Multilateral Approaches to Used Fuel/HLW Management
with focus on institutional challenges

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Key WM Cooperation Areas

- Developing strategies and concepts
- Knowledge exchange
- Developing methodologies
- Producing experimental results
- Organising joint research projects
- Communication activities
- Provision of services
- Implementing WM facilities
- Shared storage facilities
- Shared repositories

the “easy” parts

commercial drivers

the biggest challenge!
Nuclear services offered internationally .... by limited numbers of nations

- Uranium production
- Enrichment
- Fuel fabrication
- Reactor construction
- Reprocessing
- Electricity supply

WHY NOT ALSO STORAGE and/or DISPOSAL??
IAEA Reports addressing Multilateral Waste Management Issues

New Tecdoc
Viability of sharing facilities for the disposition of spent fuel and nuclear wastes

New NE Report
Options for Management of SNF and Radwaste For Countries Developing Nuclear Power
A Secure, Safe, Energy Future

Global goals:
- Security of supply of energy (NB resource and geopolitical concerns)
- Low-carbon electricity generation (Climate change concerns are now universal)

Expanded nuclear power can help ...... but we must have:
- Safe and secure NFC facilities & materials
- Security of supply of front-end services
- Security of availability of back-end services including reprocessing - if requested
- Access to geologic disposal - in all cases
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<tr>
<th>Country</th>
<th>Operational Dates</th>
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<tr>
<td>Belgium</td>
<td>Belgium: after 2025</td>
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<td>Bulgaria</td>
<td>Bulgaria: open</td>
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<td>Czech Republic</td>
<td>Czech Republic: c.2065</td>
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<td>France</td>
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<td>Hungary</td>
<td>Hungary: 2047</td>
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<td>Japan</td>
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<td>Netherlands</td>
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<td>Romania</td>
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<td>Slovenia</td>
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<td>Spain</td>
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<td>Sweden</td>
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<td>United Kingdom</td>
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THE "WASTE PROBLEM" HAS HELD BACK NUCLEAR DEVELOPMENT IN MANY OR EVEN MOST COUNTRIES.
Spent fuel management options for small nuclear programmes

- Dispose nationally – too expensive (several billion dollars) AND/OR too long to wait
- Take-back by supplier – no current offers (except Russia?)
- Send to third party country – no current offers. Some advanced disposal programmes (SF, S, F) have laws against import of radioactive wastes
- Interim storage for many decades or indefinitely – growing security and environmental risks
- Seek Partners for development of regional facilities – the SAPIERR/ERDO-WG project shows how this might work
Why do we need multinational solutions for geological disposal?

- **Nuclear safety and security must be assured - globally**
  - Neither spent fuel nor HLW nor long lived radioactive wastes should end up in numerous locations around the globe

- **Geological disposal**
  - The only feasible ultimate solution - but long timescales, difficult to site, expensive - especially for small inventories,

- Small nuclear nations may not have suitable locations, adequate financing or sufficient technical know-how - but they need a credible strategy

- A disposal service may be a powerful incentive encouraging new nuclear nations to forego full fuel cycle activities
Advantages of Multinational Repositories

- Economy
- Access to safe disposal facilities
- Enhanced global nuclear security
- Lower environmental impact
- Wider choice of geological conditions
- Increased technical potential
Challenges of Multinational Repositories

- Transport
- Different (national) legislations, definitions
- Diversity of waste streams
- Cost distribution amongst partners
- Different time schedules
- Siting … and politics!
Growing Nuclear Programmes
Growing Security Concerns

- All the security issues affect all programmes

- Possible new entrants
  - Algeria, Australia, Baltic States, Chile, Gulf States, Iran, Italy, Indonesia, Jordan, Malaysia, Nigeria, Peru, Poland, Thailand, Turkey, Vietnam

- Most attention is being given to the front-end (e.g. by IAEA, WNA, GNEP, GNPI)
  - Avoid spread of enrichment and reprocessing
  - Provide security of fuel supply for all users
  - What about the spent fuel and radioactive wastes?

➤ Secure Multinational Solutions
How Hazardous is Spent Fuel?

- **One nuclear weapon:**
  - Needs ~13 kg reactor grade Plutonium (R. Garwin)

- **10,000t spent fuel are produced annually**
  - These contain 100t Pu

- **Current separated Pu Inventories:**
  - ca 500t - 50:50 civilian and weapons programs (SIPRI)

- **A single 1000 MWe NPP, 50y lifetime**
  - 1,250t spent fuel = 12,500 kg Pu
Security Benefits of Multinational Solutions

- **Limited numbers of facilities to be secured**
  - Reduce burdens on IAEA and other organisations
  - Single facility easier to control and monitor

- **Earlier underground disposal for smaller nations**
  - Avoid extended and globally dispersed storage requirements

- **Enhanced engineered and institutional security measures**
  - Ensure highest standards of safety & security
  - Encourage harmonisation of standards (e.g. EU: 15 NP States)

- **Enhanced levels of international safeguards oversight**
  - Simpler surveillance

- **Improved financing arrangements**
  - General economic advantages of sharing well-known
  - Less chance of diversion of security funds
Key Messages

- Spent nuclear fuel is very hazardous for a very long time
- Lots of proposals are being made for the reducing risks at the front end of the NFC
- Too little is being done about the back-end
- Initiatives for multinational cooperation in storage and disposal of spent fuel/HLW are needed
Key recent developments in multinational disposal initiatives

- Increased support from IAEA (e.g. TECDOCs, DG statements, MNA Expert Group, INPRO, new consultancies)
- Increased support from EC (e.g. Waste Directive, SAPIERR funding)
- The Arius Association, the SAPIERR project, the ERDO-WG
- USA actions & proposals .... up to GNEP
- Russian actions & proposals up to GNPI
"For countries with limited waste or without access to geologically suitable disposal sites, multinational disposal at sites with good geology might be an option. Several studies have identified the potential benefits, in terms of possible economic, non-proliferation, safety and security advantages, of multinational disposal as well as the institutional and political issues standing in the way. The IAEA could help States arrive at a solution that fits their needs."
IAEA: Multinational Scenarios

- **ADD-ON Scenarios (Service Providers):** the host complements its national inventory by imported wastes

- **Co-operation scenarios:** partner countries develop a repository jointly together with the potential hosting country or countries

- **Full international or supranational scenarios:** a higher level of control and supervision is implemented
Arius is a non-profit Association established in Switzerland in 2002 to promote the interests of its Members

Arius Members are both organisations and individuals

Mission:

To promote concepts for socially acceptable, international and regional solutions for environmentally safe, secure and economic storage and disposal of long-lived radioactive wastes

Arius has led projects to achieve this mission with the involvement of organisations from many European countries: organisations from the countries below participated in the SAPIERR I or II projects:

Austria*  Estonia  Latvia  Romania*  Switzerland
Belgium  Hungary  Lithuania*  Slovakia*  UK
Bulgaria*  Ireland*  Netherlands*  Slovenia*  Spain
Czech Rep  Italy*  Poland*  Spain

*countries whose governments have nominated representatives to participate in the ERDO-WG
A European Example

National disposal programme only

No official policy

The 14 SAPIERR Working Group members

No NPP but some waste for deep disposal
SAPIERR-I and -II

EC supported projects under FP6 (2003 – 2008) to study regional/multinational disposal solutions

SAP I: Deliverables - technical, economic, legal

SAP-II: Deliverables - mainly institutional

- Legal and business structures
- Legal liabilities
- Economics (costs, benefits)
- Safety and Security
- Public and political attitudes
- Strategy and project plan for new organisation
Liabilities and Responsibilities:  
SAPIERR-II Task 2 Goals

- Identify the responsibilities to be borne throughout the long development process (legal, financial, ethical, etc.)

- Identify the various bodies that together must bear the responsibilities and carry the financial liabilities

- Propose an option (or options) for the allocation of responsibilities and financial liability;

- Discuss which aspects are peculiar to multinational projects and which are common also to national waste management programs.
SAPIERR II – Economic Analyses

- **Cost estimates for:**
  - Transport
  - Storage
  - Disposal

- **Benefits packages**
  - Review of national cases
  - SWOT on potential multinational approaches
Next Step after SAPIERR

ERDO-WG, ERDO and ERO

ERDO-WG
Working Group to lay the foundations for the ERDO

2009

ERDO
European Repository Development Organisation

≈2011

ERO
European Repository Organisation

2020-25

Investigation of Sites

Preferred Site: trigger for ERO Binding host agreements

times uncertain/flexible
ERDO-WG: prime goals

- Investigate the feasibility of establishing a formal, joint European waste management organisation
- Carry out all the necessary groundwork
- Present a consensus proposal to the governments
  - Providing that a sufficiently broad consensus is achieved by these governments or their representatives, the ERDO would be established at the end of this process

ERDO-WG works in parallel to national programmes
Some Key Elements of ERDO Model

- Co-operative, operating solely for benefit of member countries on a *not-for-profit*, shared risk basis

- Member countries with nuclear power programmes expected to have active, parallel national programme for geological disposal

- Members fund agreed programme of work proportionate to an estimate of their inventory of wastes for geological disposal

**ERDO end-point:**

- Develop regional repository operational plan (including any associated storage facilities) making safe and secure disposal available to member countries

- At an agreed time, ERDO will transition to a European Repository Organization (ERO).
ERDO-WG status

- Group has been established; 10 countries* nominated representatives; other interested
- Terms of references and outreach programme agreed
- Draft Documents prepared:
  - Operating Guidelines; Model Constitution; Cost Sharing Model for ERDO; Outline Approach to Siting
- Four meetings have taken place (Brussels, Prague, Vlissingen, Bratislava; next Vienna)
- Website (www.erdow.eu) and leaflet
- Interest in applicability of model to further global regions

* Austria, Ireland, Netherlands, Poland, Slovakia, Bulgaria, Italy, Lithuania, Romania, Slovenia
Existing and potential new nuclear power nations: can the ERDO model be adapted for use in other regions?

Arius has started a pilot project, supported by US charitable foundations (Sloan and Hewlett), to explore the potential interest and adaptability of the concept in some of these regions.
Middle East and North Africa: Iran, UAE, Bahrain, Oman, Kuwait, Saudi Arabia, Yemen, Israel, Syria, Jordan, Egypt, Tunisia, Sudan, Libya, Algeria, Morocco
Current IAEA Region Initiatives with Arius Input

Reports
- Multinational Repositories (Tecdoc 1413)
- Regional Storage (Tecdoc 1482)
- Viability Tecdoc in press
- New nuclear nations report in preparations

South East Asia: ASEAN
- Consultancies Sep 2010 and Feb 2011
- Workshop Jakarta(?) April 2011

Middle East and North Africa: MENA
- Workshop Dec 2010
- Regional Meeting 2011
Pre-requisites for Success

**TECHNICAL**
- Import for disposal not just storage
- Final disposal also of other long lived wastes
- Economic advantages to both sides
- Guarantee of continued services
- Open and transparent management structure
- Use of best knowledge and experience

**BUSINESS**
- Acceptability to the global community

**POLITICAL**
- Support of international organisations (IAEA)
Ingredients for success: add-on option

- Agreement to host a repository by a country that already is internationally trusted (especially by the USA)
- Agreement between host and supplier countries on economic issues, liabilities (?)
- Agreement by a major country with suitable repository sites to allow control – or even operation – of these by a supranational organisation a disposal facility available to all
Ingredients for success: shared solution option

- Recognition of a common need
- A number of countries that are openly interested in being potential users of a common facility
- A number of countries (possibly including any or all of the above) that are prepared to consider the possibility of hosting a shared facility
- Agreement on economic issues, liabilities etc.
- Mutual trust between all partners
Ingredients for success: any option!

- Those countries that have opted for a purely national solution must support the communal efforts of others in need of shared disposal facilities.

- Commitment by international organisations such as the IAEA and the EC to support specific repository projects and to make all efforts to ensure that the facilities are strictly regulated and safeguarded.
Conclusions

- We neglected waste disposal during the first “nuclear surge”; we must not neglect it now.
- Both safety and security aspects are both important.
- This is a key issue for existing nuclear nations wishing to expand their programme; it is equally important for nations initiating a nuclear power programme.
- New and small nuclear programmes should adopt “dual track” disposal strategies (national and multinational).
- Multinational repositories may be the “carrot” that can best convince new nuclear nations to accept further constraints on their activities.
The End
Extras
Nuclear power in new user countries: “the small print”

- NPPs produce waste that needs expensive storage and geological disposal
- The problem is easier if your fuel supplier takes back the fuel
- But, even then, you will have long-lived wastes
- You need a comprehensive long-term WM strategy and plan
- Your nuclear supplier or the international community can help with this
- The disposal options are: national, multinational and dual track
A credible disposal strategy

- Allocate responsibilities for long-term management
- Establish a funding mechanism
- Develop a sound engineering concept for disposal
- Define a practicable storage strategy ensuring safety and security
- Initiate a modestly sized national siting programme
- Initiate a “dual track” strategy allowing for multinational, regional solutions
Prerequisites to identification of potential host sites or countries

1. Recognition of a common need for a repository
2. Transparent specification of ALL requirements to be fulfilled
3. Establish, document and discuss pros and cons of hosting a facility
4. Establish TRUST in the potential implementing organisation

Siting an international repository will face the same problems as a national repository – in both cases it is NOT something you do at the start of a programme.....
Staged siting strategy

Multinational siting strategies can be modelled directly on successful, modern, national siting approaches since both approaches face very similar challenges.

By Neil Chapman and Charles McCombie

National and multinational disposal projects both have to go through exactly the same technical and stakeholder involvements steps. They may take many years to achieve siting successfully and, indeed, should avoid the premature selection of potential sites. The essence of any successful siting programme is that it is consensual and inclusive from the outset and all aspects of the repository project are transparent. The process must allow for active inclusion of local communities at all stages.

We have developed a model approach to siting a multinational repository, based around a European case study. The approach could be adapted readily to any group of countries, who may be unwilling to be in the vanguard of such a programme. For those national governments who believe that they should have complete competence in repository siting, it already visible in the European Union. We believe that such community foresightedness, along with appreciation of the potential economic and societal benefits that would accrue to a host community, may make siting a shared repository considerably less difficult than critics of multinational solutions assert.

CONSTRAINTS

In common with the most recent national repository development projects, the siting strategy (and, it would appear, the waste management strategy as well) to achieve a disposal solution. The principles of such an approach have been described in overview documents such as the report One Step at a Time produced by the National...
Finding a repository site

- No (successful) national programme **BEGINS** by nominating sites!
- Host community **volunteering or willing** assent is increasingly recognised to be necessary - nationally or multi-nationally
- Inclusive process, led by ERDO working directly with national team members and local volunteer communities
  - No national governmental declaration of willingness to be a host is required
- Allows national governments to follow a “dual track” approach: national and regional options
- Potential host communities and countries will emerge after a lengthy process of negotiation
  - Country can withdraw from process at any time up to final siting decision
Favouring national solutions: 31%
Favouring international disposal: 55.6%
Of which, favouring EU solution: 70%
Could be in Germany: Yes=No=40%
Could be in MY region: 80% against (whether international or national repository)
Challenges

Additional challenges for shared repositories arise for the following reasons:

• Complex procedures may be needed for assuring that waste packages transported from varied sources meet the acceptance requirement at the repository

• Fair mechanisms for sharing development, capital and operating costs must be agreed. These must allow for subsequent expansion of the partner organizations should further nuclear power companies be established

• Arrangements (practical and financial) must be made for the acceptance at a deep repository of long-lived wastes produced outside the nuclear fuel cycle, e.g. from medicine, industry and research.

• Users must be obligated to transfer their stored wastes to the repository on agreed schedules in order that the repository operations can be optimized
Generation cost structure

- **Gas**: 76% Fuel, 7% O&M, 17% Investment
- **Coal**: 41% Fuel, 42% O&M, 17% Investment
- **Nuclear**: 15% Fuel, 26% O&M, 59% Investment

Uranium ~ 5%
Cost ranges* [USD/MWh]

* Levelised generation costs - excluding the 5% highest and 5% lowest values