IAEA Technical Cooperation Project INT2019
Interregional Workshop on Conventional Uranium Production from Exploration to Closure

Update on IAEA Activities

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IAEA Support to Uranium Mining and Remediation

Also aspects from the Dept. of Safeguards and Dept. of Nuclear Sciences & Applications, and the Office of Legal Affairs
Uranium Production Cycle

- Prospecting
- Exploration
- Feasibility
- Mine Development
- Mining
- Processing & Production
- Transport
- Decommissioning
- Remediation
- Stewardship
IAEA Support in the Uranium Production Cycle

- Exploration and evaluation of uranium resources
- Feasibility studies for mine and processing facility development
- Regulatory development for uranium mines and processing facilities
- Stakeholder management
- Environmental management
- Nuclear applications for groundwater resource management
- Radiation safety
- Conventional safety
- Decommissioning and remediation
Our unofficial motto:

To collect and share knowledge of uranium resources and support the development of a sustainable uranium production cycle (UPC) in Member States.

Photo: P Woods, Viet Nam TC project  
Photo: B. Moldovan; Egypt TC Project  
Photo: P Woods, Rozna U Mine, Czech Republic
Challenges worldwide

• **Human resource issues:** Getting enough people with the right basic training and access to specialized training:
  - exploration, especially in applied geosciences
  - resource evaluation issues
  - feasibility studies
  - regulations
  - enforcement
  - stakeholder communication

• **Lack of specialized equipment** for use in UPC related activities

• **Need to establish and/or develop appropriate regulatory frameworks** for UPC activities in terms of human and legal resources

• Locating sources of information on services and supplies
IAEA Sub-programme on Uranium
(Department of Nuclear Energy)

• Assessment of uranium resources, production and demand
  – NEA/IAEA Red Book
  – Database of uranium deposits
  – Standardization of resource classification (joint work with UNFC-2009)
  – Report series “Uranium geology, exploration, resources, production and related activities” in regions (6 volumes, final stages of preparation)

• Supporting good practices in the uranium production cycle
  – Uranium Production Site Appraisal Team
  – Optimization of mining technologies
  – Development of low grade ores
  – Unconventional resources – esp. phosphates
  – Thorium resources (e.g. by-product of REE)
  – Support training activities

• Technical Cooperation activities
  – Recent years: 18 national projects, 2 regional projects & an inter-regional project

Photo: P. Waggitt, Brazil UPSAT 2010
Support for INIR Missions

• The IAEA conducts Integrated Nuclear Infrastructure Review missions for Member States looking to advance into nuclear power

• Comprehensive review to evaluate a Member State’s readiness to develop a nuclear power programme

• Based on the Milestones approach and encompasses three phases

• An integrated work plan is developed for each phase of review

• The NFCMS section provides support to Member States on developing policy and strategy for the front and back ends of the nuclear fuel cycle

• Aspects of the policy and strategy includes uranium production, refining, conversion, enrichment, fuel bundle production, spent fuel and waste management
Uranium Resources

• Published jointly with the NEA since 1965
• Sources: governmental reports, secretariat reports and estimates
• Latest released NEA December 2018
Red Book 2018 – Distribution of Resources*

15 countries represent approx. 95% of total world U resources

1. Australia (Producer 3)
2. Kazakhstan (Producer 1)
3. Canada (Producer 2)
4. Russian Federation (Producer 6)

Note: numbers in blue are nations rank in world resources, those in red are the nations rank in world production.

*Identified Resources at <USD130 kg/U (as of January 1, 2017)
Key messages in recent editions:

Resources more than adequate to meet high case demand scenarios

Investment and expertise required to bring resources into production*

Production costs increasing*

Long lead times owing to regulatory requirements and public resistance*

*Contributing to potential supply challenges over next 5-10 years
Recently Released - 2018

- Tecdoc 1842 Geological Classification of Uranium Deposits and Description of Selected Examples

- Tecdoc 1843 World Distribution of Uranium Deposits (UDEPO) 2016 Edition

- Tecdoc 1849 Uranium Resources as Co- and By-products of Polymetallic, Base, Rare Earth and Precious Metal Deposits
Recently Released – 2018 (continued)

• Tecdoc 1857 Unconformity-related Uranium Deposits
• Tecdoc 1861 Quantitative and Spatial Evaluations of Undiscovered Uranium Resources
World Distribution of Uranium Deposits – interactive PDF map
UPC “Milestones” document started

• The milestones approach to uranium mining and development (title to be confirmed)

• Following requests from Member States, the IAEA has started production of a document to provide advice on a Milestones approach to responsibly entering (or re-entering) the Uranium Production Cycle

• Expert meetings in Vienna in Dec. 2016 and Sep. 2017

• First draft near completion

• Interested Member States will have the opportunity to review and comment

• Publication planned for 2019 or early 2020
The Four Stages/Milestones

Milestone 1. A MS considering exploration and/or mining for the first time, or the first time for many years, but with no current significant commitment to proceeding to mining and milling (e.g. Tunisia, Sri Lanka, Nigeria, Indonesia, Paraguay)

Kinniyai Beach, Sri Lanka (photos courtesy Peter Woods)
The Four Stages/Milestones

Milestone 2. A MS proposing to initiate or reinvigorate uranium mining, with known exploitable reserves (e.g. United Republic of Tanzania, Jordan, Botswana, Turkey, Greenland\(^1\) and Mongolia)

Footnote: \(^1\)Greenland is not an IAEA Member State, but has an association with Denmark, which is.
Milestone 3. A MS with a long history of mining (and milling) uranium and wishing to enhance existing capacity and capability (e.g. Namibia, Niger and Brazil)
Milestone 4. A MS with historic, closed uranium mines and mills, sites at the end of mining stage (decommissioning and closure), a remediation stage of historic mines and mills, or at a stage where mine sites are made safe but kept in a state for possible reopening in the future (e.g. Gabon, Argentina, Canada and Portugal).
Aspects of Milestones

• National Position
• Legal Framework
• Stakeholder Involvement
• Safety and Radiation Protection
• Environmental Protection
• Protection/Enhancement of Cultural, Tourism, Farming, Pastoral and Similar Interests
• Management/Coordination/Facilitation
Aspects of Milestones (cont’d)

• Funding and Financing
• Safeguards and Security
• Transportation/Export Route
• Human Resource Development
• Site and Supporting Facilities (Infrastructure)
• Contingency Planning
• Waste (Including Tailings) Management and Minimization
Aspects of Milestones (cont’d)

- Industrial Involvement Including Procurement
- Case Studies
  - Namibia
  - Tanzania
Practical Implementation of the Milestones Approach to the Uranium Production Cycle

- **Milestones Approach in the Uranium Production Cycle**
  - First Draft Near Completion (IAEA Guidance Series)

- **Integrated Uranium Production Cycle Review**
  - IUPCR Mission
  - Scope and Process Description in Development

- **Integrated Work Plan**
  - Framework of the Integrated Work Plan in Development

- **Further IAEA Support**
  - Policy and Strategy Development
  - Expert Missions
  - UPSAT Review Mission
Summary Statement – Milestones Approach

The Milestones approach is a comprehensive methodology that will guide Member States and interested organizations to work in a systematic way towards the introduction or resumption of uranium production or decommissioning and remediation of uranium production facilities.

Key Themes Covered

• Overview of life cycle asset management
• Proposed organization structure
• Proactive asset management
• Risk based asset categorization
• Degradation mechanisms and condition based monitoring
• Care and maintenance considerations
• Maintenance considerations during closure
• Case studies
• First draft of TecDoc December 2019
Revised Tecdoc: Safe Production, Transport, Handling and Storage of Uranium Hexafluoride

Key Themes Covered

• Properties of uranium hexafluoride and other uranium compounds
• Uranium hexafluoride production and handling
• Transport of uranium hexafluoride
• Storage of uranium hexafluoride
• Radioactive waste management
• Quality assurance
• Safety analysis
• Appendix: Suggested format and content for emergency plans for fuel cycle and materials facilities
• Appendix: Examples of initiating conditions
• Revised TecDoc to be published in 2020
Uranium Production Feasibility Studies: Processing, Economic, Social and Environmental Aspects

- Support Member States as they advance plans for recovery and purification of uranium
- Technical Meeting held from 21-25 January, 2019
- A new TecDoc on uranium production feasibility studies is being drafted
URAM series


Proceedings for 2005 (STI/PUB/1259) and 2009 (TECDOC-1739) are downloadable

- Proceedings for 2014 in progress; abstracts & most presentations downloadable

Go to www.iaea.org and search for URAM 2014

Held 25-29 June 2018

2018 Sessions on:
- Nuclear power and modern energy markets
- Uranium markets
- Uranium geology and resources
- Advances in exploration
- Uranium deposit evaluation
- ISL and other U mining & processing
- Unconventional U resources, Th
- Health, safety and environment
- Tailings and waste management
URAM-2018 – Key Points

- Countries are using the slowdown to better prepare their regulatory systems so they are ready to implement good practices as mines reopen and stalled projects get moving again in the future.

- Advancements in integrated information and modelling software for operational mines.

- Innovations are ongoing for technology, analytical techniques, computerization.

- Uranium price likely to remain soft for a few more years.

- Recent shutdowns of mines are bringing supply-demand closer to an appropriate balance, but large stockpiled inventories are in existence.

- Exploration has slowed significantly in the last several years, but in many places it continues at a slower pace.
Technical Cooperation - International Expertise

Some 50 international experts imparted the training for over 700 participants during 2009-2018

Photos: H. Tulsidas, Nigerian Geol. Survey
Technical Cooperation - Lectures and Discussions

Over 350 lectures on specific topics; Q & A Sessions, Discussions

Photos: H. Tulsidas, P. Woods, OMNIS (Madagascar)
Technical Cooperation - Training

• Externally Funded Training
  – Supporting sustainable uranium mining in less prepared areas
    • Programme in Francophone Africa (French language)
    • SE Asia (Indonesia, Thailand: English language)

• Technical Cooperation
  – Training Meetings often held;
    • Recent examples; Australia, China, Mongolia, Ethiopia, Malaysia
  – Scientific Visits (1-2 weeks)
  – Fellowships (1-3 months, sometimes more)
Examples of topics covered in IAEA workshops and training courses

1. Uranium exploration in potential areas
2. Estimation and evaluation of uranium resources
3. Reporting of uranium resources in conformity with international standards
4. Conducting techno-feasibility studies and their review
5. Improving social licensing and stakeholder communications
6. Uranium mine closure and site remediation
7. Regional uranium resources and production data reporting tools and mechanisms
8. Conventional safety and radiation protection in U mines and mills
9. Radiation protection for the public living near uranium legacy sites
10. Assessment and licensing for remediation plans
Examples of equipment purchases (through IAEA Technical Cooperation)

- Radiation and radionuclide measuring equipment
- Risk modelling and GIS software
- Water, soil, air sampling equipment, pumps, other field equipment
- Laboratory equipment (e.g. ICP-MS, XRF, auto-titrator, balances, pH meters, etc)
- Drilling of observation wells and analysis of environmental samples
- Mineralogical microscope
- Equipment for deposit assessment such as crushers
- Down-hole geophysical probe
- Information management system

Photos: B. Moldovan, Jordan, 2017, Malaysia 2018
Conclusions – IAEA contributions to good practice in uranium mining and remediation

- Collection and distribution of useful information
- Promotion of IAEA safety standards and related guidance, across IAEA activities
- Training and technical meetings, symposia
- Experts to review national circumstances and provide guidance – exploring, testing, regulating, remediating
- Personnel skill development through scientific visits, fellowships (through TC)
- Provision of some equipment (through TC)
- and in all this:
- the importance of environmental and social aspects of uranium mining and remediation is emphasized
Everyone’s objective should be safe and efficient mining and sustainable remediation, with social benefits.

Something like this; a mine creating jobs and working with its community (left) and avoiding future legacies.

With a safe, sustainable end use in sight, e.g. a remediated uranium mine used for a raising cattle and fishing (right).

(photos: P. Woods)
Thank You

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and with thanks to many colleagues
Links

• CGULS CONNECT
• RSL CS CONNECT
• UPC CONNECT
• REGSUN
• Safety Standards