

What's New – Guidelines, Networks and Approaches for Modern ISR Uranium Recovery - 9432

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ABSTRACT

With the worldwide growth of demand for nuclear power, the uranium extraction industry has responded by producing more uranium to fuel the new nuclear power fleet. In doing so, the industry is facing challenges and opportunities not seen 30 years ago – and chief among these is demonstrating that the industry has incorporated lessons learned in the past 30 years to develop uranium recovery methods that are cleaner, greener, safer and more sustainable than ever before. This approach is not only prudent, but essential to demonstrating to stakeholders that the industry has matured and will meet current environmental and worker protection standards.

Just as people no longer drive cars with 30-year old technologies, the uranium recovery industry has developed new standards for safe, environmentally protective uranium recovery. Of particular interest is the advent and expansion of the use of in-situ uranium recovery (of, in current terms, ISR). As this method is the newest means of extracting uranium and has been adopted worldwide, this paper with particular focus on issues associated with use of ISR; and the agencies and networks that are focusing on ensuring that this method of uranium recovery will result in safe, sustainable uranium recovery operations.

The U.S. Nuclear Regulatory Commission (NRC) has taken an active role in ensuring that it is properly positioned to regulate the new generation of ISR facilities in the U.S. For example, in February 2007, the NRC announced that it was considering the preparation of a generic environmental impact statement (GEIS) in anticipation of receiving up to fourteen¹ potential license applications for new ISR facilities.

As the U.S. operators of research and development (R&D) and full-scale commercial production operations over a thirty plus year period, the ISR uranium recovery industry in the U.S. possesses relevant technical and environmental database, as well as associated extensive site and regional-specific analyses of the geological, hydrological, geochemical, and other relevant conditions at sites where uranium resources amenable to the ISR uranium recovery technique are found within the country. At the time of the NRC announcement that a GEIS would be prepared, this array of data and analyses was spread throughout a variety of NRC and Agreement State licenses and license amendment applications and their accompanying technical and environmental reports. The industry worked together to provide these data and analyses in the form of a Generic Environmental Report (GER) to the NRC - expending considerable effort to compile and consolidate, to the extent reasonably achievable, such data within the allotted comment period timeframe.

In addition, the industry's general comments focused on a broad overview of the statutory and regulatory programs associated with the preparation of an ISR GEIS and licensing of ISR uranium recovery projects. These were identified as issues which are frequently mischaracterized or misunderstood by interested

stakeholders and, therefore, were considered to be of primary importance that all such stakeholders understand these issues so that the risks associated with ISR uranium recovery can be gauged properly.

One issue of concern is the potential that uranium mining, milling and ISR operations may result in degradation of drinking water. This issue is aggressively addressed in the U.S. regulatory regime in several ways before and during ISR operations. Furthermore, in U.S. ISR operations, after uranium recovery ceases the groundwater in the recovery zone is restored *consistent with baseline* or other water quality standards that are approved by NRC prior to the commencement of active production operations. Upon completion of groundwater restoration, wells are sealed or capped below the soil surface using approved plugging methods. Surface process facilities are decontaminated, if necessary, and removed, and any necessary reclamation and re-vegetation of surface soils is completed. *As a result, after site closure is completed and approved, there is no visual evidence of an ISR uranium recovery site, and the decommissioned site will be available for unrestricted (i.e., any future) use.*

In over three decades of ISR, there have been *no significant, adverse impacts to adjacent, non-exempt USDWs* outside the recovery zone and into the related area of review (AOR)ⁱⁱ from ISR uranium recovery operations in the United States. Wellfield balancing, including the process “bleed,” monitoring, and pump tests at ISR uranium recovery sites have been highly successful in assuring that recovery solutions are contained within the ore (recovery) zone. Before monitoring ceases, restoration is completed to minimize or eliminate the potential risk of post-operation excursions that could result in the migration of contaminants from the exempted recovery zone portion of the aquifer to adjacent, non-exempt portions of the aquifer.

At present, further standards being developed by the IAEA and the U.S. NRC—coupled with voluntary participation in networks such as the International Forum on Sustainable Options for Uranium Production (IFSOU) - are providing guidance, support and exchanges necessary to support safe, sustainable modern uranium recovery.

This paper will present an overview of 2008-09’s major initiatives in standards and guidance development, network growth and technology advances in the area of modern ISR uranium recovery. These will include:

- Progress in completing, implementing and applying NRC’s Generic Environmental Impact Statement for ISR;
- establishment, mission, accomplishments and plans of the International Forum on Sustainable Options for Uranium Production; and
- IAEA’s Nuclear Fuel Cycle and Materials Section Programme Uranium Fuel Cycle Subprogram; and the Fuel Cycle and Waste Management Technology Section’s Center of Excellence.

INTRODUCTION

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- Establishment, mission, accomplishments and plans of the International Forum on Sustainable Options for Uranium Production (IFSOUP); and
- The International Atomic Energy Agency's (IAEA's) Nuclear Fuel Cycle and Materials Section Programme Uranium Fuel Cycle Subprogram; and the Fuel Cycle and Waste Management Technology Section's Center of Excellence

NRC's Generic Environmental Impact Statement for ISR

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As the U.S. operators of research and development (R&D) and full-scale commercial production operations over a thirty plus year period, the ISR uranium recovery industry in the U.S. possesses relevant technical and environmental database, as well as associated extensive site and regional-specific analyses of the geological, hydrological, geochemical, and other relevant conditions at sites where uranium resources amenable to the ISR uranium recovery technique are found within the country. At the time of the NRC announcement that a GEIS would be prepared, this array of data and analyses was spread throughout a variety of NRC and Agreement State licenses and license amendment applications and their accompanying technical and environmental reports. The industry worked together to provide these data and analyses in the form of a Generic Environmental Report (GER) to the NRC - expending considerable effort to compile and consolidate, to the extent reasonably achievable, such data within the allotted comment period timeframe.

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One issue of concern is the potential that uranium mining, milling and ISR operations may result in degradation of drinking water. This issue is aggressively addressed in the U.S. regulatory regime in several ways before and during ISR operations. Furthermore, in U.S. ISR operations, after uranium recovery ceases the groundwater in the recovery zone is restored *consistent with baseline* or other water quality standards that are approved by NRC prior to the commencement of active production operations. Upon completion of groundwater restoration, wells are sealed or capped below the soil surface using approved plugging methods. Surface process facilities are decontaminated, if necessary, and removed, and any necessary reclamation and re-vegetation of surface soils is completed. *As a result, after site closure is completed and approved, there is no visual evidence of an ISR uranium recovery site, and the decommissioned site will be available for unrestricted (i.e., any future) use.*

In over three decades of ISR, there have been *no significant, adverse impacts to adjacent, non-exempt USDWs* outside the recovery zone and into the related area of review (AOR)¹ from ISR uranium recovery operations in the United States. Wellfield balancing, including the process “bleed,” monitoring, and pump tests at ISR uranium recovery sites have been highly successful in assuring that recovery solutions are contained within the ore (recovery) zone. Before monitoring ceases, restoration is completed to minimize or eliminate the potential risk of post-operation excursions that could result in the migration of contaminants from the exempted recovery zone portion of the aquifer to adjacent, non-exempt portions of the aquifer.

International Forum on Sustainable Options for Uranium Production

IFSOU Originated in the fall of 2007 during discussions among uranium recovery (UR) regulatory and industry specialists meeting in Bruges-Belgium. It was recognized that there were many concerns about past practices and a great deal to be learned from past practices to avoid development of future legacy sites. IFSOU recognizes that it will be vital for members of industry, government and NGOs to join in meaningful discussions to build safe, sustainable uranium production operations. Beginning with the first IFSOU meeting during the February 2008 WM conference, we continue to seek opportunities to arrange meetings, workshops and venues to bring these groups together for meaningful and productive discussions.

To put uranium recovery sustainability in context - sustainability is an optimization of three indicators: Economic, social and environmental factors are optimized so that resources accessed today are also available for use by future generations. In the context of uranium recovery, we know that we are mining the resource, and therefore that same resource will not be available for future generations. Nevertheless, we endeavor to practice sustainable operations. We do so by ensuring that the projects have a net positive result to the local economic, social and environmental conditions by preventing generation of new legacy sites that would negatively impact future generations.

The IFSOU network has grown steadily since the inaugural meeting, and includes agencies, NGOs and members of industry. The objectives described in inviting delegates to the inaugural and subsequent IFSOU meetings were to build on past experience to avoid generating new legacy sites; and to set a new paradigm for how we communicate and create sustainable operations. Specifically, the IFSOU concept is to step away from the past practice of government and industry determining what is best for the communities and then bringing that message to them; but rather, to involve the stakeholders from the beginning.

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IFSOUP's objectives are being met by:

- Forming a network of experts (solution holders), in different areas, so that they can be readily accessed whenever needed by those in need of advice (problem holders);
- Serving as an international forum to discuss and exchange experience on the development and implementation of sustainable uranium mining and processing (i.e., recovery) operations ;
- Facilitating technology transfer for the adoption of sustainable uranium recovery operations;
- Interfacing with the IAEA; and
- Promoting stakeholder participation in the planning and development of sustainable uranium mining operations.

In addition to meeting these objectives, IFSOUP is providing assistance to companies and institutions that are committed to the implementation of sustainable mining operations; and is providing a multi-sector, living forum for workshops, panels in special topics and short courses in specific issues – and holding such gatherings within a variety of venues, and cooperating meetings and conferences. In performing these activities, IFSOUP cooperates with and complements efforts of NRC and IAEA to ensure that uranium recovery becomes more sustainable.

Among the topics of the first IFSOUP meeting, which have continued to be explored and expanded upon in subsequent meetings, were:

- Define sustainability in context
- Coordinate worldwide initiatives
- Indigenous peoples
- Principles of Code(s) of Practice
- Cameco Sustainability Approach (added over time) vs. new projects starting with sustainability plans
- ISL – technical and environmental issues
- Uranium mining in previously unmined countries
- Success stories

To expand - Sustainable development of UR projects means that the projects are developed and operated in ways which do not leave problems for future generations. The role of the regulatory community is vital both to incorporate sustainable practices that will ensure project success and instill public confidence. These practices are incorporated in the context of economic, social, and environmental issues.

- Economic issues include practices that support the affected community by development of economic opportunity during and after the project life. This requirement includes sound financial practices by the company which requires clear, predictable, and reliable governance by the regulatory community for the company to attract investors and maintain public confidence.
- Social issues include strong and respected regulation of the project to ensure that the project will not disturb the local social values of the community.
- Environmental protection is central issue for sustainable UR projects. The regulatory community has a primary role to insure that the project will be operated in an environmentally safe manner and that public health is protected.

IFSOUP meetings have resulted in a number of important findings to date, which are guiding future actions:

- Good examples of sustainable practices exist
- The challenge is to disseminate intentions and plans among all of the stakeholders
- There is a need for further discussion of ISL technical issues
- Communication constraints exist, but can be overcome with focused efforts
- The need remains for further discussion of specific needs of indigenous peoples

In the U.S., as in many parts of the world, direct involvement of indigenous groups is crucial to assessing their views on what sustainability would mean to them. IFSOUP has facilitated direct involvement of indigenous groups during its first year.

- Delegate participation was coordinated with assistance by the International Institute for Indigenous Resource Management (IIIRM)
- Tribal Participants included members of the Navajo, Spokane, Oglala Sioux and Acoma Tribes
- Donors in the industry supported delegate participation. These donors included Black Range Minerals, Uranium Energy Corp., PowerTech, Inc., Uranium Resources Inc., Strathmore Minerals Corp., and Mr. Fletcher Newton
- Delegates participated in discussions of the meaning of sustainability to the Tribes, in both a Pre-Workshop Sustainability Discussion; and at NMA/NRC 2008 Uranium Recovery Workshop

IFSOUP has been very busy in its first year. In its first year, IFSOUP has:

- Interfaced with NRC's and IAEA's Networks
- Expanded to 150+ participants
- Generated growing involvement through outreach to stakeholders
- Opened www.ifsoup.org
- Developed a diverse secretariat including representatives of all the main stakeholder groups
- Convened in Phoenix, Arizona; Denver, Colorado (2 meetings); Beijing, China; and Vail, Colorado
- Presented its development, objectives and accomplishments before the U.S. NRC during the Uranium Recovery Briefing to the Commissioners

To continue in its mission, following these first year results, IFSOUP will:

- Continue facilitating agency, NGO and UR industry networking to foster and implement safe, sustainable options for uranium production;
- Continue broadening its diverse network and constituency; and
- Incorporate as a non-profit to gain access to grants or other funding essential to continue its mission.

IFSOUP Website and Contact Information

Visit IFSOUP at: www.ifsoup.org

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IAEA's Nuclear Fuel Cycle and Materials Section Programme Uranium Fuel Cycle Subprogram; and the Fuel Cycle and Waste Management Technology Section's Center of Excellence

The IAEA's Nuclear Fuel Cycle and Materials Section Programme Uranium Fuel Cycle Subprogram; and the Fuel Cycle and Waste Management Technology Section's Center of Excellence have accelerated their activities to address the demand of member states to acquire uranium for nuclear power production in a more safe, sustainable manner.

First, the IAEA's Nuclear Fuel Cycle and Materials Section develops and directs the Uranium Production Cycle program, which is intended to "improve the capability of interested Member States to plan and make policy on uranium production or uranium requirements and to make use of preventive measures to reduce impacts on the environment"^{iv}:

"The Uranium Production Cycle subprogram provides information on the status of world uranium production and projections of uranium requirements in Member States with nuclear power programs. Member States with production and/or nuclear power use this information for their planning and policy making. The Uranium Production Cycle involves various issues, including the need to minimize environmental impacts and promote best practices in the planning, operation and closure of production facilities. This subprogram provides technical support to address these issues for Member States that are developing uranium resources, but do not have an adequate technological infrastructure, applying the philosophy that it is much more efficient to prevent pollution than to clean it up."^v

To support these objectives, the Uranium Production Cycle subprogram held the following recent technical meetings:

- The IAEA Technical Cooperation Meeting on 'Issues in Developing the Uranium Production Cycle Activities', 24-26 November 2008 in Salvador, Brazil.
- The IAEA Technical Meeting on "Uranium Exploration and Mining Methods", 17-20 November 2008 in Amman, Jordan.
- The IAEA Technical Meeting on "The Implementation of Sustainable Global Best Practices in Uranium Mining and Processing" in cooperation with the WNA 15-17 October 2008 at VIC in Vienna, Austria.
- The IAEA Technical Meeting on "Uranium Exploration, Mining, Processing, Mine and Mill Remediation and Environmental Issues" 1-5 October 2007 in Swakopmund, Namibia.

In addition, the Uranium Production Cycle subprogram is organizing the International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle - Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues (URAM-2009). This Symposium will be held on June 22-26, 2009 at the Vienna International Center (VIC) in Vienna, Austria.

The Symposium will provide a forum to delegates from national and international organizations, governmental and private, engaged in uranium geology, exploration, mining, processing, supply, demand and market and environmental issues associated with the uranium production cycle to share their experience, evolve best practices in uranium mining and processing and come out with recommendations to the Agency on future efforts the IAEA make take related to uranium production cycle. URAM-2009 will include technical sessions on:

- Uranium Markets and Economics

- Social Licensing in Uranium Production Cycle
- Uranium Exploration (including Geology and Deposits)
- Uranium Mining and Processing
- Environmental and Regulatory Issues
- Human Resources Development

The IAEA Fuel Cycle and Waste Technology Section is also focusing its efforts on enabling member states to achieve more sustainable uranium production. As reported in the December 2009 IAEA Fuel Cycle and Waste Technologies Newsletter (Volume 4, Number 3, December 2, 2009), environmental remediation (or plans for reclamation) have too often been considered only after contamination of the environment has occurred. As has been experienced in the U.S., the global community too is gradually replacing the approach of remediating contaminated sites only after the cessation of operations by the concept of environmental remediation (ER) under a life-cycle perspective that ultimately is integrated in the overall environmental management system (EMS) of the operations. This EMS approach is consistent with international sustainability practices endorsed by IFSOUP and its network participants, as described above.

In addition to this, concurrent engineering is being applied from initial planning to the post-closure phase as an input to the remediation plan. IAEA suggests that the concept of *cleaner production* could be governed by five elements:

- product modification,
- input substitution,
- technology modification,
- good-house-keeping, and
- (on site) recycling and reuse.

IAEA indicated that upwards of 90% of the total impact of nuclear power generation systems is caused by mining/milling; it is therefore clear that this sector is a natural candidate for rapid implementation of the principles discussed above. Globally, IAEA notes that the “current boom in demand for mineral resources that has increased the pressures on the rate of development, *or more precisely to exploit resources before prices drop*, is another factor to be taken into account”^{vi}.

IAEA and IFSOUP delegates have found and reported that many large mining companies are already committed, in varying degrees, to meeting sustainable practice principles. However, IAEA has expressed concern that less well-financed or new companies may find such practices cost-prohibitive or may be constrained by either technologic or legislative barriers to implementation of such practices. In addition, social concerns on the local level may not be factored in with these constraints at work.

Dr. Horst Monken-Fernandes of the IAEA Fuel Cycle and Waste Technology Section recently noted that

“Under the capitalist logic, land and the concept of place have to do with exclusive proprietorship. This ownership is understood as the right to do with the land as one pleases within the law of the day. In other words, it is a commodity, and could therefore be bought, sold, dug-up, and generally capitalized on. In short, the value of place for capitalist enterprises like mining companies is commercial, whereas for native/indigenous people, the value may be both economic and cultural, and frequently is mainly the latter. The appropriate management of this type of conflict may lead to time consuming approval processes, negotiations with traditional owners and community engagement activities, all these sitting uneasily within time-squeezed schedules. Moreover, it will affect to a large extent decisions regarding environmental remediation and leading to high and unjustified expenditures of cleanup projects.

This new situation puts new challenges on the IAEA to produce technical material that shows how environmental remediation should be done, and why and when a particular option may be seen as the best option. It must produce guidance material that reflects good existing practices keeping in mind the feasibility of the incorporation of these elements by small and medium size companies. The social dimension should also be duly introduced recognizing that issues related to stakeholder involvement in the decision making process will be more and more a decisive element in the development of these operations. It is important that ongoing discussions worldwide are reflected to ensure up-to-date approaches”.^{vii}

Dr. Monken-Fernandes concludes that the means to reach sustainable approaches for uranium production that are responsive to the needs to industry while satisfying social concerns will be achieved “through partnerships and Networking...In the end, however, the success of environmental remediation will depend on the local human capacity, which makes capacity building for technical staff, regulators and operators, from emerging economies a priority for the IAEA”^{viii}.

To this end, Dr. Monken-Fernandes has proposed the development of an international network of centres of excellence in environmental remediation – Environet, under the auspices of the IAEA. The mission of the IAEA in the scope of radioactive waste management, decommissioning of installations and environmental remediation of contaminated sites can be synthesised as:

“Assisting Member States in managing their nuclear and radiological liabilities in a safe, sustainable and cost-effective manner.”

Dr. Monken-Fernandes observes that:

“Countries that had to deal with extensive remediation work have been able to test various approaches resulting in the selection of adequate strategies for remediation. As a consequence, they are holders of expertise and know-how which may be useful and applicable to other countries that need to implement remediation programmes. However, quite often, the implementation of a safe and economic approach consistent with good international practice may be hindered by constrained human and financial resources and scarce expertise in environmental remediation.

Developing Member States face specific challenges to implement remediation projects, not only because of the lack of resources but also because of the lack of appropriate technology and expertise and these things can end-up constituting important barriers for project implementation. Experience has shown that with appropriate planning and assistance remedial actions are more likely to be implemented. As such the interaction of inexperienced with experienced countries facilitated by the IAEA may lead to better conditions for real implementation of projects and lessons learned with this relationship may inspire countries to reproduce (after necessary adaptation to local conditions and constraints) the experience gained by others.”

The objectives of Environet would be to establish the IAEA as a facilitator in sharing international experience for remediation of radiologically contaminated sites, including issues related to stakeholder involvement. The network would deal with legacy sites as well as introducing the life-cycle approach at existing and future sites to minimize the need of future remediation measures. The network would:

- Coordinate support to organizations or Member States;
- offer a broad and diversified range of training and demonstration activities;

- facilitate sharing and exchange knowledge and experience among organizations; and
- create a forum for experts' advice and technical guidance may be provided on the IAEA's programs in the area of environmental remediation.

To facilitate this ongoing demand for worldwide discussions, the IAEA is holding the International Conference on Remediation of Land Contaminated by Radioactive Material Residues to be held in Astana, Kazakhstan on May 18-22, 2009.

SUMMARY AND CONCLUSIONS

As global demand for nuclear power has accelerated, the uranium mining industry has responded with increased production. Concurrently, industry and agencies have met opposition from NGOs and even some local governments due to assumptions that uranium recovery practices may generate the kinds of legacy sites that resulted from the uranium booms of the 1950's, 60's and 70's. Increasingly, the industry is working together with NGOs and agencies to demonstrate that the industry has incorporated lessons learned in the past 30 years to develop uranium recovery methods that are cleaner, greener, safer and more sustainable than ever before.

Standards, guidance and fora under development by the IAEA and the U.S. NRC—coupled with voluntary participation in networks such as the International Forum on Sustainable Options for Uranium Production and meetings convened by IAEA—are providing guidance, support and exchanges necessary to support safe, sustainable modern uranium recovery.

ⁱ Since the announcement of the GEIS, the number of anticipated applications has expanded to more than 28, including letters of intent to license expanded or new conventional uranium recovery operations, significantly increasing the NRC's anticipated licensing workload.

ⁱⁱ The "area of review" is essentially a "buffer zone" prescribed by EPA's underground injection control (UIC) program to provide additional protection for USDWs during ISR uranium recovery. 40 CFR § 146.6 requires that all ISR uranium recovery licensees must establish a fixed radius of not less than ¼ mile for the area surrounding the recovery zone. The regulation also states:

"In determining the fixed radius, the following factors shall be taken into consideration: Chemistry of injected and formation fluids; hydrogeology; population and ground-water use and dependence; and historical practices in the area."

40 CFR § 146.6(b) (2).

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^{iv} http://www.iaea.org/OurWork/ST/NE/NEFW/nfems_rawmaterials.html; Dr. Jan Slezak

^v Ibid.

^{vi} <http://www-pub.iaea.org/MTCD/publications/PDF/Newsletters/NEFW-04-03.pdf>; Dr. H. Monken-Fernandes

^{vii} Ibid.

^{viii} Ibid.