most appropriate techniques*
- *Fabrication of work results will not be tolerated*
- *Represent the work of others fairly and accurately*
- *Respect and acknowledge the intellectual contributions of others… to do otherwise is plagiarism*
- *Avoid financial conflicts of interest*
- *Accept the affirmative responsibility to report any breach of these principles*
- *Welcome differing views and opinions on scientific and technical matters as a legitimate and necessary part of the process to provide the best possible information to regulatory and policy decision-makers*

Consensus Building Through Policy Dialogues
Lessons From the Experience of the Keystone Center

Policy Dialogues are a method for seeking areas of consensus on issues that are difficult to resolve through traditional decision-making processes because they are politically controversial and scientifically complex. The Keystone Center in Keystone Colorado and Washington D.C. has organized policy dialogues in areas as diverse as increasing waste storage at nuclear power plants, regulating biotechnology, and siting natural gas pipelines. The Center's founder, Robert Craig, draws from this experience several lessons for organizing dialogues.

- *Dare to fail. To gain the benefits, you have to be willing to take the risk.*

- *Look ahead and deal with issues as early as possible. Positions harden over time as organizations commit to them and spend resources.*

- *Take time to frame the issue in a creative, doable way – narrow enough to get your hands around it, broad enough to see its real dimensions.*

- *Create balanced groups with participants from environmental and citizen organizations, industry, the scientific community, and government. Include the full range of relevant disciplines and viewpoints.*

- *Be prepared to take months–or more. Don't expect one-weekend results.*

- *Get the best, most forthcoming people you can identify. Avoid ideologues.*

- *More extreme groups can be tempered by involving the best groups like WRI, Audubon, Environmental Defense and the NRDC.*

- *Strive for an age mix. Ask responsible, broad senior leaders to help you identify the best younger people.*

- *Convince individual CEOs of the companies involved that the dialogue is important and may be their best shot on the issue.*

- *Neutral, professionally managed facilitation is essential, and a neutral group may be needed to sponsor the dialogue. It is hard to be perceived as neutral if you are industry, an environmental group, or EPA.*

- *Focus first on achieving as much consensus as possible on the facts. Separate initial discussions of facts from later discussions of values, aspirations and goals. Convince environmentalists this is necessary.*

Source: Interview with Robert Craig at the Keystone Center in Colorado
www.keystone.org/

Traditional Knowledge
Learning From People Who Have Been Learning for Thousands of Years

When Europeans first encountered native peoples in different parts of the world, they assumed they were ignorant. Until recently, modern scientists still disregarded the "traditional knowledge" of native peoples as anecdotal, superstitious and unreliable. But in the last few years, scientists have begun paying attention to traditional knowledge and learning to appreciate how much people who have lived close to nature for thousands of years understand about changes occurring in the *natural world today. Governments are increasingly consulting native people about the environment, and scientists are incorporating traditional knowledge into their research on climate change and other topics.*

- *Companies prospecting for uranium in Australia found that aboriginal people could tell them where to find it without searching in any way. Uranium deposits outgas radon produced by radioactive decay, which ionizes the air, which attracts lightning. Aboriginal people told the companies to go to the places where lightning often strikes, which had been observed and known for centuries.*

Source: Interview with Amory Lovins, Rocky Mountain Institute, Colorado
www.rmi.org/

- *While U.S. politicians still debate the reality of global warming, the Inuit in Canada's Western Arctic have been warning of great changes occurring in their environment over the past 40 years. Inuit elders say they are afraid of the sweeping changes they have seen coming for decades. The sun is growing stronger. Fall freezes are coming later. Winters are not as cold. Permafrost is melting and bald spots are appearing in the tundra. Glaciers are receding. Tides have changed and coastlines are eroding. There are more accidents because of the changing ice conditions. Birds, beetles and mosquitoes never seen before are appearing. Thunderstorms boom where it was once too cold for them. Clouds, winds and all the ancient weather markers no longer speak clearly to the hunters.*

Source: DeNeen L. Brown, Washington Post, "Signs of Thaw in a Desert of Snow," May 28, 2002, page A1.

Sweden's "Stepwise" Approach to Public Involvement
Finding a Socially Acceptable Solution for Nuclear Waste Disposal

A recent report on nuclear waste storage by the National Academy's Research Council observed that the primary hurdles for secure nuclear waste storage are social:

> *"Difficulties in garnering public support have been seriously underestimated, and opportunities to increase public involvement and to gain trust have been missed. Waste management programs around the globe should direct their efforts beyond technical development to emphasize public participation in the decision-making process."*

Sweden has developed a model approach for integrating meaningful citizen input into the decision-making process for nuclear waste depositories. Their "Stepwise" *approach has four primary stages that allow for a high degree of citizen input into the siting process.*

1. Voluntary participation of municipalities in conducting site feasibility studies.
2. Release of the feasibility study, and the opportunity for municipalities to withdraw from further involvement.
3. Comparison and analysis of feasibility studies, with commentary invited from scholars, experts, and the full range of stakeholders.
4. Site testing, preparation of a formal environmental impact assessment, submission of the final application.

By exposing citizens to the best available scientific information and the rationale behind the decision-making, the Stepwise process avoids much of the contentiousness of the "Decide-Announce-Defend" pattern that better typifies waste site selection in the United States. One key difference in the Stepwise process is that Swedish regulations specify that nuclear waste cannot be sited without the approval of the local public. Allowing the public and public interest groups to influence the debate and share their concerns before the final application is submitted creates new opportunities to explore possible options, concerns, and solutions, prior to final decision-making. Municipalities can fully participate in the process without incurring additional financial burdens, since they are given financial compensation for their time and resources expended.

Sources: NARC Report
http://lab.nap.edu/catalog/10119.html

SKI, The Role of Swedish Regulatory Authorities in the Nuclear Waste Issue
http://www.ssi.se/english/avfallinfo_eng.pdf

Inclusive Dispute Resolution
MIT-Harvard Public Disputes Program (PDP)

Disputes over policy choices take place at every level of governance. Typically, they are resolved through expensive litigation, behind the scenes deal-making, or become an issue in the legislative process. While these conventional means of policy formulation can often find the least objectionable solution, in many cases these contentious processes can overlook the best scientific advice or innovative solutions. The MIT-Harvard Public Disputes Program (PDP) has been involved in finding alternate approaches to public policy decision-making and testing new and more effective ways to settle public disputes.

Since 1983, the PDP has been involved in over 50 major real world experiments that have used mediation, assisted negotiation, and other consensus-based approaches to produce more effective resolutions of public disputes. Many of the issues that have been addressed, such as the allocation of scarce natural resources *and the formulation of health and safety standards, have involved controversies about research methods and findings.*

In a recent example, PDP is helping to facilitate the re-licensing process for hydroelectric dams supervised by the Federal Energy Regulatory Commission (FERC). The traditional confrontational approach of assessing environmental impact and formalized review has drawbacks that can be avoided by more collaborative approaches. PDP created a training course for all the stakeholders involved that demonstrates how consensus building and negotiation skills can apply in the FERC dam re-licensing context.

Source: Conversation with Lawrence Susskind, Professor of Urban Studies and Planning at MIT. See also the PDP Web site at:
http://www.mit.edu/afs/athena/org/p/publicdisputes

Principle 4:

POLLUTION AND EXPOSURE PREVENTION

Pollution prevention is the reduction or elimination of pollution at the source (source reduction) instead of at the end-of-the-pipe or stack. Pollution prevention occurs when raw materials, water, energy and other resources are utilized more efficiently, when less harmful substances are substituted for hazardous ones, and when toxic substances are eliminated from the production process. Operating more efficiently and reducing the use and production of hazardous substances protects human health, improves economic efficiency, and preserves the environment.

Source reduction allows for the greatest and quickest improvements in environmental protection by avoiding the generation of waste and harmful emissions. Source reduction makes the regulatory system more efficient by reducing the need for end-of-pipe environmental control by government.

Under the Pollution Prevention Act of 1990, recycling is not included within the definition of pollution prevention. Here a somewhat more expansive definition is being used that embraces direct recycling of materials that were previously treated as wastes.

The range of pollution prevention strategies are listed below:

- **Material substitution** – Eliminate hazardous material used in a process, a product, or during manufacturing of a product.
- **End-product substitution or modification** – Produce a different product, or modify the existing product, so that it accomplishes the same functions with less pollution.
- **Process substitution or modification** – Use a completely different technology or design approach to carry out a process, or improve the process to reduce waste generation.
- **Equipment redesign** – Change the physical design of the equipment to reduce waste generation.
- **Direct recycling and reuse** – Reuse materials directly in the manufacturing process, or design industrial ecologies that use the wastes of one process as food for others.
- **Good housekeeping** – Institute improvements in training and new procedures, such as preventive maintenance, to reduce waste generation.
- **Inventory control** – Minimize quantities of raw materials in stock to eliminate surplus that could become waste when the product is changed or discontinued.
- **Mass balance measurement** – Monitor and assess progress in reducing emissions.

Exposure prevention involves adopting practices that eliminate or reduce exposures to hazardous substances and pollutants whose presence cannot be completely eliminated. Exposure prevention includes inventory control, monitoring, training, safety equipment, improvements in maintenance and housekeeping, and storage and isolation.

The Principle in Action

Pollution Prevention Pays
3M's Pioneering Pollution Prevention Program

When 3M launched its Pollution Prevention Pays (3P) program in 1975, it was the first time a major company made pollution prevention an integral and permanent part of its operations, implementing it company-wide in an organized way and documenting the results. The program's goal was to reduce emissions into all media—air, water and land— by eliminating pollution at the source through:

- *Product reformulation,*
- *Process modification,*
- *Equipment redesign, and*
- *Recycling and reuse of waste materials.*

The example of a 3M manufacturing facility in Missouri illustrates how eliminating pollution at the source saves money. The facility used an acid solution to clean copper sheeting for making circuit boards, a process that created 40,000 gallons a year of hazardous waste that required expensive disposal techniques. Technical employees found that a change to a mild citric acid cleaning solution did the job just as well and completely eliminated the hazardous waste.

The 3P program depends directly on the voluntary participation of 3M employees. Innovative projects are recognized with 3P Awards. 3M employees worldwide have initiated more than 4,700 3P projects. From 1975 to 1999, 3P has prevented the release of 807,000 tons of pollutants and saved the company $827 million.

Source: www.cm.com/about3m/environment/policies_about3P.jhtml

Orphan Sources Initiative
Preventing Exposures from Lost and Abandoned Radiation Sources

The Orphan Sources Initiative is designed to help states address radioactive sources for which no known owner can be identified. The Initiative is a cooperative effort between EPA's Radiation Protection Division and the Conference of Radiation Control Program Directors (CRCPD).

Orphan sources can pose a hazard to the health of people who encounter them and cost facilities millions of dollars in lost production and decontamination expenses. If a steel mill inadvertently melts an orphan source, the radioactivity contaminates the *entire batch of metal, as well as the facility processing equipment. Decontamination of an effected facility poses additional health risks to workers and is very expensive, with average clean up costs ranging from $12 to 15 million dollars.*

Orphan sources of radiation also pose national security risks, since untracked radioactive sources can potentially fall into the wrong hands and be used in the production of a "dirty bomb" or nuclear dispersion device. According to some estimates, there are over 30,000 orphan sources in the U.S. today. They are the predominant radioactive contaminant in shipments received by scrap metal processing facilities.

Currently, the Orphan Sources Initiative is addressing these issues with initial funding from the EPA to the CRCPD to assist state regulatory agencies in identifying and controlling untracked radioactive sources. The CRCPD is coordinating activities with state radiation control boards in order to catalog the quantity and types of sources awaiting disposal, and to develop a risk-based ranking system to prioritize the risks they pose and determine which sources should be disposed of first. This approach was successfully tested in Colorado, where 30 orphan sources were identified and returned to the manufacturer. EPA and the CRCPD are expanding the program to include members of the steel manufacturing and scrap metal industries, and are developing educational materials to help these industry stakeholders better identify and dispose of orphan sources

Source: http://www.epa.gov/radiation/cleanmetals/orphan.htm

Pollution Prevention by Design

William McDonough Architecture and Community Design

Systemic facilities design can play an important role in pollution prevention efforts. One of the innovators in environmentally friendly design is William McDonough, the founding principal of William McDonough+Partners Architecture and Community Design. This firm is one of the leaders in practicing ecologically, socially and economically intelligent architecture and is noted for its success in eliminating (rather than reducing) pollution problems through innovative planning and design.

In one project, McDonough worked with German chemist Michael Braungart to help design a compostable upholstery fabric free of toxic chemicals for Steelcase, a manufacturer of office furniture. The project team considered 8,000 chemicals used in the chemical industry, and rejected 7,962 of them. By the end of the process, entire line of fabrics was created using only 38 non-toxic chemicals. When the effluent at the manufacturing plant for these new fabrics was tested, regulators found that the wastewater leaving the plant was purer than the water entering the plant. The plant achieved reductions in production costs by using fewer, cheaper chemicals and eliminating regulatory concerns.

More recently McDonough+Partners worked with the Ford Motor Company in the redesign of its Rouge River manufacturing plant in Dearborn, Michigan. Storm water management was a major concern, because the new pipes and treatment plants necessary to comply with storm water regulations were estimated to cost upwards of $48 million dollars. As an alternative, the plant was redesigned to minimize the need to process water runoff. 450,000 square feet of the roof area was covered with topsoil and plants, creating a living roof that sharply reduces storm water runoff. The roof, combined with porous paving and a series of constructed wetlands and swales slows and filters the runoff, eliminating the need for expensive technical controls. The final design led to a cost savings of $35 million dollars, with the added benefit of a beautiful landscape for the workers at the facility.

Source: Conversation with William McDonough
www.mcdonough.com/

See also Natural Capitalism. Paul Hawken, Amory Lovins, L. Hunter Lovins, 1999.

Radiation Exposure Prevention
ALARA – As Low As Reasonably Possible

The Brookhaven National Laboratory ALARA Center was created in 1983 with the mission of improving protection of the health and safety of workers at NRC licensed facilities. This mission was expanded in 1988 to cover all DOE nuclear facilities as well. The goal of the organization is help insure that the radiation doses received by workers in these nuclear facilities are kept "as low as reasonably achievable."

To further this goal, the ALARA Center takes an active role in presenting at conferences, publishing articles and papers, and developing an international network of contacts. Their membership on national and international standards committees helps insure that the most up to date guidelines on radiation protection can be effectively incorporated into new regulations. The ALARA Center also advises the NRC and DOE on practices and technologies for minimizing radiation exposure in nuclear facilities.

The ALARA Center uses a variety of other means to disseminate timely information on controlling, monitoring, and reducing radiation dosages for workers in the nuclear industry:

ALARA Notes
ALARA Notes, the newsletter of the ALARA Center, has a circulation of over 1,300 and is distributed to subscribers in the NRC, DOE, and the international radiation community. The newsletter is based on contributions from the nuclear industry and internal ALARA research, and the content ranges from examples of new technologies to illustrations of best practices for successful exposure prevention.

ALARA Handbook
The ALARA Handbook is designed for front-line workers in the industry, and contains fundamental information on conducting radiation protection programs. Topics covered include information on regulations and control, exposure control, proper conversion of units, useful formulae, and the elements of an ALARA program.

ALARA Databases
The ALARA Center contains several databases on information relevant to minimizing radiation exposures. Information in these databases is accessible through the Internet or by fax. While this information is made available online only to the NRC, its licensees, and the nuclear industry, the Center periodically publishes this information in NUREG reports and in the ALARA Newsletter.

Source: http://www.dne.bnl.gov/alara/brochure.htm

Fuel Cell-Electric Concept Cars From GM and RMI
Pollution Prevention Through Whole System Redesign

At the leading edge of R&D in the automobile industry, new vehicle concepts are being developed that radically increase efficiency in the use of raw materials and energy by redesigning every aspect of the automobile and its manufacturing process. The two most dramatic examples are GM's AUTOnomy and the Hypercar design created by the Rocky Mountain Institute (RMI) in Colorado.

Both vehicles run on hydrogen using fuel cells to convert the hydrogen into electricity by an electrochemical process that generates pure water as its only byproduct. Electricity from the fuel cells drives electric motors mounted within all four wheels. While fuel cell cars will begin to appear in the early '00s, these first models will be costly, inefficient and primarily for demonstration. AUTOnomy and Hypercar are far more advanced designs – and farther in the future.

AUTOnomy represents GM's vision of how automobiles will be designed and built 15 to 20 years from now. A prototype vehicle, called Hy-wire, recently made its debut at the Paris Motor Show. A chassis platform GM's designers refer to as the "skateboard" is made of advanced composite material and houses all the drivetrain essentials and electronics. Bodies of various kinds, from 2-seater sports cars to SUVs, can be mated to the skateboard with mechanical locks and plug-in electrical connections, much like a laptop computer mates into a docking station. A drive-by-wire system replaces all conventional hydraulic and mechanical systems with electronic sensors and electric motors. The driver steers, accelerates and brakes using jet fighter-style controls, eliminating the need for foot pedals. The car incorporates vehicle self-diagnostic systems, a collision warning system and other advanced electronics. The entire vehicle is designed for easy separation, recycling and reuse of its components. It has far fewer components than a traditional automobile, so it can be manufactured more inexpensively.

RMI's Hypercar is a super-efficient mid-sized SUV. It incorporates most features of the AUTOnomy (it was actually designed first), but goes still further. Every aspect of the car, from its aerodynamics and the rolling resistance of its tires to the efficiency of its electric motors is optimized by computer simulation for maximum energy efficiency. The car's entire body is made of ultralight carbon-fiber composite, which can absorb up to five times more crash energy per pound than steel. It can drive 330 miles on 7.5 pounds of compressed hydrogen, getting the equivalent of 100 miles per gallon. Moving at 55 mph, the Hypercar uses no more power than a normal SUV needs just for its air conditioner.

Both vehicles demonstrate how pollution prevention can go hand in hand with other functional improvements, resulting in next-generation technologies more advanced in every respect.

Sources:
http://gm.com/company/gmability/environment/products/adv_tech/autonomy1_010702.html

http://www.rmi.org/sitepages/pid386.php

Also see the article "Vehicle of Change" by Lawrence D. Burns, J. Byron McCormick and Christopher E. Borroni-Bird in Scientific American, October 2002.

Principle 5

PLACE-BASED TAILORING

Place-based tailoring involves taking full advantage of the human resources and capabilities of local areas. It also involves tailoring policies to fit local or regional circumstances and encouraging experimentation.

Regions, urban areas, towns and the neighborhoods within them have enormous assets for problem solving in radiation and environmental protection and other areas. They contain a large stock of “social capital” – the norms and networks of civil society that lubricate cooperative actions among citizens and institutions. They contain community and civic organizations, entrepreneurial businesses, knowledge-based industries, traditional knowledge, independent journalism, and endowed institutions with local interests such as libraries, universities and philanthropy – all with capabilities for problem solving and social ingenuity that are often overlooked in the design of federal programs.

While uniform national policies, regulations and approaches are often justified, they are at times adopted merely for bureaucratic convenience. As a result, “one size fits all” approaches sometimes fit no one.

Place-based tailoring requires adopting a grass roots perspective; taking into account differences in climate, industry composition, and other relevant factors; fostering local and regional participation in the formulation of policies; and tailoring actions to local circumstances whenever possible. Organizing environmental information in ways that allow communities to see a comprehensive picture of local hazards across different media can help local areas to organize their own protection efforts.

Putting “place back in policy” does not imply any rejection of the importance of national or even international level policy making. All levels deserve attention.

The Principle in Action

Placed-Based Energy Demand Reduction
The Center for Neighborhood Technology’s Community Energy Coop Program

The Center for Community Technology’s (CNT) Community Energy Cooperative (CEC) is a dramatic example of taking advantage of the human resources and capabilities of a local area. The Cooperative is a pioneering effort to help improve electricity reliability by changing energy-use patterns in local neighborhoods. This effort is being supported by Commonwealth Edison (ConEd), one of the Midwest’s largest electricity producers, which serves over 3.4 million customers in a territory that extends over Northern Illinois and Chicago. Commonwealth Edison has *committed to investing $14.7 million in start up funds to the CEC over the next three years. These funds will play a critical role in CEC's efforts to create new incentives to reduce electricity demand in 6 targeted pilot communities in the Chicago area.*

The six Chicago counties where CEC will be testing their pilot program all face the prospect of increasing energy demand, and not enough generation capacity in the area to meet that demand. The CEC will use the funding from ConEd to distribute cash energy reduction payments to its residential and business members to subsidize the purchase of new energy efficient equipment or on-site generators for residential and industrial customers.

Members participating in the CEC's demand reduction programs can save money on their energy bills. Annual savings can total as much as $100 for residential members. Mid-size commercial and industrial members participating in CEC load management programs can earn $12,000 - $20,000. In order to further reduce energy demand, the CEC will provide to its commercial and industrial members free energy efficiency audits, and assist in the design of voluntary load reduction programs. Energy audits can produce up to 10 percent savings without the need for any initial capital investment. In the near future, the CEC will begin financing the purchase and installation of efficient lighting systems, microturbines and other alternative energy supply systems.

Reducing demand among its customers through CEC is a cost-effective business strategy for ConEd. First, by reducing demand on growing sections of their electrical grid, ConEd can improve the reliability of their entire electrical network. Second, reducing demand allows them to avoid the purchase of expensive supplemental electricity from 3rd party providers during days of peak demand. Finally, this pioneering program will allow ConEd to indefinitely delay the construction of a new – and costly – power generating plant to serve the region. Subsidizing demand reduction among its customers with the assistance of CEC is a much less expensive solution for ConEd that allows them to target their future capital investment in more fruitful directions.

Source: Interviews at the Center for Neighborhood Technology
http://www.energycooperative.net/pr_2000

Regional Tailoring of Energy Systems
Placed-Based Approaches to Solar Energy and Energy-Efficient Architecture

Decisions to utilize wind for electrical generation have to be place-based because wind energy resources are distributed unevenly across the United States. The same is true for hydroelectric generation, sunlight-powered photovoltaic cells, and other renewable energy sources.

In the case of wind, areas around the country are commonly assigned to one of seven wind classes, each representing a range of average wind speeds at a specified height above the ground. Class 7 represents the highest power density and class 1 the lowest. Most areas being developed today are class 5 and above, which are found primarily near the east and west coasts, along ridges in the Rocky and Appalachian mountain systems, and in a wide belt stretching across the Great Plains. Class 3 and 4 areas will open up for wind development during the later '00s as wind turbine designs are adapted to run more efficiently at lower speeds. Class 1 and 2 areas are not suitable for large wind turbines, which means that wind will never be economic in the Southeastern U.S.

It is estimated that wind areas ranging from class 5 to 7 could provide nearly 50 percent of current U.S. electricity demand. Class 3 and 4 areas are distributed much more widely and could supply several times current U.S. demand. In practice, however, land use exclusion for conflicting uses, unsuitable terrain, and aesthetic and environmental reasons will limit the amount of power generated by wind. The intermittent nature of wind will also impose limitations on its use after it begins to generate more than about 10 percent of a utility's power needs, although this problem may be solved by using electricity from wind to produce hydrogen, which can serve as both a storage medium and energy carrier.

Regional tailoring is just as important for using energy more efficiently in buildings. Ironically, advances in central heating and air conditioning led to a dumbing down of building design, allowing the same standard "boxes" to be built in every area of the country. Now architects are relearning from vernacular architecture many lessons about how to increase energy efficiency by designing for specific climates. For example, overhangs provide shading in warmer months while admitting sunlight in colder months. Buildings can be shaped to divert winds in cold climates and to catch and circulate breezes in hot climates. Vertical airshafts such as cupolas and roof monitors can remove hot air and pull in cooler air. Windows, skylights, lightshelves and lightwells can provide natural lighting. Adapting buildings to regional climates leads to more interesting and varied architectural forms as well as greater energy efficiency.

Sources: Discussions at the National Renewable Energy Laboratory in Golden, Colorado

www.nationalwind.org/pubs/wes/wes04.hym
www.sustainable.state.fl.us/fdi/edesign/news/9607/thesis/arch.htm
www.nrel.gov/

Global + Local = Glocal
The Emerging Concept of Glocalization

Glocalization is not a misspelling of globalization. Rather, it's a term that characterizes how the processes of globalization and localization are going on at the same time. Many decisions previously made at the national level are either moving upward to international organizations, devolving downward to state and local governments, or shifting sideways to nongovernmental organizations (NGOs). Local businesses increasingly market on a global scale, while global corporations practice "mass customization" – varying their products to fit the needs and preferences of specific local markets. The very definition of "local community" is being altered with the proliferation of virtual communities.

The concept of "Glocalization" reflects the increasing need to appreciate these contrasting dimensions and to devote more attention to operating locally and globally as well as on a national level.

Source: Exploring the Future: Seven Strategic Conversations that Could Transform Your Association, American Society for Association Executives, 2001.
http://www.asaenet.org/foundation/seven/

Principle 6

CUMULATIVE RISK

Cumulative risk involves devoting greater effort to assessing the combined risks from aggregate exposures to multiple agents or stressors. Potential agents or stressors include chemicals, but may also include radiation, biological agents, physical agents, or even the absence of a necessity such as habitat.

Risks to health and the environment have usually been assessed on a chemical-by-chemical basis, partly because Congressional legislation has focused on controlling sources and individual chemicals, but primarily because of the difficulty of isolating "what causes what" when examining the impacts of multiple chemicals or other stressors. But in the real world, as opposed to controlled laboratory conditions, most exposures have a cumulative character. As a result, the EPA and many other organizations are now focusing on the challenge of cumulative risk assessment.

During the 1990's, several government reports highlighted the importance of moving beyond the chemical-by-chemical approach to understand cumulative risks. These reports include the National Research Council's 1994 report Science and Judgment in Risk Assessment; and the report on Risk Assessment and Risk Management in Regulatory Decision Making released in 1997 by the Presidential/Congressional Commission on Risk Management and Risk Assessment.

Considerable progress has recently been made toward developing a population-based methodology and a widely agreed upon framework for assessing cumulative risk. New technologies, like DNA arrays, promise to dramatically improve our capability to assess cumulative risk and understand the biological mechanisms of toxicity.

Assessing the cumulative risks posed by the combination of radiation and chemicals will require better harmonization between the different regulatory approaches for chemicals and radiation, which evolved in different communities from different scientific bases. Risk harmonization requires a careful crosswalk between chemical and radiation models, parameters, risk calculations and measurement techniques. More attention to harmonization, with a focus on crafting solutions that protect public health and are socially acceptable, can reduce some of the long-standing conflicts between agencies responsible for radiation protection.

The Principle in Action

Cumulative Risk Assessment at EPA
Examples of Activities Currently Underway

1. *The Risk Assessment Forum has convened a technical panel to develop guidance for conducting cumulative risk assessments. The first step is to develop a framework and identify the basic elements of the risk assessment process.*
2. *The Office of Air and Radiation's (OAR) air toxics program has a cumulative risk focus. Under the Integrated Urban Air Toxics Strategy (IUATS), OAR will be considering cumulative risks presented by exposures to air emissions of hazardous air pollutants from sources in the aggregate. Assessments will be performed on both the national scale and on the urban or neighborhood scale.*
3. *Several Regional Offices are evaluating cumulative hazards, exposures, and effects of toxic contaminants in urban environments. In Chicago, citizens are concerned about the contribution of environmental stressors to medical conditions such as asthma and blood lead levels. In Baltimore, a regional community partnership tried to address long-term environmental and economic concerns in three neighborhoods that are adjacent to industrial facilities and tank farms. Dallas is developing a geographic information system approach for planning and scoping cumulative risks.*
4. *The Food Quality Protection Act of 1996 requires the EPA to consider the cumulative effects to human health that can result from exposure to pesticides and other substances that have a common mechanism of toxicity. The Office of Pesticides Program (OPP) has developed guidance for performing cumulative risk assessments for pesticide, and has prepared a preliminary risk assessment for Organophosphorous pesticides.*
5. *The Office of Water is planning a watershed scale risk assessment involving multiple stressors in ecological risk. This approach was developed through collaboration with external scientists and currently in the process of being evaluated.*
6. *The National Center for Environmental Assessment within the Office of Research and Development (ORD) has competed ecological risk assessment guidelines that support cumulative risk assessment guidance. Five watershed case studies are being assessed to demonstrate the guidelines approach. Each of these cases deal with the cumulative impact of stressors that are chemical, biological, and physical. In addition, NCEA has done a draft reassessment of dioxin and related compounds.*

"Hazardscapes" to Display Cumulative Risks
The Chicago Cumulative Risk Initiative

In response to a Chicago Legal Clinic petition filed in 1996 on behalf of 11 community advocacy groups, the EPA funded the Chicago Cumulative Risk Initiative. This effort is designed to identify cumulative risks to both human health and the environment from multiple sources in Cook County, Illinois, and Lake County, Indiana. The Environmental Assessment Division (EAD) at Argonne National Laboratory is providing research and technical support for this effort.

EAD and Argonne's Decision and Information Sciences Division developed a methodology they believe will be applicable to other metropolitan areas. An initial screening phase has been conducted with air toxics as the focus. Because no single basis is considered sufficient for identifying high hazard areas with regard to air toxics, the screening process depended on analyzing the consistency of multiple measures.

This screening effort produced a ***Hazardscape*** *of the Chicago area, a visual mapping of the locations and relative hazards associated with toxic emissions, air toxic concentrations, and emission sources. Pollutants were evaluated cumulatively to the degree that adequate information was available to do so. The Hazardscape provides a basis for identifying smaller geographic areas with different types and levels of hazards, so that localities subject to the largest set of hazards can be studied in more detail.*

EAD often integrates chemical and radiation risk assessment in its work for clients. While it has not yet been done, risks from dispersed radiation sources, such as TENORM from coal fly ash, could be integrated into the Hazardscape.

Source: Interview with S. Y. Chen, Jim Butler, Leslie Nieves and other members of the Environmental Assessment Division at Argonne National Laboratory.
http://www.ead.anl.gov/project/images/pa/26chgo.pdf

The Risk Assessment Forum
A Preliminary Framework for Addressing Cumulative Risk from Multiple Stressors

In response to the growing need for substantive information on cumulative risks, the EPA Science Policy Council has asked the Risk Assessment Forum to begin developing agency- assessment guidelines that address these needs by developing a framework for measuring the cumulative risks from multiple environmental stressors. The framework is being designed to identify the basic elements of the risk assessment process and provide a structure within which further research can proceed.

This framework for assessing cumulative risk has several features that make it distinctive. First, it is designed only for cases in which multiple environmental *stressors are involved, rather than the more conventional approach taken by single-agent studies. Second, within the framework, "stressors" could range from chemicals, biological agents, physical agents, or even the lack of an environmental necessity such as habitat. Finally, this framework requires that the assessment of cumulative risk only apply in cases where the interactions between multiple stressors are being measured.*

This broad approach can allow a wide range of potential stressors and interactions to be measured in a quantitative – or even non-quantitative – fashion. The framework works as a guide for further research into cumulative risks, not as a straitjacket that mandates specific research methods or imposes limits on the potential scope of investigation. Additionally, it describes a coherent framework that could apply to future investigations, which may occur out of the present jurisdiction of the EPA, or may use new research methods.

Such a broad approach towards multiple agents and cumulative risk can even be applied to the potential harms from interactions between radiation and other environmental stressors. The extension of the framework beyond chemical compounds allows the interaction of radiation with other environmental stressors to be investigated within the same framework as other cumulative risk initiatives.

Source: Discussions with staff of the EPA's Office of Research and Development

Harmonizing Radiation and Environmental Protection

Harmonizing Approaches to Radiation and Chemicals in Practice and in Theory

At the local and regional level, information about radiation sources needs to be better integrated into environmental protection programs. For example, radiation is a concern at Brownfields sites and should be – but often isn't – considered along with chemicals such as PCBs, mercury and dioxin. Partnerships need to be used to factor radiation in with other environmental training programs. Building inspectors and demolition workers can be trained on radiation sources when they are being trained on lead, asbestos and other hazardous substances. Other partners should include the insurance industry and consultants and inspectors who evaluate sites.

Source: Interview with Judy Beck, EPA Great Lakes National Program Office

At the professional level, approaches to radiological and chemical risks evolved in different communities from different scientific bases and this separation persists along legal, regulatory, programmatic, training and operational lines. Most risk managers work within either the chemical or the radiation approach and tend to be critical of the alternative approach. These disagreements have real consequences for formulating cancer cumulative risk assessment policy, setting radiation standards, and making decisions about cleanup at sites containing radioactive and mixed waste. As a result, more attention needs to be given to opportunities for harmonizing these different approaches.

A workshop of risk managers and other experts convened by the Johns Hopkins University Risk Sciences and Public Policy Institute and the Environmental Law Institute and supported through a cooperative agreement with the EPA's Office of Radiation and Indoor Air concluded that harmonization is a potentially achievable goal. It can be realized without requiring that all problems be treated identically. Complete agreement on specific methodologies is less important than crafting solutions that protect public health and are socially acceptable.

The two approaches can be bridged to a significant extent by developing flexible risk management principles based on national criteria, performance-based risk standards, institutional controls, and other creative strategies. Early solicitation of public input to help risk managers design approaches that are acceptable to the affected community is the key to maximizing cost-benefit, cost effectiveness and cost-acceptability. In order to be acceptable, the costs and benefits of any proposed remedy must be understood by the parties at risk, and the remedy needs to take into account their values and concerns. Cooperation in case studies of actual cleanups can be a basis for continuing dialogue and improved interagency interaction.

Source: Workshop proceedings are available at ELI's website www.eli.org/about/center.htm

Principle 7

STEWARDSHIP

Stewardship involves taking responsibility for providing the expertise and resources to maintain an adequate level of protection to human health and the environment across generations. Stewardship can be viewed as the “master principle” that encompasses all the others. It calls for high responsibility in service to the long run greater good, rather than the pursuit of short-term self-interest.

To serve as a steward is to hold something safely in trust for another. Historically, the term was associated with accepting the responsibility to protect a kingdom while the king was away or to govern for the sake of an underage king. The concept has evolved to a much broader meaning today: accepting responsibility for the well being of future generations and the greater community of life. This concept of stewardship overlaps with the idea of sustainable development – development undertaken with a sense of responsibility to meet current needs without compromising the ability of future generations to meet their own needs.

Of all the areas of human activity, radiation protection arguably requires the greatest commitment to long-term stewardship. The long half-life of many radioactive materials requires long-term protection. The use of nuclear power, in particular, requires what Alvin Weinberg, the former director of Oak Ridge National Laboratory, called “a vigilance and a longevity of our social institutions that we are quite unaccustomed to….”

A new concept, called product stewardship, has developed recently to achieve environmental protection through a wide spectrum of strategies including full cost accounting, pollution prevention, and increased reuse, recycling and composting. The distinctive nature of the product stewardship concept is its emphasis on having those who design, produce and use products accept responsibility for the environmental impacts of those products over their entire life cycle from design to end of life. The greater any party’s ability to influence a product’s life-cycle impacts, the greater that party’s responsibility for addressing those impacts.

Product stewardship requires case-by-case analysis. In some circumstances, government may need to assume the primary stewardship responsibility in others, economic incentives may need to be established for changes in consumer behavior. But in almost all cases manufacturers must play a major role. By holding manufacturers at least partly responsible for end-of-life management of their products, they have an incentive to design the products with fewer toxics and to make them more durable, reusable and recyclable.

The Principle in Action

The Earth Charter
A Historic Global Charter for Planetary Stewardship

Below is a brief excerpt from the Preamble to the Earth Charter, a universal declaration adopted by the UN system in March 2000 and meant to become as central to international affairs as the Universal Declaration of Human Rights.

"We stand at a crucial moment in the Earth's history, a time when humanity must choose its future. As the world becomes increasingly interdependent and fragile, the future at once holds great peril and great promise. To move forward we must recognize that in the midst of a magnificent diversity of cultures and life forms we are one human family and one Earth community with a common destiny. We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and to future generations."

Source: The Earth Charter:
http://www.earthcharter.org/earthcharter/charter.htm

Native American Perspectives on Stewardship

> *"The white man does not understand…*
> *He kidnaps the earth from his children.*
> *And he does not care."*
>
> *-Chief Seattle*
>
> *"We learned the hard way. We destroyed the salmon once, and had to create the first Salmon Ceremony to teach our children to respect them. They still know the lesson of Salmon Woman: if you use up the resources now, you'll have none for the future."*
>
> *-Jewell Praying Wolf James*
>
> *"The ancient people of the land understood that to be in harmony with all things was not only the highest and finest way to live, but also the most practical, useful, beneficial and abundant. Their practice was one of being in harmony… I believe that the truly profound teachings of humanity go beyond race and any specific spiritual practice or philosophy. It literally comes down to, "Are you in fact living in harmony, or are you not?*

"Because we are habit-forming creatures, we're in the habit of living in this world as it is, and don't see how bad it is… We don't know what a truly healthy, whole, vibrant, alive way of being can be… When we really wake to a way of living in harmony with all things, we will turn around and look back and… won't believe we could have functioned in this much pollution and dysfunctional disharmony."

-Brooke Medicine Eagle

"The courageous vision of long-term stewardship of the land, the water, and the air is possible only if the institutional promise to future generations is kept, a promise not unlike those historically expressed in Treaties. Indeed the noblest courage of keeping one's own words of honor is essential to any long-term undertaking."

-U. Skil'weesa Spring

"The traditional Native view is: 'This is where I fish. This is where my children and grandchildren will live. We have a sacred duty to protect this land.' We know that stewardship responsibilities must be carried out into the far future. The poetic concept of the "7th Generation" is still a cultural aspect of Native life. But the way it really happens is through the hard work of building institutions that instill into your children and grandchildren both the traditional values of stewardship and the modern knowledge needed to be effective stewards."

-David Lester, Council of Energy Resource Tribes

Long-Term Stewardship of Contaminated Sites

Over the past few years, the concept of long-term stewardship has evolved from an abstract idea to a set of specific activities that experts widely agree will be needed at contaminated sites around the country. Even after all remediation and engineering activities have been completed, many of these sites will still harbor residual contamination. The portions of these sites that are not safe enough for unrestricted use will require long-term attention, in some cases spanning several centuries, to protect people and the environment from the hazards that remain. Major elements of the required long-term stewardship include:

- *Long-term site surveillance and monitoring;*
- *Maintenance of waste disposal facilities;*
- *Application and enforcement of legal restrictions to prevent inappropriate land and groundwater use (often referred to as "institutional controls");*
- *Preservation of institutional memory on the types and nature of risks at sites;*

- *Communication mechanisms to keep future generations informed of site hazards;*
- *Research and development, and, where appropriate, application of new technologies to further eliminate residual contamination.*

Many of the sites being cleaned up under the Superfund and RCRA programs are likely to require this kind of long-term stewardship. They include several sites on the EPA's National Priorities List, several closed military bases, and over a hundred sites in the nuclear weapons complex.

The costs and institutional requirements of long-term stewardship need to be addressed more fully. The full range of stakeholders – DOE, EPA, state agencies and local governments, tribal nations, state and local radiation protection officials, environmental groups, and local citizens – need to deal with very basic questions that have not yet been fully answered, including:

- *What organization should be charged with ensuring protection at these sites?*

- *Is federal legislation needed to create a coherent long-term stewardship program with clear mechanisms of external accountability?*

- *How can long-term financial security of the organization charged with long-term stewardship be assured? (Currently, any liabilities that DOE may have for long-term stewardship are not identified in its budget.)*

- *How can DOE, EPA, and state regulators most effectively work with local governments on long-term stewardship issues that affect them? (Many of the mechanisms for implementing long-term stewardship, including zoning, property records, deed notification, building permits and information management, depend on local governments. But no provision has been made for involving local governments in planning and decision-making or for funding local governments to pay for activities associated with long-term stewardship.)*

Sources: "Long-Term Stewardship and the Nuclear Weapons Complex." Resources for the Future.
www.rff.org/reports/PDF_files/stewardship.pdf

"The Role of Local Governments in Long-Term Stewardship at DOE Facilities. Environmental Law Institute.
www.eli.org/store/rr01localDOE.htm

Alvin Weinberg on Long-Term Stewardship
The Longevity of Social Institutions Required for Nuclear Stewardship

"We nuclear people have made a Faustian bargain with society. On the one hand, we offer…an inexhaustible source of energy…. But the price we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to…."

"We have relatively little problem dealing with wastes if we can assume always that there will be intelligent people around to cope with eventualities we have not thought of. If the nuclear parks that I mention are permanent features of our civilization, then we presumably have the social apparatus… for dealing with our wastes indefinitely…. The knowledge and care that goes into the proper building and operation of nuclear power plants and their subsystems is something we are committed to forever…."

Source: Alvin Weinberg, Director of the Oak Ridge National Laboratory, "Social Institutions and Nuclear Energy," Science, January 7, 1972, pp. 27-34.

The Product Stewardship Institute
Finding Cleaner Technologies to Maximize Production and Minimize Impact

The Product Stewardship Institute (PSI) is the first non-profit organization dedicated to product stewardship in the U.S. PSI is a joint initiative between the Massachusetts Executive Office of Environmental Affairs and the University of Massachusetts at Lowell, and is designed to help Massachusetts as well as other states increase production while minimizing the environmental impacts from manufacturing.

PSI provides a forum for the coordination of state and local government efforts to develop and expand product stewardship efforts nationwide. It identifies research and other technical needs and helps manage and link research projects conducted by other organizations. It is building a product stewardship "virtual network" of professionals around the country who work at government agencies, non-profit organizations, and academic institutions.

PSI has already developed Draft Action Plans for several priority products, including electronics, mercury, pesticides, paint, and carpets, and it is consulting with the EPA on potential applications of product stewardship concepts and methods to radiation protection. The Institute's Draft Action Plans are intended to provide a basis for continuing discussion between manufacturers, environmental groups, industry groups, and as a common starting point for stewardship negotiations and agreements.

PSI Product Stewardship systems can be implemented though state and local regulations, or as voluntary and self-funded industry initiatives. One successful example is the Rechargeable Battery Recycling Corporation (RBRC), an industry managed organization that is funded from contributions from manufacturers in the rechargeable battery industry. The RBRC assists in coordinating the recycling of the batteries, with no further cost to consumers or the government.

Ultimately, Product Stewardship creates a more balanced accounting of costs that helps insure that all those involved in manufacturing, selling, and using products are bearing full responsibility for the environmental impacts of the product over the entire course of its life-cycle. This shift in accountability can support efforts to reduce the amount of toxics in products, maximize the efficient use of resources during production, and help to increase the recycling and reuse of selected materials at the end of a products life.

Source: Interview with Scott Cassel, founder of the Product Stewardship Institute
www.productstewardshipinstitute.org/

Two Exercises to Apply the Principles

The seven principles that emerged from the project's workshops reflect the views of over a hundred thought leaders from every sector of the radiation protection community about how to improve decision-making in radiation protection. Applying the principles to the issues that are most important to you will help you develop approaches that work economically, environmentally and socially, avoiding unintended negative consequences. Applying the principles will help you avoid paralyzing conflicts by finding common ground that different parties can agree upon.

This section of the Handbook provides two exercises designed to help small groups apply the principles to specific issues. The exercises pose questions for reflection and discussion. Thinking through your own answers to these questions will allow you to apply the principles in a systematic way and come to your own conclusions.

The first exercise below involves a brief discussion of the seven principles so you can consider the implications of each of them. The second exercise will take you into a more in-depth discussion of the principles that seem to you most relevant and important.

Exercise 1: Initial Discussion of All Seven Principles

You may well find that the two to three hour discussion you have in this initial exercise has considerable value and leads to changes in your approach to issues you are considering. An additional purpose of this exercise is to discover which principles are most relevant for the issue you are considering, so that you can explore the implications of those principles in greater depth.

Fourteen questions are set out below – two for each principle. Spend 5-10 minutes discussing each of them. You can spend more time on some and less on others as seems appropriate. *Your group does not need to reach agreement about the answers to the questions*. Simply discuss each question for 5-10 minutes and then move on to the next. At the end, assess which questions led to the most productive discussions or surfaced the most important controversies. The principles associated with those questions are the ones that most merit further discussion.

This exercise is best done with a small group of no more than 8 people. If more people are involved, break them into multiple groups of 4-8. Have each group pick a facilitator/recorder who asks the questions, moves the discussion along, insures that everyone involved has a chance to contribute, and takes notes on a flip chart or notepad. Devoting three hours (including time for a break) for completing this exercise will allow for unhurried discussion. A minimum of two hours should be available.

Discussion Questions:

Whole System Thinking

1. How might we reframe this issue to see more clearly the larger context from which it arises?

2. What are the full range of benefits and costs we need to try to understand in dealing with this issue – economic, environmental and social?

Transparency

3. What do we need to do to deal with this issue in a more open, accountable manner?

4. What can we do to make higher quality information on this issue available to the public in more accessible, understandable, and usable forms?

Inclusive Science and Policy

5. What natural science and social science disciplines that are relevant for dealing with this issue have not been drawn upon to date, and how can we effectively utilize those areas of expertise?

6. If we want to get the input of all the relevant stakeholders for decision-making on this issue, who needs to be included?

Pollution and Exposure Prevention

7. What kind of *preventive* strategies might we employ to minimize this problem in the future or to keep this issue from arising in the first place?

8. Can product and process innovations, new technologies, or changes in behavior make it possible to eliminate or reduce this use of radiation or radioactive materials without reducing functionality?

Place-Based Tailoring

9. How can we use the knowledge and capabilities that exist at the local level to help deal with this issue?

10. Are uniform national policies needed in dealing with this would it be better to adapt solutions to different regional, state or local circumstances and encourage experimentation?

Cumulative Risk

11. Are there other environmental risks present in this situation beside the radiation risk being assessed?

12. What additional risk assessment efforts are justified to better understand the cumulative risks posed by both radiation and other agents or stressors?

Stewardship

13. If current approaches related to this issue continue, in what ways might the issue become more difficult for future generations to deal with?

14. In this issue area, what party has the greatest ability to influence life-cycle impacts, and therefore should bear significant responsibility for addressing those impacts?

Exercise 2: In-Depth Discussion

At the end of the initial discussion of all seven principles, you are likely to find that one or more of the seven principles seem especially relevant to your organization and the issue you are considering. You can design follow-on sessions for more in-depth discussion of those principles by drawing on the more extensive list of questions set out below.

For any principle you want to explore further, review the list of questions associated with it. Then select the questions that you believe would prompt the best discussion. Feel free to formulate your own questions related to the principle(s) that are specifically focused on the issue you are considering.

Use the same discussion format used in the first exercise with small groups and facilitator/ note-takers. As before, your group does not need to reach agreement on the questions you discuss. The discussion should not be approached as a decision-making meeting but as an opportunity to think creatively and share ideas.

Questions for In-Depth Discussion

Whole System Thinking

- How might we reframe this issue to see more clearly the larger context from which it arises?
- What are the full range of benefits and costs we need to try to understand in dealing with this issue – economic, environmental and social?

Economic Costs & Benefits

- Are there overt or hidden subsidies that need to be accounted for to make fair cost comparisons?
- How great are the risks to capital? Is a modular approach possible that allows a series of comparatively small investments to be made on an as-needed basis, or are comparatively large initial investments necessary?
- What are the expected normal operating costs, including factors such as management and repairs?
- How much are costs likely to increase or decrease in the future due to factors like rising resource prices, economies of scale with rising production volume, or incorporating the cost of externalities?

- Are there related indirect costs that are not normally factored in but that should be included in full comparisons?

- How large is the potential cost of malfunctions or accidents in terms of the numbers of people affected and the magnitude of potential consequences to those affected?

- What are the full lifecycle costs, from cradle to grave?

Environmental Costs and Benefits

- What are the potential impacts on human health and the associated costs? (e.g., costs for health care, loss of productivity from absenteeism)

- What are the potential impacts on vulnerable species and ecosystems?

- Is contamination/damage to land possible? If so, what are the likely impacts? Is effective restoration possible?

- Is contamination of water or air possible? If so, what are the likely impacts? (e.g., damage to agriculture and forestry, damage to fish and shellfish production, accumulation of toxins, loss of genetic information)

- What are the potential impacts on ecosystem services? (e.g., provision of clean water, water storage and flow regulation, food and materials production, breakdown and recycling of wastes, etc.) How much value should be placed on these services in evaluating actions that could degrade or protect them?

- Are the environmental impacts temporary and reversible? If so, what expenditures would be required for environmental restoration?

- Are some of the environmental impacts highly resistant to remedy or irreversible? What cost should be assigned to such impacts?

- Is there some risk, even if small, of catastrophic impacts? How should that risk be factored in if it exists?

Social Costs and Benefits

- To what extent do different approaches to this issue increase or decrease the potential for social conflicts? (e.g., NIMBY, social protest, local control and state’s rights vs. national control, interregional conflicts where some areas receive more benefits and others bear more costs)

- To what extent do different approaches to this issue foster local participation and choice, allowing different communities to opt for different approaches and risk-benefit balances?

- To what extent do different approaches risk Infringements on civil liberties? (e.g., to discourage dissent, prevent sabotage, guard against diversion of materials)

- To what extent do different approaches and technologies create risks to national security? (e.g., vulnerability to sabotage or cut-offs of critical supplies, proliferation of radioactive materials or weapons)

- Are there long-term social implications that have not been factored in? (e.g., long-term viability, impacts on livability, externalities that will effect future generations)

- Does total cost accounting make the approach or technology in question more, or less, competitive and attractive?

Transparency

- What do we need to do to deal with this issue in a more open, accountable manner?

- What can we do to make higher quality information on this issue available to the public in more accessible, understandable, and usable forms?

Transparency vs. Secrecy

- Is there unnecessary secrecy around this issue that can be lifted? (in either the public or private sector)

- Would greater transparency in this area increase public trust or produce other benefits? Would it cause problems or harm any parties?

- Can enforcement information in this area be made more available to the public?

Information Gaps

- Are there important information gaps that need to be filled by monitoring or research? If so, what can we do to help fill these gaps?

- Is the information available to the public on this issue up to date? What can we do to keep it up to date?

- Is the industry or organization involved in this issue already required to disclose information on some chemicals or pollutants? Are there good reasons why other information, including radiation-related data, should not be regularly disclosed?

- Is research or monitoring addressing effects on the environment as well as human exposures?

Usefulness to Public

- Is high quality, credible information on this issue available to the public in understandable, usable forms? (e.g., with technical terms eliminated or clearly explained) If not, what can we do to provide it?

- Are there additional strategies we could develop to improve public access? (e.g., create a Web page, provide information in Spanish as well as English)

- Would it be useful and practical to provide public information on this issue in community or zip code specific formats?

- What can we do to help provide guidance to the public in interpreting data/information on this issue? (e.g., providing explanations in terms of relative risk)

- Are there particular communities that have a special need for information on this issue? (e.g., people adjacent to facilities) How can we meet this need?

- Can sensor technology be used to provide information about exposures at specific local sites?

Integration of Information

- Has information on this issue been integrated into broader environmental databases? (e.g., included in TRI)

- Is there good information on this issue in various federal agencies, at other levels of government, or in nongovernmental organizations that could be integrated to provide a more complete picture?

- Are there actions we can take to reduce data/information redundancies and increase public access to the information?

- Does the public have easy, organized access to the full range of views on this issue? Can we make information on different views available in a way that allows people to get a quick overview, and to also be able to drill down into more detailed information?

- What can we do to better organize information in a way that calls attention to cumulative risks? (e.g., chemical + radiation, or nuclear plants in flood plains)

Inclusive Science and Policy

Sound Science

- Is the research funded or dominated by an individual or organization with a preset agenda? Are there pressures to come up with “right answers” or predetermined conclusions?

- Is the research dealing with hypotheses that are testable in the sense of being susceptible to disproof through evidence and experiment?

- What more can we do to ensure that our research process is objective and fact-based rather than ideological in character?

Range of Disciplines

- What are the main questions that go beyond health physics that need to be addressed?

- Have all the natural science disciplines with any significant bearing on this issue been involved in formulating the questions and methods for research?

- What aspects of this topic involve economics, governance, organization, behavioral change, or other issues related to the social sciences? What research questions should be formulated in these areas?

Range of Viewpoints

- Have non-mainstream but relevant and evidence-oriented views been taken into account in formulating research questions and designing research methods related to this topic?

- What are the major viewpoints that have not been reflected in the way past research on this topic have been conducted? What are the additional research questions we would ask if we wanted to take those views into account and test their validity?

- If we want to get the input of all the relevant stakeholders for decision-making on this issue, who needs to be included?

- Are there place-based and cultural differences in perspective that could add to the discussion and inform the development of policy? (e.g., a local as well as a national perspective, the cultural perspective of Native Americans or other minorities)

Dealing with Strong Disagreements

- Would it be useful in this situation to employ techniques of negotiation and alternative dispute resolution to foster greater agreement on policy approaches or on questions and methods for research?

- Could a facilitated policy dialogue including representatives of all the major viewpoints involved in the issue reach greater agreement on the facts of the situation?

Pollution and Exposure Prevention

Need Assessment

- What kind of *preventive* strategies might we employ to minimize this problem in the future or to keep this issue from arising in the first place?
- Does the potential degree of risk justify making significant efforts to reduce pollution and exposures even before the science is conclusive about the health and environmental risks involved? (Precautionary Principle)
- Could pursuing opportunities for pollution prevention lower the total cost of the service or product?

Technology Improvement

- Where does the pollution trail indicate there are inefficiencies in the process that create costs? (e.g., costs from wasteful use of inputs, costs of pollution control or waste storage, or risks of fines, lawsuits, loss of good reputation, license revocation, etc.)
- Can an adjustment to the process be made in order to reduce the amount of input/output of hazardous substances involved?
- Can a new process or product be developed that reduces the use of a radioactive material or hazardous substance?
- Can benign substances be substituted for hazardous ones?
- Where radioactive materials are involved, can less radioactive material or lower dose rates be utilized without reducing functionality? Are radioactive materials truly necessary for the application in question?
- Are there more effective ways of tracking, isolating and storing radioactive materials that could be applied in this situation?
- Are there opportunities for better product stewardship of radioactive materials or other hazardous wastes to achieve risk/exposure reduction goals?
- Can exposures to radiation be reduced without increasing other pollutants? (e.g., greenhouse emissions, acid rain and other environmental problems would increase if coal is substituted for nuclear in power generation)

- Are there more environmentally advanced methods and technologies we can use that do not involve the use of hazardous materials that could work just as well or better at a competitive cost?

Behavioral Change

- Are there improvements in workforce training that could help our workers effectively reduce contamination or exposures or adopt improved technologies?
- What opportunities exist to provide better information on a regular basis to enable people to use equipment properly, avoid unnecessary exposures, and reduce doses or contamination?
- What improvements in inventory control, maintenance and housekeeping could reduce exposures to radioactive materials and hazardous chemicals?

Cumulative Risk

Need Assessment

- Are there other environmental risks present in this situation that should be considered along with the radiation risk being assessed? What is the full range of hazardous agents that may be present?
- Would a place-based analysis show that there are particular local places where multiple stressors may converge to increase risks?
- Where there are multiple agents present, are the risks well known? What additional risk assessment may be justified to better understand the cumulative or synergistic effects of multiple agents?
- Should other media (air, water, soil) be considered that have not yet received attention?
- Have we given adequate consideration to ecosystem risks as well as risks to human health?

Science and Methods

- Have we adopted methods for harmonizing chemical and radiation models, parameters, risk calculations, and measurement techniques?
- Is additional research needed to allow us to assess the cumulative risk of multiple stressors? In the situations we are dealing with, what are the highest research priorities?
- Are precautionary measures justified if the cumulative/synergistic risks in the situation we are dealing with cannot be characterized?
- What does our organization need to do to improve its ability to assess risks posed by cumulative exposures and interactions between hazardous agents? What changes should be made in the training of our people responsible for radiation protection?

Place-Based Tailoring

Need Assessment

- Are uniform national policies justified in dealing with this issue, or would solutions be better if they are adapted to different regional, state or local circumstances (land, climate, culture, politics, etc.)?
- Are there endangered species or fragile ecosystems in this local area that merit special consideration in making policies, choosing technologies, or taking other actions?
- How can we use the knowledge and capabilities that exist at the local level to help deal with this issue?
- On what level—local, state, regional, national, global—can we get the best leverage to address this issue?
- Would place-based tailoring on this issue encourage local public involvement, grass roots efforts, or better "corporate citizenship" at the local level?
- If we adapt policies and approaches to local circumstances, will this create serious inequities between different areas?
- Would place-based tailoring on this issue lead to less environmental protection, pose any threats to surrounding regions, or create any kind of long term problems?

- Is there a need for a national "minimum level" requirement (e.g., air quality standards), but also a need for adjustments at the local level?

Customizing Solutions

- How can policies and actions related to this issue be customized to fit our unique local, state or regional circumstances?
- Are there technologies particularly appropriate for use in this local setting?
- Are there research questions related to local risks, benefits, and impacts that need to be addressed?
- If we look at this issue from a local perspective, does that produce new insights about what national policies on the issue should be like?
- Is this a situation where the best approach is for the Federal government to establish performance-based goals and then let local areas determine how to achieve the goals?

Opportunities for Partnerships

- Are there other communities with similar circumstances that are dealing with the same issue? Are there opportunities for learning from each other's experience?
- How can we establish a network for sharing successes and difficulties, techniques, and lessons learned at the local level? (e.g., use our own resources, work with a state or Federal agency, work with a nonprofit organization at the national level)
- Are there local places in other countries dealing with the same problem confronting our local area? (e.g., other uranium mining communities around the world) Are there opportunities for "multi-local" networking and learning on a global scale?

Stewardship

Need Assessment

- Does this topic involve issues of fairness to future generations?

- If current policies and priorities related to this issue continue, in what ways might the issue become more difficult for future generations to deal with? Could the way we are handling this issue now compromise the ability of future generations to deal with the issue or meet their needs?

- Will dealing with this issue require us to devote expertise and resources over a long period of time to maintain across generations an adequate level of protection to human well being, health and the environment?

- In this issue area, what party has the greatest ability to influence life-cycle impacts, and therefore should bear significant responsibility for addressing those impacts?

Strategies of Stewardship

- Are there more environmentally advanced technologies we can utilize or develop that will not pose threats to the well being of future generations?

- How can we make our products fully or more fully recyclable?

- How can we make more efficient and higher value use of resources that cannot be replenished?

- Are we using renewable resources on a sustained yield basis?

- Can we utilize leasing arrangements so that the manufacturer retains responsibility for the recycling or final disposal of the product?

- What changes are needed (in funding, organizational structure, policy, or anything else) to assure that this issue is dealt with appropriately over the long run?

- Are we losing expertise needed to deal with this issue responsibly over the long run? If so, what can we do to prevent this?

- Are existing methods of isolating and storing dangerous materials adequate for protecting health, national security, and the environment over the entire period of time when the materials will remain dangerous?

- Is it reasonable to expect that future generations will continually maintain the social stability and resources to provide continuing stewardship related to this issue over the time periods required?

- What incentives can we provide to government and corporate leaders for choosing responsible stewardship over short-term gains?

APPENDIX A

PARTICIPANTS AND CONTRIBUTORS 1999 – 2002

Conference of Radiation Control Program Directors (CRCPD)
Colorado Department of Health, Radiation Division
Massachusetts Radiation Control Program
Metropolitan Water Reclamation District of Greater Chicago
Association of State and Territorial Solid Waste Management Officials (ASTSWMO)

Committee to Bridge the Gap
Desert Research Institute
National Safety Council
National Information Resource Service
Sierra Club
Critical Mass Energy Project
Environmental Law Institute
Pew Environmental Health Commission
Arlintonians for a Cleaner Environment
Institute for Energy & Environmental Research, (IEER)
Coalition for Environmentally Responsible Economies (CERES), Boston, MA
Product Stewardship Institute, (PSI), Boston, MA
Society of Organizational Learning, Boson, MA
Tellus Institute, Boston, MA
Rocky Mountain Institute, (RMI), CO
Keystone Center, CO
Colorado Sustainability Project, Denver, CO
Center for Neighborhood Technology, Chicago, IL
Nuclear Energy Institute (NEI)
National Council on Radiation Protection and Measurement (NCRP)
American College of Radiology
Health Physics Society
Consumer Federation of America
Woodrow Wilson Center for International Scholars

Intertribal Council of Arizona
The Navajo Nation
Council of Energy Resource Tribes (CERT), CO
Umatilla Tribe Science Advisor
Institute for Tribal Environmental Professionals

University of Massachusetts – Lowell, Center for Sustainable Production
University of Nevada Las Vegas (UNLV)
University of Virginia Environmental Risk Assessment

George Washington University
Illinois Institute for Technology

Virginia Power
Chevron Research and Technology Company
Motorola
Sanford Cohen & Associates, Inc.
New Mexico Environmental Evaluation Group

Interagency Steering Committee on Radiation Standards (ISCORS)
Department of Energy (DOE), Office of Strategic Planning & Analysis
DOE, Air, Water & Radiation Division
DOE Nevada
DOE, Idaho Operations Office
DOE Lawrence Livermore National Laboratory
DOE Argonne National Laboratory, Chicago, IL
DOE National Renewable Energy Laboratory, Golden, CO
FDA, Center for Devices and Radiological Health (CDRH)
Department of State, Office of Nuclear Energy Affairs
US Nuclear Regulatory Commission (NRC)
DOD, Radiation Research & Policy Working Group
Occupational Safety Health Agency (OSHA)
Center for Disease Control (CDC)
US Army Corp of Engineers (USAE)
US EPA
- ORIA, (RPD, Montgomery, AL and Las Vegas, NV laboratories)
- OAR (AA, OPAR) OSWER, OECA (FFEO, OEJ), OCFO, OA (SHEMD, NACEPT)
- Regional Offices
- EPA Tribal Air Program

International Atomic Energy Agency (IAEA)
Electricite de France

APPENDIX B

QUESTIONNAIRE FOR PRIMARY EXPERT INTERVIEWS & FOCUS GROUPS

Key Questions for the Future of Radiation Protection: 2025

What are the most significant radiation-related issues that will need to be dealt with between now and 2025? *1.* *2.* *3.* *Other:*	***What are the least appreciated, neglected challenges?*** *1.* *2.* *3.* *Other:*
What are the most important prevention opportunities? *1.* *2.* *3.* *Other:*	***What "wild cards" – low probability but high impact developments – could create new challenges and opportunities that are not being seriously considered today?*** *1.* *2.* *3.* *Other:*

Submitted by (optional): ____________________Phone:_____________E-mail:____________

APPENDIX C
SCENARIO DISCUSSION SESSION AGENDA

Face-to-Face Meetings of Small Groups

9:00-9:30 Opening

- Welcome
- Introductions
- Project Overview
- Brief presentation/review on the 4 Scenarios

9:30-10:15 Discussion of Scenarios

- Review scenario descriptions
- Self-select into scenario groups
- Discuss "Most Preferred" aspects of each scenario and the "Positive Alternatives" to bad aspects
- Scenario groups report on their discussions

10:15-10:30 Break

- Enter list generated by participants into the Group System

Individuals Work at Group System Terminals

10:30-11:15 Exercise on Strongest Areas of Agreement About the Preferred
Introduction to the use of the Group System

- Warm Up Exercise: Votes on the "Most Likely" and "Most Desirable" scenarios
- Opportunity to add to the Preferred Future List
- Consolidate the List
- Rating vote
- Discuss vote results

11:15-12:15 Exercise on Principles for Guiding Action

- Brief presentation on principles for guiding action suggested to date
- Opportunity to enter additional principles into the list of principles
- Enter comments on principles – how they apply to/ what they mean for radiation protection
- Enter comments on key roles for implementing principles (government, private sector, public interest, partnerships)

12:15-12:30 Closing

- Invite comments on insights from the last exercise or the entire morning
- Evaluation form
- Thanks to participants