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Deep Borehole Disposal International Drivers

Andrew Orrell
Section Head, Waste & Environmental Safety
Department of Nuclear Safety and Security

Waste Management 2017
Session 081
March 8, 2017

Topics

- Safety Objective
- Why DBH?
- Disposal Challenge
  - Cost and Acceptance (EU example)
  - DBH: A solution for who, what?
- Other Issues

Fundamental Safety Premise

- **The fundamental safety objective is to protect people and the environment from the potential for harmful effects of radioactive waste.**
- **To manage the waste burden through *permanent disposal* in a manner that protects the *accessible biosphere*****
- **The strategy to achieve this fundamental safety objective is to *contain and isolate*, the waste from the accessible biosphere, to the extent that is necessary to have reasonable confidence that the uncertainties of e.g. 1Myr timeframes are addressed.**
  - **Disposal facilities are to be developed in such a way that people and the environment are protected both now and in the future**
  - **To leave future risks no greater than one would accept at present.**

***groundwater and other resources used by or accessed by people).**

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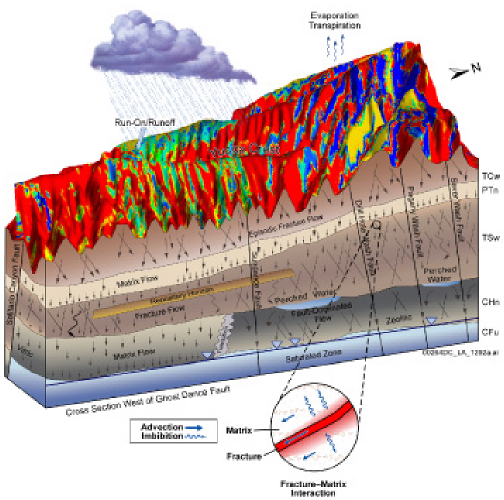
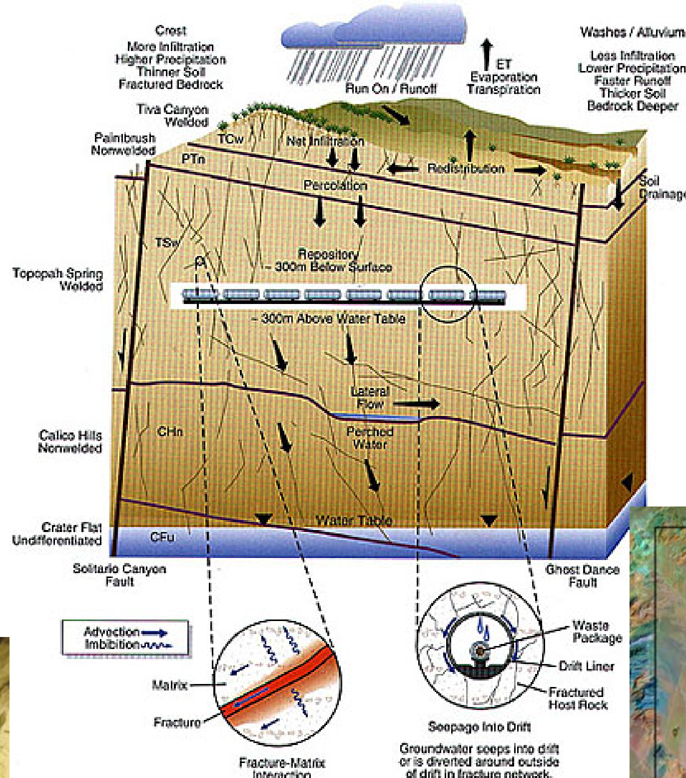
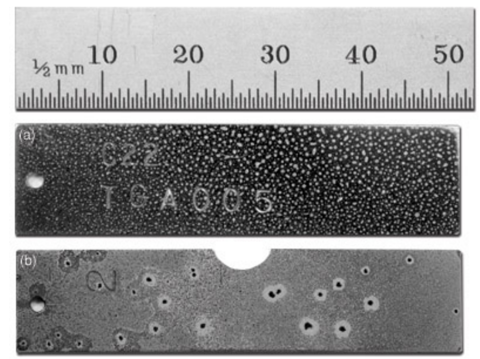
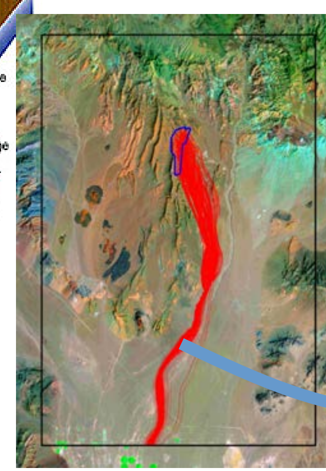
Why DBH?
Common Issues of Mined Repositories

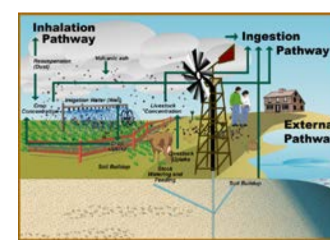
- Coupling between the surface and near-field disposal environment and **dose assessment**



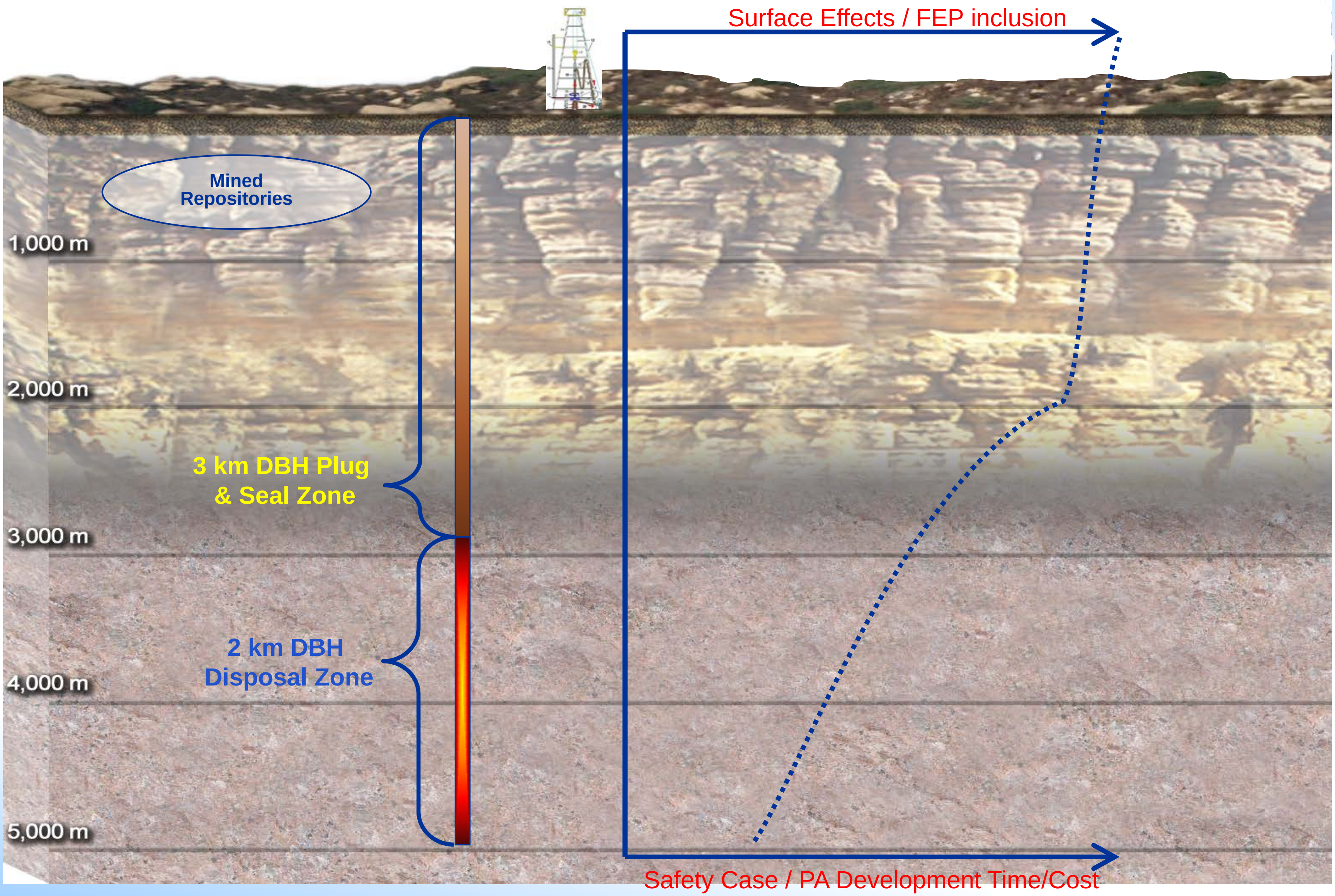








Deep Borehole Disposal Concept
FEP Screening with Depth (isolation)



Common Issues
Cost and Availability

EUROPEAN
COMMISSION

Brussels, 4.4.2016
SWD(2016) 102 final

COMMISSION STAFF WORKING DOCUMENT
Accompanying the document

Communication from the Commission

Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee

{COM(2016) 177 final}

Nuclear reactors in shut down status per EU MS and technology (PRIS Jan 2016)

	BWR	FBR	GCR	HTGR	HWGCR	LWGR	PHWR	PWR	SGHWR	Total
BE								1		1
BG								4		4
DE	9	1		2	1		1	14		28
ES	1		1					1		3
FR		2	8		1			1		12
IT	2		1					1		4
LT						2				2
NL	1									1
SE	2						1			3
SK					1			2		3
UK		2	27						1	30
Total	**15**	**5**	**37**	**2**	**3**	**2**	**2**	**24**	**1**	**91**

Decommissioning Strategy

Immediate dismantling	Deferred dismantling	No preferred option
Belgium Bulgaria Spain Finland (Loviisa) France Croatia Italy (Note 1) Lithuania Netherlands (Borssele) Sweden Slovenia Slovakia (Note 2)	Finland (Olkiluoto) Hungary Netherlands (Dodewaard) Romania United Kingdom	Czech Republic Germany

- Note 1 Italian NPPs have been formally under an operating mode status for many years after stopping producing electricity.
- Note 2 Decommissioning plans for JE V2 have not been decided and consider both options as possible. Source: (Slovakian National Nuclear Fund, 2014).

Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee {COM(2016) 177 final}

Estimated costs of decommissioning EU NPPs

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MS	Estimated Decommissioning costs (EUR billion, note 1)	Total NPPs			Estimated cost of decommissioning (EUR billion per unit)	Estimated cost of decommissioning (EUR billion per GWe)
		Units	Capacity (MWe)	Average capacity		
BE[123]	3,7	8	5 931	741	0,5	0,6
BG[124]	3,0	6	3 558	593	0,5	0,8
CZ	1,5	6	3 904	651	0,3	0,4
DE	38,0 (note 2)	36	26 375	733	1,1	1,4
ES	4,5	10	8 188	819	0,5	0,6
FI[125]	1,0	4	2 752	688	0,3	0,4
FR	22,6	70	66 919	956	0,3	0,3
HR	0,2	0,5 (note 3)	344	344	0,4	0,6
HU	1,2	4	1 889	472	0,3	0,7
IT	Not available	4	1 423	356	NA	NA
LT	2,6	2	2 370	1 185	1,3	1,1
NL	Not available	2	537	269	NA	NA
RO[126]	1,4	2	1 300	650	0,7	1,1
SE	3,4	13	10 861	835	0,3	0,3
SI[127]	0,2	0,5 (note 3)	344	344	0,4	0,6
SK[128]	3,1	9	3 665	407	0,3	0,9
UK[129]	36,9	45	13 598	302	0,8	2,7
Totals Note 4	**123,3**	**222**	**151 998**	**704**	**0,6**	**0,8**

Source: Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee {COM(2016) 177 final}

Waste management estimates reported by Member States (including costs for the building of geological repositories)

MS	Estimated Waste Management costs (EUR billion)	Lifetime electricity supplied from NPPs [TWh]				Estimated cost of waste management (EUR per MWh)
		Average lifetime load factor[132]	Actual electricity supplied as of Sep 2015	Estimated future electricity supplied, considering official LTOs	Total	
BE[133]	7,0	84%	1 399	349	1 748	4,0
BG	0,5	65%	518	288	807	0,6
CZ	5,0	82%	515	819	1 334	3,8
DE Note 1	7,7	88%	4 836	398	5 234	1,5
ES[134]	10,0	85%	1 740	1 297	3 037	3,3
FI	5,6	91%	697	344	1 041	5,4
FR[135]	45,8	73%	11 873	9 203	21 076	2,2
HR	0,5	84%	78	60	138	3,7
HU	4,3	86%	389	234	624	6,8
IT	Not available	NA	143	0	143	NA
LT	3,2	NA	311	0	311	10,3
NL	Not available	84%	148	54	202	NA
RO	2,8	92%	133	315	448	6,3
SE	7,6	75%	2 200	1 186	3 386	2,2
SI	0,5	84%	78	60	138	3,7
SK	5,0	81%	412	295	707	7,1
UK	24,1	70%	2 629	817	3 445	7,0
Totals	**129,6**	**77%**	**28 098**	**15 718**	**43 816**	**3,0**

Source: Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee {COM(2016) 177 final}

Country Nuclear Power Profiles

IAEA

http://cnpp.iaea.org/pages/index.htm

Argentina	**China**	Indonesia	**Mexico**	**Slovakia**	Turkey
Armenia	**Czech Republic**	**Iran**, Islamic Republic of	Morocco	**Slovenia**	**Ukraine**
Bangladesh	Egypt	**Italy**	**Netherlands**	**South Africa**	United Arab Emirates
Belarus	**Finland**	**Japan**	Nigeria	**Spain**	**United Kingdom**
Belgium	**France**	Jordan	**Pakistan**	**Sweden**	**USA**
Brazil	**Germany**	**Kazakhstan**	Philippines	**Switzerland**	Viet Nam
Bulgaria	Ghana	**Korea**, Republic of	Poland	Syrian Arab Republic	
Canada	**Hungary**	Kuwait	**Romania**	Thailand	
Chile	**India**	**Lithuania**	**Russia**	Tunisia	

Boldface indicates countries with NPPs

Mexico BWR Spent Fuel Management

- Used nuclear fuel from the Laguna Verde reactors is stored underwater at the site. The storage pools have been re-racked to provide enough space for the reactors' entire lives. About 1200 tonnes of used fuel exists at present. The same strategy of on-site storage is employed with used fuel from research reactors.

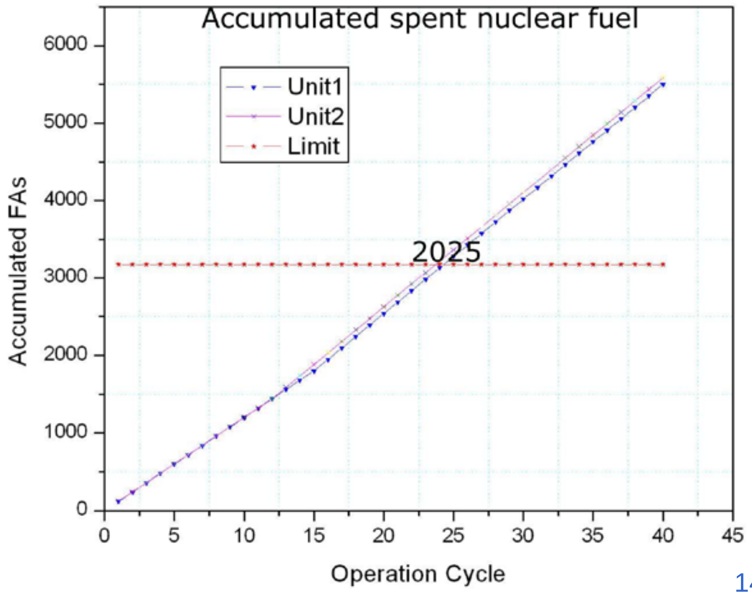
Mexico

2.7. Fuel cycle including waste management

- As for spent nuclear fuel, the current plans are to store it at the reactors' pools. These have been re-racked to increase the original capacity in order to accommodate the spent fuel that the reactors will produce during their expected operating life. This plan gives CFE time to make a more definite decision on long-term storage methods, dependent on future developments in uranium availability and price, expansion of the Mexican nuclear power capacity, new technologies, etc.
  - [In 2014, the Laguna Verde nuclear power plant finalised a contract for independent spent fuel storage installation services for both units.]

Mexico - Financial

- Given the magnitude of the resources required, it is critical to plan for the acquisiton of funds as soon as possible
- Required amount : 4,700 Million dollars in:
  - SF Temp. Facility 2015 (456 Million)
  - LILW Repository 2020 (873 Million)
  - Deep Geological Rep. 2045 (2,195 Million)
  - LV Decommissioning 2060 (770 Million)
- A debt that cannot be left to future generations



Global Perspective – Disposal of HLW / SNF

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- Disposal solutions are particularly challenging for:
  - Countries with small nuclear programmes,
  - Countries with nuclear applications only,
  - Nuclear newcomer countries
- Nuclear newcomer countries embracing nuclear power defer the issue of disposal
  - It is not a requirement to have disposal capacity in place a-priori to power production, only a plan.

Other Concerns

- Retrievability
- Need for mined space
- Stuck Packages
- Competition with other programs
- ???

Conclusion

- DBH is A solution, not THE Solution
  - Optimization is possible with OPTIONS
  - Disposal needs options…

- Solve the problem

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Thank you!