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※以降、参考資料 4-1-5～4-1-8 は、著作権等に配慮し添付せず、入手した書名のリストのみ挙げます。
参考資料 4-1-5：The Port Hope Project -What you should know-（PHAI パンフレット）
参考資料 4-1-6：WASTE NUCLEAR SUBSTANCE LICENCE PORT HOPE LONG-TERM LOW-LEVEL RADOACTIVE WASTE MANAGEMENT PROJECT
参考資料 4-1-7：Port Hope LTWMF License Conditions Handbook “Compliance Framework Document associated to the Port Hope Project Waste Nuclear Substance License WNSL-Wl-2310.00/2022.”
参考資料 4-1-8：Port Hope Project ENVIRONMENTAL ASSESSMENT STUDY REPORT. LLWRMO-03710-ENA-12003 Revision 1d1. January 2006.

(2)WCS 社処分場関連
参考資料 4-2-1：　WCS 社からの入手資料
参考資料 4-2-2：　John Till 氏経歴

(3) TCEQ 関連

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(4) NRC 関連

参考資料 4-4-1： Regulation of commercial low level radioactive waste: An Overview of 10 CFR Part 61（OHP プレゼンテーション資料）

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参考資料 4-4-3： Performance Assessment Approaches & Methods – NRC’s LLW Program（OHP プレゼンテーション資料）

北米調査行程表（1/2）

日付	時間	場所	備考
3/11(月)	17:00 15:50	東京　成田発 トロント空港着 Crowne Plaza Toronto Airport 泊	ANA 全日空　6812 便/エア・カナダ　002 便 33 Carlson Ct, Toronto, ON M9W カナダ
3/12(火)	07:15 09:00 14:00 14:30 17:00 17:30 20:00	ホテル発 PHAI-AECL /CNSC/との打合せ （環境修復サイト見学 10:45-12:00） Cameco 社との打合せ ポートホープ発 Crowne Plaza Toronto Airport 泊	PHAI 115 Toronto Road, Port Hope, ON L1A 3S4 Cameco まで移動 205 Peter Street Port Hope, Ontario L1A 3V6 33 Carlson Ct, Toronto, ON M9W
3/13(水)	06:30 08:30 11:05 15:04 16:33 18:00	ホテル発 トロント便発 ヒューストン着（乗継用） ヒューストン乗継便発 ミッドランド空港着 Days Inn Midland 着	ユナイテッド航空　8350 便 ユナイテッド航空　4191 便 3904 W Wall St, Midland, TX
3/14（木）	10:00 13:00 13:00 17:00 20:00	ホテル発 WCS 処分場着 WCS 処分場訪問 WCS 処分場発 Days Inn Midland 着	9998 W State Highway 176, Andrews, TX 79714 3904 W Wall St, Midland, TX
3/15（金）	06:30 08:15 09:25 11:40 12:40 14:00 16:40	ホテル発 ミッドランド便発 ダラス/フォートワース着 ダラス/フォートワース便発 オースティン着 TCEQ　ウランセクション打合せ Econo Lodge 着	アメリカン航空　2502 便 アメリカン航空　1893 便 Austin TX 78711-3087 9102 Burnet Road Austin, TX 78757
3/16（土）	12:15 14:15 16:14	ホテル発 オースティン便発 ソルトレーク空港着 Hilton Homewood Suites Hotel 着	デルタ航空 3408 便 423 West 300 South, Salt Lake City, Utah, 84101

北米調査行程表（2/2）

日付	時間	場所	備考
3/17（日）		終日自由行動 Hilton Homewood Suites Hotel 泊	 423 West 300 South, Salt Lake City, Utah, 84101
3/18（月）	08:00 10:00 10:30 17:00 19:00	ホテル発 クライブ処分場着 クライブ処分場訪問 クライブ処分場発 Hilton Homewood Suites Hotel 着	クライブ処分場まで ES 社送迎 Interstate 80, Exit 49　Grantsville, UT 84029 ホテルまで ES 社送迎 423 West 300 South, Salt Lake City, Utah, 84101
3/19（火）		UDEC　DRC 打合せ（2 時間程度） Hilton Homewood Suites Hotel 着	Salt Lake City, Utah 84114-4850 423 West 300 South, Salt Lake City, Utah, 84101
3/20（水）	07:30 09:40 15:58 17:00	ホテル発 ソルトレーク便発 ワシントン DC（ナショナル）空港着 Days Inn Washington DC 着	 デルタ航空　2384 便 4400 Connecticut Avenue
3/21（木）	13:00 14:00 17:00 18:00	ホテル発 NRC 打合せ NRC 打合せ終了 Days Inn Washington DC 着	 One White Flint North 11555 Rockville Pike 4400 Connecticut Avenue
3/22（金）	10:00 11:00 12:20 15:25	ホテル発 ワシントン DC　ダレス空港着 ワシントン DC 発 東京　成田空港着（3/23）	 ANA 全日空 1 便

Introduction of Japan Atomic Energy Agency

March 2013

Makoto Hasegawa

Japan Atomic Energy Agency

Delegation member list

Mr. Makoto HASEGAWA : Director General,
Nuclear Cycle Backend Directorate, JAEA

Mr. Zaitsu TOMOHISA : Supreme Engineer,
Nuclear Cycle Backend Directorate, JAEA,

Mr. Kazuhiko SATO : Assistant Principal Engineer,
Ningyo-toge Environmental Engineering Center, JAEA

Mr. Akihiro SAKAI : Assistant Principal Engineer,
Low-Level Radioactive Waste Disposal Project Center, JAEA

Mr. Tatsuo SAITO : Engineer, Nuclear Cycle Backend Directorate, JAEA

Mr. Ikken SATO : Director of Washington Office,
International Affairs Department, JAEA

Mr./Dr. Kohei KUSHITA : Deputy Director of Washington Office,
International Affairs Department, JAEA

Mr./Dr. Hiromichi FUMOTO : Manager, Working Team for Uranium Waste Management
Disposal System, Japan Society of Newer Metals

JAEA's position of Nuclear Development Organization

【JAEA's Position 】

MEXT
Ministry of Education, Culture, Sports, Science and Technology

- Science and Technology Policy Bureau
- Research Promotion Bureau
- Research and Development Bureau

【Incorporated Administrative Agency】

- JAEA(Japan Atomic Energy Agency)
- IPCR (Institute of Physical and Chemical Research Japan)
- NIRS (National Institute of Radiological Sciences)

:

【JAEA's wok scope 】

Work scope of JAEA ordained by the Japan Atomic Energy Agency Act of 2005.

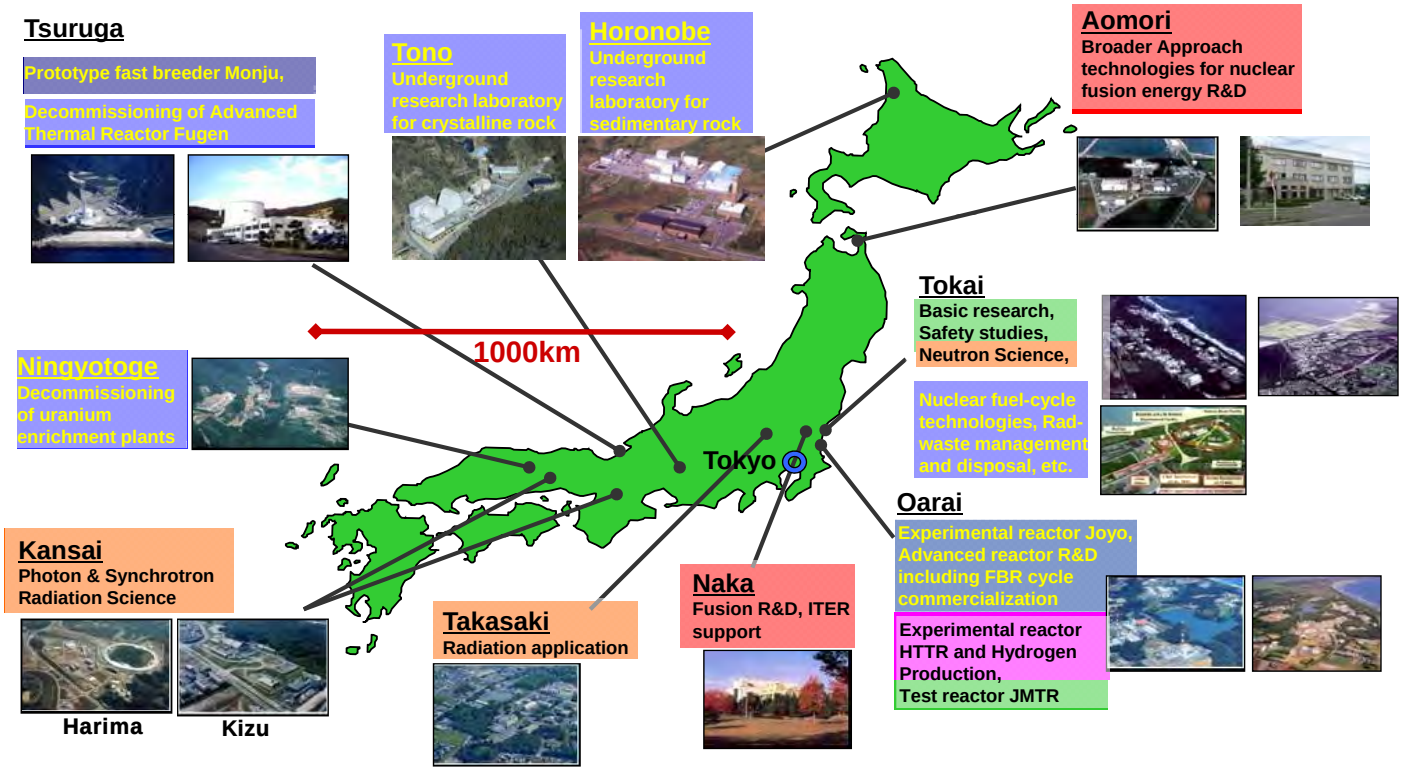
1) Basic research of nuclear energy
2) Application research of nuclear energy
3) Technical establishment of nuclear fuel cycle
   - R&D of Fast Breeder Reactor
   - R&D of nuclear fuel for FBR
   - R&D of Reprocessing
   - R&D of treatment and disposal of HLW
4) Promotion of application of R&D results of above areas
5) Utilization Sharing of facility and equipment
6) Human resource development of nuclear energy field
7) Collection, arrangement and dissemination of nuclear information
8) Study and analysis requested by government (including safety regulation, nuclear disaster prevention, international non-proliferation)
9) Related areas

②

Overview Activities of Japan Atomic Energy Agency

③

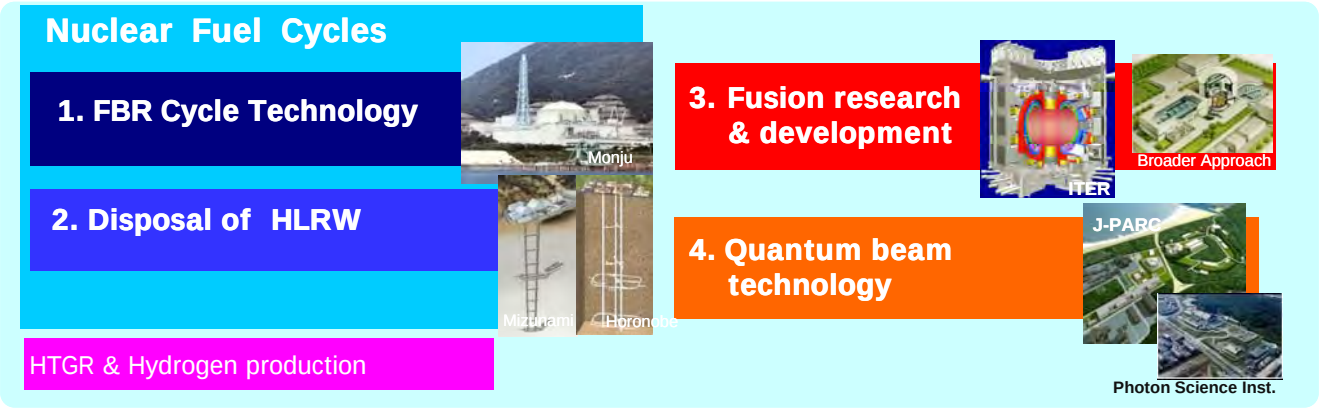
Outline of JAEA



Permanent employee: ～4000　Annual budget: ～200 billion yen (～2 billion US dollars)

④

JAEA's Activities



Activity to secure safe nuclear power and peaceful use

- Safety research
- Nuclear nonproliferation

Decommissioning & disposal of low level waste

Cooperation with academic and industries, international collaboration, human resource development ・・・

Universal scientific technology base

Basic nuclear power engineering research, state-of-the basic research, etc.

⑤

Progress of JAEA's R&D Activities

FBR Cycle Technology

- System Start-up Test of Monju underway after its restart on May 6,2010.
- Fast reactor Cycle Technology development (FaCT) Project for conceptual designs of commercial and demonstration FR cycle facilities and key technologies toward 2015.
- Trilateral (JAEA-USDOE-CEA) cooperation on SFR prototype/demonstration and related R&D.

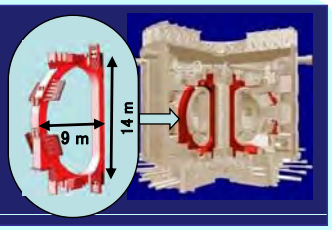
Geological Disposal technology for HLW

- Ongoing excavation at Underground Research Laboratories (URLs)

  Current depths of shafts
  Mizunami: ca. 500m
  Horonobe: ca. 350m
- The URLs provide an opportunity to experience/study deep geological environment

Fusion Energy R&D

Started procurement of superconducting magnets, the first among the ITER Parties



- Activities as a Domestic Agency of the ITER Project
- Aomori R&D Center as a base of BA Activities
- JT-60 experiment completed, construction of JT-60SA started as one of BA Activities

Quantum Beam Technology (J-PARC)

- The facility construction completed, with the experiments having started in Dec. 2008 at the Materials and Life Science Facility and in Feb. 2009 at the Nuclear and Particle Physics Facility.
- Applied the law to MLF to promote common use, and the common use start in October 2011,

⑥

Disposal of Low-level Radioactive Waste

JAEA is promoting the disposal of LLW generated from the R&D of the nuclear energy / medical and industrial use of radioisotope in Japan.

Background

Accumulation of the wastes

- **A total of 580,000 drums (200-liter drum equiv in fiscal 2011.) from 2,400 different sources since the 1950s.**
- **JAEA has more than 60% of them.**

Issues on backend activities

- **No organization had been assigned a role of waste disposal and repository operation.**
- **Many waste storage facilities are approaching their limit.**
- **The issues will affect R&D facility operations.**
- **It is difficult to promote nuclear facility**

Many wastes have been stored in storage facilities.

Aged facilities cannot be decommissioned.

Disposal of LLW

- **JAEA was assigned an implementing organization for the disposal with the amendment of JAEA Act in 2008.**
- **JAEA is now responsible for siting and constructing a repository.**
- **JAEA is also asked to dispose of the waste from other organizations.**
- **The total project cost is expected to be about 20-Billion-Dollar.**

[Image of repository]

[Rough schedule of waste disposal]

Pre-operaion (8 years)	Operation (50 years or more)

- Siting
- Envir. exam.
- Licensing
- Construction

A total of 530,000 wastes forms for disposal (200-liter drum equivalent) estimated to be generated by 2048.

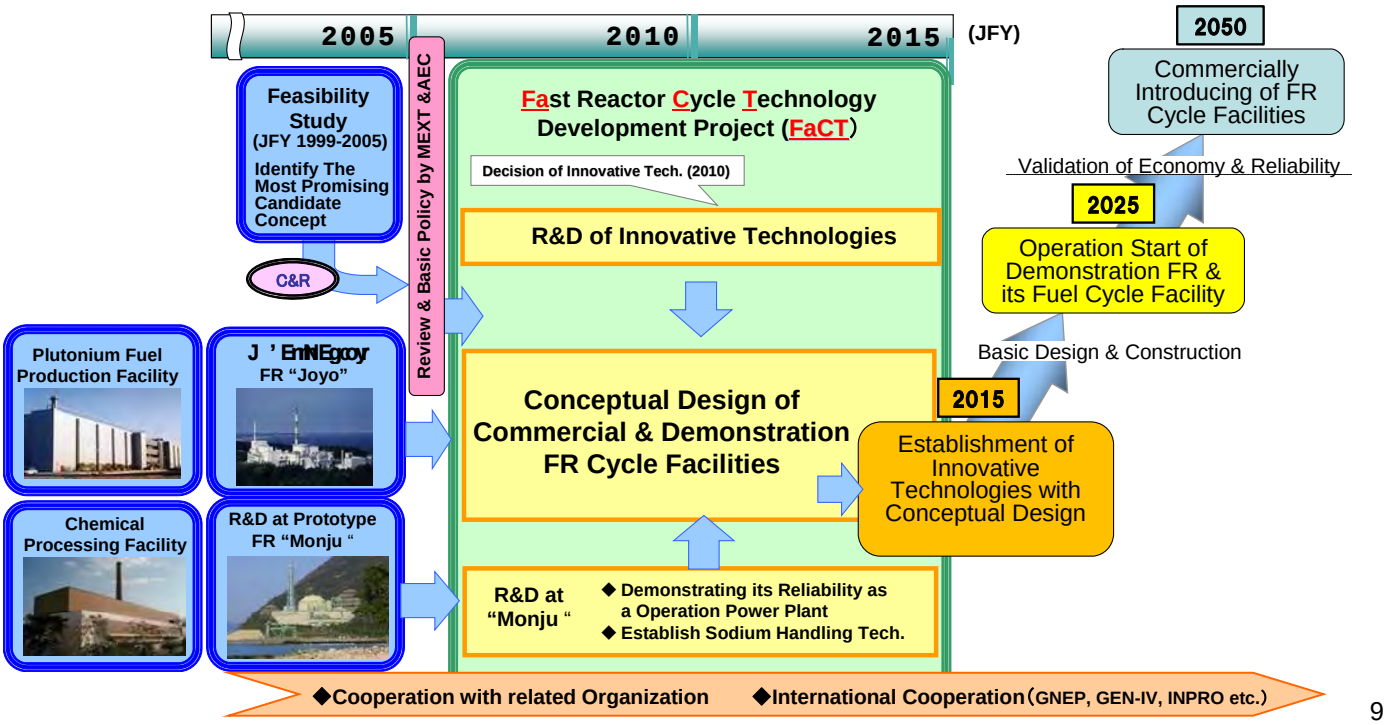
Early implementation of the disposal is demanded in order to promote nuclear R&D and radioisotope utilization.

⑦

Appendix

The Fast Reactor Cycle Technology Development（FaCT) Project

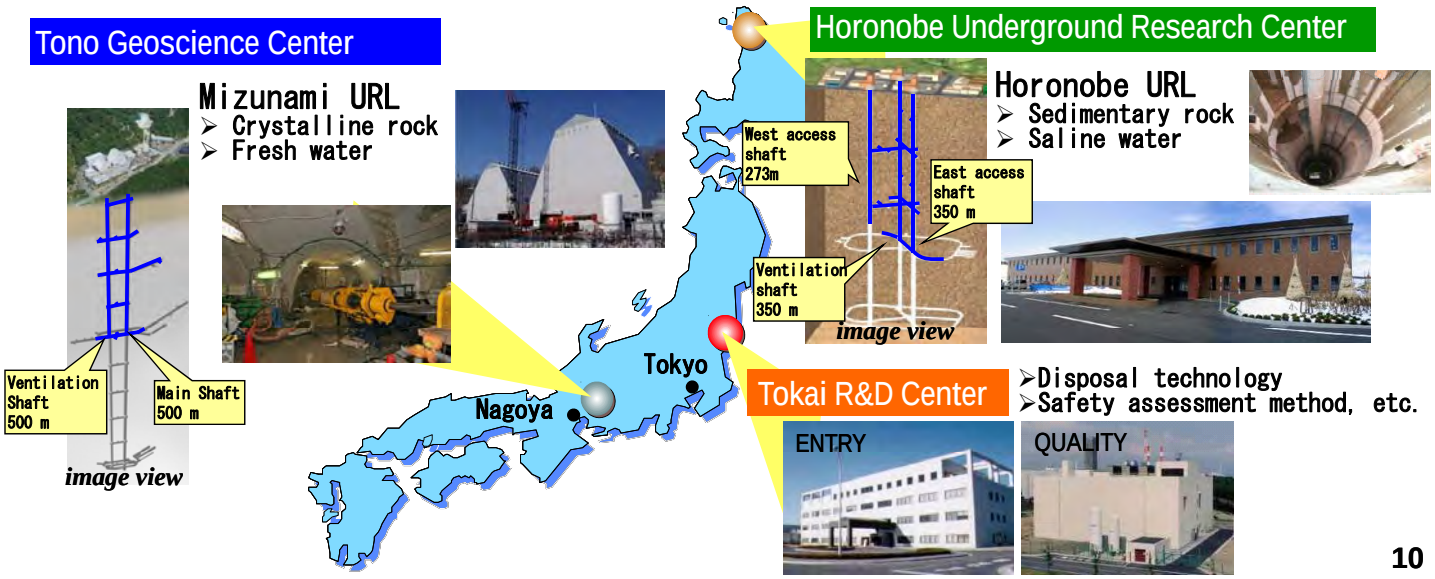
Fast Reactor Cycle Technology Development (FaCT) Project will present conceptual design on demonstration and commercial plants, and an R&D program toward commercialization around 2015. It is also plannd to start operation of demonstration FR around 2025 in order to commercially introduce FR cycle facilities before 2050.



High-Level Radioactive Waste Disposal

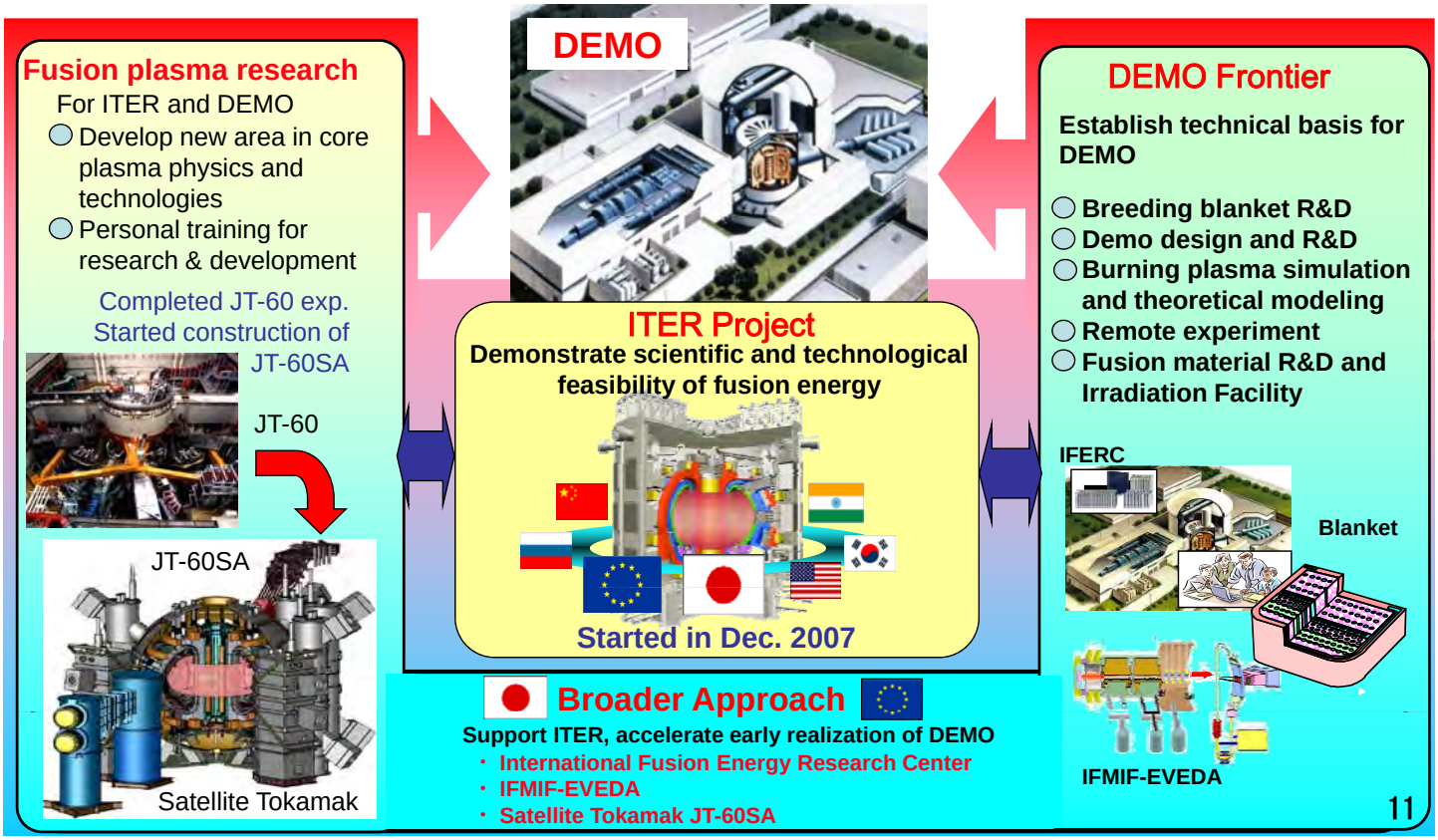
Objective:
- Development of technical basis for supporting the implementation of geological disposal project (by NUMO) and for contributing to safety regulations

Activities:
- Development of integrated methods / techniques for characterizing the deep geological environment and demonstrating their applicabilities
- R&D for engineering technology and safety assessment methods
- Development of technical knowledge base to develop convincing safety case

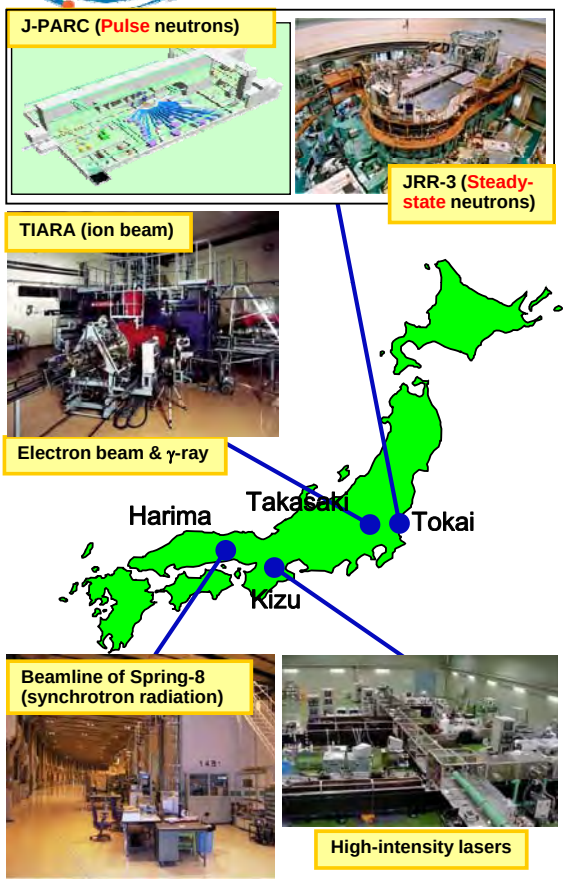


Fusion Energy Research

Aming at realization of a fusion energy system by promoting overall fusion R&D.

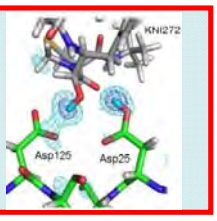


R&D on Quantum Beam Technlogy



Tokai Neutron science with reactor and J-PARC

- Success in determination of whole atom positions in HIV-protease-Towards developing more effective anti-HIV drugs-

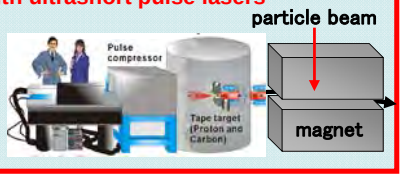


Takasaki Application of ion, electron and γ-ray beams for material- and bio-technology

- Development of highly durable polymer electrolyte membranes most appropriating to residential fuel cell system using radiation-grafting technique.

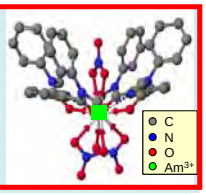
Kansai (Kizu) High field science with ultrashort pulse lasers

- Generation of MeV-class protons with high-intensity lasers
  - ⇒ Development of compact ion-beam cancer therapy instrument

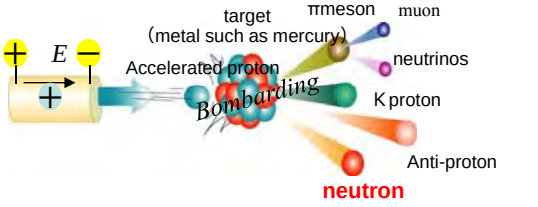


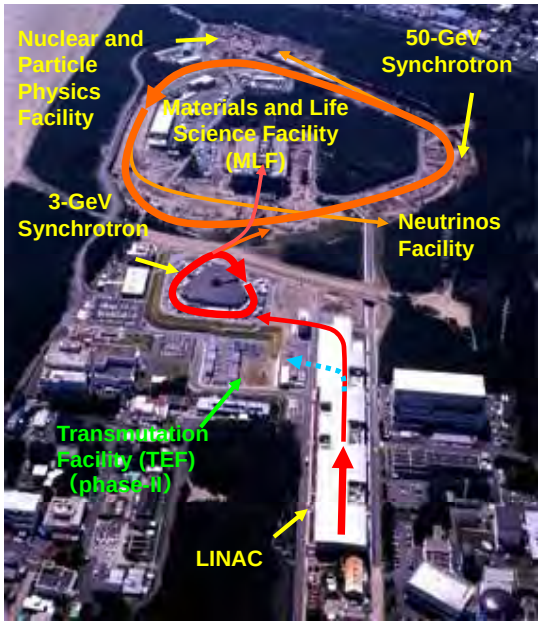
Kansai (Harima) X-ray science with SPring-8

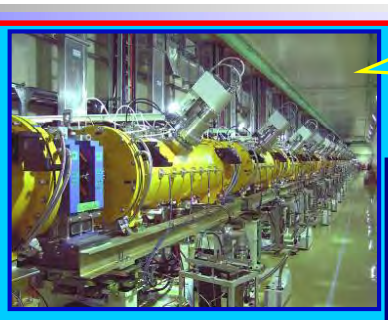
- Development of new separation molecules for simplification of reprocessing of nuclear spent fuel



J-PARC Project (high-intensity proton accelerator)







Linac energy of 181MeV was achieved successfully in January 2007.

The 8 neutron beam-lines are available for experiments.

The 3-GeV synchrotron successfully operated in October 2007.

- Joint project of JAEA and KEK.
- J-PARC has been completed in 2008.

Open and available to domestic and foreign researchers as an international user facility. Estimated annual users over 4,000

MLF has started in common use in Dec. 2008.

The Purpose of the delegation

The Purpose of our delegation

The purpose of delegation is to learn the success case of the safety disposal of depleted uranium and other uranium bearing wastes.

Point-1: We'd like to learn the concept of performance assessment depleted uranium and other uranium bearing wastes because of constructing the regulation regarding them.

Point-2: We'd like to learn the basis of the design and waste acceptance criteria of disposal site because of planning the LLW disposal facility of JAEA that is shown before.

Point-3: We'd like to learn the way of involving local residences or other stakeholders in the decision making about disposal.

Performance Assessment

Point-1: We'd like to learn the concept of performance assessment depleted uranium (that USA is in the ongoing amendment of 10CFR61) and other uranium bearing wastes because of constructing the regulation regarding them.

- We have almost 50 thousands drums that is equivalent 200liter drum, of uranium bearing waste at present corresponding to LLRW in USA and Canada. The average activity is relative low, 10Bq/g in package.
- However, we don't' still prepared the regulations or guidelines of safety disposal of uranium in Japan.
- The reason is the unique characteristics of uranium as followings;
  (1) its growing up of activity came from decay chains
  (2) emission of radon gas of several 10,000 years later
  (3) On the other hand, uranium and radon are are in normal soil.
- We consider to dispose of uranium waste on the same dose limits as other wastes also including radon, even if uranium and radon are natural nuclides.
- For that, we need to know what the required concepts and designs are.

Design and Waste Acceptance Criteria

Point-2: We'd like to learn the basis of the design and WAC of disposal site because of planning the LLW disposal facility of JAEA that is shown before.

- We have to protect the general public from the peak dose of the uranium waste, which will come after 10,000 years
- It is very important to design the disposal site, especially its radon barrier and impermeable barrier.
- Therefore, we have to prepare the precondition optimizing WAC due to attaining the performance objective of general public protection, after the function of those barriers will be lost.
- We'd like to get the information as followings,
  (1) reflection of the performance assessment for 10,000 years in the disposal site design (for example, a zoning, underground depth, cover soil thickness, and radon barrier and impermeable barrier)
  (2) the fundamental view points of a disposal site design, especially radon barrier and impermeable barrier.
  (3) the degradation of a site function assumed in 10,000 years.
  (4) the criteria necessary for uranium waste only, especially impurities of uranium recovered from spent fuels.
  (5) the dose assessment reflected in a design when it exceeds 10,000 years and even if a disposal site deteriorates completely.

Involving Stakeholders

Point-3: We'd like to learn the way of involving local residences or other stakeholders in the decision making about disposal.

- **We have to explain to local residents and other stakeholders about the safety disposal with location concerning specific approach of uranium, the half-life of the uranium and radon emanation.**
- **The radon influence from natural soil is about 1 mSv/y that is 100 times of performance objective in Japan, 10microSv/y.**
- **We think it is important to give suitable explanation of the technical information about safe uranium disposal, and to grasp what to think, what to be important and want to discuss.**
- **We'd like to learn how to explain plainly safety disposal of uranium waste within these characteristics peculiar to uranium.**
- **We'd like to know what is for local-residents and stakeholders to worry about problems of a uranium bearing waste disposal site, for example, location, closing, and environmental recovery, and to desire of these explanation.**

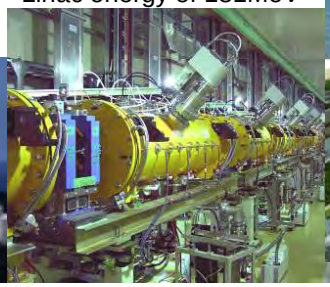
Future Plan

- We have a plan to collect the newest information of the concept of performance assessment and the design of disposal site regarding depleted uranium and other uranium bearing waste in this year. We will visit Canada, USA, France, UK, etc. in this year.
- We will be considering the concept of uranium disposal in next year on the base of these information .
- After that, we will propose the way of thinking of uranium disposal rule in Japan.

Prototype fast breeder Monju,

Experimental fast breeder Joyo

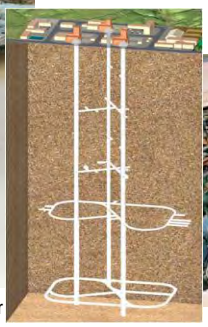
Linac energy of 181MeV



J-PARC

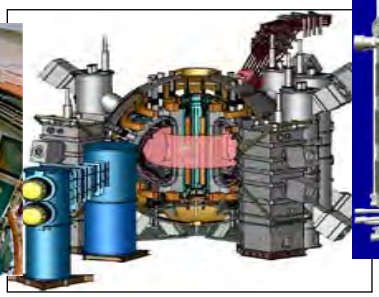
Thank you for your attention

Tono Geoscience Center

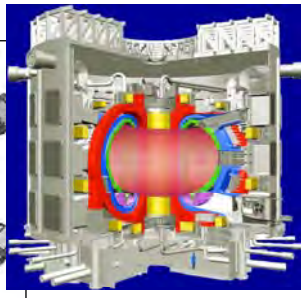


Horonobe Underground Research Center

JRR-3 (Steady-state neutrons)



Satellite Tokamak



Iter

Safety Assessment Method for Near Surface Disposal of Uranium Waste

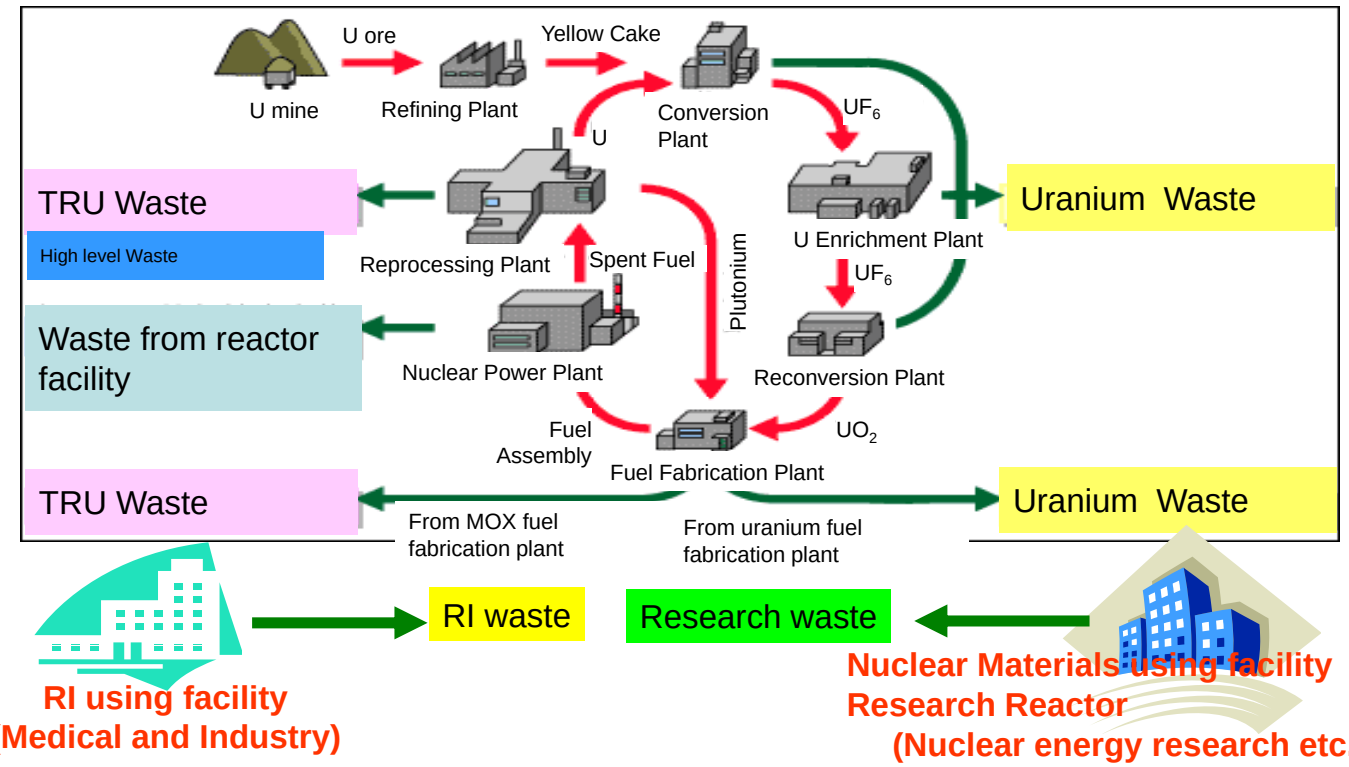
March 2013

Akihiro Sakai
Low-level Radioactive Waste Disposal Project Center
Japan Atomic Energy Agency

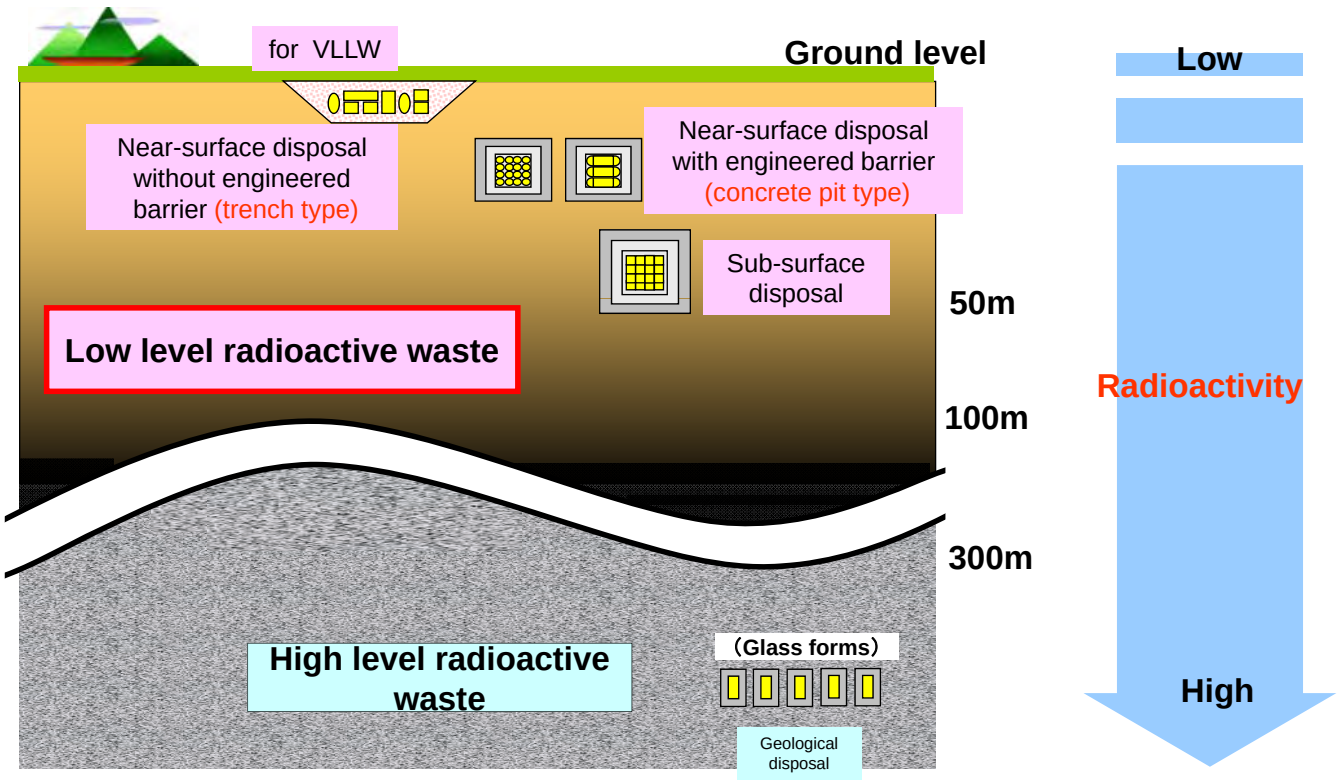
Contents

- ✓Current framework of disposal of LLW in Japan
- ✓Current proposal method for near surface disposal of uranium waste with the low level of activity concentration in Japan

Nuclear Fuel Cycle and Radioactive Waste in Japan



Disposal Concept of Radioactive Waste in Japan



Disposal Business of Low-level Radioactive Waste in JAEA

JAEA is promoting the disposal of LLW generated from the R&D of the nuclear energy / medical and industrial use of radioisotope in Japan.

Background

Accumulation of the wastes

- A total of 580,000 drums (200-liter drum equiv in fiscal 2011.) from 2,400 different sources since the 1950s.
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Issues on backend activities

- No organization had been assigned a role of waste disposal and repository operation.
- Many waste storage facilities are approaching their limit.
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Many wastes have been stored in storage facilities.

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- JAEA is now responsible for siting and constructing a repository.
- JAEA is also asked to dispose of the waste from other organizations.
- The total project cost is expected to be about 20-Billion-Dollar.

[Image of repository]

[Rough schedule of waste disposal]

Pre-operaion (8 years)	Operation (50 years or more)

- Siting
- Envir. exam.
- Licensing
- Construction

A total of 530,000 wastes forms for disposal (200-liter drum equivalent) estimated to be generated by 2048.

Early implementation of the disposal is demanded in order to promote nuclear R&D and radioisotope utilization.

Outline of Implementer of Disposal Business In Japan

Radioactive Waste	Disposal Concept	Sources of Radioactive Waste: Commercial Nuclear Power Plant etc.	Nuclear Energy Research etc.	Medical and Industry
Low level waste	Near-surface disposal	Japan Nuclear Fuel Limited (established as Japan Nuclear Fuel Industry Limited in 1985)	Japan Atomic Energy Agency (JAEA was assigned implementing organization for the disposal with the amendment of JAEA Act in 2008.)	
	Sub-surface disposal	**LLW from operation/ decommissioning of commercial NPP and related plants**	**LLW from JAEA, other nuclear energy research institutes, medical institution and other user of radioisotope**	
	Geological disposal	TRU waste which are by-products from reprocessing process of spent fuel and MOX fabrication process etc.		
High level waste		Nuclear Waste Management Organization of Japan (established in 2000)		
		High level waste generating from reprocessing process of spent nuclear fuel		

Status of preparing safety regulation for disposal

Radioactive Waste			Disposal method	Safety reviewer guideline	Legislation etc. on safety regulations
High-level radioactive waste			Geological disposal	Future discussion	Published
Low- level radioactive waste	TRU waste		Geological disposal,	Future discussion	Partially Published
			Sub-surface disposal, Near surface disposal	Partially Completed	
	Waste from nuclear reactor	Waste of Core Structures etc. (Relatively higher radioactive concentration)	Sub-surface disposal	Completed	Published
		LLW / VLLW	Near surface disposal with/without engineered barrier	Completed	Published
	Uranium waste		Near surface disposal, etc.	Future discussion	Future discussion
	Waste from research facilities, RI using facilities, etc.		Near surface disposal, etc.	Partially Completed	Partially Published

The waste included in JAEA disposal project

The waste generated from JAEA's facilities

The waste generated from research and demonstration reactors

The waste generated from research and demonstration facilities, etc

The waste generated from all facilities

Safety guideline and regulations for disposal of uranium waste have not been prepared yet.

Outline of the Ningyo-toge Environmental Engineering Center, JAEA

March 2013

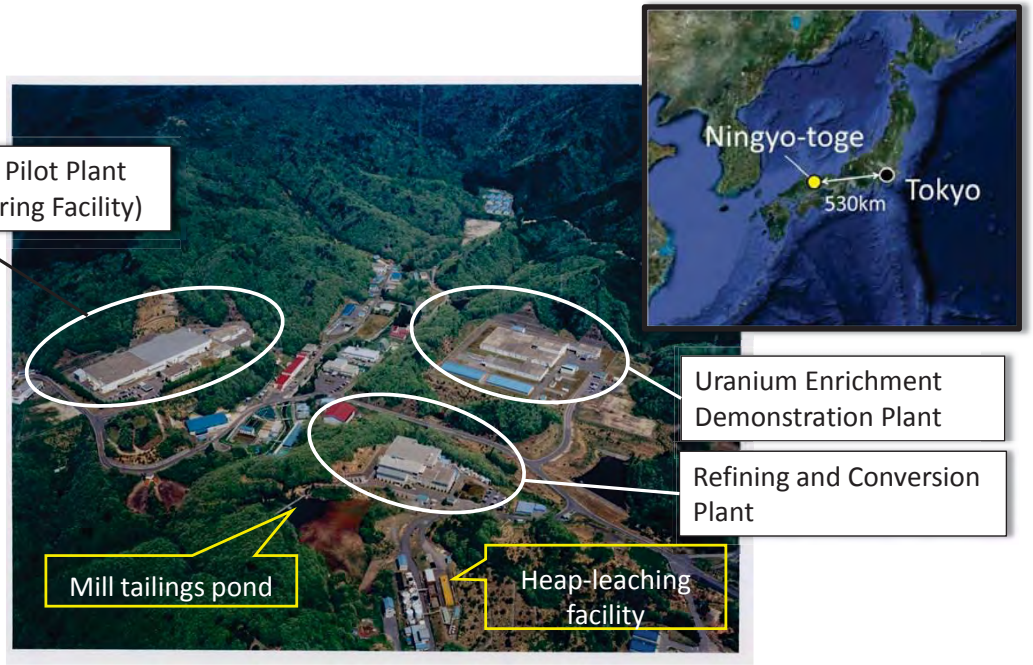
Kazuhiko SATO

Ningyo-toge Environmental Engineering Center,
Japan Atomic Energy Agency

Contents

- Overview of Ningyo-toge Environmental Engineering Center
- On-going projects at the center
- Issues on disposal of uranium-bearing waste

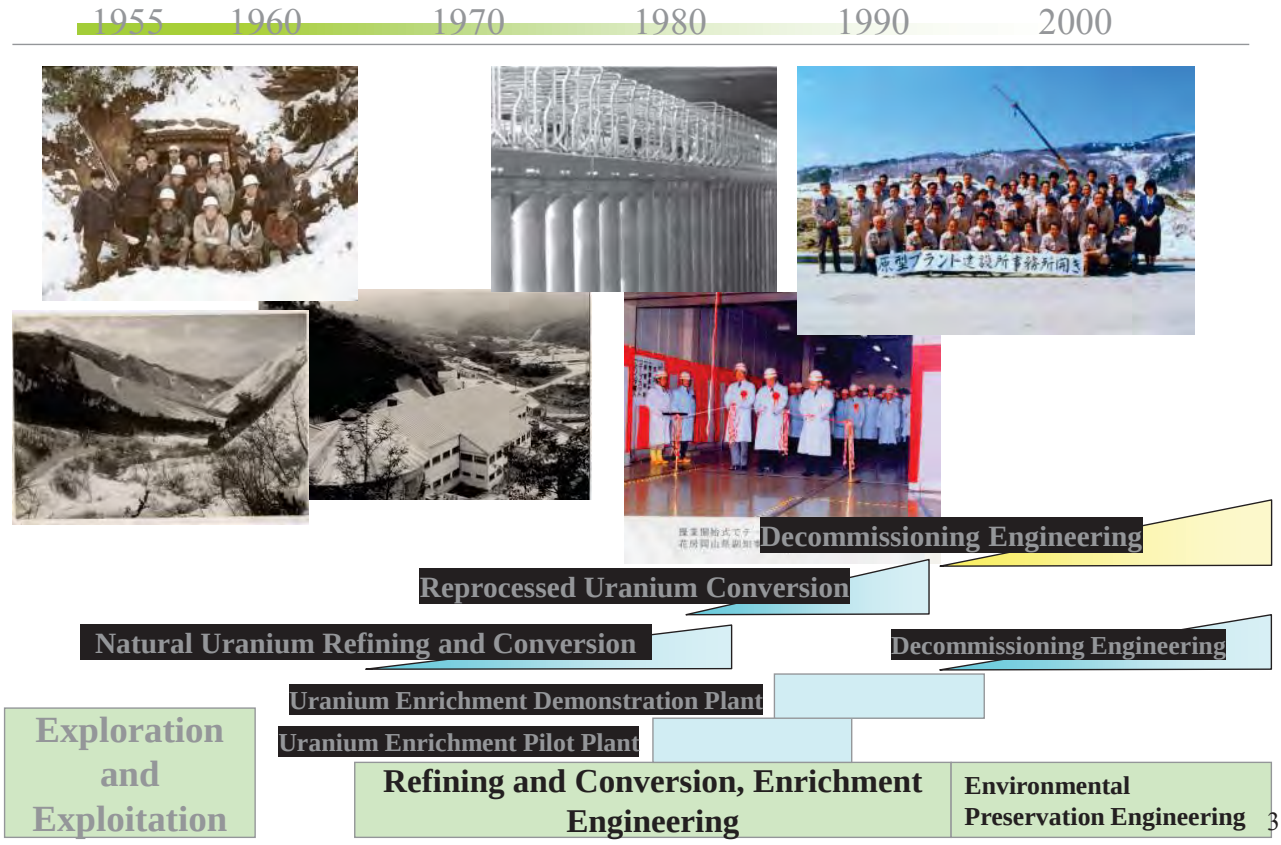
Locality and Major Facilities



Site area is 1.2million m^2. Number of Nuclear fuel cycle facility is 31 in all.

The main facility are refining and conversion plant, uranium enrichment plant and milling facility.

History



Progress at Ningyo-toge

Mining and milling

•Established uranium exploration technology and support domestic and overseas exploration

•Technological Support for engineers from foreign countries

Enrichment

•Accomplish non-stop operation for 13 years

•Produced about 350tU of enriched uranium

•Established cascade technology, plant operation engineering

(System technology, UF_6 recovery, maintenance , Quality Assurance)

•Technology transfer to JNFL (Rokkasho, Aomori)

Conversion

•Established natural uranium conversion technology (produced about 385tU by PNC process)

•Established reprocessed uranium conversion technology (produced about 340tU of UF_6)

•Demonstrate reprocessed uranium conversion process

Major On-going Projects

1. Environmental reclamation

Reclamation of mill tailings pond

2. Decommissioning of nuclear facilities

2-1. Dismantling

Uranium Refining and Conversion Plant

Uranium Enrichment Demonstration Plant

2-2. Decontamination

Decontamination of used Gas Centrifuge Facility for Clearance

2-3. R&D for Disposal

Characteristic of radioactive

Basic experiment of uranium-bearing sludge for waste treatment

Environmental Reclamation

Current Status

- **Sediment**
  - Sludge from former milling facility
  - Precipitate from water treatment facility
- **Capacity/Volume**
  - Approved volume : approx.40,000m^3
  - Current volume : approx.85% filled
- **Radionuclides' concentration rate**
  - ^{238}U : 3.0Bq/g
  - ^{226}Ra : 16Bq/g

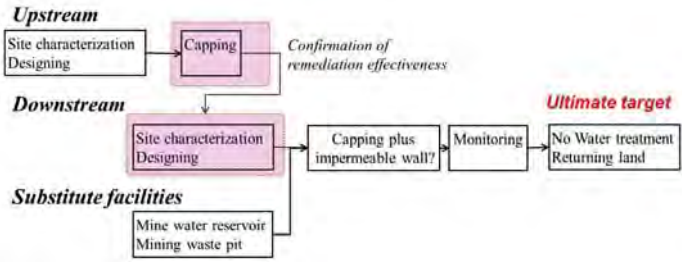
- **Stability / current role**

Concrete dam
- Enough seismic resistance strength

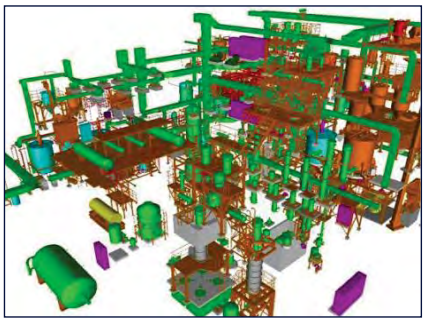
Downstream
- Submerged
- Composed of fine-grained material
- Still used to
  - Impound mine water as a buffer reservoir
  - Deposit mining waste

Upstream
- Dried / Stable

Reclamation Strategy
- **Two-step strategy (Upstream --> Downstream)**
- **Experience/data used for Downstream**
- **Capping to reduce radon emanation & gamma radiation**
  minimize water infiltration
  use natural material only
- **Substitute facilities before Downstream measure**



Decommissioning Status of Major Facilities

Uranium Enrichment Demonstration Plant	Enrichment Engineering Facility	Refinement & Conversion Facility
		
○Development of Residual Uranium Recovery by IF_7 Gas - finished DOP-2 processing - preparing for DOP-1 processing : negotiation between officials	○Centrifuge Dismantling & Decontamination Test ○Developing validation method for Clearance ○Refillment Enriched UF_6 to Transport-licensed cylinder for delivery	○Dismantling Process Equipments, towers / vessels / piping etc.

Issues on Disposal of Uranium-bearing Waste

- Character of uranium-bearing waste:
  - long-lived waste,
  - build-up of uranium progeny,
  - radiation protection from radon inhalation exposure,
  - relationship among safety regulations of various uranium-utilize facilities
    e.g. nuclear fuel facility, nuclear source material facility, uranium mill, non-nuclear facility (NORM)
- Object to be disposed:
  - waste generated from nuclear fuel facility,
  - waste generated from nuclear source material facility,
  - depleted uranium
- Management system (disposal system):
  - facility type (trench/ pit/ subsurface/ deep-geology),
  - stepwise control (period of institutional control),
  - institutional control (active/passive),
  - future land use,
  - long-term storage, disposal of exempt waste

Note: Underline indicates our concerns what we would like to ask and discuss.
Current consideration for some of the items is described in the presentation "Safety Assessment for Near Surface Disposal of Uranium Waste" by Low-level Radioactive Waste Disposal Project Center.

Issues on Disposal of Uranium-bearing Waste

- Guideline for safety assessment:
  - long-term assessment scenario,
  - assessment scenario for radon inhalation exposure after a long-term period of time,
  - assessment criteria
- Waste acceptance criteria:
  - waste form,
  - chemical form,
  - radioactivity (concentration/total activity)
- Designing of disposal facility:
  - radon barrier,
  - impermeable liner,
  - waste arrangement in a disposal cell
- Stakeholder involvement

Note: Underline indicates our concerns what we would like to ask and discuss.
Current consideration for some of the items is described in the presentation "Safety Assessment for Near Surface Disposal of Uranium Waste" by Low-level Radioactive Waste Disposal Project Center.

Summary

- On-going projects
  - Reclamation project of former uranium mining facilities
  - Decommissioning projects
    - Uranium enrichment facilities
    - Refining and conversion facility
- Ningyo-toge Environmental Engineering Center, JAEA is one of the major operators that generates uranium-bearing waste in Japan.
  - Various types of uranium-bearing waste have been and will be generated from several types of nuclear facilities.

- Our concern
  - establishing the waste management system which accepts all of the uranium-bearing waste.

参考資料 3-1

カナダ（CNSC、PHAI/AECL 及び Cameco）への質問事項と回答内容※注 1

CNSC への質問※注 2

1. ウラン廃棄物処分の安全評価について

1-1　長期評価シナリオ

Q1-1-1：性能評価シナリオの作り方についての要件と実施例等の解説について説明してくれないか？

A：　2006 年に発行した CNSC のガイドライン（Regulatory Guide G-320）に準拠していないが、PHAI では、地下水移行シナリオと人間侵入シナリオの評価を行っている。G-320 では FEP 分析の結果、設定することになっている。

Q1-1-2：覆土の劣化による廃棄物露出や、侵入者と廃棄物の直接接触は想定するか？

A：機能不全に係るシナリオとして評価される人間侵入シナリオでは、掘り返しによる廃棄物との接触が考慮されている。

Q1-1-3：処分場不透水性バリアで、長期評価時に劣化は考慮されるか？もし、考慮されるなら、粘土層等の材料の透水性の経時的な変化をどのように取り入れているか？また、compliance period を超える期間については、どうか？

A：地下水移行シナリオのケーススタディとして、ライニング及びドレン（集水設備）の機能不全が考慮されている。ライニングの耐久性は、Landfill のガイドラインで求められている耐久性（150 年及び 350 年がある）を参考としている。

Q1-1-4 : 安全評価/性能評価における超長期評価の要件とシナリオの要件・事例を説明していただけないか？

A：設備の機能不全を検討し、評価対象となるシナリオを選定している。

Q1-1-5 : バリア機能喪失後の安全評価/性能評価は、公衆防護のための処分場設計を最適化できるのか？

A：バリア機能喪失は、地下水移行シナリオで検討している。評価基準として、健康上課題となる物質に対してオンタリオ州の地下水基準及び飲料水基準を適用している（Ra-226 は線量基準）。結果として、防護は図られている（2011 年にオンタリオ州の基準が改定されているが、遜色ないものとの認識）。

Q1-1-6：侵入者保護の長期評価時に、サイト内ウランの地下水流出による減少分を考慮するか？

A：人間侵入シナリオのソースタームとして、地下水による現象は考慮されない。

Q1-1-7：覆土の厚さを決めている基準は何か？人間侵入と関係があるか？

A：Landfill のガイドラインである。

※注 1：　口頭の回答及び提供頂いた資料から質問の結果を記載している。また、CNSC 及び PHAI/AECL は、同じ会議に出席しているとともに、その際の提出物を相互に理解していることから、CNSC 及び PHAI/AECL への質問では、同じ質問では同じ結果を示している。

※注 2：　Port Hope プロジェクトは、長期管理であることから、超長期の評価は基本的に求められないが、制度的管理の逸失や設備の機能不全を前提としたシナリオ評価が行われている。ここでは、「処分」を「長期管理」と読み替えて、対応する調査結果を示した。

Q1-1-8：　下記の(1)~(3)についてコメントを頂きたい。

(1) 廃棄物に含まれる化学的に有害な物質は、何を想定しているか？

A：Ra-226、ウラン、アンチモニー、ヒ素、コバルト、銅、鉛、ニッケル、ベリリウム、カドミウム、モリブデン、亜鉛

(2) 有害物の環境への影響評価の基準は？地下水中の濃度か　？

A：オンタリオ州の地下水基準及び飲用水基準

(3) 評価期間の規定はあるか？もしあれば、何故その期間に決めたのか説明した文献はあるか。／もし無ければ実用上の評価例はあるか。

A：ピークが検出されるまであるいは 1 万年まで。ただし、G-320 ではピークが検出されるまでとしている。

1-2　ラドン評価シナリオ

Q1-2-1：米国/カナダにおけるラドンからの線量の評価方法はどのようか？

A : 廃棄物もしくはさらに土壌から大気中に散逸したラドンガスを吸入する。もしくは、さらに、屋内に侵入（大気中ラドン濃度に同じ）したラドンガスを吸入する。パラメータは、Port Hope Environmental Assessment Study Report に示されている。

Q1-2-2：ウラン製錬鉱さい、NORM の安全評価の方法は、LLW と異なるのか？異なる場合はその違いについて教えてほしい。

A：カテゴリーが異なる。

2　ウラン廃棄物処分場の設計、受入条件について

2-1　遮水及びラドンバリア (Impermeable burrier and radon barrier)

Q2-2-1：ラドンバリアやカバー（覆土）の性能、仕様、要件及び継時的な劣化についての規制、指針等があれば説明していただけないか？

A : Landfill ガイドラインを参考としている。ラドン評価は、設計されたものからの散逸率がバックグランドと比較して遜色ないかで判断される。

Q2-2-2：遮水バリアの設計、基準、評価及び継時的劣化について説明していただけないか？

A : Landfill のガイドラインを参考としている。また、ジオメンブレンは、加速試験の標準がある。

3-2 モニタリング・管理期間終了要件／終了時期

Q3-2-1：サイトの閉鎖後（管理期間終了後）の利用の考え方は？

A：LTWMF の跡地をレクリエーション施設とすることが地域住民の希望。

PHAI/AECL への質問※注3

1. ウラン廃棄物処分の安全評価について

1-1　長期評価シナリオ

Q1-1-1：性能評価シナリオの作り方についての要件と実施例等の解説について説明してくれないか？

A：2006 年に発行した CNSC のガイドライン（Regulatory Guide G-320）に準拠していないが、PHAI では、地下水移行シナリオと人間侵入シナリオの評価を行っている。G-320 では FEP 分析の結果、設定することになっている。

Q1-1-2：侵入者保護の長期評価時に、サイト内ウランの地下水流出による減少分を考慮するか？

A：人間侵入シナリオのソースタームとして、地下水による現象は考慮されない。

Q1-1-3：評価期間/性能保証期間を過ぎた後の有害物影響について、どう考えるか？地元説明を行った資料を見せてもらえないか？

A：地下水移行シナリオを管理期間以降も評価している（最大 5 千万年）。説明は Port Hope Environmental Assessment Stud report に示されている。

1-2　ラドン評価シナリオ

Q1-2-1：米国/カナダにおけるラドンからの線量の評価方法はどのようか？

A：廃棄物もしくはさらに土壌から大気中に散逸したラドンガスを吸入する。もしくは、さらに、屋内に侵入（大気中ラドン濃度に同じ）したラドンガスを吸入する。パラメータは、Port Hope Environmental Assessment Study Report に示されている。

Q1-2-2：カナダではウラン製錬鉱さいや NORM の安全評価の方法は、LLW と異なるのか？異なる場合はその違いについて教えてほしい。

A：カテゴリーが異なる。

2　ウラン廃棄物処分場の設計、受入条件について

2-1　遮水及びラドンバリア

Q2-1-1：ラドンバリアやカバー（覆土）の性能、仕様、要件及び継時的な劣化についての規制、指針等があれば説明していただけないか？

A：Landfill ガイドラインを参考としている。ラドン評価は、設計されたものからの散逸率がバックグランドと比較して遜色ないかで判断される。

Q2-1-2：遮水バリアの設計、基準、評価及び継時的劣化について説明していただけないか？

A：Landfill のガイドラインを参考としている。また、ジオメンブレンは、加速試験の標準がある。

2-2　廃棄物の受け入れ、配置

Q2-2-1：処分場における廃棄物を配置する決め方と、配置ごとの濃度等の制限はあるか？

A：相対的に濃度の高い廃棄物（LLRW）を下層に、低い廃棄物（汚染土壌等）を上層に配置している。直接被ばく及び人間侵入に対する対抗性を考慮している。

※注 3：Port Hope プロジェクトは、長期管理であることから、超長期の評価は基本的に求められないが、制度的管理の逸失や設備の機能不全を前提としたシナリオ評価が行われている。ここでは、「処分」を「長期管理」と読み替えて、対応する調査結果を示した。

Q2-2-2：種別の異なる廃棄物の安全評価は個別に行うのか？

A：埋設対象物は、全て歴史廃棄物に区分されている。

Q2-2-3：処分されるラジウム/ウラン鉱さい、劣化ウラン及びそれ以外のウラン含有廃棄物の容積と放射能量はいくらか？

A： Port Hope Environmental Assessment Study Report に示されている。

Q2-2-4：劣化ウランに含まれる Tc-99 等の不純物が処分シナリオ上の決定経路に関与する事があると聞く。それらウランの不純物についての受入条件はあるか？

A：Port Hope で扱われた原料は天然ウランであるため、T-99 等の不純物に係る課題は関係ない。

Q2-2-5：ウランに伴う Tc-99 等の不純物核種について、処分場での配置や埋設深度での制約はあるか？

A：対象外。

Q2-2-6：有害物の環境影響評価について、要件と基準値を教えていただけないか？

A：オンタリオ州の地下水基準及び飲用水基準に示されている。

3 その他

3-1 モニタリング

Q3-1-1： ウラン廃棄物に起因したモニタリング項目、頻度、期間等は何に基づいているか（法令、地元との協定など）？

A：空気中ラドン濃度、土壌中ウラン濃度をモニタリングする。頻度は、当初は頻繁に、やがて、5 年、10 年、20 年と、やがて間を置いていく。

Q3-1-2：ウラン廃棄物を含む LLRW サイトの事業者による管理期間の長さと終了要件を説明していただけないか？

A：管理期間として 500 年。地元との協議により決定された。

Q3-1-3：ラドン被ばくについて、地元地域は関心を寄せているか？それにどのように対処しているか？

A：ない。ラドンよりも不動産価値の下落である。

Q3-1-4：

(1)サイトの閉鎖後（管理期間終了後）の利用の考え方は？

A：レクリエーション施設。

(2）その決定方法（決定プロセス）は？

A：Screening Report 作成などにおいて、地域との協議を行い、また、意見交換を行っている。

(3）地域が関与するステップとその内容について例示していただきたい。

A：Screening Report、環境影響評価、ライセンス申請書に対して、ドラフトに係るワークショップ、意見公募が行われる。また、説明資料やニュースレターの配布、説明会、ワークショップ、Citizen Liaison Group との意見交換などにより、常に地域住民とコンタクトして要望を確認している。

3-2　その他

Q3-2-1：カナダにおいては、汚染の除去（Clean up）及び処分施設（LTWMF）に関連して、法的な要求項目として何があり、地域からの要望によりそれ以外に実施したものとして何があるか？

A：常に地域住民とコンタクトして要望を確認している。

Q3-2-2：地域の関与に係る仕組みとしてどの様なものがあるか？そして、地域の関心事はどこにあるか？とその効果は？（評価がなされていたら教えていただきたい）

A：パンフレット、ニュースレター及び年次報告書等の情報提供、ワークショップ及び Project Information Exchange の開催、Citizen Liaison Group からの意見聴取、環境影響評価及び実施計画策定での意見公募等を行っている。

Q3-2-3：サイト周辺のコミュニティの関心事はどの様なものか？

A：風評による不動産の下落。これに対して、補償制度を設けている。

Cameco への質問

1 ウラン廃棄物処分の経験について

Q1-1：核燃料サイクル施設から発生したウラン廃棄物の産廃処分事例はあるか？

A：カナダ国内での産廃処分事例はないが、米国の規制免除（U： 500ppm）を適用してアイダホ州（US Ecology）での有害廃棄物処分場での処分実績はある。例外として、軍事用タンク（>500ppmU）のものも US Ecology で処分したケースもある。金属廃棄物のリサイクルも行っている。ドラム缶の角を切り落として、無制限リリースしている。基準は、0.4Bq/cm2（α）である。

2　ウラン廃棄物処分場の設計、受入条件について

Q2-1：劣化ウランに含まれる Tc-99 等の不純物が処分シナリオ上の決定経路に関与する事があると聞く。それらウランの不純物についての受入条件はあるか？

A：転換原料は天然ウランを用いているため、T-99 等の不純物に係る課題はない。

Q2-2：これまで貯蔵されてきた劣化ウランやフッ化マグネシウムスラグを LTWMF で処分する計画と聞く。どのように処分前コンディショニングを行うのか？また、どのような廃棄物形態なのか？

A：PHAI の LTWMF に受け入れ可能な廃棄物は、1988 年以前に発生した廃棄物とその当時稼働していた施設の解体物である。これらは、LLRW の歴史廃棄物（historical waste）に区分される。劣化ウランは米国に売却したため、処分する対象にない。今後も発生量が少ないため、課題とならない。歴史廃棄物に区分されるフッ化マグネシウムの一部は、ドラム缶に詰めるだけで前処理なしで受け入れられる。バルク廃棄物との扱いである。

3 その他

3-1 モニタリング

Q3-1-1：以下の（1）～（4）についてコメントを頂きたい。

(1)ウラン原料、製品及び廃棄物の取扱い起因したモニタリング項目、頻度、期間等は何に基づいているか（法令、地元との協定など）？

A：（特定の回答なし。）

(2)ラドンのモニタリング項目は、フラックスあるいは濃度として測定しているのか？

A：Cameco は PHAI と異なり、転換施設を除いて、ラドンのモニタリングは行っていない。

更問：Cameco の廃棄物を受け入れた US Ecology 社の有害廃棄物処分場ではラドンのモニタリングは行っているのか？

A：分からない。

(3)公表の仕方は？

A：ウェブサイトで結果を示している。

(4)モニタリングの項目・方法等を決定するにあたって、地域の関与はどの様なステップでなされたのか？

A（特定の回答なし。）

Q3-1-2：ラドン被ばくについて、地元地域は関心を寄せているか？それにどのように対処しているか？

A：PHAI のようにラドンのモニタリングは行っていない。地域住民はウランやラドンへの関心より、化学物質であるフッ素を気にかけている。

3-2　その他

Q3-2-1：カナダでは劣化ウラン管理はどの様な方針なのか？

A：Cameco においては、劣化ウランは米国に送っている。

Q3-2-2：地域の関与に係る仕組みとしてどの様なものがあるか？そして、地域の関心事はどこにあるか？とその効果は？（評価がなされていたら教えていただきたい）

A：地域の関与に係る特定の回答はなし。長寿命廃棄物への関心は強くない。地域の関心事は、転換施設に隣接する港をレクリエーション施設に活用すること。現在は、地域のヨットクラブがあるが、PHAI の Port Hope プロジェクトの一環で港の底質を浚渫し、一般開放されることを希望している。Cameco の事業に対する市民の評価を理解するために、パブリックサーベイを行っている。

Q3-2-3：サイト周辺のコミュニティの関心事はどの様なものか？

A（上記回答に含まれる）

Q3-2-4：サイト近隣のコミュニティとの接し方で、どの様な点に注意すべきか？

A：透明性、疑問に対して誠実に答えること、定期的に市民と顔を合わせることである。

Q3-2-5：カナダにおいては、汚染の除去（Clean up）及び処分施設（LTWMF）に関連して、法的な要求項目として何があり、地域からの要望によりそれ以外に実施したものとして何があるか？

A：法的要求として、環境影響調査報告書及び実施計画書に対して、ドラフトの段階から意見公募を行い、反映することがある。これらの文書を作成し規制側へ申請した後、更に規制サイドでの意見公募がなされ、その反映も求められる。

Q3-2-6：閉鎖後のサイト移管の手続きについて説明していただけないか？

A：移管手続きについても示された詳細な廃止措置計画の提出が求められるが、Cameco は現在そのステージにない。

Q3-2-7：廃止後に係る地域の注目点は？（サイト利用計画等）

A：化学物質取扱施設の解体が重要であろう。課題はウランではなく、化学物質にあう。特に、フッ素はキーになる課題である。

追加 Q3-2-8：市民団体の活動はあるか？また、福島原発事故の事業への影響はあるか？

A：活動家はグリーンピースのように、より活動的であり、洗練されてきている。福島原発事故以前の状況としては、ある活動家が「安全ではない」と言って回ったが、市民は反応しなかった。事故以降においては、オーストラリアの有名な活動家が滞在し、「ここから引っ越すべきだ」とキャンペーンを張った。しかしながら、パブリックサーベイの結果は、事故前 83-84%、事故後 85-88%の割合で廃棄物は重要でないとみなしている。これは、PHAI によりこの地域の廃棄物の対策が打たれることを理解していることの反映であると考えている。

参考資料 3-2

WCS 社への質問事項と回答内容※注 4

1.　性能評価について

Q1-1：1 万年以降の性能評価において、ウランの子孫核種の生成による放射能の増加を考慮したか？

A：1 万年以降の評価を行っているのは地下水シナリオに相当する井戸水経路だけである。井戸水経路の評価では、子孫核種の生成を評価できるモデルであるが、ウランの子孫核種に関する線量の値は 0 となっている。人間侵入シナリオにおけるボーリングによる外部被ばく経路及び放射性ガス吸入経路では、ウラン（U-238）の子孫核種の生成は、Th-234,Pa-234m のみ考慮されている。

Q1-2：1 万年以降の性能評価シナリオで地形や気候の変化を考慮しているか？その結果、覆土の厚さの減少や地下水流速の変化を考慮しているか？

A：気候の変化による浸透水量の変化を想定している(降雨量が 20inch/year の 2 倍)とのこと。（TCEQ より）

安全評価書では通常の条件は、降雨量が 16 inch/y(≒0.4m/y。日本は 1.8m/y 程度）の計算条件である。パラメータの分布を考慮した感度解析では、29 inch/y の降雨量による計算を実施。

覆土の侵食は通常の条件では想定していない。感度解析で覆土の侵食を想定した解析を実施。（1.2×10^{-5}m/y=0.012mm/y）

Q1-3：人間侵入シナリオが発生するまでの評価期間中において、設定している線源は廃棄物中の核種の減衰と地下水による環境への移行を考慮しているか

A：劣化ウランなどの評価の場合は、地下水による環境への移行を想定することが考えられるが詳細はこれからであるとのこと。（TCEQ より）

安全評価報告書では、制度的管理期間終了後時点（100 年後）での評価を実施し、長期における評価は実施していない。そのため、地下水による環境への移行は考慮されていない。

Q1-4：処分場の透水性バリアの経時的な劣化は考慮しているか

A：透水性バリアは、粘土、砂等の天然の材料の機能を評価している。（不飽和層（1.26E-3m/y = 4.0E-11m/s)、飽和層（0.02m/y = 6.0E-10 m/s）など。）経時的な変化は考慮されていない。パラメータの分布を考慮した感度解析で 4.0E-11m/s→2.4E-10m/s に低下した（測定試験の 95%の値）際の感度解析を実施している。

※注 4：口頭の回答及び安全評価書等資料から質問の結果を記載している。

2.　ラドンからの線量評価について

Q2-1：ラドンガスの評価基準は、線量か、又は散逸率か？

A：線量で評価している。

ただし、ウラン鉱さい（11.e(2))の処分場では、線量基準ではなく、EPA による 40CFR part192 に定められた処分エリアにの地表面における平均フラックスが 0.74 Bq/m^2/s より低いことを基準としている。この基準は、DOE Order 435.1 に定められ、DOE の LLRW サイトにも適用されている。

Q2-2：吸入線量の場合、他の核種と合計するか？

A：合計し、トータルで 0.25mSv/y であることを確認されている。

Q2-3：ウランの崩壊連鎖から生成するラドンを評価しているか？

A：評価されていない。ラジウムから生成するラドンが評価されている。

Q2-4：人間侵入シナリオにおける長期評価において、ラドンバリアの性能や覆土の厚さの経時的な変化を考慮しているか？

A：人間侵入の長期評価は実施されていない。

Q2-5：日本では、IAEA の天然核種の免除レベル（1Bq/g）以下の濃度であれば、廃棄物処分場でのラドン評価を免除する措置を取り入れようとしている。貴社では、IAEA の天然核種の免除レベルを受け入れ基準や性能評価に取り入れている点はあるか？

A：RCRA 廃棄物は、10CFR part40 の Source material の考え方に従って免除レベルが決められており、IAEA の免除レベルは採用されていない。

3.　廃棄物の種類毎の性能評価について

Q3-1：FWF、CWF では、放射能濃度の低いウラン含有廃棄物はその他の Class A 廃棄物と廃棄物セルを区別しているか？他の LLRW と区別していない場合、性能評価では、ウラン廃棄物と他の廃棄物の混合物をソースタームとして扱っているか。

A：CWF 施設では、ウラン廃棄物の受け入れが想定されておらず、FWF 施設は操業されていないため、ウラン廃棄物の受入の実績がないと考えられる。安全評価におけるソースタームは、井戸水経路では、混合物として扱われているが、ボーリングによる外部被ばく経路では、それぞれの施設における廃棄物の平均放射能濃度を用いて、それぞれの濃度について行われ、最も高い値を施設の評価結果としている。

Q3-2：性能評価においては、ウランについて埋設施設全体の平均放射能濃度を計算条件として用いているか。もし設定しているなら、施設全体の平均放射能濃度は以下のどの方法で算出しているのか、

(1)　処分場全体の「敷地境界までの体積」中の平均ウラン濃度

(2)　廃棄物を埋設する堀区画(embankment)中の平均ウラン濃度

(3)　処分場の受入廃棄物パッケージの平均ウラン濃度

(4)　それ以外 。

A：井戸水経路では、②廃棄物層（廃棄物、容器、充填材）の混合物の平均放射能濃度として扱われている。ボーリングによる外部被ばく経路では、各発生施設の廃棄物の平均放射能濃度について実施し、最も高い結果を評価結果としている。

Q3-3：処分セルにおいて埋設した放射能の合計や平均放射能濃度を制限するために処分セルにお

ける廃棄物の配置や配列に関する規定はあるか？ここで、処分セルとは、廃棄物の配置の管理のために処分場を分割したエリアの一つを意味する。

A：放射能濃度の平均化を図るような管理は行われていない。被ばく線量の低減化のため、定置時間の低減を図り、受入れた順に定置している。

Q3-4：ウランの個々の廃棄体濃度の上限値、処分場における受入放射能の上限値は決まっているか？それらの上限値は、性能評価より決定したものか？

A： Waste Acceptance Plan では、LLRW 埋設施設の放射能濃度の受入の上限値は、Class A, B, C に従っていると考えられる。また、許可申請書において、CWF 施設では、C-14 の埋設総放射能量が 600Ci（2.2E13Bq)に、FWF 施設では、C-14、Tc-99、I-129 の埋設総放射能量がそれぞれ 180Ci（6.7E12Bq)、35Ci（1.3E12Bq)、0.15Ci（5.6E9Bq）を超えないように制限されている。

Q3-5：なぜ、ウラン製錬鉱さい（Byproduct（11e(2)）と LLRW は分けて処分されているのか？ウラン製錬鉱さい（11e(2)）の処分における線量基準、評価シナリオは LLW の処分と異なるのか？

A：規制制度が異なるため、分けて管理しているとのこと。LLRW では、州法（10CFR part 61 に基づく）に基づき、250μSv/y を線量基準として、管理期間終了後の安全評価を実施されている。ウラン鉱さいの処分施設でも類似の評価を実施し、州法に基づき、操業中は 1mSv/y、閉鎖後は 250μSv/y を線量基準として評価が実施されている。

Q3-6 ：RCRA 処分場におけるウランの放射能濃度の受け入れ基準は？その値の根拠を教えてほしい。RCRA 処分場では性能評価を実施しているか？

A：Waste Acceptance Criteria において、Texas 州の基準に基づいた受入基準が設定されている。

4. 遮水カバー、ラドンバリアについて

Q4-1：遮水カバーの性能はどのように設計しているのか？遮水カバーの性能についての基準、指針等があれば教えてほしい。

A：遮水シートの設計は、テキサス州法における要件に基づいて設計されている。閉鎖後の浸透水の廃棄物の接触の最小化、人間侵入に対する抵抗性、自然現象等による覆土の劣化への抵抗性等に対する要件に対して、個々に設計されている。

Q4-2：CWF 及び FWF における遮水カバーのうち、ラドンバリアの役割を果たしている層はあるか？ラドンバリアの性能はどのように決めているのか？ Byproduct 処分場においてはどうか？

A：ラドンの遮へいに特化したバリアの説明はないが、覆土の厚さはラドンのバリアとして評価している。LLRW の処分場の安全評価では、覆土厚さ 9m の条件から NUREG/CR-3533 を参考に地表面での flux が算出されている。

5. モニタリングについて

Q5-1：LLRW 処分場において、ラドンのモニタリングを行っているか？ラドンに起因したモニタリング項目、頻度、期間等は何に基づいているか（法令、地元との協定など）？また、Byproduct 処分場ではどうか？

A：テキサス州法にモニタリングの義務が示されている。（LLRW の処分場は、30 TAC 336.708(a)(3)項と (10)項。Byproduct 処分場は、25 TAC 289.260(f)(l)(A)項。）

モニタリング計画書によれば、ラドンのモニタリングを実施し、4 半期に 1 回評価する計画となっている

追加 Q5-2：ウランに関するモニタリングは実施しているか？（地下水中濃度、土壌中濃度）

A：LLW 処分場：地下水では 4 半期に 1 回のサンプリング分析が行われる。モニタリング計画書によれば、通常はグロス α の測定であり、グロス α の値が制限値を超えた場合にウラン、Am、Th の分析が行われると記載されている。表層土、草木では測定は実施されない。

6. 処分場閉鎖後の管理期間について

Q6-1：制度的管理の期間は、100 年間か？制度的管理は、誰が行うか？制度的管理期間の後は処分サイトはどのように使用されるのか？

A：管理期間は、LLRW と Byproduct 処分施設で 100 年、RCRA 処分施設で 30 年である。テキサス規制当局が土地を所有するが、制度的管理を行うとは限らず、第 3 者に任せる可能性もある。

参考資料 3-3

TCEQ への質問事項と回答内容

１．テキサスの処分施設の安全規制に関する質問）

Q1-1：現在、廃棄物の種類ごとに独立に処分施設を設置（RCRA, 11e(2), LLRW (CWF, FWF)）しているが,安全規制の違いによるのか。

A：規制上の要請ではなく、州法のシステムによる（法が分けられているためである）。

Q1-1-1：免除レベルの廃棄物を処分している RCRA で線量評価、あるいはラドンの散逸率の評価は、安全評価項目として求められるのか。

A：RCRA は規制を免除されている（ので、ラドン評価も求められない）。NRC は経済性も考慮して免除対象とするウランの重量濃度を 0.05％未満とした。

Q1-2：ラドンに関して線量基準は設けているのか？

A : RCRA 施設には線量適用が無い。副生成物施設では 20pCi/m2/sec が工学的バリアについて（ラドン規制を）実施されている。LLW にはラドン線量独自の基準はない。このことは線量限度である 25mrem/y とある意味で競合している。鉱さいのフリーリリースのための基準では、表面から 15 ㎝で 5pCi/g でなければならないが、これはおよそ 25mrem/y 相当である。

追加 Q1-2-1：　25mrem/y には、ラドン被ばくを含めるのか、含めないのか。

A：　年間 25mrem は維持しているといえる。

追加 Q1-2-2 ラドンのモニタリングは義務付けているのか､義務づけているとしたらその内容は？

A：　我々は RCRA 施設を含めて、予備的にラドン測定をしている。

Q1-3：30 TAC 336.709 及び改定ドラフトの州政府の基準では、性能評価期間を 1000 年もしくは線量が最大となる時点までとしているが、事業者は 1 万年までと 10 万年までの最大線量を求め、10 万年以上は定量評価の意味がないとしている。

追加 Q1-3-1：定量評価の意味がないという事業者の意見に賛成か？

A：　ピーク線量は 16,000 年後に出るが、誤りではなく安心を与えるために、10 万年（まで評価すること）が決められた。

追加 Q1-3-2：長期間（例えば劣化ウランの 210 万年後のピーク）では規制の適否の判断はどのように行うか。

A：　劣化ウランでは、ピーク線量の発生は数百万年後になるが、評価期間は政策的または経済的な観点から定められねばならない。なぜなら、不確定性が非常に大きいからである。例として、ユタ州クライブは 20000 年が NRC 規制遵守として示されているが、これが 20 万年に及べば、経済的あるいは不確定性の観点から不要となる。

追加 Q1-3-3：　それらの議論は公開されているのか？

A：　少なくともこれらのヒヤリングはウェブ上で公開されている。

Q1-4：混合廃棄物に関して、有害物の環境影響評価の要件と基準値は何か？

A：RCRA はウラン基準についておよそ 50μg/L を維持している。この基準は飲料水基準（EPA 基準 30μg/L）ではない。テキサス州基準を選択している。

２．ウランの処分問題に関する質問

Q2-1：　FWF ではウランが処分されているが、CWF にはウランは含まれていない。FWF と CWF で規制に違いはあるのか？

A：FWF と CWF は一体で許可申請されており、総和としてインベントリが管理され、両施設の平均濃度が計算されている。平均算出は、埋戻し土壌、コンクリリートコンテナ、及び覆土等含めた体積で計算されている。

Q2-2：RCRA 廃棄物として処分されるウラン廃棄物について聞きたい。25TAC289.251 では、原料物質（source material）は 0.05wt%未満で規制除外されると規定されている。この規定における原料物質には特別核物質（special nuclear material）を除くウラン核種が含まれるが、劣化ウランも含まれるか。また、NORM について 150pCi/g 以下の基準もあるが、原料物質と NORM の免除基準はウラン廃棄物に対する違いは何か？

A：　原料物質は劣化ウランのようなもの。NORM は油やガスのようなものであるので、対象となる材質で区別される。

Q2-3：開発行為によって発生したラジウム廃棄物は 30pCi/g を超えても免除されるのか。その免除規定にラドン散逸率の制限はないのか。ラドン散逸率が 20 pCi/m2 /sec を超え、40CFR192 に抵触するのではないか？

A：　テキサス州は独自のルールを持っており、30pCi/g 未満について、ウラン製錬所と開発行為は別である。

Q2-4：RCRA のウラン、ラジウムの免除レベルについて、これらの数値は廃棄物中のウラン、ラジウムの平均濃度に適用されるのか。その場合受け入れてよい最大濃度はどのように決まるのか。

A：　RCRA は大量のウラン廃棄物受け入れは想定されていない。劣化ウランは 0.05%と定義されている。航空機のカウンターウェイトのような「堅固な（discreet）」ウランは同様に定義されている。濃縮ウランは決して受け入れない。浅地中処分規制は 0.05%平均である限り対象外である。一般的な廃棄物は測定のためサンプリングされる。免除における大容量の取扱いは想定されていないが、NRC ガイダンスによれば「ケースバイケース」で評価するとしており、我々もそのように解釈する。

Q2-5：現在の NRC による 10CFR61 の見直し結果をどう評価するか？　事前に NRC とすり合わせを行ったのか？　すり合わせを行った点は何か？

A：　NRC にはコメントを出したが、ドラフトは NRC だけで作成され、TCEQ は参加していない。

Q2-6：NRC の見直し結果を、州政府の基準の見直しにどのように反映しようと考えているのか？変更内容、スケジュールは？　（コンプライアンス期間、性能期間 、２段階アプローチ等）

A：テキサスはコンパクト（廃棄物受入州間協定）を構成している州なので、連邦規則と適合するように維持されなければならない。しかしながら、適合の度合いはカテゴリーにより一様ではない。NRC はカテゴリーのリストを示す予定であり、TCEQ は 3 年以内に修正を終える。NRC は 10CFRpart61 修正が発行されるまでは、適合させるカテゴリーについて彼らがどう考えているかを表明しないだろう。

追加 Q2-6-1：今後の反映スケジュールの概要はどうか？

A：　NRC は 2013 年 10 月までに 10CFRpart61 更新を終える。TCEQ 規制は、NRC の更新日から 3 年以内に更新されねばならない。

追加 Q2-7：　WCS 社処分場では気候変動は考慮しているか？

A：　考慮している。現在の降水量は 20incn/y だが、将来予想では 2 倍にしている。

追加 Q2-8：　安全評価で、覆土の深さは減少するか？

A：WCS 社は浸食をモデル化しようとしたが、難しすぎた。不確実性が大きすぎて、浸食のモデル化を断念した。そこで彼らはその代わりに浸水を増大させることで、劣化を表現した。

追加 Q2-9：　モンテカルロシミュレーションを行っているか？

A:　不確定性のためにモンテカルロシミュレーションを行っている。パラメータ範囲を想定し、95%までの値が 10mrem/y 未満であれば許容できるとして、結果を評価している。詳細は NUREG-1573 に記載されている。

追加 Q2-10：　制度的管理期間の長さはどれだけか？

A：　RCRA は 30 年、副生成物は 100 年、CWF-FWF 施設は 100 年である。

追加 Q2-11：　人間侵入シナリオを評価しているか？

A：　次のような NRC ガイダンスに従って評価している

①　掘削者は、廃棄物から放射性物質と放射線を漏えいさせる。

②　居住農耕者は、家畜を飼って、作物を収穫する。

追加 Q2-12：　劣化ウラン受入計画はあるか？

A：　ある。UF_6 を UO_3 に転換するプラントを WCS サイトから 20 マイルの場所に建設する計画がある。

追加 Q2-13：　地下水のモニタリングはしているか？

A：全 β、全 γ、ラジウム及びウラン濃度他をモニタリングしている。

追加 Q2-14：　ソースタームの核種移行による流出による減少を、放射壊変の他に考慮するか？

A：　考慮する。劣化ウラン評価が申請される予定だ。詳細は今は待っているといい。

追加 Q2-15：　Tc-99 はどの廃棄物から来たのか？

A：　Tc-99 は様々な廃棄物に由来し、特定できない。例えば、原子炉の解体時に、解体樹脂も Tc-99 を含んでいる。

追加 Q2-16：　処分場閉鎖後の制度的管理は誰が実施するのか？

A：　我々が実施するが、おそらくサードパーティが行う可能性が高い。TCEQ はサードパーティと契約するだろう。

以上

参考資料 3-4
ES 社への質問事項と回答内容※注 5

1.　性能評価について

Q1-1：DU の処分における 1 万年以降の定性的な性能評価では、サイトに残存する放射能濃度を評価していると考えて良いか？その際、ウランの子孫核種の生成による放射能の増加を評価しているか？

A：ウランの子孫核種の生成を考慮した評価を行っている。

Q1-1-1 : NRC の 10 CFR part61 が改訂された後、10,000 年以降の線量評価を実施することを考えているか？

A：その予定であるが、調査中である。現在、10,000 年以降は定性的な評価を実施しているが、10 CFR part 61 が改正されれば、その改正に従う。

Q1-1-2：人間侵入シナリオが発生するまでの評価期間中において、設定している線源は廃棄物中の核種の減衰と地下水による浸出を考慮しているか

A：考慮している。ただし、人間侵入シナリオの線量評価は 10,000 年までの期間である。

Q1-1-3：人間侵入のシナリオにおいて、以下の条件を想定しているか？

(1)廃棄物と覆土の混合物が地表から廃棄物層までの掘り返しにより、地表に掘り返された状態となり、侵入者がその混合物から被ばくする条件

A：クライブサイトの地下水は利用できないので、施設に穴を掘るシナリオは想定していない。ただし、モニタリング井戸における地下水中の放射能濃度は評価している。（500 年以内の期間）

(2)長期の侵食によって覆土の厚さが減少し、その後、侵入者がその覆土の上で被ばくする条件、又は地表から廃棄物層まで侵入者の掘削により、廃棄物と覆土の混合物から被ばくする場合

A : 覆土の侵食を想定している。（降雨などでできる水道による覆土の侵食）10,000 年以降は線量評価を実施していない。

Q1-1-4：処分場の透水性バリアの経時的な劣化は考慮されるか。

A：覆土の侵食を想定している。（透水係数は経時的な変化ではなく、最大値と最小値を設定したモンテカルロシミュレーションで平均、中央値、95%の値を評価している。）

2.　ラドンからの線量評価について

Q2-1　：

Q2-1-1：ラドンガスの評価基準は、線量か、または散逸率か？

A：TEDE（total effective dose equivalent 実効線量の合計）で評価している

Q2-1-2：吸入線量の場合、他の核種と合計するか？

A：他の核種と合計するが、Am-241 や Pu の内部被ばくが大きく、ラドンによる被ばくは小さい

※注 5：口頭の回答及び安全評価書等資料から質問の結果を記載している。

Q2-1-3：ウランの崩壊連鎖から生成するラドンを評価しているか？

A：評価している。

Q2-1-4：人間侵入シナリオにおける長期評価において、ラドンバリアの性能や覆土の厚さの経時的な変化を考慮しているか？

A：覆土の侵食を想定している。

Q2-2：日本では、IAEA の天然核種の免除レベル（1Bq/g）以下の濃度であれば、廃棄物処分場でのラドン評価を免除する措置を取り入れようとしている。貴社では、IAEA の天然核種の免除レベルを受け入れ基準や性能評価に取り入れている点はあるか？

A：ラドンについては、EPA の基準に従っている。（地表面での放出率 20pCi/m2/s）モニタリングでは、サイトのバックグラウンドと同レベルであることを確認している。（したがって、ラドンの被ばくの考え方に IAEA の基準は取り入れていない）

3　廃棄物の種類毎の性能評価について

Q3-1：放射能濃度の低いウラン含有廃棄物(例えば、10nCi/g 以下）はその他の Class A 廃棄物と一緒に処分しているか。他の LLRW と一緒に処分する場合、安全評価において両者からの線量は分けて計算する必要はないか。

A：一緒に処分している。ウランの線量は別に計算をしているが、本来その必要はない。線量は合計してトータルの線量で示している。

Q3-2：劣化ウランの処分は申請手続き中であると認識している。現在申請中の劣化ウランは、他の LLRW と一緒に処分されるか。他の LLRW と一緒に処分する場合、安全評価において両者からの線量は分けて計算する必要はないか

A：DU は他の廃棄物と同じ施設に処分すると考えている。

Q3-3：性能評価においては、ウランについて埋設施設全体の平均放射能濃度を計算条件として用いているか

もし設定しているなら、施設全体の平均放射能濃度は以下のどの方法で算出しているのか、

(1)　処分場全体の「敷地境界までの体積」中の平均ウラン濃度

(2)　廃棄物を埋設する堀区画(embankment)中の平均ウラン濃度

(3)　処分場の受入廃棄物パッケージの平均ウラン濃度

(4)　それ以外。

A：処分場の平均化は、保守的となるような平均値が使われる。（DU の性能評価では、DU が処分される領域において平均化するモデルとなっている。）

Q3-4：処分セルにおいて埋設した放射能の合計や平均放射能濃度を制限するために処分セルにおける廃棄物の配置や配列に関する規定はあるか？ここで、処分セルとは、廃棄物の配置の管理のために処分場を分割したエリアの一つを意味する。

A：放射能濃度の平均化より、放射性物質の配置に気をつけている。例えばラジウムの放射能濃度が 300pCi/g(11 Bq/g)より大きい廃棄物は、処分場内の深い位置に埋設されるようにしている。

Q3-5：ウラン廃棄物と劣化ウランの個々の廃棄体濃度の上限値、処分場における受入放射能の上限値は決まっているか？それらの上限値は、性能評価より決定したものか？

A：廃棄体におけるウランの放射能濃度の上限値は決まっている。DU では、18,000pCi/g が上限

である。DU の放射能濃度では、U-238 の放射能の寄与が想定されたもので、U-234 と U-235 の寄与は無視されている。

Q3-6：ウラン製錬鉱さい Byproduct（11e(2)）と LLRW は区画を分けて処分されているが、その理由は。Byproduct（11e(2)）の性能評価を行うシナリオ、線量基準は LLW と異なるのか？

A：Byproduct 処分施設は、DOE が所有者となる施設であり、LLRW 処分場はユタ州が所有する施設であるため、両者を一緒にすると所有に関する問題が生じるため、分かれている。

4. 遮水カバー、ラドンバリアについて

Q4-1：遮水カバーの性能はどのように設計しているのか？遮水カバーの性能についての基準、指針等があれば教えてほしい。

A：Groundwater discharge permit の書類によれば、地下水の濃度基準（U-238 で 26pCi/l 等）を最小でも定められた期間（放射性物質は 500 年）を満足し、最善の技術 BAT(Best Available Technology)を用いて設置することが記されている。

Q4-2：ラドンバリアの性能はどのように決めたのか？ Byproduct 処分場においてはどうか？

A：NRC は、1000 年間の閉じ込め（表面の放出率が 20pCi/cm^2/s - 10CFR part40）を求めている。VITRO 施設では、7feet（約 2m）必要と計算されたが、現在は、評価して 2feet（60cm）としている。7.2 日（2 半減期）ラドンを閉じ込める性能となっている。

ラドンバリア　LLRW　2 feet 上部の 1feet 5×10^{-8} cm/s　下部の 1feet 1×10^{-6} cm/s

11e2　上部の 1feet 5×10^{-8} cm/s　下部の 3feet 1×10^{-6} cm/s　(頂部)

5. モニタリングについて

Q5-1：LLRW 処分場において、ラドンのモニタリングを実施しているか？また、Byproduct 処分場ではどうか？

A：ラドンのモニタリングは処分セルの上と敷地境界で行っている。ラドンはバックグランドレベルである。

Q5-2：ウランに関するモニタリングは実施しているか？（地下水中濃度、土壌中濃度）

A：VITRO 施設が建設される前のバックグラウンドでは、Cs-137 で 3pCi/g, Co-60 で 2pCi/g であった。地下水では、グロス α とグロス β を週 2 回測定している。草木は過去 18 年間一度も汚染が検出されていない。ウランの地下水中の放射能濃度は、年 1 回測定している。

6. 処分場閉鎖後の管理期間について

Q6-1：制度的管理の期間は 100 年間か？制度的管理は誰が行うか？制度的管理期間の後、処分サイトはどのように使用されるのか？

A：ユタ州は、VITRO と 11e2（byproduct）の処分場以外の所有者である。ES は制度的管理期間中の資金の責任があり、処分サイトの管理はユタ州が方針を決めると考えられる。

参考資料 3-5

UDEQ への質問事項と回答内容

１．クライブの既存の処分施設の安全規制に関する質問）

Q1：現在、廃棄物の種類（クラス A, VITRO,11e(2), NORM・NARM）ごとに独立に処分施設を設置しているが,法令が異なるからか？

A：　廃棄物の種類が異なるためである。Class A North と Class A は最近合併して Class A West になった。Vitro, 11e(2), NORM は連邦所管の廃棄物を取り扱っている。

Q1-1：安全規制の観点からの主な相違点はあるのか。（設計要件、安全評価方法、管理方法等）？

A：廃棄物の種類が異なれば、設計等は異なる。例えば、粘土層の要件は異なる。VITRO は主としてバルク廃棄物（固化されていない廃棄物）が占めている。Class A では、追加のコンテナがある場所もある。

Q1-2：ラドンに関して線量基準は設けているのか？

A：　ラドンフラックスは濃度と比べて不確実である。連邦規則の要求により、長期間の安定性が求められているので、空隙は砂で充てんされることが、ラドンバリアに必要となる。例えば蒸気発生器では、砂と低濃度のコンクリートを入れて空隙を埋める。蒸気発生器の内部を充填する内容物には特段の注意はしない。空隙を発生させないことが重要である。

Q1-2-1：ラドンのモニタリングは義務付けているのか、義務づけているとしたらその内容は？

A：　他の同位体と同様に、ラドンについても空気中のサンプリングが必要である。年に 4 回のサンプリングが要求される。我々は基準値より傾向を重視する。1989 年にウラン製錬工場に対し、ラドンの測定が定められた。40CFR192 により、20pCi/m2/sec がフラックスの上限となった。閉鎖後は、連邦政府が測定し、フラックスが 20pCi/m2/sec を超えたら、より強いラドンバリアを作って対処する。

Q1-3：州政府の基準（UAC R313－25-8）によれば、ピーク線量が線量限度（UAC R313－25-19）の 10%を超える場合にサイトスペシフィックな性能評価が必要になる。ここで、大量の劣化ウランを埋設しない処分場でも、ウラン廃棄物では、ピーク線量の発生時点が 1 万年を超え、その時の線量評価が不確定になることがあると思われる。この場合、評価期間を 1 万年までとする等の代替策はあるか？

A：　Q8 と類似した質問のため、合わせて回答する。

Q1-4：混合廃棄物に関して、有害物の環境影響評価の要件と基準値は何か？

A：地下水の化学物質によるものであり、連邦政府からの要請がユタ州政府より強い。30 年間の（環境影響評価）期間が、EPA によって有害廃棄物に関して要求されている。

コメント：(Mr.Lebaran)：　被ばく影響の規制は、NRC-UDEQ-DRC の組織系統で行われている。一方、有害物に関しては、EPA-UDEC-DSHW の組織系統で規制される。地下水に関しては、DSHW は数件の項目しか要求していない。年間の地下水サンプリング等である。この値があるレベルを超えると、サンプリングの頻度が毎月になる。

2. 多量の劣化ウランの処分問題に関する質問

Q2-1：モラトリアム以前の劣化ウランの処分に関して認可する際、ステークホルダーにはどのような説明をしたのか？

A：　モラトリアム以前には、軍用の遮へい材のような、少量のものが処分されたが、大量の固体廃棄物は処分されなかった。その後民間からより大量の土のような廃棄物が発生し、これらの安全な処分についてはより保守的なライセンス要件が課せられた。Discreet 廃棄物（安定な固体状の、散逸しない形状の廃棄物）は問題ないが、数千本のドラム缶に入った劣化ウランは一つのサイトに集約されたことが問題視された。

Q2-2：クライブにおけるモラトリアムが定められたのは、劣化ウランの処分が問題視されたためだと聞いている。モラトリアムを必要とした考え方と、その導入過程の概要を知りたい。またモラトリアム制定当時、クライブに劣化ウランを処分することに対してステークホルダーが表明した主な意見は何か？

A：　公衆の主張によれば、サバンナリバーサイト（SRS）からの廃棄物は、本質的に 10CFR61 を反映していないので、固有の廃棄物系統（unique stream）とされるべきだとされた。5,400 本のドラム缶が Clive サイトに保管されており、今日ではより多くの劣化ウランが存在する。

Q2-3：現在の NRC による 10CFR61 の見直し結果をどう評価するか？

A：ユタ州法が連邦法と共通性を必要とする度合いには、3 段階がある。

Class　A は　必ず適用されるべきだ。

Class　B は、適用されることが望ましい。

Class　C は、状況による。

Q2-3-1：UDEQ は事前に NRC とすり合わせを行ったのか？

A：　公式の打合せでは、我々はコメントすることが許され、多くのことを話し合った。

Q2-3-2 すり合わせを行った点は何か？

A：　我々の最大の関心事は、廃棄物分類を変えないで欲しいということだ。

Q2-4：NRC の見直し結果は、2013 年 2 月 1 日施行の UAC R313-25-8 で反映されたのか？ そうであれば、変更済み及び変更予定の概要と、今後のスケジュールが知りたい。

A：我々は NRC の修正について、適用の仕方を長期間議論している。10CFR61 の修正はまだ公式なものではないので、我々も州法への反映はできない。NRC の修正後、通例、州法への共通性適用には約 3 年間がかかる。NRC は 7 月にドラフト版のルールを委員長に提出し、委員長の法制化に当たっての判断を我々は待つことになる。

Q2-4-1：R313-25-8 では、「大量の劣化ウランを浅地中処分全ての施設」に対して、「性能評価期間は最低 1 万年とし、追加のシミュレーションを線量ピークの時点まで、定量的に実施すること」とされているが、追加のシミュレーション期間の長さに何らかの制限はあるか。

A：　制限は無い。10CFR61 の修正はまだ公式なものではないので、反映については短寿命の、（定量）評価を求められる期間より短寿命の廃棄物については問題ない。劣化ウランは長寿命で、（定量）評価を求められる期間より長い寿命を持つ。劣化ウランについては、R313-25-8 は 120 万年の定性的評価を求めている。これは非常に困難だろうが、テキサス州法もピーク線量を求めている。パブリックコメントで、我々ユタ州は提案を提出した。ユタ州の廃棄物分類は変更前と同一に保たれなければならない。我々は NRC に、ユタ州の ClassA 廃棄物処分に影響を与えることが無いよう要請した。国際的な基準に追いつくための、線量評価上の技術的な更新は問題ない。しかしながら、非技術的な修正による変

更はあってはならないと主張した。

全ての規則変更は、保健と安全のための柔軟性を持つべきである。原子力規制では、評価期間の限度は無いが、不確定性があり、不確定性が評価期間の限界を定めると我々は認識している。数 100 万年の期間は不確定性を伴う。例えばユタは今は乾燥しているが、25 万年前は海の底にあった。

Q2-4-2： 120 万年の評価を求める要請があったのか？

A： 要請があった。科学的というより社会的な何らかの意思表明が求められていた。公衆は、防護をさらに追加することによる信頼性を要求していた。より高い防護には、より大きい不確定性が伴う。

Q2-5：性能評価手法に関して、一昨年事業者が州政府にレポート（Final Report for the Clive DU PA：Model /1 June 2011）を提出したが、基本的に受け入れるのか、それとも何か別に要件を提示し変更を求めるのか？

A： 公式にはその報告書はまだ検証されていない。我々は契約者からの技術的な支援を必要としている。主要個所の第 1 版が夏の終わりにも一般公開される予定だ。我々はすぐにこれを JAEA の齋藤氏と坂井氏に連絡できる。

追加 Q2-6： Energy Solution 社は Class A South を Class A West に動かしたのか？

A： WM2012 報告当時は ClassA South を前提にしていたが、見直された報告書は ClassA West のパラメータで作成されている。Neptune 社によれば、敷地境界に 10 フォート近付く他には、South から West への変更に伴う安全評価上の重大な変更はないということだ。

追加 Q2-7： ClassA North についてはウェブサイトに情報が無いのか？

A： ClassA North は現在では ClassA と統合されて ClassA West でライセンスされている。

追加 Q2-8： 以前の 7 フィートのラドンバリアが 2 フィートに変更されたのは何故か？

A： NRC ガイダンスに基づいて、使用できる最適な技術を適用している。7 フィートの設計は、DOE によって VITRO 処分施設の設計時に使用された。その他の処分場は NRC に基づく。ウランは ClassA 中に 300pCi/g で一様に分布しており、設計は規制者が誰であるかに依存する。

追加 Q2-9： ユタ州では、安全評価時に平均濃度を使用するか？

A： 評価モデルは平均値を要求する。平均値は不確定性を数値としては考慮していないが、Kd を使用する場合には、不確定性の観点から平均値採用は十分に保守的である。

以上

参考資料 3-6

NRC への質問事項と回答内容

Q1：今回の見直しの原因となったのは何か、また NRC での見直しにおける目標とは何か。

A1：今回の見直しの要因としては、民間濃縮施設の操業に伴い発生する多量の劣化ウランの処分を行う上で、現行の 10CFR61 では安全に処分を行うための規制要件が不十分である点である。このための見直しを 2008 年から始めているが、見直しの目標としては、地下水移行に関する性能評価と人間侵入に関する解析の要件を 10CRF61 の中に明示することにある。

Q2：提案内容に関して州政府と事前のすり合わせを行ったか？

A2：NRC は NRC からの規制権限を代理で引き受けるという合意州プログラムを持っており、現在条件が満たせば参加する用意のある州は 39 ある。このうち、商業処分施設を有する 1 つの州に、39 の州を代表する代表者として、NRC の規制改定作業チームに参加してもらっている。

Q3：コンプライアンス期間 1 万年を決めた技術的根拠は何か？

A3： 1990 年代にテストケースとして、バーンウェル処分場のインベントリ（軽水炉や産業利用によるもので短寿命核種と長寿命核種混在）を用いて、湿地条件での処分を想定し、10 万年までの性能評価計算をした結果、ピーク線量が 5 千年から 7 千年に出現。この結果に関しては NUREG—1573 の中で公表(2000 年)され、軽水炉や産業利用からの廃棄物に対しては、保守的に性能評価期間として 10000 年を推奨、ただしウランがかなりの量含まれる場合にはさらに長い期間評価する必要性を勧告している。このような結果を踏まえ、今回の改訂のようにウランを多量に含む場合は、コンプライアンス期間として 10000 年、それを超える期間として性能評価期間を定める、2 段階方式を提案。

Q4：コンプライアンス期間以後の性能評価期間に関して、最大想定期間は何年か？

A4 ：現時点では性能評価としての最大期間は想定していない。性能評価期間は、廃棄物インベントリやサイトの地質学的安定性から、ケースバイケースで決められるべきものと考えている。

Q5：コンプライアンス期間以後の検討条件として例えばトータル α で 10ｎCi/g のように濃度規制を与えているが総量規制は必要ないのか？

Q5：どれくらいの量が処分できるかは、性能評価に基づいて申請者と規制者で決めるべきもので、サイトスペシフィックなもの。改訂案でもサイトスペシフィックな廃棄物受け入れ基準という考え方を示している。

Q6：ミルテーリングのコンプライアンス期間（最大 1000 年）と 10CFR61 のコンプライアンス期間（10000 万年）の違いはどのように理解すべきか？また、ラドンの取り扱いで違いはあるか。

A6：ミルテーリングのような 11e(2)廃棄物の規制は 10CFR40 で定めており、ミルテーリングの安定性を保つための設計目標を 1000 年、少なくとも 200 年間は救済措置が効果的であるべきとしている。また、この考え方の前提として、永久的な能動的管理がある。一方、低レベル廃棄物の処分の規制要件を定めた 10CFR61 では 100 年を超える期間の制度的管理によるクレジットを許可していない。ラドンに扱いに関しては、現行の 10CFR61 には定めがない

が、今後の改訂作業の中、ラドンに関するガイドラインを定めていきたい意向。一方ミルテーリングに関しては、10CFR60 の中でラドン 222 の放出を 20PCi/m2s を超えないように定める規則がある。

Q7 : 定義で定めた長寿命廃棄物とそうでない廃棄物では、安全評価方法以外での相違点は何か？（設計要件、管理方法等）

A7 : 今回の改訂では、従来の 10CFR61 の基本的考え方を変えるものではない。多量の劣化ウランを処分する場合には追加的な措置が必要で、その方法としてはインベントリに制限を加えるとか、深いところに処分するとか、パッケージングを厳重に行うなどが考えられる。

Q8 : 国際機関（ICRP、IAEA、OECD/NEA）の検討結果や各国の規制状況は、ラドンを含む長寿命廃棄物の処分に係る改定をどのように反映しているのか？

A8 : ICRP 勧告に対してはフレキシブルに対応。また 10CFR61 の基本的フレームワークは、IAEA の GSG-1 の考え方と調和するように作られている。

Q9 : 見直し案に対してのコメント受け付けは２０１３年１月７日までとしているが、どのようなコメントが出ているのか？またコメントに対して修正すべき点はあるのか？

A9 : どのようなコメントが出たかについては公開しているのでそれを見ればよいとの事。なおコメントをどう反映するかについてまだ公表できる段階にないとの事。

Q10 : 改定に向けた今後のスケジュールは？

A10 : ２０１３年７月に改訂案を委員会に提出し、パブリックコメントの後、２０１４年後半に制定。そのあと、州政府の規制改定には３年程度を要し、実際に運用されるのは２０１７年後半の見通し。

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Regulatory Approach for Licensing the Port Hope Project in Canada

JAEA Visit, Port Hope, Ontario
March 12, 2013

Presenters:
Don Howard, Director
Milena Kostova, Senior Project Officer
Wastes and Decommissioning Division

E-doc: 4103840

nuclearsafety.gc.ca

Outline

- An overview of the CNSC and licensing process
- Licensing Approach for Port Hope Project
- Specific Regulatory Tools
- Concluding Comments

Canadian Nuclear Safety Commission (CNSC)

- Established in May 2000, under the ***Nuclear Safety and Control Act*** **(NSCA)**
- CNSC is the Sole Nuclear Regulator in Canada
- CNSC consist of:
  - The Commission - quasi-judicial administrative tribunal
  - The CNSC Staff – technical and scientific staff
- Commission Tribunal members are independent

A regulator with 66 years of experience

Canadian Nuclear Safety Commission (CNSC)

- Nuclear Safety and Control Act
- Regulates the use of nuclear energy and materials to:
  - protect the health, safety and security of persons and the environment;
  - respect Canada's international commitments on the peaceful use of nuclear energy; and
  - disseminate objective information

Regulatory Philosophy

Licensees responsible for the protection of health, safety, security, and the environment and respecting Canada's international commitments

CNSC responsible for regulating licensees, assessing whether licensees are compliant with the NSCA, regulations, and international obligations

Safety, Security and Safeguards

CNSC Regulates Facilities and Activities...

- Nuclear power plants
- Uranium mines and mills
- Uranium fuel fabricators and processing
- Industrial and medical applications of nuclear substances, such as nuclear medicine and cancer treatment centers
- Research labs and educational facilities
- Export/import of controlled nuclear substances, equipment and technology
- Waste management facilities
- Transportation of nuclear substances

...from Cradle to Grave

Independent Commission Tribunal

- Commission members are independent
- Commission hearings are public and Webcast

Transparent decision-making

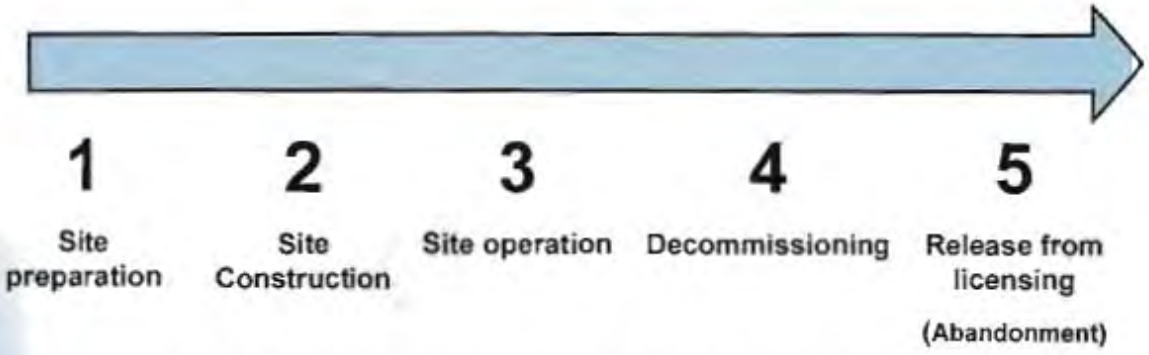
CNSC Staff

Scientific, technical and other professional staff, responsible for:

- implementing the decisions of the Commission
- verifying compliance with licences and regulations
- reviewing licence applications and performing EA review work
- developing regulatory guidance
- advising on regulatory policy and options
- engaging citizens and communities through outreach

Located Across Canada

CNSC Licensing Process



Financial guarantees are required at stages 1 through 4

Staged approach/Early Planning

CNSC Licensing Process (cont'd)

CNSC oversight
- Licence conditions
- Inspections
- Compliance assurance

Licensee obligations
- Health and safety
- Environmental protection
- Security
- Monitoring
- Reporting
- Financial guarantee

Harmonization with Provincial/Federal Agencies

- CNSC utilizes a harmonized approach with other federal, provincial or territorial departments in areas such as health, environment, transport and labour – a joint regulatory review process.
- The CNSC expects the applicant/proponent of nuclear facilities to comply with all applicable federal and provincial regulations.
- Federal and provincial agencies are considered in the regulatory process and are reflected, as appropriate, in the licence in the form of site-specific requirements.

Regulatory Approach for Waste

- Approach stems from the *Nuclear Safety and Control Act* (NSCA), and CNSC regulatory policy document
  P-290, Managing Radioactive Waste
- Three principles:
  - Plan for the complete life of the facility
  - Multi-barriers between radioactive material and people/the environment
  - Defence in depth – never rely on a single system or process for protection

Safety and Control Areas

- Management Systems
- Human Performance
- Operating Performance
- Safety Analysis
- Physical Design
- Fitness for Service
- Radiation Protection
- Occupational Health and Safety
- Environmental Protection
- Emergency Preparedness & Fire Protection
- Waste Management
- Security
- Safeguards
- Packaging and Transport
- Other: Public Information Program, Financial Guarantees

Compliance Program

Verification

Clarity

Enforcement

Radioactive Waste Classification

- High-level radioactive waste (HLW)
- Intermediate-level radioactive waste (ILW)
- Low-level radioactive waste (LLW)
  - low-level short-lived radioactive waste (VSLLW)
  - very-low-level radioactive waste (VLLW)
- Uranium mine and mill tailings

HLW ILW LLW Uranium mine & mill tailings

Licensing Approach Historic Waste Remediation

- **Historic waste**
  - Low-level radioactive waste
  - No longer managed in an acceptable manner
  - The original producer can not be hold responsible
  - The Federal Government has accepted responsibility
- **Environmental Remediation**
  - Not considered as a distinct stage of the licensing process

Regulatory approach based on risk and application of existing regulations

Licensing
The Port Hope Project (cont'd)

- Federal Government of Canada took responsibility for cleaning the LLRW in Port Hope – 1.28$ billion
- Atomic Energy Canada Limited (AECL) is conducting the project on behalf of the Federal Government
- Licence application submitted in 2004
- Environmental Assessment completed in 2007
- Estimates had to be reviewed

CNSC used specific regulatory tools to advance the project through Phase I

Specific Regulatory Tools
The Port Hope Project

- Protocol for licensing activities
- Licence with hold point
- Federal-provincial resolution of clean-up criteria

Specific Regulatory Tools
The Port Hope Project (cont'd)

- The Port Hope LTWMF will not be a prescribed nuclear facility as defined by the Regulations – total activity less than 10^{15} Bq
- Appropriate type of licence is a Waste Nuclear Substance Licence (WNSL)
- The regulatory requirements for a WNSL do not cover activities as operation, site preparation, construction, remediation

Specific Regulatory Tools
Protocol for licensing activities

- To define the project-specific documentation required to support a WNSL for the Port Hope Project
- To define the roles and responsibilities of the government parties:
  - NRCan – the Federal Government responsible authority
  - AECL – the proponent
  - CNSC – the regulator
- To establish administrative framework and service standards for the regulatory review

Protocol for Licensing Activities Technical Documentation

- Detailed Design Description Reports:
  - For on-site construction and remediation of LTWMF
  - For off-site sites remediation
- Water Treatment Definition Report
- Environmental Management and Protection Plan
- Environmental Assessment Follow-up Plan
- PHAI Quality Assurance Plan
- PHAI Radiation Protection Plan
- PHAI Training Plan
- PHAI Occupational Health and Safety Plan
- PHAI Security Plan
- PHAI Transport of Radioactive Material Plan
- PHAI Emergency Plan

In support of an application for a Waste Nuclear Substance Licence

Protocol for Licensing Activities Additional Technical Documentation

- CNSC staff also required additional technical documentation

  - Dust Management Requirements and Plan
  - Planning for Small-Scale Sites Remediation
  - Remediation Verification Procedure
  - Communication Plan for Phase 2

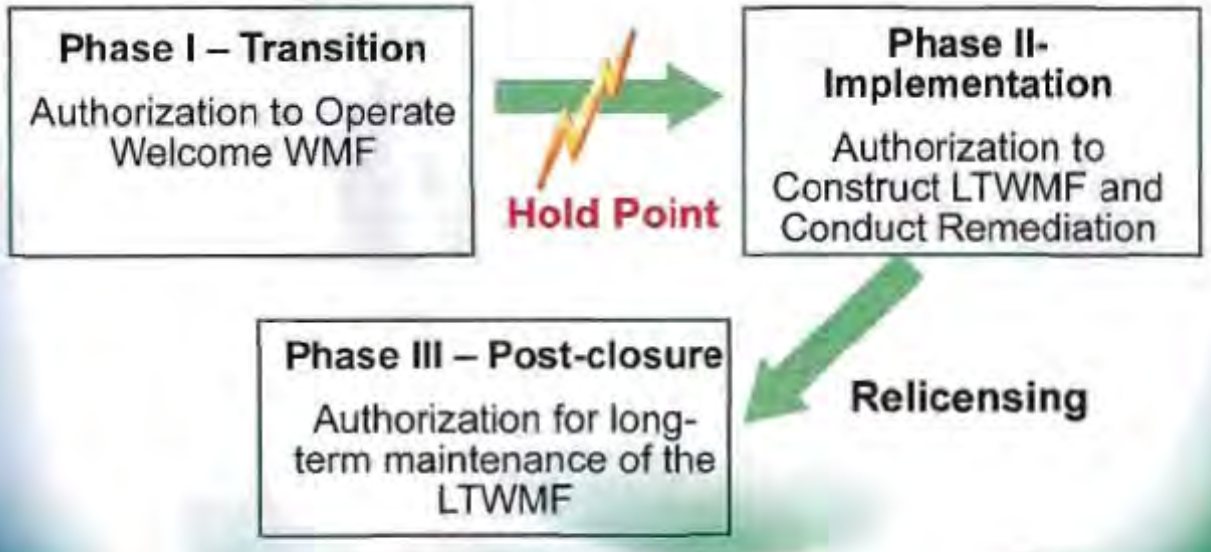
Meets CNSC and Provincial Requirements

Licensing
The Port Hope Project

- **Phase I: The transition phase, which is now completed:**
  - Possession and management of the nuclear substances at the Welcome WMF
- **Phase II: The implementation phase, expected to take up to seven years, involves:**
  - Construction of the Long-Term Low-Level Radioactive Waste Facility (LTWMF)
  - Integration of the waste from the Welcome WMF;
  - Clean up and remediation of off-site historic waste within the Municipality of Port Hope and transfer to the new LTWMF;
- **Phase III: The post-closure phase, involving long-term monitoring and maintenance of the LTWMF.**

Specific Regulatory Tools
Licence with hold point

- To allow government funding for finalizing the technical documentation



Specific Regulatory Tools
Federal-provincial resolution of clean-up criteria

- Original clean-up criteria were developed during the EA in consultation with public stakeholders
  - for different type of land use
  - for radioactive COPCs – 0.3 mSv/a
  - for non-radioactive COPCs – general provincial standards
- In 2011 new provincial standards came into force
  - Ontario MOE standard included more restrictive value for uranium – 23 ppm vs. 35 ppm
  - CNSC staff conducted bioaccessibility testing for uranium
  - AECL conducted additional risk assessment

To confirm that clean-up criteria of 35 ppm for uranium is protective for people and the environment

Specific Regulatory Tools
Adopted Clean-up Criteria

Key COPCs	**Residential/ Parkland** Based on 2011 OMOE Generic **A**	**Industrial/ Commercial** Based on 2011 OMOE Generic **B**	**Welcome WMF and Highland Drive Landfill C**
Radium-226 (Bq/g)	0.24	0.92	0.92
Thorium-230 (Bq/g)	1.11	4.62	4.62
Arsenic (ppm)	18	18	40
Uranium (ppm)	**23**	33	76

To address public concern for future use of remediated land, 23 ppm was adopted as clean-up criteria for uranium

Concluding Comments

- Canada's independent nuclear regulator
- CNSC responsibilities include the licensing, compliance and enforcement of the radioactive waste management facilities in Canada
- Protection of workers, the public and the environment is top priority
- Transparency and, aboriginal and public consultation are strongly valued
- There is a harmonized approach to relations with other government departments

Concluding Comments (cont'd)

- Successful transition from planning to the implementation phase
- Set out specific licensing requirements within the existing regulatory framework
- Development of protocol and licence with hold point set precedent for using similar tools for other projects
- Successful resolution of clean-up criteria in overlapping federal-provincial jurisdictions

A WNSL authorizing the implementation Phase –II was issued to AECL on November 15, 2012

Additional Resources

CNSC website

- **Regulatory Framework**
  http://www.nuclearsafety.gc.ca/eng/acts-and-regulations/regulatoryframework/index.cfm
- **Regulatory documents**
  http://www.nuclearsafety.gc.ca/eng/acts-and-regulations/regulatorydocuments/index.cfm
- **Licensees and Applicants**
  http://www.nuclearsafety.gc.ca/eng/licenseesapplicants/index.cfm
- **Environmental Assessment**
  http://www.nuclearsafety.gc.ca/eng/ea/index.cfm
- **My Community**
  http://www.nuclearsafety.gc.ca/eng/mycommunity/index.cfm

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CNSC CCSN

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Canada

Presentation to Japan Atomic Energy Agency (JAEA)

Presented by:
Glenn Case, Walter van Veen, Sandra Faught, Judy Herod
March 12, 2013

Canada

PORT HOPE AREA INITIATIVE

Historic Low-level Radioactive Waste

Canada

UNRESTRICTED

2

PORT HOPE AREA INITIATIVE

Historic Low-level Radioactive Waste

PORT HOPE AREA INITIATIVE

The Need for a Solution

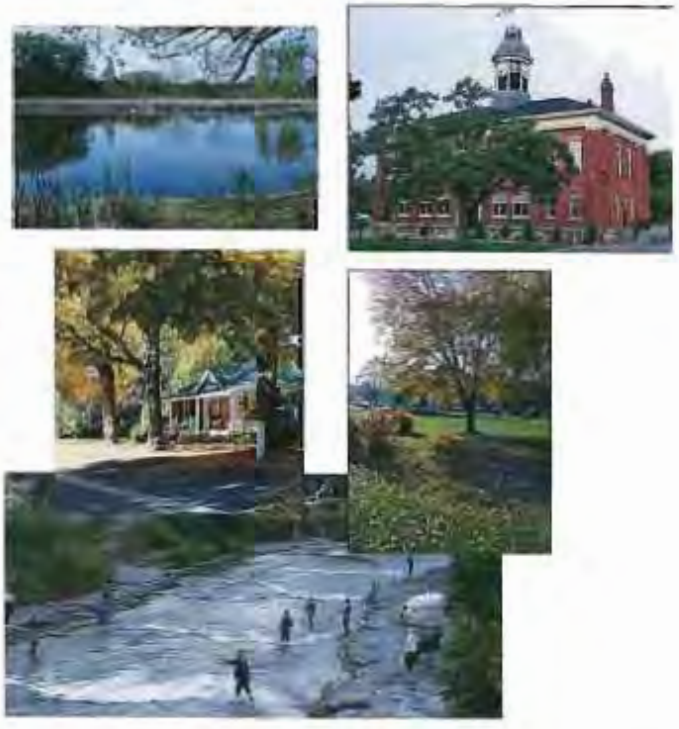
- LLRW problem Identified in mid 1970s in Port Hope, Welcome and Port Granby
- Initial cleanup of 100,000 m^3 in Port Hope – 1976 to 1982 – waste taken to Chalk River Laboratories
- Low-Level Radioactive Waste Management Office established – 1982 to present
- Independent Siting Task Force province-wide search unsuccessful – 1986 to 1996
- Community-based solutions & concepts advanced to federal government – 1997 to 1999

PHAI formed as result of 2001 Legal Agreement between the municipalities of Port Hope and Clarington and Government of Canada

PORT HOPE AREA INITIATIVE

Port Hope Area Initiative

The purpose of the Port Hope Area Initiative is the cleanup and safe management of historic low-level radioactive waste in the Municipality of Port Hope and Municipality of Clarington, leaving an honourable legacy for future generations.



PORT HOPE AREA INITIATIVE

Port Hope Area Initiative Management Office

Natural Resources Canada

- Project sponsor
- Acquires land and signs lease agreements
- Provides funding, policy direction, oversight

Atomic Energy of Canada Limited

- Project lead
- Manages EA and licence commitments
- Delivers community programs

Public Works & Government Services Canada

- Tenders and manages major contracts

Project Milestones

Phase 1 – Detailed Environmental Assessment 2002 to 2007

Phase 1a Detailed Design and Licensing 2008 to 2011

Phase 2 – Construction/cleanup 2012 to 2022

2012 – 2015

- Property radiological survey – 4,800
- Construction of waste water treatment plant, support buildings and engineered aboveground mound
- Road upgrades – ongoing to end of cleanup

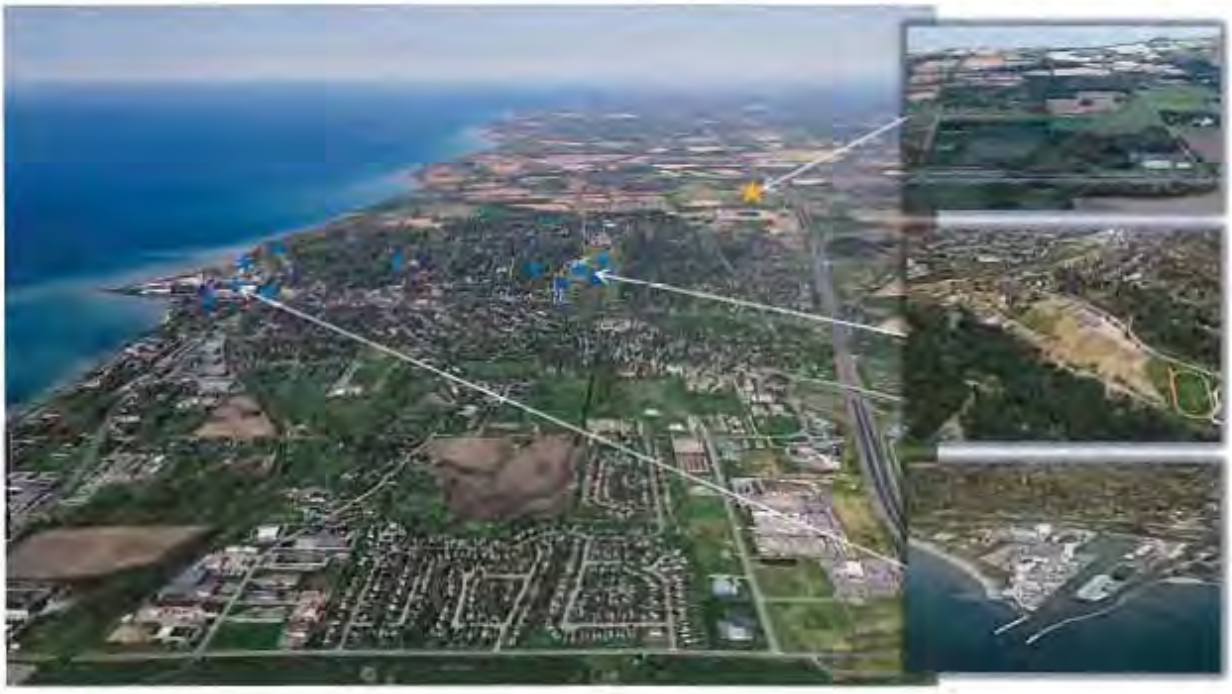
NRCan Minister announces PHAI funding commitment: $1.28 billion

2015 – 2022

- Cleanup – remediation and restoration of sites
- Waste transported to aboveground mound facility
- Mound capped and closed

Phase 3 – Long-term maintenance and monitoring – 2022 and beyond

Port Hope Project

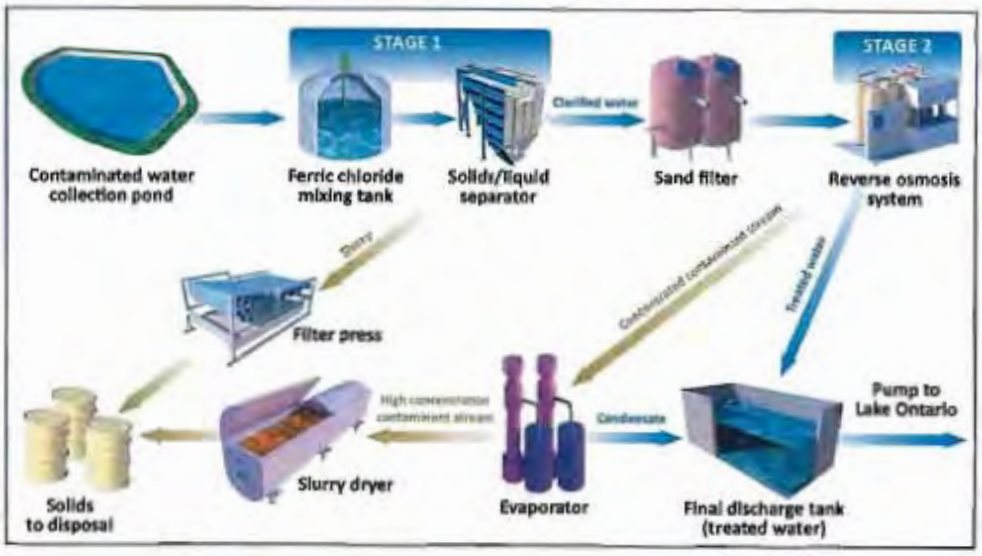


PORT HOPE AREA INITIATIVE

Long-Term Waste Management Facility

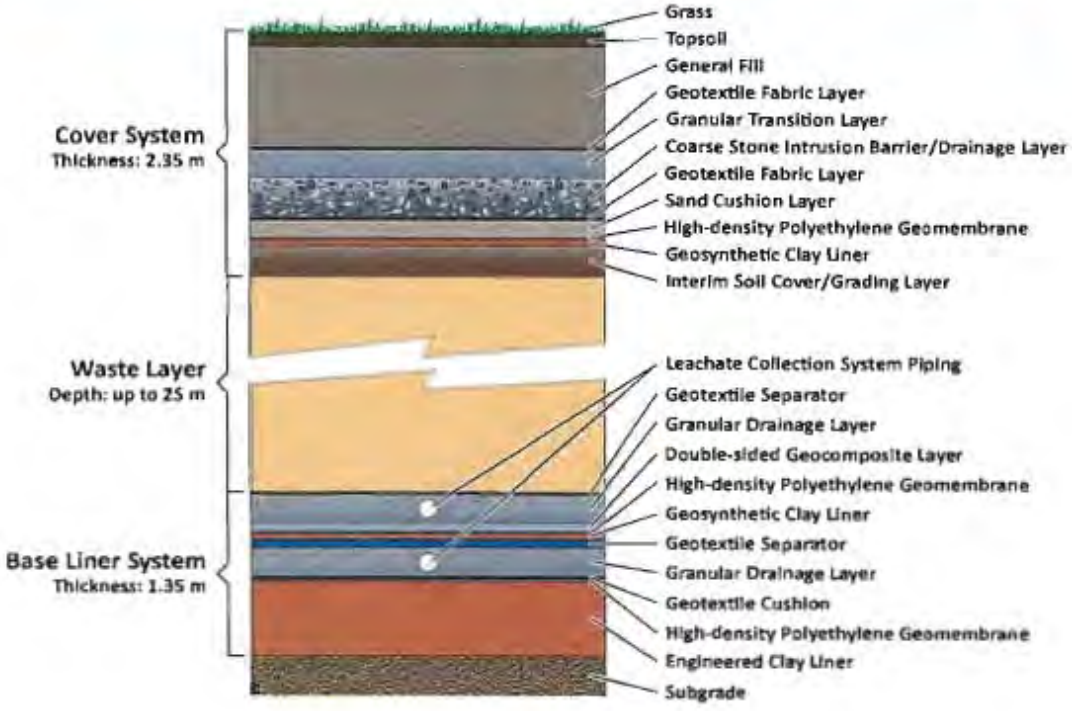
PORT HOPE AREA INITIATIVE

Enabling Infrastructure



PORT HOPE AREA INITIATIVE

Above Ground Mound



PORT HOPE AREA INITIATIVE

Port Hope Waterfront Area

PORT HOPE AREA INITIATIVE

Port Hope Harbour

Canada

UNRESTRICTED

PORT HOPE AREA INITIATIVE

Highland Drive Area

Canada

UNRESTRICTED

PORT HOPE AREA INITIATIVE

Property Radiological Survey

- Comprehensive survey of 4,800 properties
- 90 per cent of properties **not** expected to require cleanup
- Cleanup and restoration of contaminated properties to begin after 2015
- At completion, letters to property owners will confirm property meets PHAI criteria
- Will eliminate need for construction monitoring and radiological status letters

PORT HOPE AREA INITIATIVE

Key Waste Sites and Transportation Routes

PORT HOPE AREA INITIATIVE

Safely Transporting Waste

- Using proven, internationally accepted practices to protect people and the environment, low-level radioactive waste will be moved safely during the Port Hope Area Initiative clean-up.

Strict controls, approved by the Canadian Nuclear Safety Commission, are in place to ensure:

- Dust is controlled and suppressed
- Work sites are kept clean to avoid tracking of soil
- Trucks are cleaned, tightly covered and monitored
- Crews are trained and supervised in specialized waste-handling methods
- Worker safety and the environment are monitored at all times

Clean site access

The truck approaches and exits the work site along a segregated clean road twice.

Controlled loading

An excavator carefully loads a truck within a controlled-access work zone. To prevent spillage, trucks are never overloaded.

Secure tarping

A tarpaulin completely covers the load and extends down the sides of the truck where it is securely tied.

Radiation monitoring/trip tracking

A technician measures the gamma radiation field of the load to make sure it meets regulations for public safety. The gamma radiation reading is recorded on a trip ticket along with the load size, licence plate number, driver's name, date and departure time.

Confirming truck clean

The cab, wheels and tires are checked. No truck is released from the work site until it is confirmed clean.

Transportation along designated routes

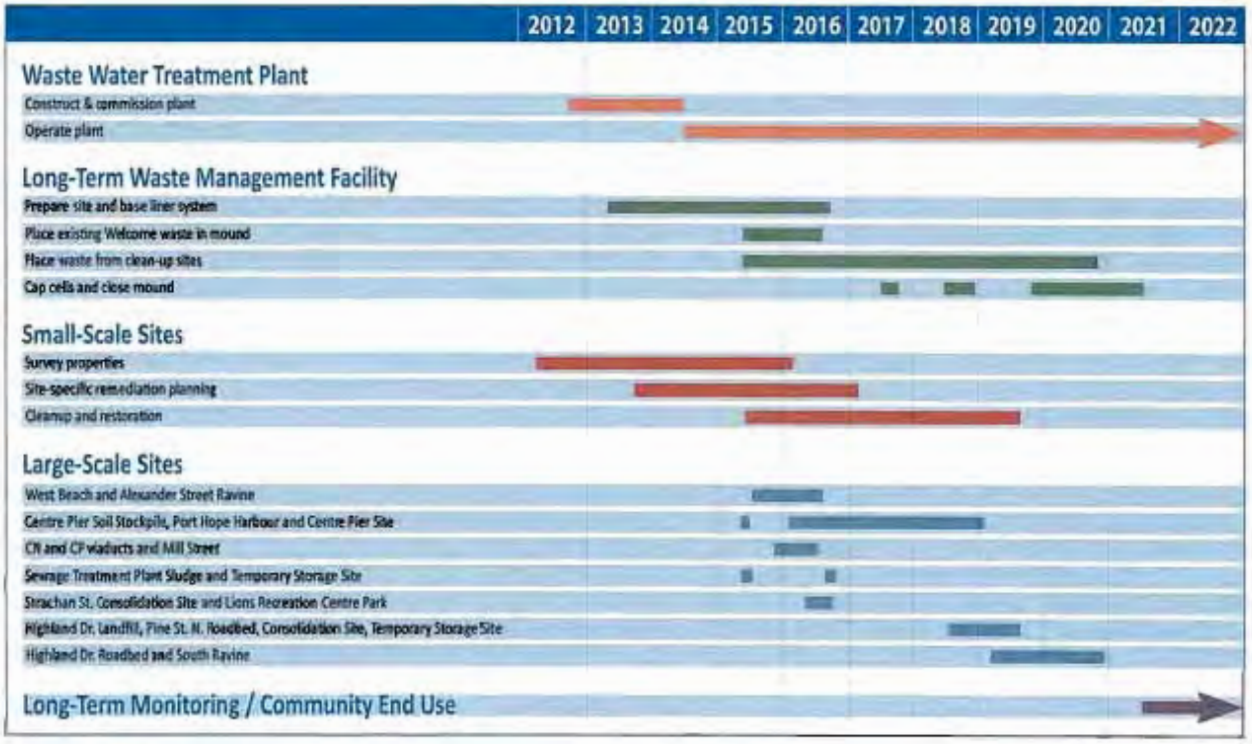
With the load secure and the truck thoroughly monitored, it is ready to leave the work site. Trucks will travel only on designated transportation routes for the Project.

PORT HOPE AREA INITIATIVE

Long-Term Monitoring / Community End Use

PORT HOPE AREA INITIATIVE

Schedule Overview



Canada

UNRESTRICTED

PORT HOPE AREA INITIATIVE

Regulatory Requirements

Canada

UNRESTRICTED

PORT HOPE AREA INITIATIVE

Detailed Environmental Assessment

Atmospheric Environment
Air quality and noise

Geology and Groundwater Environment
Groundwater, storm water and waste water quality & flow; soil quality

Aquatic Environment
Water quality, flow and sediment quality

Terrestrial Environment
Plants and wildlife habitat

Socio-Economic
Community life, heritage, Aboriginal interests, traffic and transportation

PORT HOPE AREA INITIATIVE

Atmospheric Environment

Atmospheric Environment
Air quality and noise

PORT HOPE AREA INITIATIVE

Dust Monitoring

PORT HOPE AREA INITIATIVE

Geology and Groundwater Environment

Geology and Groundwater Environment

Groundwater, storm water and waste water quality & flow; soil quality

Aquatic Environment

Aquatic Environment

Water quality, flow and sediment quality

Terrestrial Environment

Terrestrial Environment

Plants and wildlife habitat

PORT HOPE AREA INITIATIVE

Socio-Economic Environment

Socio-Economic

Community life, heritage, Aboriginal interests, traffic and transportation

PORT HOPE AREA INITIATIVE

Emergency Planning

PLAN

Identify potential risks and how to prevent and reduce them

TRAIN

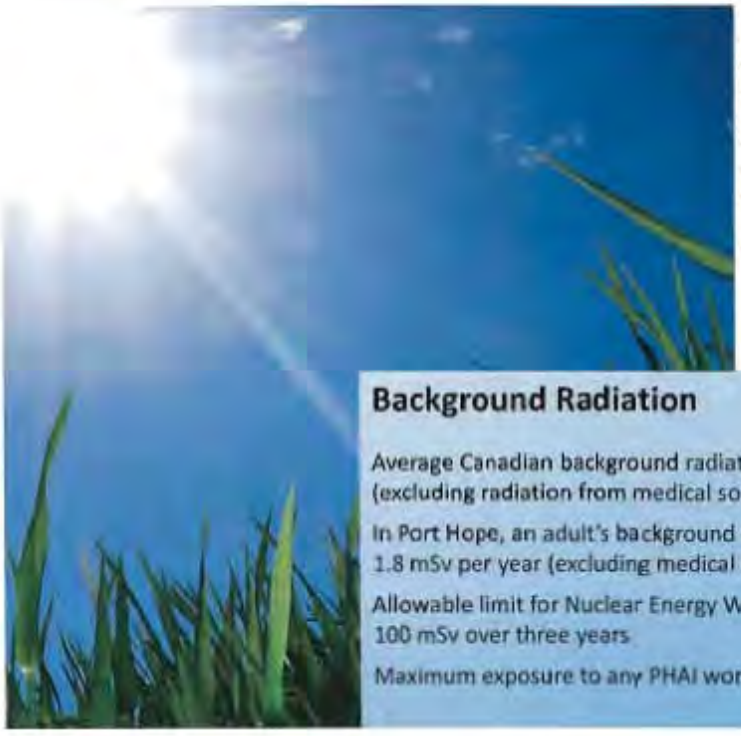
Use experience and lessons-learned to reduce risks and prevent emergencies

RESPOND

Respond according to defined and approved plans

PORT HOPE AREA INITIATIVE

Radiation Protection



- Radiation Protection Plan
- Dedicated Radiation Protection Staff
- Canadian Nuclear Safety Commission oversight
- Control Dust
- Monitor for airborne radioactivity
- Monitor does rates from activities
- Monitor workers
- Use protective equipment and clothing

Predicted public doses from construction and cleanup will be much less than the CNSC limit of 1mSv/yr for members of the public

Background Radiation

Average Canadian background radiation is about 2 mSv per year (excluding radiation from medical sources);

In Port Hope, an adult's background radiation is approximately 1.8 mSv per year (excluding medical doses);

Allowable limit for Nuclear Energy Workers (NEW) – 50 mSv per year or 100 mSv over three years

Maximum exposure to any PHAI worker will be confined to 3 mSv per year

PORT HOPE AREA INITIATIVE

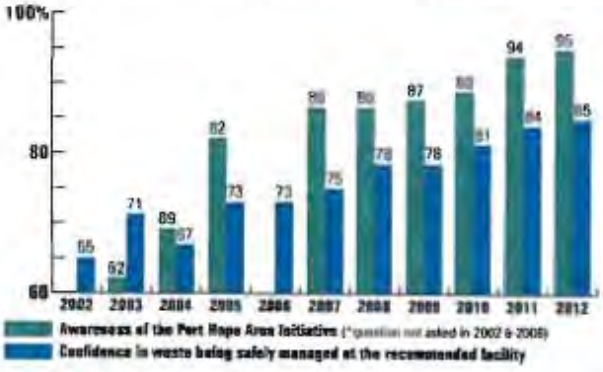
Communications

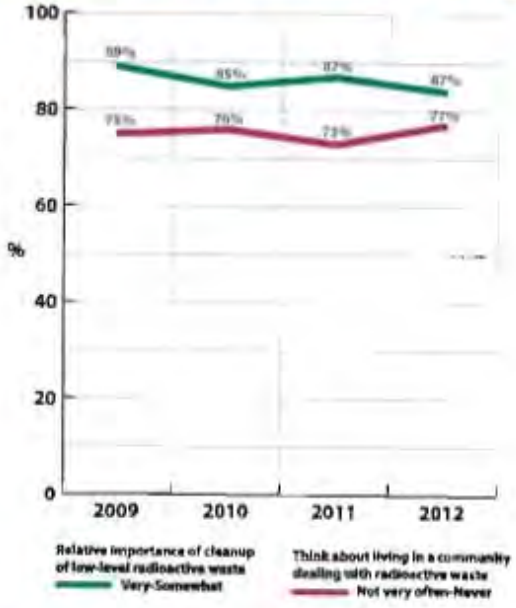
PORT HOPE AREA INITIATIVE

Port Hope Public Attitude Survey

Powerful tool to:

- Measure effectiveness of communications program
- Understand people's attitudes and preferences
- Monitor their evolving understanding of the projects
- Adjust and prioritize communications approaches based on findings





11 years of survey data clearly demonstrate increasing awareness (95%) and confidence (85%)

Canada

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PORT HOPE AREA INITIATIVE

Property Value Protection Program

- PVP Program offers compensation to eligible property owners if they experience:
  - Loss on sale;
  - Loss on rental income;
  - Mortgage renewal difficulties
- Legal Agreement commitment; in place until two years after the LTWMF is capped and closed – 2001 to 2024
- Protects property owners from real estate losses caused by project activities; contributes to stabilized real estate market and public confidence.

Canada

PORT HOPE AREA INITIATIVE

Port Granby Project

Canada

PORT HOPE AREA INITIATIVE

Port Granby Existing Site

Canada

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PORT HOPE AREA INITIATIVE

Lakefront Bluffs

Canada

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PORT HOPE AREA INITIATIVE

Port Granby Project

Canada

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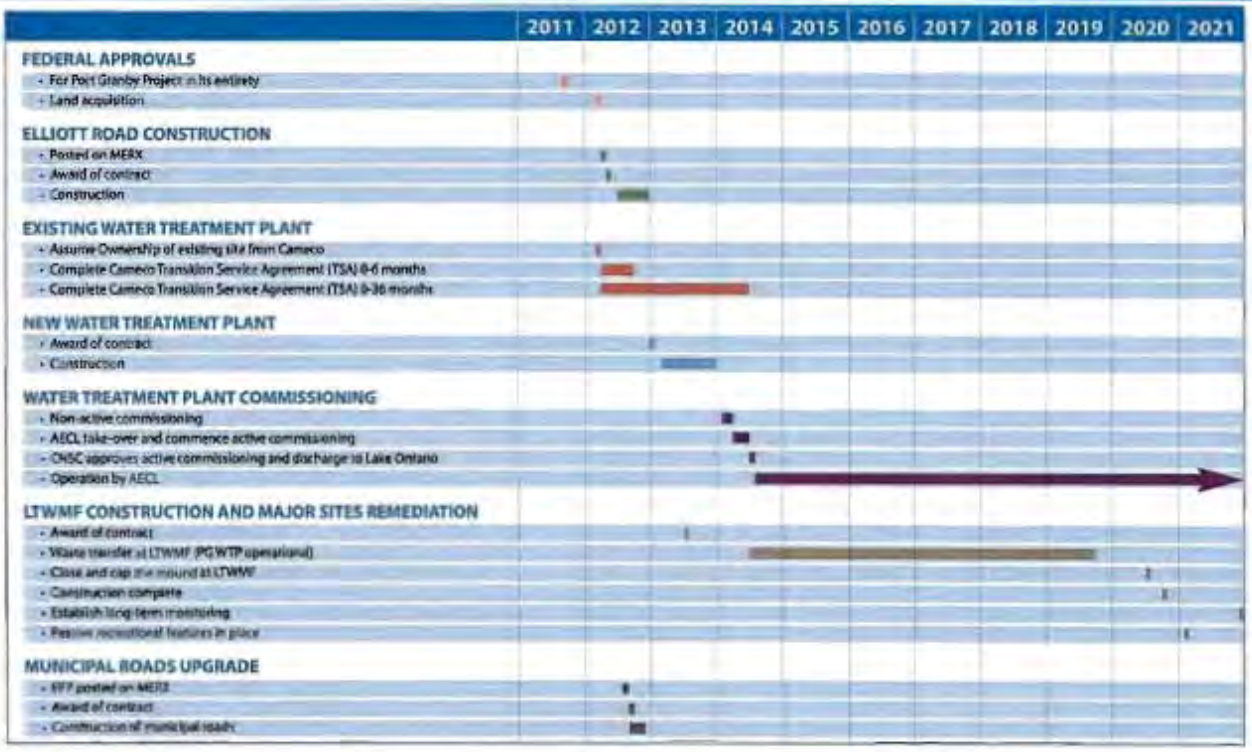
PORT HOPE AREA INITIATIVE

Schedule



Canada

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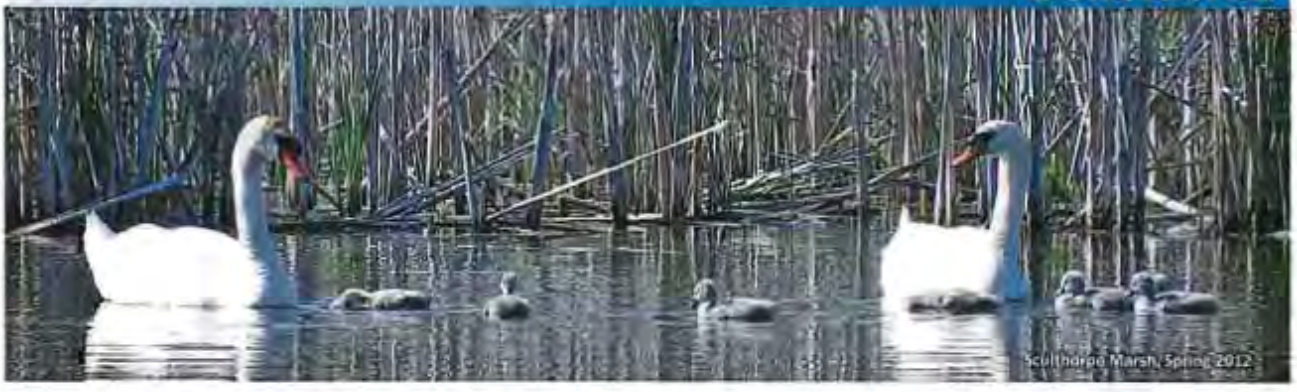
PORT HOPE AREA INITIATIVE

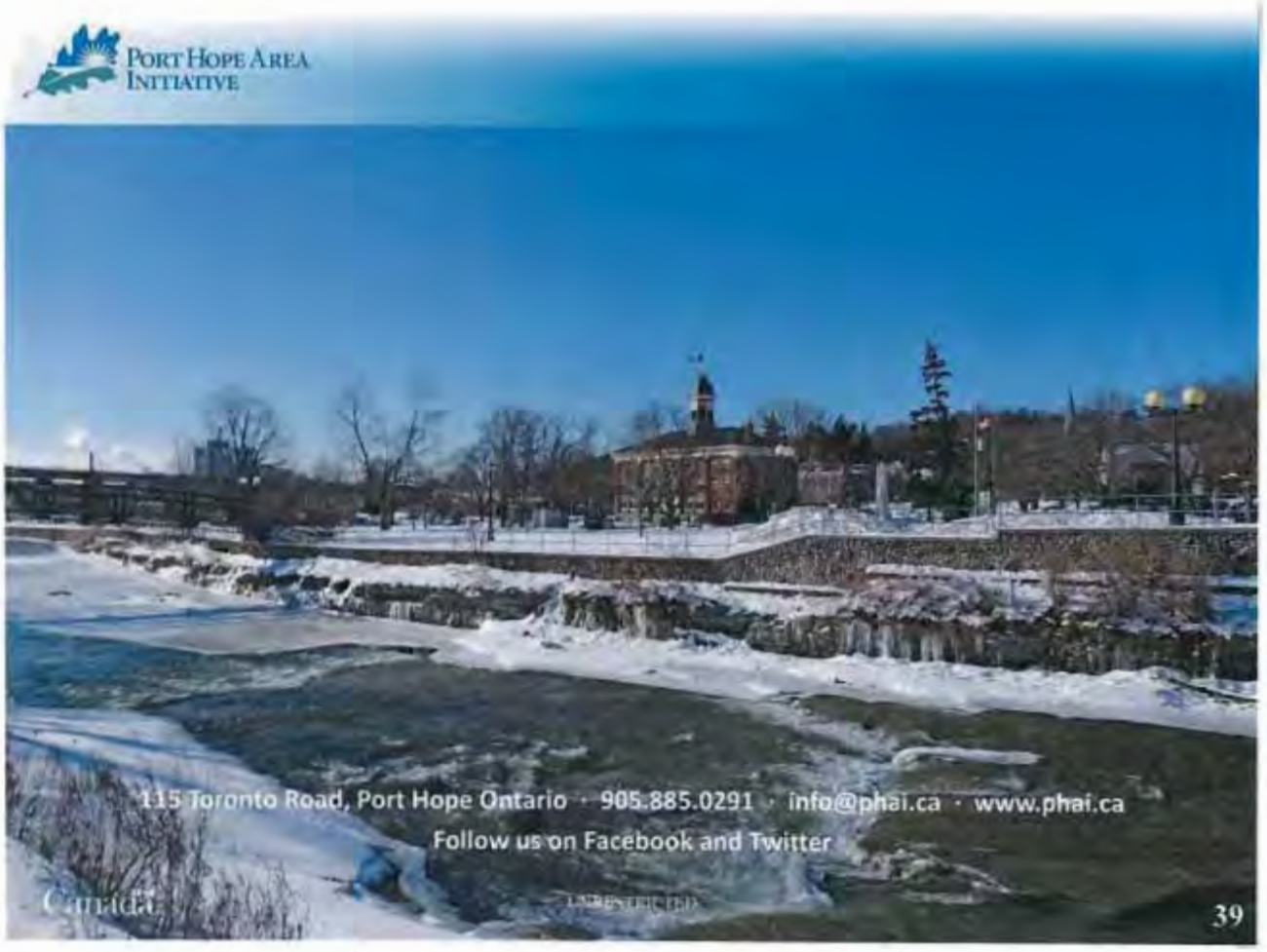
Conclusion



- Design documentation is complete
- Plans, programs and team in place
- Health, safety and the environment top priorities
- Government of Canada funding commitment
- Ready to proceed and complete Phase 2 over the next 10 years

Canada

UNRESTRICTED


Port Hope Area Initiative
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Canada
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Port Hope Area Initiative
Port Granby Project
Port Hope Project
Tour Guide

PORT HOPE AREA INITIATIVE

Tour Guide

The Port Hope Area Initiative (PHAI) is a community-initiated environmental remediation project that began in 2001.

Its goal is the cleanup and safe, local, long-term management of low-level radioactive waste in the Port Hope area and the Port Granby waste storage facilities. The waste is historic in nature because it resulted from radium and uranium refining done in Port Hope dating back to the 1930s. The Government of Canada has assumed responsibility for the cleanup and long-term safe management of this waste. The PHAI will contribute to the long-term renewal and regeneration of Port Hope and the Port Granby waste site area. Potential project benefits include an improved natural environment and enhanced opportunities for social and economic growth.

The initiative includes two separate projects:

PORT HOPE PROJECT

The Port Hope Project involves the cleanup of approximately 1.4 million cubic metres of historic low-level radioactive waste in various locations throughout the community, the construction of an engineered aboveground mound for its safe long-term management on the site of the current Welcome Waste Management Facility and long-term maintenance and monitoring.

PORT GRANBY PROJECT

The Port Granby Project involves the relocation of approximately 450,000 cubic metres of historic low-level radioactive waste from an existing site in the Municipality of Clarington on the shoreline of Lake Ontario to a new engineered aboveground mound facility 700 metres north, away from the lake, where it will be safely managed and monitored for hundreds of years.

HISTORY OF LOW-LEVEL RADIOACTIVE WASTE IN THE REGION

There was a time, a century ago, when radium was heralded as a miracle element – a cure-all for everything from tummy upset to cancer. You could buy radium pendants for rheumatism, all-natural radon water for vigour, uranium blankets for arthritis and thorium-laced medicine for digestion. Radium solutions like "Radithor" health tonic were all the rage.

Radium was also used for its luminous qualities on watch dials. It was even combined in products such as toothpaste, fertilizer, makeup and food.

As a so-called "wonder of the age," radium was one of the most valuable elements on the planet.

In fact, one tiny, pea-sized chunk of radium could sell at the time for close to $70,000.

Find the radium... find your fortune.
Charles and Gilbert Labine found both. While prospecting for silver near Great Bear Lake in Northwest Territories in the 1920s, the Labine brothers discovered pitchblende ore – a raw material with component parts of radium and uranium. It was a find of potentially epic financial proportions.

But it wasn't easy to get the radium out of the ore. It took approximately one ton of pitchblende ore combined with ten tons of chemicals to produce a few precious grams. The Labine brothers launched a search for a location big enough to accommodate their radium extraction operation and close enough to water for easy access to shipping. They found it the day they got off the train in Port Hope, Ontario. Conveniently located on the shore of Lake Ontario, Port Hope even offered an empty waterfront factory ready for occupation.

PORT HOPE HARBOUR 1930's
INSETS WORKING WITHIN ELDORADO

HISTORY OF LOW-LEVEL RADIOACTIVE WASTE IN THE REGION (cont'd)

The Labine brothers' company, Eldorado Gold Mines Ltd., ran a prosperous operation in Port Hope in the 1930s. Their factory provided needed jobs and supplied a market hungry for radium, but troubles began to mount. They were far from the world's only source – and were soon faced with increasing competition and complications ensuing from the advent of World War II. With market share slipping away, the Labines needed a new source of revenue. They found it in the mountains of rubble created by the radium refining operation.

In this discarded waste was a by-product called uranium that would prove to be another historic "find." The market for uranium — including the research and development of atomic weapons — would soon change their fortunes forever.

With the level of sensitivity and security surrounding activities in the plant now heightened, Eldorado's Port Hope operation was purchased by the Government of Canada in 1942, creating Eldorado Limited, a Crown Corporation.

Historic, low-level radioactive waste

As previously mentioned, it took massive amounts of ore and chemicals to refine tiny amounts of radium and uranium. Leftover material was discarded in a wide variety of ways – and places. These waste materials contain radium-226, uranium, arsenic and other contaminants resulting from the refining process.

Consistent with waste disposal practices of the time, some of the rubble was simply discarded around the former Eldorado plant, some swept into Port Hope harbour, some dumped in local dumpsites and some distributed throughout the community as fill.

Roughly one million cubic metres of historic low-level radioactive waste and contaminated soil are now located at various sites throughout the Municipality of Port Hope and at the Welcome Waste Management Facility, which has been closed since 1955.

Following the closure of the Welcome site, a new facility was developed in Port Granby, Ontario, in the Municipality of Clarington.

The Port Granby Waste Management Facility accepted local historic low-level radioactive waste until its closure in 1988.

As part of the PHAI construction phase, the waste will be excavated from its current locations and safely transported to state-of-the-art, long-term low-level radioactive waste management facilities in the respective communities.

NOTE: The historic waste found at various locations in urban Port Hope is monitored and inspected regularly by the Low-Level Waste Management Office to ensure that it does not pose a risk to health or the environment.

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Highland Dr. South ravine	Page 30
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CHRONOLOGY: 1932 to 2001

1932
Eldorado Gold Mine Ltd. opens radium refining facilities in Port Hope

1933 – 1939
Processing residues retained on plant site

1934 – 1944
Processing residues stored 300 – 400 metres west of plant site (Eldorado Disposal Area)

1930s – 1970s
Properties and sites in the Town of Port Hope become contaminated from spillage during transportation, purposeful, unmonitored or unauthorized diversion of contaminated fill and materials, wind and water erosion and spread from residue storage areas

1942 – 1954
Production emphasis shifts from radium to uranium refining

1944
Government of Canada takes over Eldorado Gold Mines Ltd. And the company is renamed Eldorado Mining and Refining Ltd.

1945 – 1948
Processing residues stored at Monkey Mountain Residue Area (beside Highland Drive, then known as Pidgeon Hill) in Port Hope

1948 – 1974
Used equipment, incineration etc. (not residue) stored at Pidgeon Hill storage compound

1948 – 1954
Residues stored at Welcome Disposal Area in Hope Township, approx. 3 km northwest of the plant site

1952 – 1954
Radium refining stops facilities dismantled and removed from plant site

1955 – 1980
Waste management operations moved approx. 12 km west to Port Granby Residue Area in Clarke Twp. near Clarington

1963
Company becomes Eldorado Nuclear Ltd. and in 1982, Eldorado Resources Ltd.

1976 – 1981
Atomic Energy Control Board directs a large-scale radiation reduction program in the Town of Port Hope (over 100,000 tonnes of contaminated soil are transferred to a site at Chalk River Laboratories

1982
Low-Level Radioactive Waste Management Office (LLRWMO) is established to manage historic waste in the Town of Port Hope and across Canada

1982 – present
LLRWMO investigates characterizes and consolidates certain waste within the Town of Port Hope and establishes Construction Monitoring Program to maintain construction spread

1985 – present
Cameco's programs for waste reduction, regulating and recovery, remedy waste generation (small volumes of waste produced are now stored on site)

1988
The federal government establishes a Sting Task Force on Low-Level Radioactive Waste Management to site a permanent management facility for Port Hope Area wastes

1988 – 1996
Sting Task Force meets all Ontario municipalities to consider hosting a long-term management facility for low-level radioactive waste, but no agreement reached

1997
Hope Township initiates a community proposal to construct a long-term waste management facility for wastes at the Welcome Waste Management Facility site

1999
Port Hope and Clarington also develop proposals to establish long-term management facilities for low-level radioactive wastes within their communities

2000
The Government of Canada and Hope Township Port Hope (now amalgamated to form the Municipality of Port Hope) and Clarington Issue Principles of Understanding, outlining terms for a project to clean up low-level radioactive waste

2001 – The Port Hope Area Initiative begins
A Legal Agreement is signed which commits the federal government and the municipalities to the site cleanup, transportation, isolation and long-term management of historic low-level radioactive waste

WASTE SITE AND TRANSPORTATION ROUTE MAP

The Port Hope Project involves the construction of a new long-term waste management facility at the closed low-level radioactive waste management facility and adjacent property, south of Highway 401 and west of Baulch Road, in the Municipality of Port Hope. Existing waste at the site will be excavated and placed in a new, engineered aboveground mound.

Other historic low-level radioactive waste and specified industrial waste from various sites in the urban area of Port Hope will be removed and safely transported to the new facility. The facility is being designed to manage a capacity of approximately 2 million cubic metres of waste (including contingencies and daily clean soil cover materials) from within the Municipality of Port Hope.

Transportation routes were determined during the Environmental Assessment phase to minimize disruption to the community and use existing truck routes.

TOUR STOPS

Tour stop 1

Strachan St. Ravine Area (10,17)

Tour stop 2

Major sites, South end (5,16,9)

Tour stop 3

Waterworks site (7)

Alexander St. Ravine (6)

Former Coal Gasification Plant (18)

Tour stop 4

East waterfront sites (15,14,13)

Tour stop 5

Highland Drive Area (1,2,3,4,11,12)

Tour stop 6

Current Waste Management Facility

Tour stop 7

Current Waste Management Facility, Port Granby

TOUR STOP 1: STRACHAN STREET RAVINE AREA

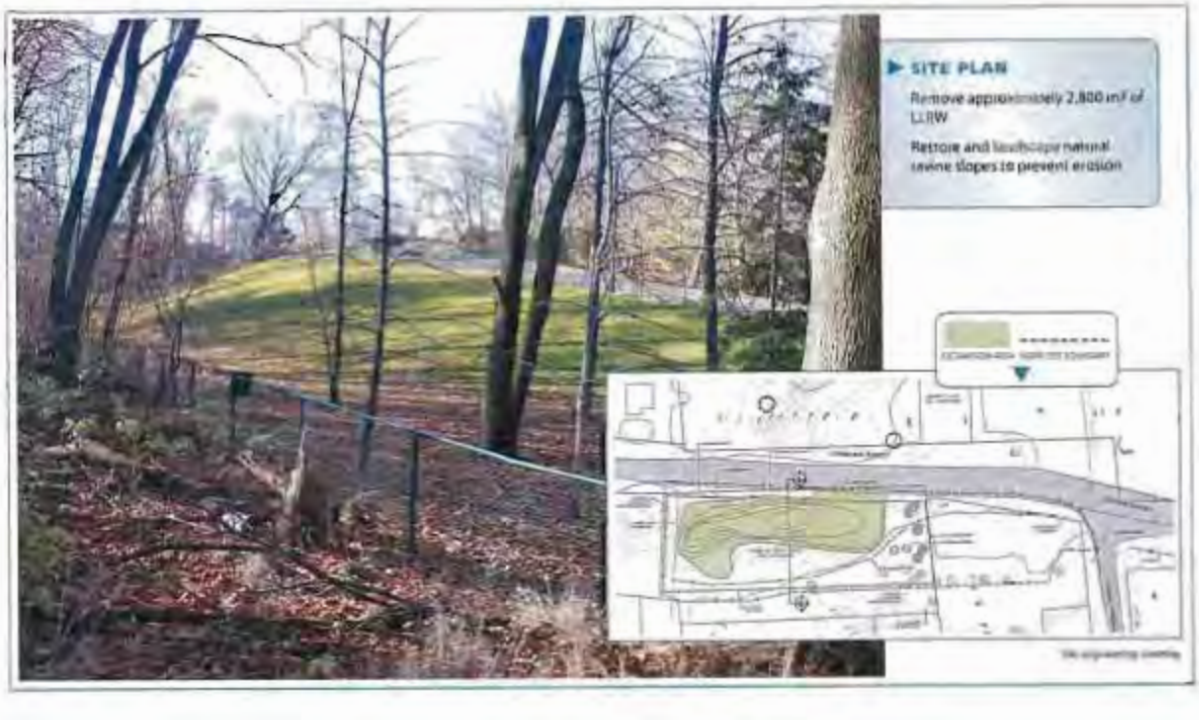
10 ❑ **Strachan Street Ravine consolidation site**

17 ❑ **Lions Club Recreation Centre (foundry waste)**

Numbers coincide with the key waste site map legend

STRACHAN STREET RAVINE CONSOLIDATION SITE

LOW-LEVEL RADIOACTIVE WASTE (LLRW) SITE



LIONS CLUB CENTRE RECREATION SITE (FOUNDRY WASTE)

HISTORIC INDUSTRIAL WASTE SITE

TOUR STOP 2: WATERFRONT AREA SITES

5
- Waterfront Area Sites
- Port Hope Harbour
- (Geotube technology)

16
- Centre Pier (Industrial Waste)

8
- CN and CP Viaducts Area

9
- Mill St. South Site (Firefighter's Museum)

Numbers coincide with the key waste site map legend

WATERFRONT AREA SITES

HISTORIC INDUSTRIAL/
LOW-LEVEL RADIOACTIVE
WASTE SITES

PORT HOPE HARBOUR

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE

Geotubes separate contaminated water from sediment – water treated on site

Harbour wall rehabilitation drawing

Site engineering drawing

GEOTUBE TECHNOLOGY

CENTRE PIER

HISTORIC INDUSTRIAL/
LOW-LEVEL RADIOACTIVE
WASTE SITES

CN AND CP VIADUCTS AREA

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE

Site engineering drawing

MILL STREET S. SITE (FIREFIGHTER'S MUSEUM)

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE

Site engineering drawing

TOUR STOP 3: WEST BEACH AREA

7 ❑ West Beach, former waterworks site

6 ❑ Alexander Street Ravine site

18 ❑ Former Coal Gasification plant

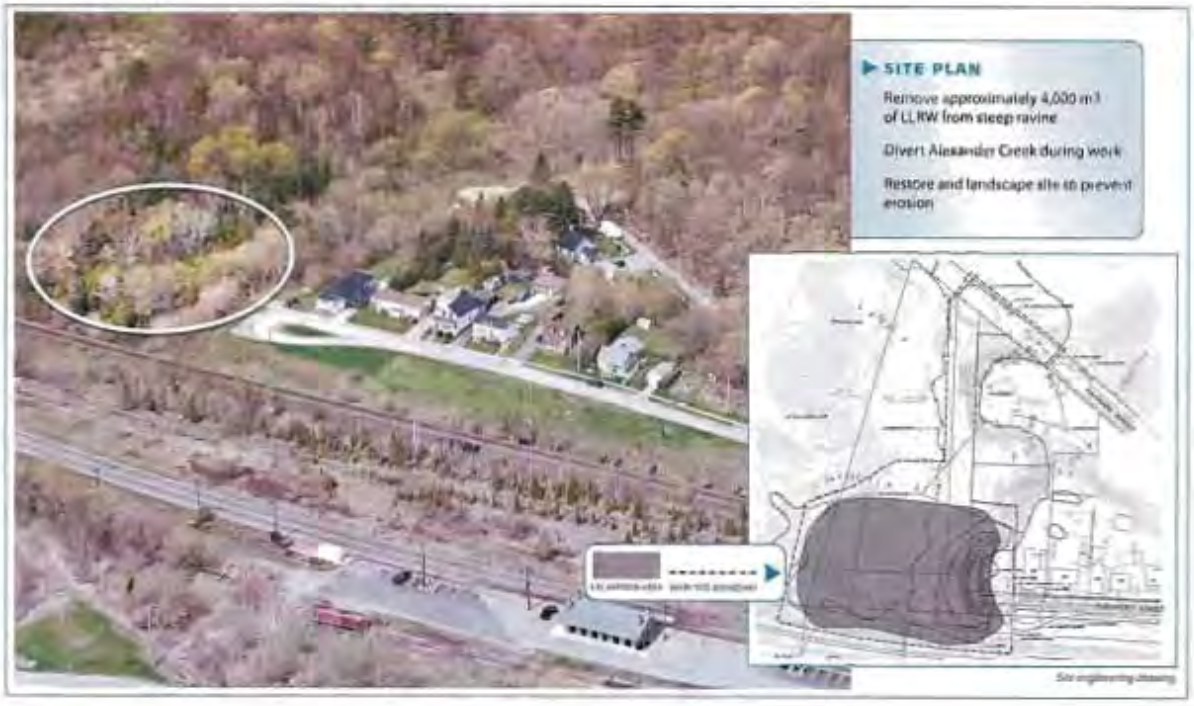
Numbers coincide with the key waste site map legend

WEST BEACH, FORMER WATERWORKS SITE

LOW-LEVEL RADIOACTIVE WASTE (LLRW) SITE

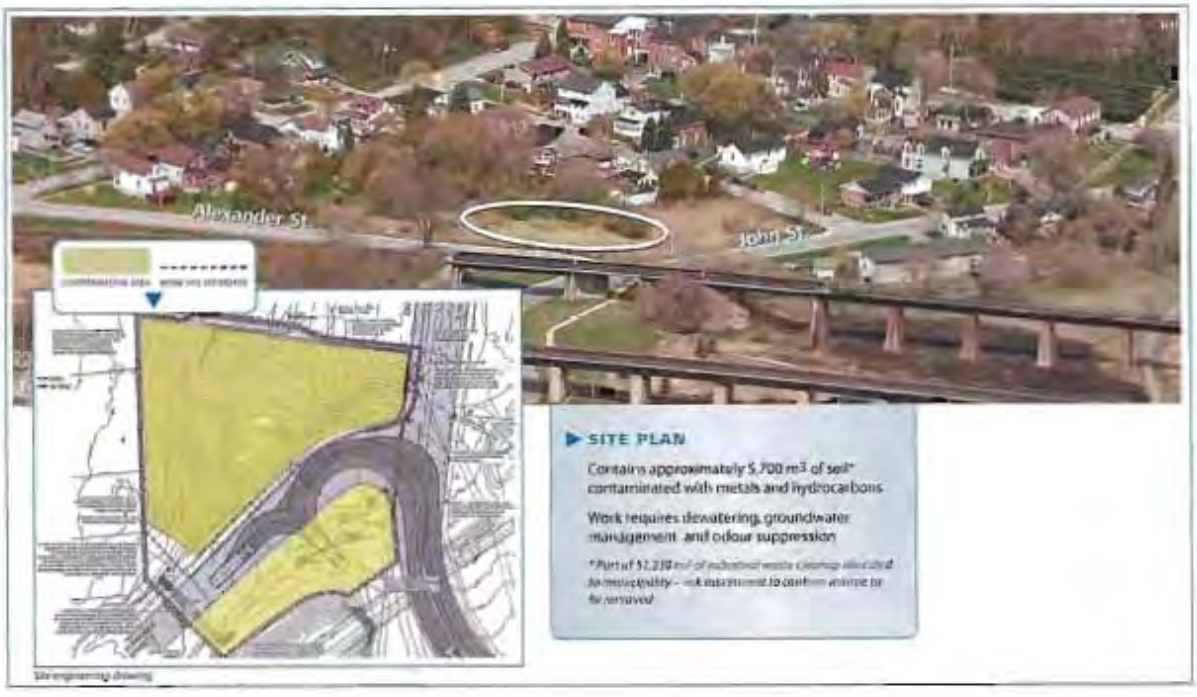
ALEXANDER STREET RAVINE

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE



FORMER COAL GASIFICATION PLANT

HISTORIC
INDUSTRIAL
WASTE SITE



TOUR STOP 4: EAST WATERFRONT – MUNICIPAL/INDUSTRIAL SITES

15 ❑ **Chemetron Lagoon**

14 ❑ **Sewage Treatment Plant Sludge**

13 ❑ **Sewage Treatment Plant Temporary Storage Site (dosed)**

Numbers coincide with the key waste site map legend

EAST WATERFRONT SITES

HISTORIC INDUSTRIAL/
LOW-LEVEL RADIOACTIVE
WASTE SITES

TOUR STOP 5: HIGHLAND DRIVE AREA SITES

- 1 ❑ Highland Drive municipal landfill site (closed)
- 3 ❑ Highland Drive road bed
- 4 ❑ Highland Drive South ravine
- 11 ❑ Highland Drive Northern sites
  - 2 ❑ Pine Street extension consolidation site
  - ❑ Pine Street extension road bed
- 12 ❑ Pine Street extension temporary storage site

Numbers coincide with the key waste site map legend

HIGHLAND DRIVE AREA SITES

LOW-LEVEL RADIOACTIVE WASTE (LLRW) SITE

HIGHLAND DRIVE ROAD BED

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE

HIGHLAND DRIVE SOUTH RAVINE

LOW-LEVEL
RADIOACTIVE WASTE
(LLRW) SITE

HIGHLAND DRIVE NORTHERN SITES

- **HIGHLAND DR. LANDFILL**
  Remove approximately 50,000 m³ of LLRW
  Separate LLRW from landfill solid waste
  Schedule work during fall and winter to minimize odours
- **PINE ST. N. EXTENSION ROADBED**
  Remove approximately 7,000 m³ of LLRW from internal roadway
- **PINE ST. N. TEMPORARY STORAGE SITE**
  Remove approximately 9,000 m³ of LLRW generated from ongoing clean-up activities
- **PINE ST. N. CONSOLIDATION SITE**
  Remove approximately 47,000 m³ of LLRW from existing storage mound

TOUR STOP 6: CURRENT WASTE MANAGEMENT FACILITY, WELCOME

- ❑ Current Waste Management facility, Welcome
- ❑ Onsite support buildings
- ❑ Aboveground mound cross section
- ❑ Completed facility

Numbers coincide with the key waste site map legend

CURRENT WASTE MANAGEMENT FACILITY, WELCOME

The Port Hope Project involves the construction of a long term waste management facility (LTWMF) between Baulch and Brand roads south of Highway 401 in Port Hope, the remediation of various contaminated sites within the Municipality including the harbour and specified historic wastes from the Cameco site; the transfer by truck of the contaminated material to the new facility along specified transportation routes; integration of wastes at the existing Welcome waste management facility; and the maintenance and monitoring of the facility for several hundred years.

An estimated 1.4 million cubic metres (m3) of waste, primarily contaminated soils will be placed in the new LTWMF originating from the following sources within the Municipality:

- Approximately 620,000 m3 of LLRW from the existing Welcome Waste Management Facility;
- Approximately 572,000 m3 of LLRW and commingled waste from various remediation sites in the Municipality;
- Approximately 51,250 m3 of waste from contaminated industrial sites; and,
- 150,000 m3 of Cameco-owned pre-1988 waste and waste from demolished buildings (*Cameco Vision 2010*).

The LTWMF will have a containment capacity of 1.9 m3 to allow for a contingency should additional waste above cleanup criteria be found. The LTWMF will consist of an above-ground engineered containment mound with a low-permeability base liner and final cover. The site will be accessed by a project access road extending west from Toronto Road.

CURRENT WASTE MANAGEMENT FACILITY, WELCOME

PORT HOPE PROJECT
LONG-TERM WASTE
MANAGEMENT FACILITY

ONSITE SUPPORT BUILDINGS

1. Truck Decontamination Facility

2. Facility Operations Centre

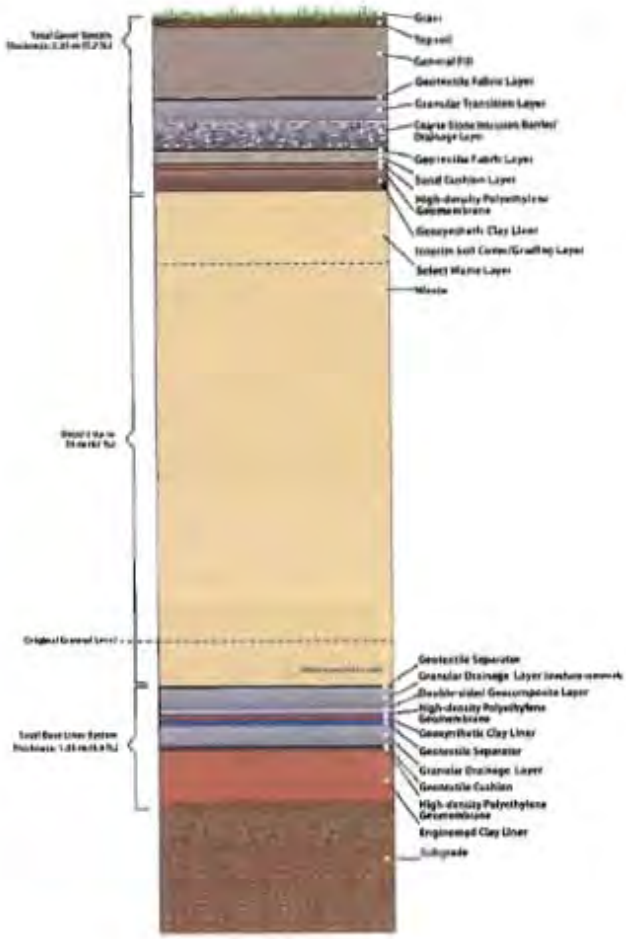
3. Truck Weighing Station

ABOVEGROUND MOUND CROSS SECTION

Multiple layers of natural and manufactured materials encase the waste and isolate it from the environment.

COVER SYSTEM: two impermeable layers in the cover system keep the waste dry by preventing moisture from entering the mound. A thick fill layer provides shielding – ensuring surface radiation is the same as natural background level once the mound is capped and closed.

BASE LINER SYSTEM: a double base liner incorporates multiple impervious layers to prevent contamination from entering the groundwater. Mound performance is monitored through collection of water (leachate) removed from this layer.



COMPLETED FACILITY

TOUR STOP 7: CURRENT WASTE MANAGEMENT FACILITY, PORT GRANBY

- ❑ Current Waste Management facility, Port Granby
- ❑ Transporting waste
- ❑ Building an aboveground mound

Numbers coincide with the key waste site map legend

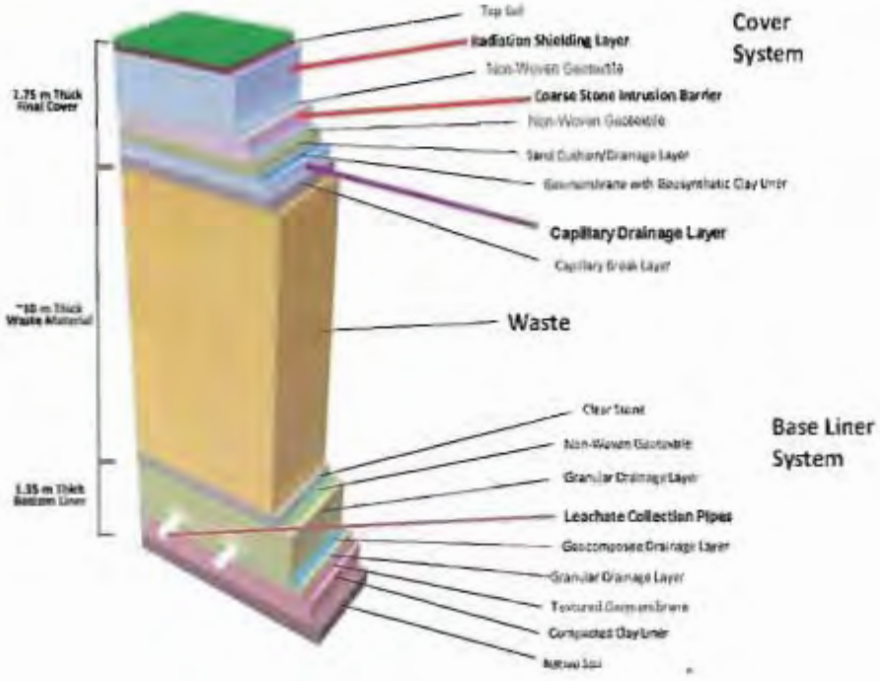
PORT GRANBY PROJECT

CURRENT WASTE MANAGEMENT FACILITY, PORT GRANBY

CURRENT WASTE MANAGEMENT FACILITY, PORT GRANBY

TRANSPORTING WASTE

BUILDING AN ABOVEGROUND MOUND



PORT HOPE AREA INITIATIVE

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The Management of Cameco Corporation's Fuel Services Division Waste

Thomas Smith
Senior Environmental Specialist
Cameco Corporation

March 12, 2013

Topics

- Cameco Corporation Overview
- Cameco's Fuel Services Division
- Waste Historical Context
- Recycling Programs
- Current Waste Disposal Practices
- Vision In Motion Project
- Long Term Decommissioning Plans

Cameco

Cameco Corporation Overview

- World leader in uranium production
- Headquartered in Saskatoon, Saskatchewan
- Provides 16% of the world uranium mine production
- 435 million pounds of proven and probable reserves
- Major supplier of uranium processing services
- Fuel Services Division - Blind River, Cobourg and Port Hope, ON
- 31.6% share of Bruce Power – B Units

Cameco

Fuel Services Division

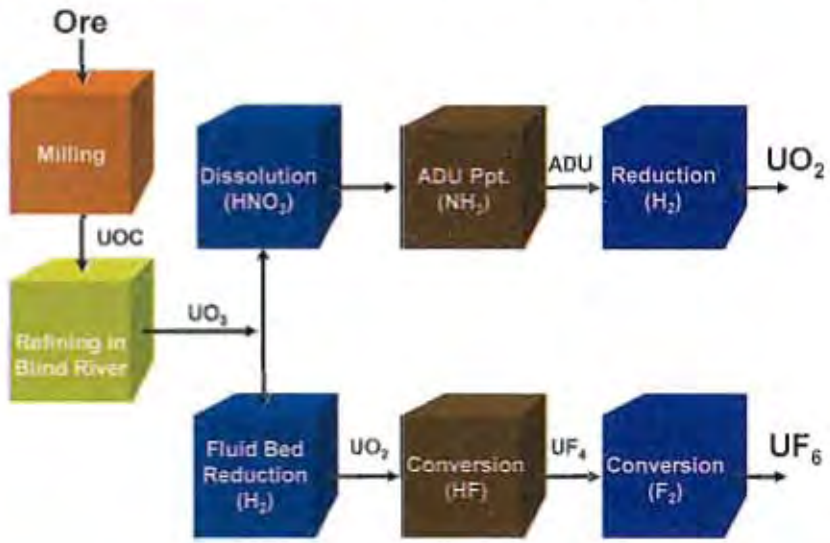
Port Hope conversion facility (PHCF)

Blind River refinery (BRR)

Cameco fuel manufacturing (CFM)

Cameco

Uranium Conversion Process



Cameco

Port Hope conversion facility

Fuel Services History

1932	Gilbert Labine started radium refinery
1953	Radium refining ended
1955	Port Granby WMF opened
1957	American Machine and Foundry (AMF) established in Port Hope
1958	Uranium metal production started
1959	UO_2 production started
1964	AMF acquired by Westinghouse
1970	UF_6 production started
1978	New UO_2 plant
1983	Blind River refinery opened
1984	New UF_6 plant
1988	Cameco formed
1988	Port Granby WMF closed
1988	Westinghouse purchased and renamed Ziractec Precision Industries (ZPI)
2006	Cameco acquires ZPI and renames Cameco Fuel Manufacturing
2010	Welcome WMF transfers to Natural Resources Canada
2012	Port Granby WMF transfers to Natural Resources Canada

Cameco

Welcome waste management facility

Cameco

Port Granby waste management facility

Cameco

Recycle Programs

- Production process recycling started late 1970's
- Liquid and solid chemical residues containing recoverable uranium were recycled at uranium mines located in Agnew Lake, Elliott Lake and Bancroft, Ontario until 1996
- Post 1996, the processes were modified to produce solid products. These are now sent to a uranium mill located in Blanding, Utah for uranium recovery
- Cameco introduced techniques to clean and free release metal for recycle at the PHCF
- Contaminated combustible materials are incinerated at the BRR and the ash is recycled

Cameco

Ammonium nitrate

- All ammonium nitrate produced by UO_2 operations and certified sold to Agrico Canada Ltd.
- Quantity released in calendar year 2004 was 2014 tonnes, with 2206 tonnes being produced.
- The 2003-2004 fiscal year ended June 30. The average concentrations of uranium and radium in the solution were well below the CNSC limits
- Average of 2 to 3 mg U/l
- Mixed with Urea and spread agricultural as 28 % nitrogen.

Current Waste Management Practices

- Cameco cleans contaminated metal for free release
- Cleans metal using grit blasting equipment
- Recycles metal that meets criteria
- All contaminated combustibles are incinerated
- Contaminated non-combustibles disposed at a permitted landfill

Cameco

Current Waste Management Practices

- Certain wastes not amenable to internal processing
- Disposal options for low-level radioactively contaminated wastes are limited primarily due to cost considerations
- In recent years, Cameco has started to ship marginally contaminated wastes (<500 ppm uranium) to the United States for disposal in a permitted landfill

Cameco

Current Waste Management Practices

- Marginally contaminated material sent to USEI for disposal:
  - Concrete
  - Soil
  - Spent carbon anodes
  - Insulation
  - Roofing material
  - Uranium ore concentrate

- Objective to divest FSD of all legacy waste by the end of 2016

Cameco

Current Waste Management practices

- Landfill owned by US Ecology Incorporated (USEI)
- Located near Grandview, Idaho
- Facility treats and disposes hazardous waste, non-hazardous industrial waste and low-activity radioactive material
- Site characteristics help ensure permanent waste isolation
  - arid climate
  - deep groundwater
  - favourable geology
  - multi-layer liner system

- Grand View facility represents an ideal choice to minimize environmental liability

Cameco

The Blind River Refinery Project

- Restoration projects at PHCF generated 560 Quatrex totes of marginally contaminated materials
- Totes transferred to the BRR for incineration
- Incineration not possible - stored in yard awaiting disposal options
- Material characterized jointly between Cameco and USEI
- Waste material met the USEI Waste Acceptance Criteria (WAC)

Cameco

The Blind River Refinery Project

- Quatrex totes containing waste not acceptable for transport due to weather degradation
- Totes repackaged into PacTec IP2 rated lift bags
- Total of 273 PacTec lift bags
- USEI gondola rail cars dispatched to Blind River
- Bags loaded on flatbed trailers at the BRR, local trucking firm off-loaded at the rail siding
- Rail cars picked up and delivered to the USEI facility

Cameco

Successes

- Bags transferred from railcar to truck in US

- USEI disposal facility

Cameco

Vision In Motion Project

- Vision in Motion is a remediation project at PHCF
- Removal of soil, demolition of structures
- Waste to be disposed at LTWMF in Port Hope
- 150,000 m^3 allocated for Cameco waste
- EA approved in 2012

Cameco

Long Term Decommissioning

- Cameco is required to maintain Preliminary Decommissioning Plans (PDP) for its licensed facilities
- PDPs and resulting financial guarantees are updated every 5 years
- Produced in accordance with CNSC regulatory guidelines and CSA standards
- The current PDP's are predicated on demolition and clean up of the Blind River Refinery and Port Hope Conversion Facility. The Cameco Fuel Manufacturing (CFM) structure would be decontaminated but left standing.
- All wastes arising from the decommissioning projects would be stored in an above ground engineered mound to be located in Blind River

Cameco

Summary

- Cameco's Fuel Services Division has operated successfully for >20 years since the closing of the PGWMF
- Cameco makes every effort to minimize the generation of waste by recycling when possible
- Certain non-recyclable uranium contaminated wastes that meet the USEI WAC are being shipped to the USEI landfill located near Grandview, Idaho for disposal
- Vision In Motion is a near term clean up of the PHCF
- Long term decommissioning plans are in place with the appropriate financial guarantees

Cameco

Thank You

Community Engagement

Bill Koch
Director, Public and Government Affairs
March 12, 2013

Community Engagement

- **22 community forums since 2006**
  - Past health studies
  - Economic impact
  - CNSC relicensing process
  - Panel of health experts
  - Emissions
  - Radiation
  - Fire safety/emergency response
  - Community investment
  - Public opinion research

Cameco

Community Engagement

- **Community Newsletter - *Energize***
  - Mailed to every home in Port Hope three times a year
  - 150,000+ distributed since 2006

Cameco

Community Engagement

- **Presence at community events such as the Port Hope Fall Fair**
- **Outreach to local schools – partner with Scientists in Schools**
- **Established community website in 2006**
  - Reportable spills to the Ontario Spills Action Centre
  - Quarterly Monitoring and Operational Performance Report
  - Annual public opinion results
  - Public disclosure protocol

Cameco

Community Engagement

- Stakeholder meetings
- Quarterly updates to Port Hope Council
- News releases/media inquiries
- Community investment
- Employee giving & volunteerism

Cameco

Community Engagement

Blind River

- Regular meetings with Chief and council of the Mississauga First Nation (MFN)
- Memorandum of Understanding signed in 2010
- Training opportunities

Cameco

Local Economic Impact

- Approximately 775 employees in Northumberland County
- Cameco accounts for approximately 13% of all economic activity in Port Hope (2010 study conducted by Professor Harry Kitchen of Trent University)
- 160 employees in Blind River

Cameco

Thank You

Cameco

THE TEXAS SOLUTION

WCS Waste Disposal Licenses

- Low Level Radioactive Waste and Mixed LLRW Disposal
  - Final LLW license received – September 2009
  - CWF - First LLW disposed – April 2012
  - FWF - Ready for operations – September 2012
- Includes Federal and Compact Landfills
  - Texas Commission on Environmental Quality (TCEQ) has taken ownership of Texas Compact Landfill and WCS leases it back for operations.
  - U.S. Department of Energy (DOE) signed Agreement to take ownership of the Federal landfill post-closure.

Texas Low Level Radioactive Waste Compact Commission

- Federal Low-Level Waste Policy Act (LLWPA) passed by U.S. Congress in 1980, amended in 1985.
- LLWPA authorized states to form Compacts for safe, secure disposal of low-level radioactive waste. Texas, Vermont and Maine subsequently form Texas Compact. (Maine withdraws prior to licensing and construction.) Vermont has paid state of Texas $25 million for LLRW disposal guarantee.
- Texas LLRW Disposal Compact Commissioners appointed by Texas and Vermont governors in 2009. New appointments made in 2011 by both Vermont and Texas.
- Compact Commission held their first meeting in Feb. 2009. Meets regularly to approve import and export petitions.
- WCS operates the Texas Compact disposal facility – the first site licensed and opened under LLWPA.

THE TEXAS SOLUTION

Texas Commercial Low Level Radioactive Waste Disposal Facility

Waste Control Specialists (WCS) operates the disposal facility for the Texas Low-Level Radioactive Waste Compact Commission, under a license issued by the Texas Commission on Environmental Quality (TCEQ). Located in remote Andrews County, the facility is located in an ideal semi-arid environment, situated in a geologic formation of relatively impermeable red bed clay. The unique design of the facility makes it the most robust low level disposal operation ever constructed and assures that it will be protective of human health and safety -- and the environment -- for centuries to come.

Safety and the Environment

The Texas Compact Disposal Facility features the most environmentally protective design in the industry with below-grade disposal in concrete-lined cells that are constructed inside a natural 600-foot formation of almost impermeable Dockum red-bed clay. The waste is placed in steel reinforced concrete containers which sit atop more than seven feet state-of-the-art comprehensive liner system. During the construction and licensing process, over 640 borings were taken to determine geologic characteristics and confirm that the facility is not over an aquifer or adjacent to any underground drinking water supply. The Texas State Water Development Board's 2006 map confirms the site characteristics. Today, groups come from all over the world to tour this unique facility.

Economic Impact

WCS is creating jobs and revenue for Andrews County and state of Texas. The State of Texas receives 25 percent of the gross disposal fee for all non-compact waste disposed of at the facility, and five percent of the in-compact waste disposal fee. Andrews County, as the host county, receives five percent of the gross fee for all waste disposed of in the Compact facility. In 2012 – with less than half a year of disposal operations – these fees generated $4.5 million for the state and $800,000 for the county.

On an annualized basis the WCS disposal operations generate:

- Over 160 full-time jobs in Andrews County
- $13 million - in annual payroll
- $16 million in revenue for the state of Texas
- $4 million in revenue for Andrews County
- $35 million in annual operating expenses

Transportation

The entire disposal process is tightly regulated, beginning with the transportation of the waste which is overseen by the U.S. Nuclear Regulatory Commission and U.S. Department of Transportation. Strict controls, special containers, rigorous oversight, extensive training and specified routes have made the shipment of low-level radioactive waste a safe, routine part of U.S. commerce for more than 50 years. Radioactive materials are transported on our highways every day and the likelihood of a transportation accident related to the shipment of low-level waste to the WCS site that would result in a measurable radiation exposure to the public is virtually nil.

THE TEXAS SOLUTION

Texas Federal Low Level Radioactive Waste Disposal Facility

Waste Control Specialists (WCS) operates a disposal facility for U.S. Department of Energy waste, under a license issued by the Texas Commission on Environmental Quality (TCEQ). Located in remote Andrews County, the facility is located in an ideal semi-arid environment, situated in a geologic formation of relatively impermeable red bed clay. The unique design of the facility makes it the most robust low level disposal operation ever constructed and assures that it will be protective of human health and safety -- and the environment – for centuries to come.

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Economic Impact

WCS is creating jobs and revenue for Andrews County and state of Texas. The State of Texas receives five percent of the gross disposal fee for all federal waste disposed of at the facility, and five to 25 percent of the compact waste disposal fee. Andrews County, as the host county, receives five percent of the gross fee for all LLW waste disposed of at the facilities. In 2012 – with less than half a year of disposal operations – these fees generated $4.5 million for the state and $800,000 for the county.

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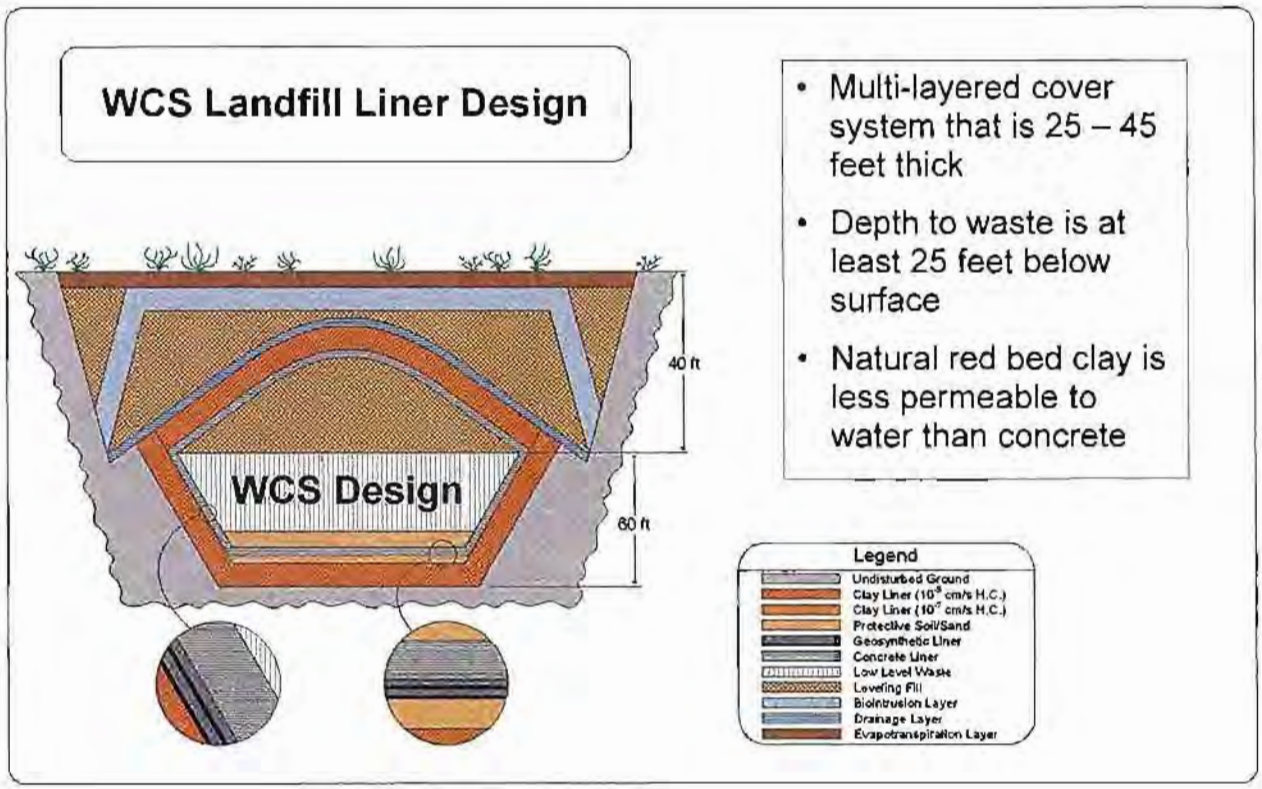
THE TEXAS SOLUTION

WCS Landfill Design



THE TEXAS SOLUTION

Site Characteristics

- Over 640 borings to determine geologic characteristics and confirm WCS is not over an aquifer
- Approximately 520 monitoring wells that are measured monthly, many of which are dry
- Over 260 monitoring wells are laboratory sampled on a quarterly basis, if there is enough water
- WCS installed 160+ borings by December 31, 2007 and that grew to over 640 borings today

Map of Borings/Wells

- WCS is not above or adjacent to any underground drinking water supply
- Texas State Water Development Board map confirms site characteristics
- Hydraulic conductivity of clay is $1x10^{-9}$ cm/sec and the 225-foot zone is $1x10^{-8}$ cm/sec
- Horizontal groundwater travel is 4 feet (1.3 meters) per 1,000 years
- Groundwater is ~ 16,000 years old

John Till 氏と Risk Assessment Corporation 社の活動の経歴について

本資料の内容は、Risk Assessment Corporation のウエッブページから調査したものである。
John Till 氏は、1977 年に Risk Assessment Corporation（RAC）の前身 Radiological Assessment Corporation を設立し、現在は、RAC の社長として、早期は放射性物質、近年は、化学物質も含めた環境影響評価の分野に携わっている。
1983 年には、USNRC が出版した放射線の環境リスク評価に関する Radiological Assessment の共著者として携わった。
1988 年には、ハンフォードの環境線量再構築プロジェクトを技術的に推進するパネルの議長となり、プロジェクトの推進と環境修復活動の情報の公開に努めた
その間、RAC は、オハイオ州の Fernald 濃縮施設、ロッキーフラッツ施設の環境修復に携わると共に、初期のサバンナリバーサイトの環境修復にも携わった。
放射性物質による環境汚染の修復の検討を進める上で、化学物質による汚染も重要であることがわかるようになり、化学物質に環境汚染の修復にも分野を広げるようになった。
RAC は、1998 年に現在の RAC に移行た。現在では、

- ロッキーフラッツにおける土壌のクリーンアップレベルの評価
- 2000 年 5 月のロスアラモスで起こった大規模火災（セログランデ火災）において、放出された放射性物質や化学物質の公衆への影響評価
- 汚染した線源からのリスクの低減対策について意思決定者とステークホルダーがともに検討するプロセスの確立
- 訴訟において、原告に対する線量、被ばく量を独立機関として計算

のような活動を行っている。
RAC は、個々の専門家の集合体であり、ワークに対して、適した能力を持った専門家が仕事にあたる。これは Till 氏の会社の経営コストを抑えるための方針の一つである。
Till 氏の主な著書、論文は以下の通り。

著書

- John T. Till and Helen A.：“Radiological Risk Assessment and Environmental Analysis”, Oxford University Press (2008).
- Till, J.E., H.L. Beck, W.J. Brady. T.F. Gesell, D.G. Hoel, E.E. Kearsley, D.C. Kocher, J.D. Moreno, C.R. Weinberg, E.B. Douple, I. Al-Nabulsi.：“A Review of the Dose Reconstruction Program of the Defense Threat Reduction Agency.” National Academy Press, National Academy of Sciences, Washington, DC 20001, (2003).

公開論文
被ばく、リスク評価

- Till, J.E.：“Environmental Dose Reconstruction.” Proceedings Thirty First Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP).Washington, D.C., April 12–13, 1995. National Council on Radiation Protection,

Bethesda, Maryland. (1997)
- Till, J.E.：Keynote Address. Proceedings of the First Annual University of Washington Conference on the Ecological, Community and Occupational Health Issues at Hanford, December 3, 1997. University of Washington Press, Seattle, WA. (1998)
- Till, J.E., G.G. Killough, K.R. Meyer, W.S. Sinclair, P.G. Voillequé, S.K. Rope, and M.J. Case.：“The Fernald Dosimetry Reconstruction Project.” Technology, Vol. 7 pp270-295. (2000)
- Till, J.E., A.S. Rood, P.G. Voillequé, P.D. McGavran, K.R. Meyer, H.G. Grogan, W.K. Sinclair, J.W. Aanenson, H.R. Meyer, S.K. Rope, and M.J. Case.：“Risk to the Public from Historical Releases of Radionuclides and Chemicals at the Rocky Flats Nuclear Weapons Plant.” Journal of Exposure. Analysis and Epidemiology, Vol. 12 (5) pp355-372. (2002)

リスクコミュニケーション

- Till, J.E. ： Keynote Address. Proceedings of the First Annual University of Washington Conference on the Ecological, Community and Occupational Health Issues at Hanford, December 3, 1997. University of Washington Press, Seattle, WA. (1998)
- Till, J.E. “Dose to Individuals: Who and How.” Proc. The Future Policy for Radiological Protection. Nuclear Energy Agency Forum in Collaboration with the International Commission on Radiological Protection, Lanzarote, Spain, 2–4 April. (2003)
- Till, J.E. and D. McBaugh.：“Practical and Scientifically Based Approaches for Cleanup and Site Restoration.” Health Physics, 89 (5). (2005)
- Till, J.E. and K.R. Meyer.：“Public Involvement in Science and Decision-Making.” Health Physics, Vol. 80 (4) pp 370-379. (2001)

History

In 1977 John E. Till, PhD, founded Risk Assessment Corporation, which was incorporated in the state of South Carolina in 1979. At that time, the corporation was called Radiological Assessments Corporation, reflecting its focus on radiological issues.

In those early days, RAC’s work included research on the environmental transport and fate of materials such as tritium, carbon-14, and technicium-99. During this period, John co-edited Radiological Assessment, published by the U.S. Nuclear Regulatory Commission. It was the first comprehensive textbook describing methods for environmental risk analysis.

1983 年に USNRC が出版した

RAC also focused on the development of user-friendly software for predicting concentrations of radioactive materials and chemicals in the environment. MICROAIRDOS ©, DECOM © and DECHEM were early prototypes of software now widely used in risk assessment.

In 1988 John was appointed chair of the Technical Steering Panel that was responsible for

directing the Hanford Environmental Dose Reconstruction Project (HEDR).
1988 年　Till 氏は、

Under his leadership, HEDR was instrumental in helping lift the shroud of secrecy that enveloped the nuclear weapons complex in the U.S. For the first time, the public was given access to information about the facilities' activities and the analysis that characterized the magnitude and duration of radioactive releases into the environment, as well as the human exposures and health effects that would have occurred.

RAC went on to complete a dose reconstruction for the Fernald Feed Materials Plant in Ohio and for the Rocky Flats Plant near Denver, Colorado, as well as the early phases of the dose reconstruction for the Savannah River Site in South Carolina, and Idaho National Laboratory in Idaho. As these studies progressed, it became clear that significant quantities of chemicals were also used and released into the environment at these facilities, so that the scope of later dose reconstruction studies broadened to address the impact of these releases too.

On May 1, 1998, the corporation's name was changed to Risk Assessment Corporation to more accurately reflect its expanded mission to address both radionuclides and chemicals in the environment. More recently, RAC has focused on applying its skills to address present-day issues. These include:

- establishing a robust approach to determine soil clean-up levels for the Rocky Flats site
ロッキーフラッツのクリーンアップレベルの評価
- conducting a series of independent audits of Los Alamos National Laboratory in New Mexico to determine compliance with the Clean Air Act
ロスアラモス研究所の大気汚染法への対応の独立した監査の実施

- analyzing the exposure and risks to the public from radionuclides and chemicals released by the Cerro Grande Fire at Los Alamos in May 2000
2000 年 5 月のロスアラモスで起こった大規模火災（セログランデ火災）において、放出された放射性物質や化学物質の公衆への影響評価

- establishing a process to work with stakeholders and decision makers to identify and reduce risks from contaminated sources
汚染した線源からのリスクの減少と同定のために決定者とステークホルダーとともに働くプロセスの確立

- independent calculations of exposures and doses to plaintiffs in a number of legal

cases
法的ケースの原告に対する線量、被ばくを独立機関として計算

RAC is incorporated in South Carolina. John Till is the President and Helen Grogan is the executive officer. It is a consortium of independent consultants, each called on when their skills match the needs of a project. This format allows RAC to obtain the skills of talented scientists who may contribute to projects on a part- or full-time basis, and are free to live and work where they choose. Each team member may pursue work on other fronts and for other organizations as long as it does not present a conflict of interest. That said, for most team members, RAC activities are their primary source of income.

One of John's goals has been to minimize the bureaucratic and overhead costs of a large organization. Each team member signs a contract with RAC for each project they are anticipated to work on.

John is responsible for the overall management of the team. Helen manages the technical aspects of projects and provides John with assistance. Although team members live in many different parts of the U.S., they meet regularly at project locations to collect information and discuss technical methods. The team also meets at least three times a year for a number of days to discuss each project under contract, evaluate progress, and make team business decisions.

Our clients represent educational, government, and private organizations, including:

- Battelle Memorial Institute
- Centers for Disease Control and Prevention
- Colorado Department of Public Health and Environment
- Colorado State University
- Department of Justice
- DOW Chemical Company
- E. I. DuPont Corporation
- Environmental Protection Agency
- National Cancer Institute
- New Mexico Environment Department
- Nuclear Regulatory Commission
- Philadelphia Academy of Natural Sciences
- Rocky Flats Citizen's Advisory Board
- San Ildefonso Pueblo
- Three-Mile Island Public Health Fund
- University of Tennessee-Battelle, Oak Ridge National Laboratory

Books

Radiological Risk Assessment and Environmental Analysis, co-edited by John T. Till and Helen A. Grogan, published by Oxford University Press. This textbook is an update and major revision to Radiological Assessment: A Textbook on Environmental Dose Analysis, co-edited by John E. Till and H.R. Meyer, which was published by the U.S. Nuclear Regulatory Commission in 1983. As the first comprehensive textbook about dose assessment, it became a standard reference for scientists.

Till, J.E., H.L. Beck, W.J. Brady. T.F. Gesell, D.G. Hoel, E.E. Kearsley, D.C. Kocher, J.D. Moreno, C.R. Weinberg, E.B. Douple, I. Al-Nabulsi. 2003. A Review of the Dose Reconstruction Program of the Defense Threat Reduction Agency. National Academy Press, National Academy of Sciences, Washington, DC 20001.

Selected Open Literature Publications

Source Term Analysis

Mohler, H.J., K.R. Meyer, H.A. Grogan, J.W. Aanenson, and J.E. Till. 2004. "Application of NCRP Air Screening Factors for Evaluating Both Routine and Episodic Radionuclide Releases to the Atmosphere." Health Physics, 86 (2).

Exposure and Risk Analysis

Grogan, H.A., W.K. Sinclair, and P.G. Voillequé. 2001. Risks of Fatal Cancer From Inhalation of Plutonium-239,240 By Humans: A Combined Four Method Approach With Uncertainty Evaluation. Health Physics 80(5): 447–461.

McGavran, P.D., A.S. Rood., and J.E. Till. 1999. "Chronic Beryllium Disease and Cancer Risk Estimates with Uncertainty for Beryllium Released to the Air from the Rocky Flats Plant." Environmental Health Perspectives. Vol. 107 (9): 731-744.

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Rood, A.S., P.D. McGavran, J.W. Aanenson, and J.E. Till. 2001. "Stochastic Estimates of Exposure and Cancer Risk from Carbon Tetrachloride Released to the Air from the Rocky Flats Plant." Risk Analysis, Vol. 21 (4) pp 675-695.

Contaminant Transport Modeling

Grogan, H.A., J.W. Aanenson, P.D. McGavran, K.R. Meyer, S.S. Mohler, H.J. Mohler, J.R. Rocco, and L.H. Wilson, and J.E. Till. 2006. "Applied Modeling of the Cerro Grande Fire at Los Alamos: An Independent Analysis of Exposure, Health Risk, and Communication with the Public." In Applied Modelling and Computations in Nuclear Science, Oxford University Press, November.

Rood, A.S., H.A. Grogan, and J.E. Till. 2002. "A Model for A Comprehensive Assessment of Exposure and Lifetime Cancer Incidence Risk from Plutonium released from the Rocky Flats Plant, 1953-1989." Health Physics, Vol. 82 (2) pp 182-212.

Rood, A.S., G.G. Killough, and J.E. Till. 1999. "Evaluation of Atmospheric Transport Models for Use in Phase II of the Historical Public Exposures Studies at the Rocky Flats Plant." Risk Analysis, Vol. 19 (4): 559-576, Neeses, SC, 29107.

Environmental Data Management and Analysis

Grogan, H.A., J.E. Till, K.R. Meyer, and H.J. Mohler. 2004. "Involving Stakeholders and Tailoring Environmental Databases for Shared Analysis of a Contaminated Site." Proc. EnviroInfo 2004. 18th International Conference Informatics for Environmental Protection. October 21-23, 2004. Sh@ring. CERN, Geneva, Switzerland.

Integrated Software Development

H.J. Mohler, J.W. Aanenson, H.A. Grogan, and J.E. Till. 2005. "Creating Spatially-Linked Data and Risk Evaluation Tools to Support Community Participation and Decision Making for a Contaminated Site." Proc. EnviroInfo 2005. 19th International Conference Informatics for Environmental Protection. September, 7 – 9. Networking Environmental Information. Brno, Czech Republic.

Risk Communication

Grogan, H.A., J.E. Till, K.R. Meyer, and H.J. Mohler. 2004. "Involving Stakeholders and Tailoring Environmental Databases for Shared Analysis of a Contaminated Site." Proc. EnviroInfo 2004. 18th International Conference Informatics for Environmental Protection. October 21-23, 2004. Sh@ring. CERN, Geneva, Switzerland.

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Till, J.E. and D. McBaugh. 2005. "Practical and Scientifically Based Approaches for Cleanup and Site Restoration." Health Physics, 89 (5).

Till, J.E. and K.R. Meyer. 2001. "Public Involvement in Science and Decision-Making." Health Physics, Vol. 80 (4) pp 370-379.

The Cerro Grande Fire was a disastrous forest fire in New Mexico, United States of America, that occurred in May 2000. The fire started as a controlled burn, and became uncontrolled owing to high winds and drought conditions. Over 400 families in the town of Los Alamos, New Mexico, lost their homes in the resulting 48,000-acre (190 km^2) fire. Structures at Los Alamos National Laboratory were also destroyed or damaged, although without loss or destruction of any of the special nuclear material housed there. Amazingly, there was no loss of human life. The US General Accounting Office estimated total damages at $1 billion

FACILITATOR'S SUMMARY
JOINT DOE NRC PUBLIC MEETING ON LOW-LEVEL WASTE
PHOENIX, AZ
MARCH 4, 2011

The U.S. Department of Energy (DOE) and the U.S. Nuclear Regulatory Commission (NRC) convened a joint meeting on the low-level radioactive waste (LLW) issues of concern to each agency. The DOE portion of the meeting focused on revisions to DOE Order 435.1 (–435.1") and the NRC portion of the meeting focused on the NRC's regulations in 10 CFR Part 61 (–Part 61"). The DOE portion of the meeting occupied the morning session and the NRC portion occupied the afternoon session. The meeting included a joint panel of DOE and NRC officials at the end of meeting to discuss crosscutting issues. Francis X. (–Chip") Cameron facilitated the meeting.
Note: Except for certain DOE or NRC staff, and other instances where it would be helpful for an understanding of the issue raised, individual commentators are not identified by name. For presentation materials associated with this meeting, including the meeting transcript, go to www.em.doe/pages.compliance.aspx (DOE's web site) or to www.nrc.gov (go to "Low-level Waste, Potential Revision to Part 61", NRC's web site).

DOE Order 435.1 Introduction

Mr. Bill Levitan, Director of the Office of Environmental Compliance, in DOE's Office of Environmental Management (EM), opened the DOE session on the DOE complex-wide review of DOE Order 435.1. He mentioned some of the successes of the DOE LLW program, e.g., WIPP now operational and accepting TRU waste for disposal, the closing and emptying of tanks at Hanford, Savannah River, Idaho, and West Valley. Mr. Levitan noted that his office, the Office of Environmental Compliance, is responsible for ensuring the implementation of 435.1 across the Department. His office is also responsible for considering other laws and regulations such as CERCLA, RCRA, and NEPA. Mr. Levitan emphasized the importance of public input from meetings such as this one to the revision of 435.1, particularly in terms of developing a risk informed and performance based system for protecting the environment and public health.

Mr. Marty Letourneau, project lead for the update of 435.1, emphasized a number of points about the update of 435.1. First, that a DOE complex-wide review was the starting point. The complex-wide review was based on a self-assessment tool that each site within the DOE complex could use to look for –best management practices" and –areas for improvement". The complex-wide review has been completed and has been posted on the EM website. Based on the self-assessment, Mr. Letourneau noted some of the key findings:

- 435.1 has been successful. Significant progress has been made in radioactive waste management
- The Low-level Waste Disposal Facility Federal Review Group has improved the consistency of DOE performance assessments.
- There are new requirements that did not exist when 435.1 was first issued that need to be integrated into an updated 435.1.

- There is still a need to identify paths to disposal for some wastes.
- There is an opportunity and need to clarify definitions.
- The relationship between 435.1 and other DOE Orders and other statutory requirements needs to be clarified. and,
- The exemption process for the use of offsite non-DOE commercial facilities needs to be clarified.

Mr. Letourneau was followed by several members of the DOE staff, Linda Suttora, Marty Letourneau (for Joel Case), J.R. Stroebel, and Frank DiSanza, who summarized the following areas of the update, respectively, general requirements and strategic planning, high-level waste, TRU, and low-level waste.

Mr. Levitan emphasized that the 435.1 update would be issued by DOE for public comment. Those comments would be incorporated before the formal DOE review process would begin under the DOE Directives Review Board. This would take place in the October 2011 to August 2012 timeframe. Mr. Letourneau noted that one unanswered question still under consideration was whether parts of 435.1 should be promulgated as a DOE regulation rather than an Order.

DOE Order 435.1 Discussion

A facilitated public comment period and discussion followed the DOE overview, with participation by those physically on site in Phoenix (approximately 80 to 100) and by those participating offsite through the WebX system (approximately 10 to 15). Some of the more salient points raised by questions and comments were:

- The issue of the use of excess DOE facilities after cleanup will be addressed through the Asset Revitalization Initiative (related to, but broader than, the ―energy park" concept). DOE will ultimately involve the communities where these sites are located to determine what their vision is for these facilities and sites.

- The issue of how 435.1 should address the relationship between CERCLA and DOE's Atomic Energy Act (AEA) responsibilities was explored. DOE's viewpoint is that CERCLA and 435.1 are trying to accomplish the same objective – to ensure that the waste from cleanup gets managed correctly. Therefore, 435.1 recognizes CERCLA as meeting its AEA responsibilities

- A real issue facing the Department is the timing of the closure of WIPP and the cleanup of the Hanford site, i.e., WIPP might need to close before Hanford is finally cleaned up.

- A serious issue is whether, and how, the Department is going to handle the national security implications of leaving several hundred nuclear weapons equivalent of plutonium in the ―near-surface" at Hanford. Although CERCLA criterion 9 will be used in the decision making process on this issue, there hasn't

been any recognition of maintaining security for 10,000 years over a burial ground of this material. Furthermore, DOE should be paying more attention to the huge changes in the understanding of actinide chemistry and their mobility in the environment. DOE noted that the DOE Low-level Waste Disposal Facility Review Group was tracking the new information associated with not only actinide chemistry but other radionuclides and chemicals

- The issue of blending at DOE facilities and how to avoid it being considered ―dilution" was raised. DOE stated that it was working closely with the NRC staff on concentration averaging and blending in terms of 435.1. Furthermore, DOE and NRC are in agreement that the blending of two waste streams is not dilution. Dilution is the blending of waste with clean material. The primary DOE concern is that issues over blending don't result into picking through barrels of waste and separating out piles of highly contaminated and lesser contaminated materials, when in fact, it's all waste and probably going to the same place. Questions were raised about having to look through waste containers to do a detailed segregation of various types of waste, for example ―little pieces of used fuel", as opposed to looking at a fissile gram equivalent and then shipping the canister off without segregation. . Mr. Letourneau indicated that you had to look at the context of the situation. For example, under 435.1 DOE has managed small quantities, pieces of used fuel, as low-level waste where it was used in a research facility. However, if you where in a fuel fabrication plant, it would need to be looked at differently. Otherwise, you could average over the content of the drum. Another member of the audience asked, how do you draw the line on when small pieces of spent fuel are considered low-level waste? Mr. Letourneau noted that the process for determining this is in the current version of 435.1 and reiterated that it is situational. There is no numerical standard. It was put in place to allow a small piece of spent fuel to be examined in a laboratory setting without having the researcher than need to go through an extremely complicated, and unnecessary, process of managing it a spent fuel rather than low-level waste.

- The applicability of 435.1 to private businesses that characterize, ship, and dispose of DOE waste at commercial facilities was raised. DOE stated that the DOE entity that is the generator of the waste must pass on to the contractor and any subcontractors the requirements of 435.1. In terms of disposal, the license of the disposal facility will control. However, DOE is re-examining the process for disposal at commercial facilities to possibly replace the requirement for DOE sites to get a Headquarters exemption before they ship waste to a commercial facility, with some type of process that assures that the commercial facility is in compliance with its license.

- A concern was raised on the DOE complex wide review on the identification of best practices and areas needing improvement and the availability of that information to the public. DOE stated that the objective of the review would be to use the best practices from some sites to address areas of improvement at other sites. For example, the best practice of unreviewed disposal questions in use at

the Savannah River site, or the use of the Low-level Waste Disposal Facility Review Group to help to assure that performance assessments are consistent across all sites. Furthermore, the best practices that could be applied across the DOE complex will be considered for incorporation into the 435.1 update. As noted previously by Bill Levitan, the 435.1 update would be issued for public comment.

- The issue of the use of models in probabilistic risk assessments was raised with the concern being that the 435.1 update contain a requirement that the analysis be based on how accurate or inaccurate the modeling is compared to reality and not on how precise the model is looking only at itself. Mr. Letourneau recognized that this is a legitimate concern and it will be addressed in the update.

- The period of performance issue was raised for the first of several times in the discussion. How did DOE reach the conclusion that 10,000 years was the correct period of performance? Is it a policy decision or a technical decision? What are the implications of doing qualitative analyses beyond the 10,000 year time frame? And how does all of this relate to ―peak dose"? Mr. Letourneau stated that DOE wanted to recognize the NRC recommendation in NUREG-1573 of a 10,000 year period of performance. NRC, the State of Utah, and other entities were stating a period of performance of 10,000 years. However, DOE is still using the 1,000 year period of performance for compliance purposes. Peak dose will be looked at up to 10,000 years. However, a quantitative analysis beyond 10,000 years will also be required, but the use of that analysis will be qualitative. This would allow the Department to look at the peak dose beyond 10,000 years and do a qualitative interpretation of it that allows the decision maker to help understand what happens after 10,000 years. Rusty Lundberg, Director of the Division of Radiation Control, from the Utah Department of Environmental Quality, offered that 10,000 years seemed to be a time period that many agree on now. The State of Utah, in its regulations, will look at the time period beyond 10,000 years to consider peak dose of depleted uranium (DU). This information would be used qualitatively by the decision maker to see what would be helpful in meeting the objective of the regulator. A performance assessment expert noted that the Order that preceded 435.1, had a 10,000 year period of performance in it, but 435.1 dropped it to 1,000 years. The NRC staff also noted that the inventories of waste considered in the EIS on the promulgation of 10 CFR Part 61 found that most of the dose was covered within the 10,000 year period.

- A member of the audience, referring back to Mr. Letourneau's previous remark that the DOE is considering whether to take the update 435.1 to rulemaking, advised that the sufficient concentrations part of the Order should go to rulemaking. Furthermore, according to this commentator, the Nuclear Waste Policy Act (NWPA) requires the NRC to make a determination on sufficient concentrations. Therefore, there needs to be alignment between DOE and the NRC on who makes this call, and how it is made. A staff member from the NRC Office of General Counsel clarified that the NRC has the authority to define

sufficient concentrations under the NWPA but is not required to do so. Mr. Letourneau stated that the DOE technical staff would talk with the DOE General Counsel to identify which sections of the updated 435.1 should be placed into a regulation, e.g., a section of updated 435.1 would address waste classification, including waste incidental to reprocessing, concentration averaging, and blending. This might be a candidate for rulemaking.

- The discussion returned to the public process for updating 435.1. Mr. Letourneau stated that the draft of the update would go though the DOE directives review system. It will also be noticed in the Federal Register for public comment. Both the public and the internal DOE comments will be considered before the document is placed in the DOE approval process for DOE Assistant Secretaries. The document will be ready for the internal directives system and public comment in October of 2011. A full year is scheduled for comment. It will be ready for the final approval process in August/September 2012.

NRC 10 CFR Part 61 Introduction

The afternoon session of the joint DOE-NRC Public Meeting on LLW issues began with presentations and discussion on the NRC plans to revise 10 CFR Part 61 and the NRC regulations governing the disposal of LLW. The afternoon session concluded with a DOE-NRC panel that addressed crosscutting issues between 435.1 and Part 61.

Mr. Larry Camper, Director of the Division of Waste Management and Environmental Protection, within the Office of Federal, State, and Environmental Management Programs, opened the discussion. Mr. Camper noted that alignment with DOE on the approach to LLW is a laudable goal and that although there are statutory constraints and different roles, alignment is something that makes a lot of sense. He then discussed the goals of the NRC portion of the meeting. First, to introduce SECY-10-0165, the NRC staff approach to the comprehensive revision of Part 61 (December 27, 2010; NRC ADAMS # ML103230435). He also emphasized that public comment on the options identified in the staff approach are important to the NRC and that there will be a number of public meetings on the re-examination of Part 61. The basic questions on which the NRC is looking for input from the public are: Should the staff revise the existing Part 61 or should it be left as it currently is? What recommendations do you have for specific changes to the current rule? What are your suggestions for possible new approaches to commercial LLW management in the United States? He then introduced Dr. Charlie Miller, Director of the Office of Federal, State, and Environmental Management Programs at the NRC. Dr. Miller first noted that the current LLW rule, 10 CFR Part 61, was fully protective of public safety and protection of the environment. The rule is being implemented by Agreement States because all of the licensed LLW facilities are now located in Agreement States. Dr. Miller explained that the SECY-10-0165 grew out of a staff briefing of the Commission. The Commission directed the staff to outline its approach to a comprehensive revision of Part 61 that is risk informed and performance based. At that time, the NRC staff was engaged in developing a technical basis to support a limited rulemaking to revise Part 61 to require site-specific performance

assessments for new and emerging waste streams. Today's public meeting is the start of the process to get public input on the questions that Mr. Camper identified. Dr. Miller emphasized that meaningful, clear communication with the public is an important agency goal for the NRC.

Various NRC staff members than provided information on Part 61, including its historical development, revision of the Branch Technical Position on concentration averaging, options for revising part 61, risk informing Part 61, alignment and harmonization of Part 61 with the International Atomic Energy Agency standards, and the NRC's path forward to a decision on a possible comprehensive revision. The topics and individual presenters from the NRC can be found on the attached agenda from the meeting. One of the important background references is NUREG-1853, ―The History and Framework of Commercial Low-level Waste Management in the United States."

The five options identified in SECY-10-0165 on the possible revision of Part 61 are:

- Risk inform the waste classification framework
- A comprehensive revision to Part 61
- Align Part 61 with the international standards
- Establish site-specific waste acceptance criteria
- Maintain the *status quo*

NRC 10 CFR Part 61 Discussion

A facilitated public comment period followed with participation by those physically on site in Phoenix (approximately 80) and by those participating offsite through the WebX system (approximately 10). Some of the salient points raised by questions and comments were the following:

- A commentator from EPRI suggested any NRC work on revision to Part 61 incorporate the concepts of reasonableness and reflection. On reflection, this commentor was referring to looking at the baseline technical assumptions such as the volume of waste to be disposed of, the specific attributes of the site, and how these compare to the EIS that was originally developed for the Part 61 rulemaking. The rulemaking should be reflective of current LLW practices. An example of the use of ―reasonableness" is to not use a limitless supply of intruder scenarios but rather to construct a series of reasonable intruder scenarios that are well defined and bounded in the types reasonable scenarios. There should also be recognition of intruder barriers. The commentor also challenged the assumption that 100 years of institutional controls was the correct time frame and that the NRC staff should reconsider the assumptions on the length of institutional controls, as well as issues of physical security. The commentator also emphasized the concept of ―acceptableness", using an analogy of ditches alongside a road. The ditches are the science and the road represents the practical implementation aspects of the rulemaking. Mr. Camper agreed with the need to re-examine some

of the existing baseline assumptions, as suggested by the commentator. Mr. Letourneau later provided the following observations on the intruder scenario. He stressed that it is important to understand the nature of the intruder scenario, that it is based on a 500 millirem dose standard in a year. Therefore, whether the intruder lives there for one year or 70 years, you are only looking at the highest dose during that time period and comparing it to the 500 millirem standard. So as unreal as it may seem to assume that someone will live on the site, it may make us more comfortable to understand that we are looking at an annual dose against the limit. Furthermore, exercising institutional controls at the facilities, including armed guards, gates, and periodic inspections, we should be able to prevent and discover human intrusion fairly quickly. Therefore, the highest dose for the intruder is usually going to be in that first year after you assume that you've lost institutional control. Due to decay and short-lived products, the further out you go, the intruder dose scenario gets smaller. We don't need to make up a lot of scary, bizarre, scenarios about who is living there and for how long.

- John Greeves and Jim Lieberman offered an approach, and distributed a paper (presented at the earlier *2011 Waste Management Conference*), for revising Part 61. They suggested their option should be a "sixth" option to the ones provided in the NRC Commission Paper. They termed it the "Greeberman" option. The Greeberman option would be implemented in the limited rulemaking now underway by the NRC. It would make explicit the site-specific performance requirement for all waste streams, not just DU. The waste classification tables in Part 61 would be retained but the site specific performance assessment could override the waste classification tables if appropriate. Mr. Greeves noted that this would avoid the time and resources associated with a comprehensive revision.

- In a similar vein, another member of the audience affirmed the notion that the NRC and DOE should be guided by science, including improved dosimetry and better knowledge of waste streams. The commenter expressed the view that it's not too difficult to revise Part 61 and doesn't believe that the tables are useful. Rather a site specific performance assessment approach is entirely appropriate and could be accomplished in the NRC limited rulemaking. It matches up fairly well with what the industry is going to do anyway. Another commenter expressed the belief that it was time to revise Part 61 and you shouldn't be concerned with it being too complex or complicated for people to understand. It's already pretty complicated. He also noted Dr. Michael Ryan's earlier admonition at the *2011 Waste Management Conference* to not worry about concentrations but rather focus on total quantities of radionuclides at a particular disposal site and their subsequent dose effects. Mr. Letourneau from DOE offered his agreement with these two commenters. Mr. Camper from NRC noted that the NRC staff is willing to look at a revision to Part 61 and to deal with it realistically.

- Mr. Letourneau, DOE, offered a number of thoughts on the revision of Part 61. First that the rationale for the waste classification scheme in Part 61 was to make it easy on the generator. For example, it was originally envisioned that Company

X would take Class A, Company Y would take Class B, and so on. This has not proved to be true in actual practice and it's time to move away from this assumption as a driving force for the tables. He next addressed the evaluation that would be conducted under the National Environmental Policy Act (NEPA) for any revision of Part 61. The NEPA analysis will be the appropriate place to explore new LLW management concepts and alternatives to the present system, e.g., the 100 year institutional control concept. Mr. Camper later offered that what is needed is a new environmental analysis under NEPA that reflects the reality of waste disposal today. Third, Mr. Letourneau cautioned against putting too much detail in the rule, versus putting the details in an associated regulatory guide. Fourth, Mr. Letourneau noted that the DOE restricted and unrestricted release program matched up well with the IAEA 1 millirem standard. Fifth, in terms of Class C and Greater-than-Class C (GTCC), choose a line for GTTC that is politically, if not scientifically supportable, and live with it. Do site-specific performance assessments for everything below that line. Anything above the line is unsuitable for shallow land burial. Finally, in terms of the performance assessment, it will constantly have to be updated as the facility receives new waste. The DOE uses a performance assessment maintenance plan to manage the uncertainty and to ensure that the performance assessment is updated, when appropriate. This type of maintenance plan should be part of any future Part 61 regulatory regime.

- A commenter asked how the NRC's rulemaking on site-specific performance assessments for DU would match up with the radiation protection standards in 10 CFR Part 20 in terms of human intrusion calculations? The NRC clarified that there is no dose standard for the intruder in part 61. However, the staff is proposing to establish one in the ongoing Part 61 limited rulemaking concerning the introduction of a site-specific performance assessment. Any future changes to Part 20 would eventually need to be looked at for their implications for Part 61. In addition, there will be a specified period of performance in the NRC limited rulemaking mentioned above. At present, the period of performance in the current Part 61 is not specified. Whether the limited rulemaking is eventually opened up to include all waste streams, as proposed by the ―Greeberman" option, is an open question.

- The NRC staff clarified that all public comments and suggestions on alternative suggested approaches to revising Part 61 were welcome, not just comments limited to the five proposed options described in the Commission Paper.

- A commenter raised the issue of recent studies on cardiovascular and stroke death risk as opposed to cancer death risk curves. The NRC staff suggested that the commenter bring this to the attention of the NRC staff working on the revision of Part 20.

- Rusty Lundberg, Director of the Division of Radiation Control, in the Utah Department of Environmental Quality, offered some perspectives from a state

regulators point of view. Mr. Lundberg advised that, in addressing these disposal issues, we not only look at current science, but look beyond that to the larger philosophical and policy issues. These issues are extremely important in achieving host state public confidence. He cited the Utah example of the local government having the foresight to establish a zoning area and criteria for particular types of disposal facilities. He then spoke to the idea of state consistency and harmonization in the approaches to waste disposal. The states believe that a consistent floor is helpful to them but they also need flexibility to account for localized or geographic demographics. He believed that you would not be able to site disposal facilities in Utah without this type of flexibility.

- A commenter from the performance assessment community advocated that site-specific performance assessments were the only way to go. There are just too many differences between sites to rely on any type of generic performance assessments, including public and inadvertent human intrusion. Who might be showing up and, what might they be doing at a particular site, must be looked at in the context of a specific disposal site.

- A representative of a citizens advisory group made a number of points. This commenter recommended the adoption of suggested NRC option three in SECY-10-0165, realigning Part 61 with the international standards of the IAEA, in combination with site-specific performance assessments. The commenter also was also concerned with how the NRC Agreement State program worked – in particular, a question was asked as to whether the NRC's regulatory authority was handed over wholesale to the Agreement States without any restrictions? Mr. Camper clarified that there are specific requirements (or criteria) that an Agreement State needs to meet before the NRC will relinquish its control. There are also continuing standards and criteria that a state must meet after they become an Agreement State. A member of NRC's Office of General Counsel noted that states have three years to implement any regulations that the Commission issues. Depending on the regulation, states may be required to adopt an identical regulation, something that is more restrictive, or not to adopt the regulation at all.

  The citizen's advisory board commentator further believed that a lot of money is being spent managing certain waste streams that are not hazardous. Rationality has to be injected into the process. The commenter also advocated that a *de minimus* provision be introduced into the regulatory framework below which free release of certain materials would be allowed. To deal with human intrusion possibilities, the commenter recommended that long-term stewardship programs be established—institutional controls, physical barriers, and educational programs.

- A final commentator recommended that people look at a company website, www.skb.se, for information on a current disposal site that currently manages GTCC-like wastes.

DOE/NRC Dialogue on Cross-cutting Issues

- An NRC staff member noted that one potential area of collaboration between DOE and NRC could be LLW performance assessment activities. In this regard, it was also recommended that a joint DOE-NRC working group be formed to discuss and harmonize performance assessment issues. Mr. Letourneau reported that DOE was currently establishing such a group and it would be open to all with an interest, thus, in effect, creating a community of practice. Other panelists believed this to be a laudable idea.

- A commentator from the United Kingdom (UK) provided a summary of the UK approach to LLW disposal. Their experience was very similar to the United States in that they used Tables to classify waste based on concentrations. Five years ago, they embarked on a revision of the system and moved to a risk informed process. However, they did not discard the classification system and the majority of the disposals are based on the classification system. For what the commentator called ―new routes", they use a site specific performance assessment. This has led to better solutions. Other aspects of the UK system are that they only look at credible human intrusion scenarios. The institutional control period is decided on a case-by-case basis. It can extend for up to 300 years after closure of the disposal facility. The period of performance is determined by the significance of the risk to the public. Based on this information, Mr. Letourneau suggested that perhaps the United States could keep the A, B, and C classes but the dividing line between those classes would be based on a site-specific performance assessment. For example, your site-specific performance assessment would tell you how high a concentration you could have before Class B would kick in. An industry commentator from the United States, referring to his facility as a ―boutique" disposal site, supported Mr. Letourneau's idea. At his company makes disposal decisions, they decide what should go into the standard trench, whether they need to excavate a new deeper, wider trench, and so on.

- An industry commentator urged that DOE and NRC harmonize the period of performance for a LLW performance assessment. According to the commentator, it doesn't make sense to have a different period of performance for the disposal of the same type of waste depending on if it is an NRC/Agreement State licensed site or a DOE-operated site. Dave Esh, from the NRC, based on his experience with performance assessments, noted that the period of performance is based on societal and policy considerations, as well as technical considerations. Some of these considerations may be mutually exclusive between different groups or programs. Therefore, there may always be different periods of performance. Dr. Esh believed that the best we can do is to clearly develop what we think is a sound approach and share it with stakeholders and get feedback. Different periods of performance are not a fatal flaw. Prompted by Mr. Letourneau, the following information was elicited from the audience—the period of performance

for non-DU wastes at the Clive site in Utah is 500 years, Texas is 1,000 years, and South Carolina is 2,000 years.

- A commentator from the radiopharmaceutical industry recommended an update of Part 61 to take account of arid sites and to recognize the new waste disposal practices since Part 61 was originally promulgated. In addition, concentration limits should be recalculated for current site conditions and practices. The pharmaceutical industry could support any of the options except the fifth option—maintaining the status quo. Finally, this commentator, suggested that the NRC also look at the costs to licensees of storing waste on site, for those licensees who can't afford disposal.

- Another commentator recommended that the NRC seek early stakeholder input on these issues before the NRC staff forwards a second paper to the Commission, in 2012.

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REGULATION OF COMMERICAL LOW-LEVEL RADIOACTIVE WASTE: AN OVERVIEW OF 10 CFR PART 61

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FSME Meeting with
Japan Atomic Energy Agency

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Today's Presentation

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Background
- Development Process for Rule
  - Waste Streams Considered
  - EIS Findings
  - Regulatory Philosophy
- How Regulation Works
- Part 61 and Performance Assessment
- Current Rulemaking Background

2

Background

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Early low-level radioactive waste (LLW) management practices included
  - Ocean dumping … ~ 60 sites
  - Shallow landfill disposal … ~16 government sites

- Shift to commercial landfills in 1960s
  - Beatty (NV) 1962-92
  - Maxey Flats (KY) 1963-77
  - West Valley (NY) 1963-75
  - Richland (WA) 1965-present
  - Barnwell (SC) 1969-present
  - Sheffield (IL) 1968-78

- Sites licensed by the Atomic Energy Commission

Background *continued*

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- Performance issues at all sites
  - Collecting and leaking meteoric water … 'bath tub effect'
  - ground failures and surface subsidence

- Root cause studies conducted by
  - US Geological Survey, National Academy of Sciences, and General Accounting Office

- Nuclear Regulatory Commission response
  - LLW Task Force formed in 1977
  - Commenced work on new LLW regulation

Rulemaking Philosophy

U.S.NRC
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- Intent was to improve on past disposal practices
- Alignment with how other NRC fuel-cycle facilities are regulated*
  - Protect the public*
  - Protect workers*
  - Redundant systems*
  - Achieve long-term waste isolation
  - Protect the intruder
- Develop one-size fits all type of regulation

Rulemaking Process

U.S.NRC
United States Nuclear Regulatory Commission
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- Developed following NEPA process
  - *National Environmental Policy Act of 1969*
  - Major Federal actions require preparation of Environmental Impact Statement (EIS)
- 1978-82
  - NRC publishes *Advance Notice of Proposed Rulemaking*
    - Requesting public comment
  - Draft EIS prepared (NUREG-0782)
    - Record of decisions on what should go into rule and why
  - Four (4) public meetings
  - Three (3) technical workshops
  - Final EIS issued (NUREG-0972)
    - What is in Part 61

Scoping Process
Waste Streams

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- Need to establish baseline for Part 61 EIS
- Canvassed commercial LLW generators
  - Construct a waste profile
  - Identify dominant radionuclides
  - Define a likely inventory for disposal
- Key findings
  - Waste streams not uniform
    - 37 waste streams among 4 classes
    - 25 radionuclides of interest (both short and long-lived)
- Department of Energy waste streams not considered

Scoping Process
EIS Findings

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- Evaluate effectiveness of potential mitigation measures
  - Controlling concentration levels
  - Specifying waste form/waste package configurations
  - Reliance on institutional controls
  - Performance of engineered (intruder)/natural barriers
- Exposure pathways
  - Focus on intruder (new concept) as well as receptor scenarios (individuals/communities that are 'down-gradient')
  - Two exposure scenarios
    - *Concentration-limited: within disposal facility footprint*
    - *Activity-limited: outside of disposal facility footprint*

'What ifs" ... Significance of Time

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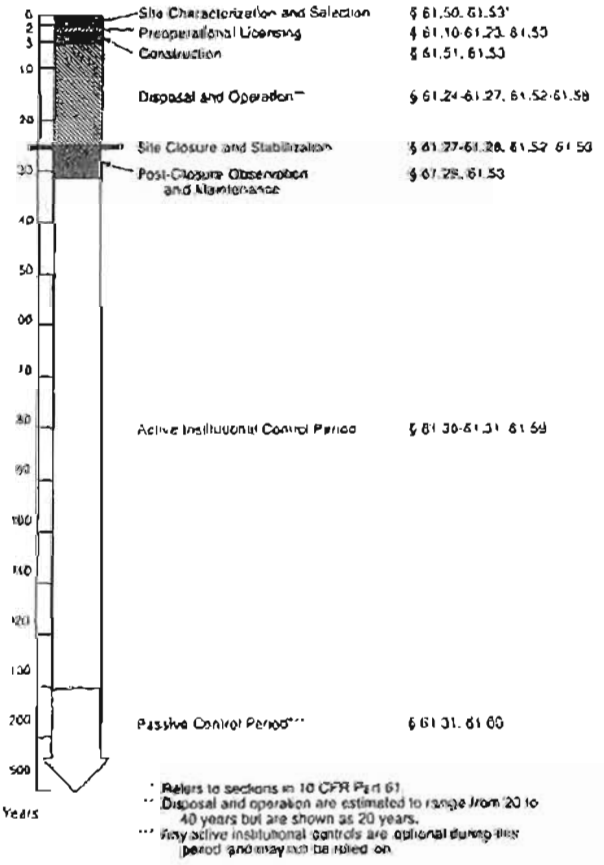
- If wastes are differentiated based on activity, time can help in LLW management
  - Duration of institutional controls
  - Expectations concerning integrity of waste form
  - Contributions due to engineered barriers
- EIS findings (*ala* Part 61 rule)
  - Duration of institutional controls: at least 100 yrs
  - Expectations concerning integrity of waste form: at least 300 yrs
  - Contributions due to engineered barriers: up to 500 yrs
- Time of compliance not specified in rule ... Intrinsically addressed by regulation in ...
  - Concentration tables (decay vs time): §61.55
  - Durability of institutional controls (at least 100yrs, up to 600 yrs): §§61.52, 61.59
  - Waste form stability requirements: §61.7(b)(2)



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Protecting People and the Environment

Part 61 Regulation At a Glance

U.S.NRC
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- Based on a three-tier waste classification system
  - Class A, Class B, and Class C LLW
  - Classification is concentration-based
  - Respective classes defined according to §61.55 waste classification tables
    - Governed by 12 radionuclides

- Level of protection
  - General public: 25/75/25 mrem coupled w/ 4 mrem public water
  - Workers: 10 CFR Part 20
  - Inadvertent intruder: §61.55 tables

Part 61 Waste Class Overview

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CHARACTERISTIC	CLASS A WASTE	CLASS B WASTE	CLASS C WASTE
Concentration	low concentrations of radionuclides	higher concentrations of radionuclides	highest concentration of radionuclides
Waste Form	must meet minimum waste form requirements	must meet minimum waste form requirements	must meet minimum waste form requirements
	does not require stabilization (but may be stabilized)	requires stabilization for 300 years	requires stabilization for 300 years
Examples	typically contaminated protective clothing, paper, laboratory trash	typically resins and filters from nuclear power plants	typically nuclear reactor components, sealed sources, high activity industrial waste
Intruder Protection	after 100 years, decays to acceptable levels to an intruder	after 100 years, decays to acceptable levels to an intruder, provided waste is recognizable	after 500 years, decays to acceptable levels to an intruder
	requires no additional measures to protect intruder	requires stabilization to protect intruder	requires stabilization and deeper disposal (or barriers) to protect intruder
Segregation	unstable Class A must be segregated from Classes B and C	need not be segregated from Class C	need not be segregated from Class B

So What is LLW According to 10 CFR Part 61?

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- LLW is defined by exclusion … LLW is not
  - High-level radioactive waste
  - Spent nuclear fuel
  - Transuranic radioactive waste
  - Uranium mill tailings – 11(e)2 material
- Sub-classification of a particular LLW class
  - Three classes acceptable for near-surface burial
  - Greater-than-Class C LLW
    - Not acceptable for near-surface disposal
    - Geologic disposal or alternate NRC-approved method

In Summary, Part 61 is …

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- Non-prescriptive
  - Limited sitting/design/engineering requirements
  - Waste segregated
  - Reliance on institutional controls
- Risk-informed
  - Potential waste streams understood
  - Waste managed in context of Subpart C performance objectives
- Conclusion
  - Regulation is integrated/performance-oriented

Part 61 and Performance Assessment

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- Genesis
  - Evolved from reactor PRA technology and contaminant fate and transport studies
  - Promulgation of HLW standards and regulations requiring probabilistic calculations (late 1970s)
- Initial Part 61 development process did not involve performance assessment (as currently defined)
- Calculation methods
  - Activity-based: Direct contact
  - Concentration-based: Groundwater

Performance Assessment *continued*

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- Predictive models are necessary as hazards of concern transcend conventional engineering experience
  - Engineered containment systems likely to fail over time
  - Natural systems can attenuate releases
- Calculation methods
  - Activity-based: Direct contact
  - Concentration-based: Groundwater

Performance Assessment *continued*

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- 1990s: Staff focus on LLW performance assessment capability
  - New siting activities: California, Nebraska
  - Commission *1995 PRA Policy Statement*

- Test Case (limited documentation)
  - Assumed humid disposal scenario (most conservative)
  - Complex engineering design
  - Duration of analyses: 20,000 to 100,000 yrs
  - Peak dose for 'conventional' Part 61 inventory occurs 5000-7000 yr range
  - Peak bounded by mobile, long-lived radionuclides
  - Supplemental analyses submitted by Sandia National Laboratories

Performance Assessment *NUREG-1573*

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- Published in 2000
  - Reflects input from public workshops
  - Consideration of written comments from public
  - Advice from Federal Advisory Committee

- Constitutes staff recommendations, not regulatory guidance

- Three key features
  - Staff position on key LLW policy issues
  - Defines attributes of an acceptable LLW performance assessment process
  - Insights from earlier 'test case' results

Site-Specific Analysis Rulemaking Background

Michael P. Lee, PhD
Senior Staff Engineer

Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs

March 21, 2013
FSME Meeting with
Japan Atomic Energy Agency

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Site-Specific Rulemaking: *Commission Direction*

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- SRM-SECY-08-0147 (March 18, 2009)

" ...proceed with rulemaking in 10 CFR Part 61 to specify a requirement for a site-specific analysis for the disposal of large quantities of depleted uranium (DU) and the technical requirements for such an analysis ... develop a guidance document for public comment that outlines the parameters and assumptions to be used in conducting such site-specific analyses ...."

- SRM-COMWDM-11-0002/COMGEA-11-0002 (January 19, 2012)

SRM-SECY-08-0147

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- 2009-2011 Activities
  - 2 public meetings (2009)
  - 6 meetings with Advisory Committee on Nuclear Waste
  - Prepared regulatory basis and draft rule text (May 2011)
  - Solicited public feedback
    - Created docket
    - Public meeting (May 18, 2011)
- Completed Initial Rulemaking Package (Fall 2011)
  - Performance assessment required to meet §61.41
    - 20,000-year period of performance (quantitative)
    - Post 20,000-year evaluation to peak dose
  - Intruder analysis to meet §61.42
    - 500 mrem dose limit to intruder

SRM-COMWDM-11-0002/ COMGEA-11-0002 (Jan 2012)

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- Flexibility to use current International Commission on Radiological Protection (ICRP) dose methodologies
- Two-tiered period of performance:
  - *Tier 1*: Compliance period covering reasonably foreseeable future
  - *Tier 2*: Longer period based on site characteristics and peak dose to a designated receptor, that is not *a priori*
- Flexibility to establish site-specific waste acceptance criteria (WAC) based on the results of the site's performance assessment and intruder assessment
- Balance Federal-State alignment and flexibility

2012 Public Outreach Campaign

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LOCATION	DATE	EVENT
Phoenix	March 2	NRC-Sponsored Public Meeting #1 (following WM2012 Meeting)
San Francisco	April 23	LLW Forum Spring Meeting
Orlando	May 7	CRCPD/OAS Annual Meeting
Dallas	May 15	NRC-Sponsored Public Meeting #2
Tucson	June 22	EPRI Annual LLW Meeting
Rockville	July 19	NRC-Sponsored Public Meeting #3

January 2012 SRM: *Public Meeting Feedback*

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- ICRP Recommendations
  - General support
- Time of Compliance/Period of Performance
  - Two-tiered approach: general support
  - Term "Foreseeable Future": mixed response
    - <1000 yrs; 1000-10,000 yrs; >10,000 yrs
    - Term undefined
- WAC
  - General support
- Compatibility
  - Preserve flexibility and maintain neutrality

January 2012 SRM: *Comment Categories (%)*

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- **TOC/POP Definition*** *20%*
- "Other" *10%*
- Waste Classification Tables *10%*
- Site-Specific Performance Assessment *9%*
- **ICRP*** *9%*
- **Compatibility Issues*** *9%*
- Disposition of Depleted Uranium *8%*
- **WAC*** *6%*
- Human Intrusion *6%*
- Duration of Institutional Controls *5%*

Approximately 200 comments, questions, and suggestions submitted
Percentages are approximate and do not total 100%

Times of Compliance at a Glance

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EPA RCRA	Chem	∞	Disposal	30+ yrs	Non-technical
Uranium Mill Tailings	Rad	LL	Remediate	200 yrs (<1000 yrs)	Non-technical
Part 20 Decommission Criteria	Rad	VSL	Release	1000 yrs	Technical
DOE Order 435.1	Rad	SL	Disposal	1000 yrs	Non-technical
LLW Disposal Facility (10 CFR 61)	Rad	SL	Disposal	(10,000 yrs)	Technical
EPA Underground Injection	Chem	∞	Disposal	10,000 yrs	Technical
DOE WIR Determinations	Rad	SL-LL	Remediate	DOE: 1000 yrs NRC: 10,000 yrs	Technical
DOE Siting Guidelines (10 CFR 960)	Rad	LL	Screening Action	100,000 yrs	Technical
EPA HLW/SNF/TRU Generic Standards (Part 60)	Rad	LL	Disposal	10,000 yrs	Technical
EPA HLW/SNF Site-Specific Standards (Part 63)	Rad	LL	Disposal	10,000 yrs – 15 mrem 1,000,000 yrs – 100 mrem	Technical

Remaining Steps

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- Brief Advisory Committee on Reactor Safeguards
  - April 2013
- Submit Rulemaking Package to EDO
  - July 2013
- Seek Public Comments
  - Late Fall/Early Winter 2013
  - *Subject to Commission approval*

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Performance Assessment Approaches & Methods - NRC's LLW Program

Rateb (Boby) Abu Eid, Ph. D. (boby.abu-eid@nrc.gov)
Division of Waste Management and Environmental Protection
U.S. Nuclear Regulatory Commission,
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Bilateral Discussion with Japan Atomic Energy Agency (JAEA)

March 21, 2013

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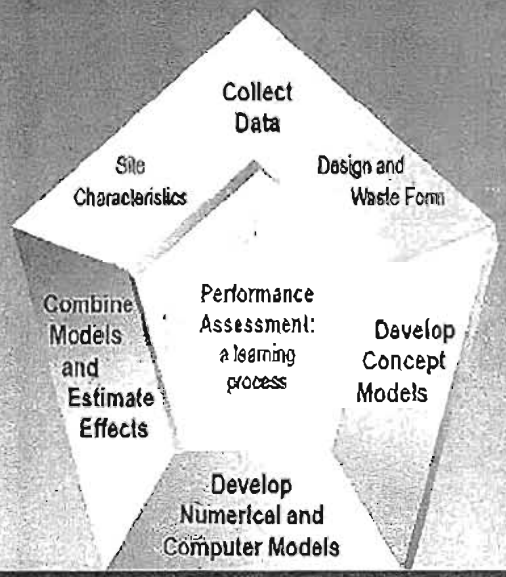
Overview of Performance Assessment

What is Performance Assessment?

- Systematic analysis of what could happen at a site

Why use it?

- Complex system
- Systematic way to evaluate data
- Internationally accepted approach



What is assessed?

- What can happen?
- How likely is it?
- What can result?

How is it conducted?

- Collect data
- Develop scientific models
- Develop computer code
- Analyze results

2

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10 CFR Part 61 Subpart C Performance Objectives

- § 61.41 Protection of the general population from release of radioactivity: *(annual doses not to exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ and maintain effluent releases ALARA).*
- § 61.42 Protection nof individuals from inadvertent intrusion: (Design, operation, and closure of the disposal facility must ensure protection of individuals from inadvertent intrusion).
- § 61.43 Protection of individuals during operations: (Operation must be conducted in compliance with § Part 20 and effluent releases shall be governed by § 61.41).
- § 61.44 Stability of disposal site after closure: (the LLW facility must be sited, designed, used, operated, and closed to achieve long-term stability) so that following closure, only surveillance, monitoring, or minor custodial care are required

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NRC's Approach to Risk-Informed, Performance Based Assessments for LLW & Decommissioning

- Facilitate application of risk-informed and performance-based implementation of the NRC's rulemaking, licensing, and oversight functions for LLW, including waste incidental to reprocessing, and decommissioning on a case-by-case basis.
- Staff engagement in development, maintenance, and evaluation of probabilistic environmental models and codes for risk/dose analysis.
- Use of probabilistic distributions as inputs to uncertain physical and behavior parameters, particularly in independent staff reviews.
- In review of DOE waste incidental to processing determination, the staff utilizes risk-informed performance-based approaches including uncertainty/sensitivity analyses and alternate conceptual models. The risk insights gained during the review are utilized to establish the monitoring areas for a site
- Use of probabilistic tools with sensitivity/uncertainty analysis to demonstrate compliance with the dose criteria

4

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NRC's Integrated Risk Management

Objective

Manage the risks from the use of byproduct, source, and special nuclear materials through appropriate performance-based regulatory controls and oversight

Goal

Provide risk-informed and performance-based defense-in-depth protection to:

- Ensure appropriate barriers, controls, and personnel to prevent, contain, and mitigate exposure to radioactive material according to the hazard present, the relevant scenarios, and the associated uncertainties
- Ensure that the risk resulting from the failure of some or all of the established barriers and controls, including human errors, are maintained acceptably low

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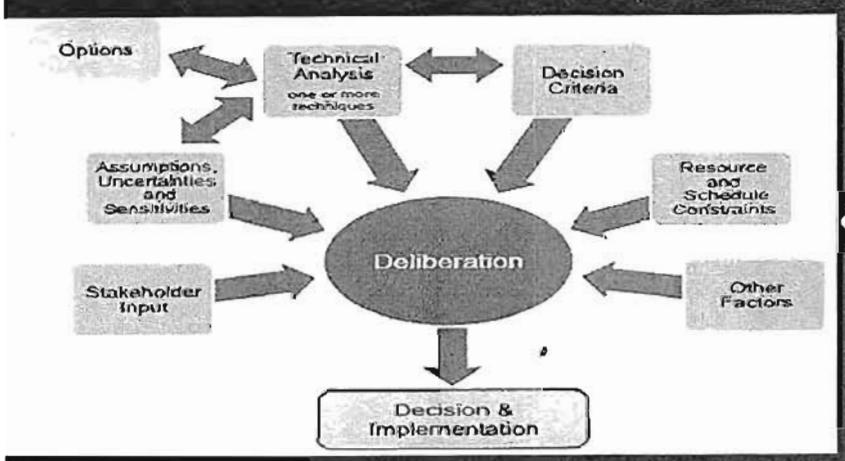
Decision-Making Process

Use a disciplined process to achieve the risk management goal



Deliberation Process

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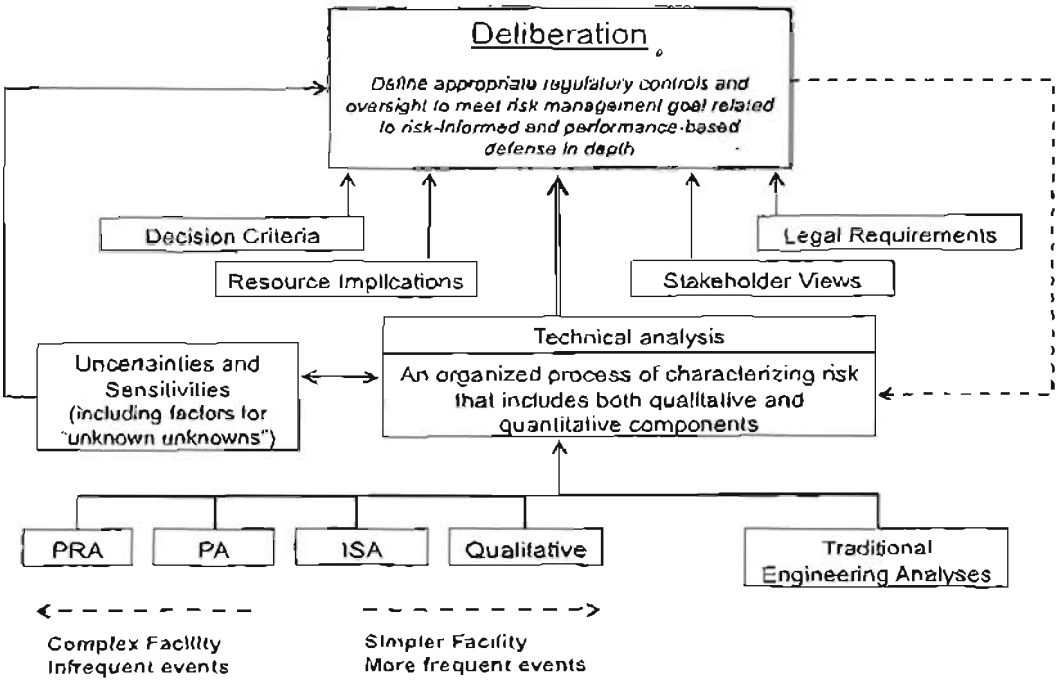
Technical Analysis Techniques and Deliberation



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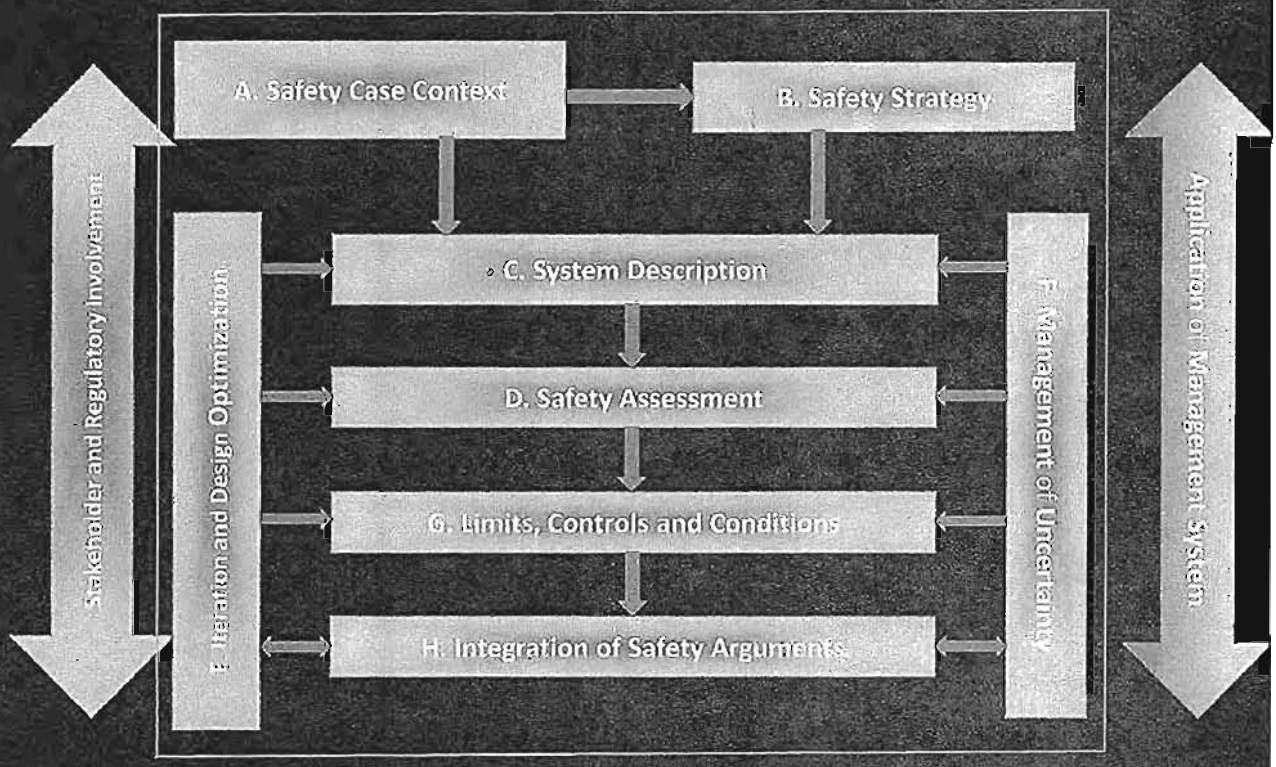
IAEA Safety Case Components



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Sources of Radioactive Waste & Waste Types

- Nuclear fuel cycle
  - Mining of ore (NORM)
  - Uranium milling (Mill tailings)
  - Conversion (LLW)
  - Enrichment (LLW)
  - Fuel Manufacture (LLW)
  - Nuclear power production, isotope production and use (Spent fuel, LLW)
  - Reprocessing (HLW, TRU)
  - Waste disposal
- Non-fuel cycle (Naturally Occurring and Accelerator Produced Materials)

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NRC Waste Classification Table for Long-Lived Radionuclides

Radionuclide	Concentration
C-14	296,000 MBq/m^3
C-14 in activated metal	2,960,00 MBq/m^3
Ni-59 in activated metal	8,140,000 MBq/m^3
Nb-94 in activated metal	7400 MBq/m^3
Tc-99	111,000 MBq/m^3
I-129	29.6 MBq/m^3
Alpha emitting transuranics with ½ lives > 5 years	3700 Bq/gram
Pu-241	129,500 Bq/gram
Cm-242	740,000 Bq/gram

Note: If concentration is < .1 Table value, waste is Class A. If concentration is > 0.1 but less than or equal to Table value, waste is Class C. If concentration is > Table value, waste is greater than class C.

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NRC Waste Classification Table for Short-Lived Radionuclides

Radionuclide	Concentration, MBq/m³		
	Col. 1	Col. 2	Col. 3
Total of all radionuclides with < 5 yr half-life	25.9×10^6	n/a	n/a
H-3	$1.48 \times {}^{6}10$	n/a	n/a
Co-60	25.9×10^6	n/a	n/a
Ni-63	129,500	2.59×10^6	25.9×10^6
Ni-63 in activated metal	1.30×10^6	25.9×10^6	259×10^6
Sr-90	1480	5.55×10^6	259×10^6
Cs-137	37,000	1.63×10^6	170×10^6

Note: If concentration does not exceed column 1, waste is Class A. If concentration is > col. 1 and < col. 2, waste is Class B. If concentration is > col. 2 and < col. 3, waste is Class C. If > col. 3, waste is not acceptable for near-surface disposal

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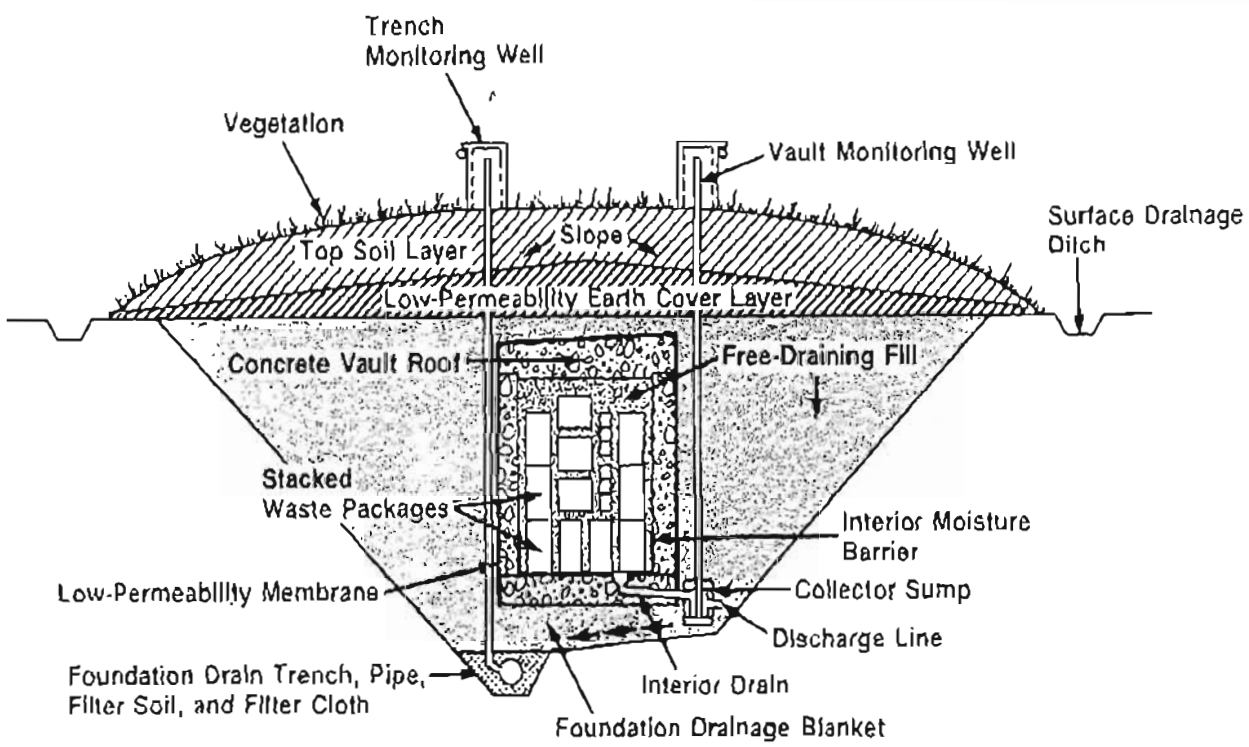
A LLW Disposal Design Concept



NUREG-1573

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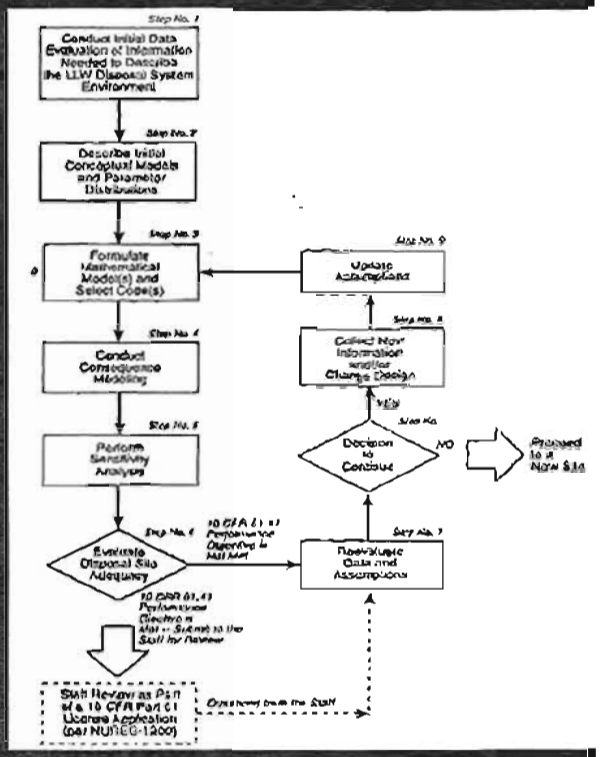
Steps in NRC NUREG-1573 PA Methodology Reviews

- Data evaluation
- Conceptual models & scenarios
- Parameter distributions
- Mathematical models & codes
- Consequence modeling & analysis
- Sensitivity & uncertainty analysis
- Initial evaluation of site performance
- R-evaluation of data & assumptions
- Assessment of compliance with 10 CFR 61.41 & § 61.42



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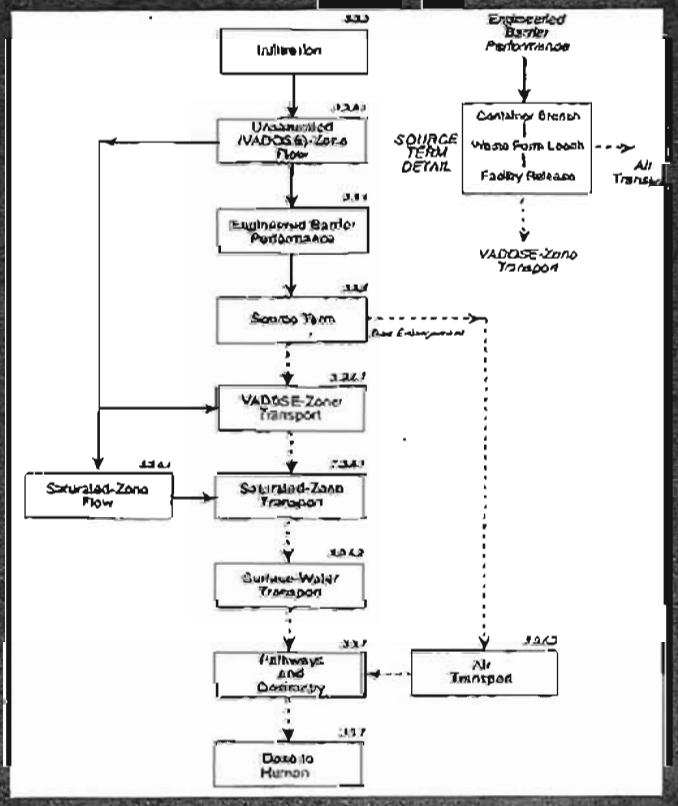
Specific Processes Considered in NRC LLW PA

- Infiltration
- UZ Flow
- Eng. Barrier Performance
  - Container Breach
  - Waste Form Leach
  - Source term releases
- VZ Transport
- SZ flow and Transport
- Surface water transport
- Exposure scenarios & pathways transport
- Dose to human

NUREG-1573



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NUREG-1854 PA Reviews Generic Approaches

Discusses the main areas that should be addressed during a WIR review; applies to all four WIR sites (SRS, INL, Hanford, West Valley); It is risk-informed and performance-based. Based on existing NRC guidance (e.g., NUREG-1573, NUREG-1757) as well as staff experience

- The guidance emphasizes the need for adequate modeling to support its stability
- The amount of model support is to be commensurate with the risk significance of the model
- Model support may entail multiple lines of evidence
- The guidance recognizes that traditional validation may not be possible for some PA models
- Technical basis is needed for the performance of intruder protection systems
- Types of scenarios envisioned: residential, agricultural, recreational, hunting & fishing, well-driller, construction, or others
- Site stability PA includes:
  - Natural stability of the site (e.g., effects of floods, erosion)
  - Stability of the waste (e.g., potential for differential settling)
  - Stability of the engineered facility (e.g., vault degradation)

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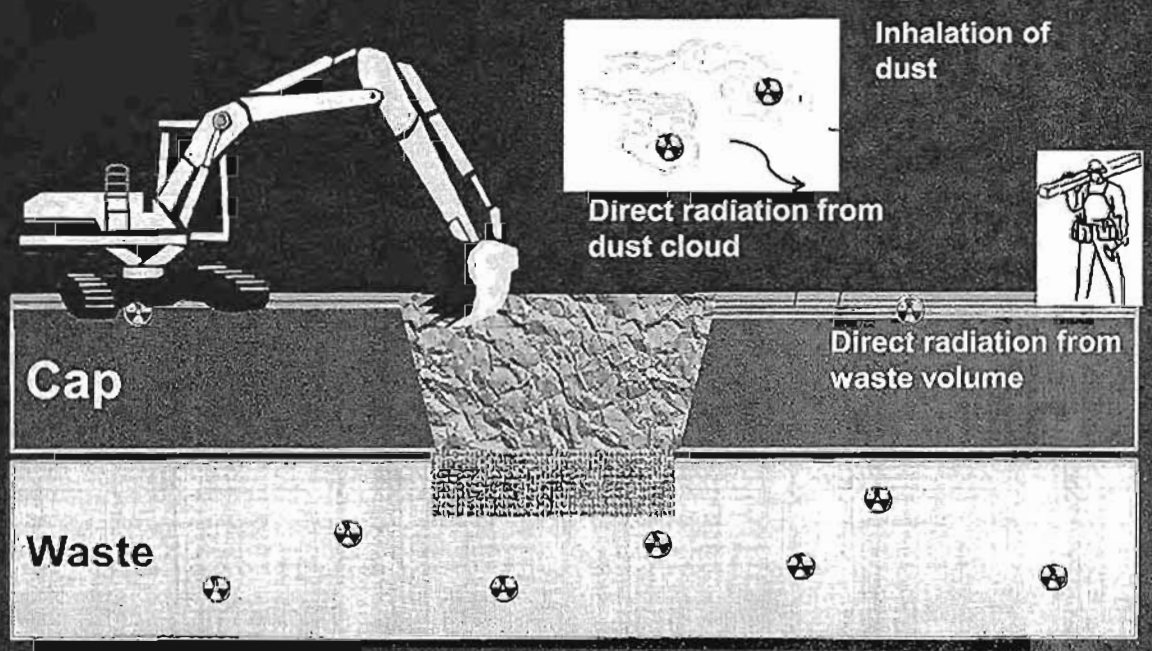
Intruder Scenario Used for LLW PA

Intruder Construction



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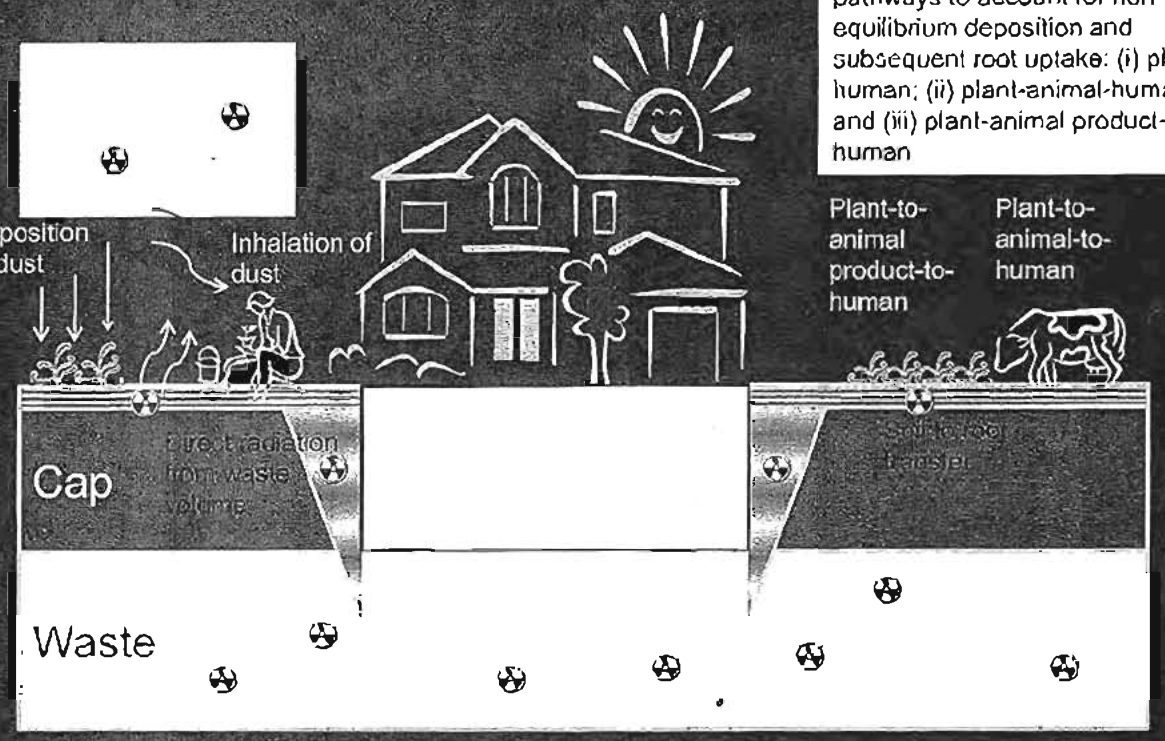
Intruder Agriculture Scenario for LLW PA

NOTE: Includes modified food pathways to account for non-equilibrium deposition and subsequent root uptake: (i) plant-human; (ii) plant-animal-human; and (iii) plant-animal product-human



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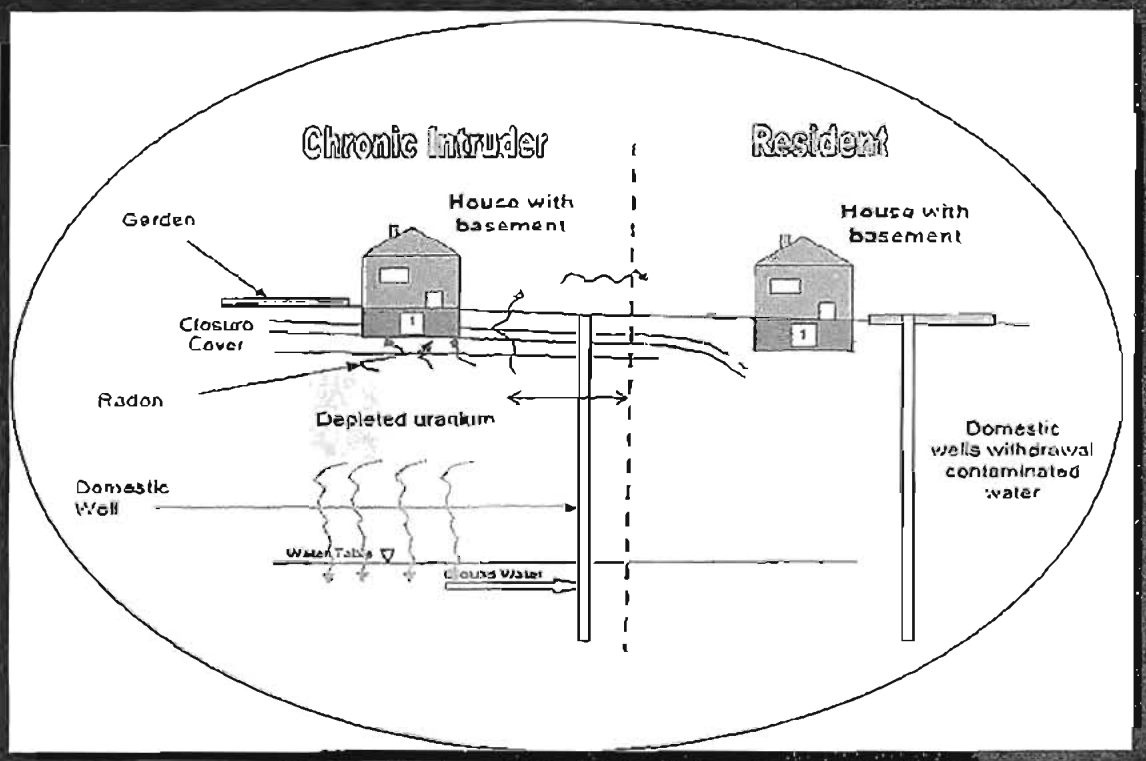
Schematic Illustration of Examples of Exposure Scenarios for DU Disposal



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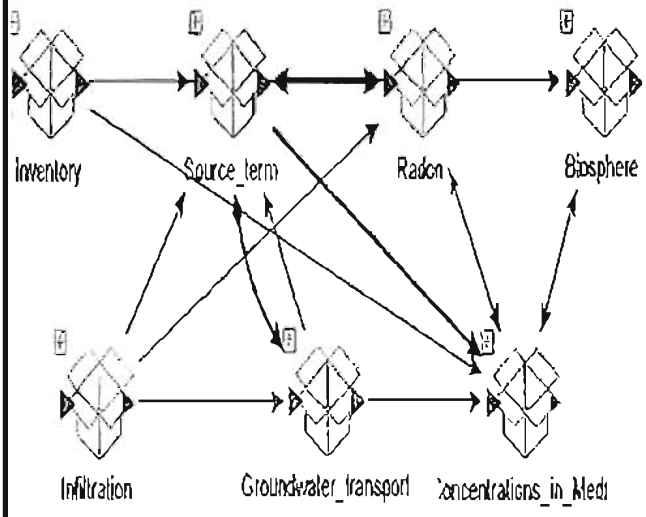
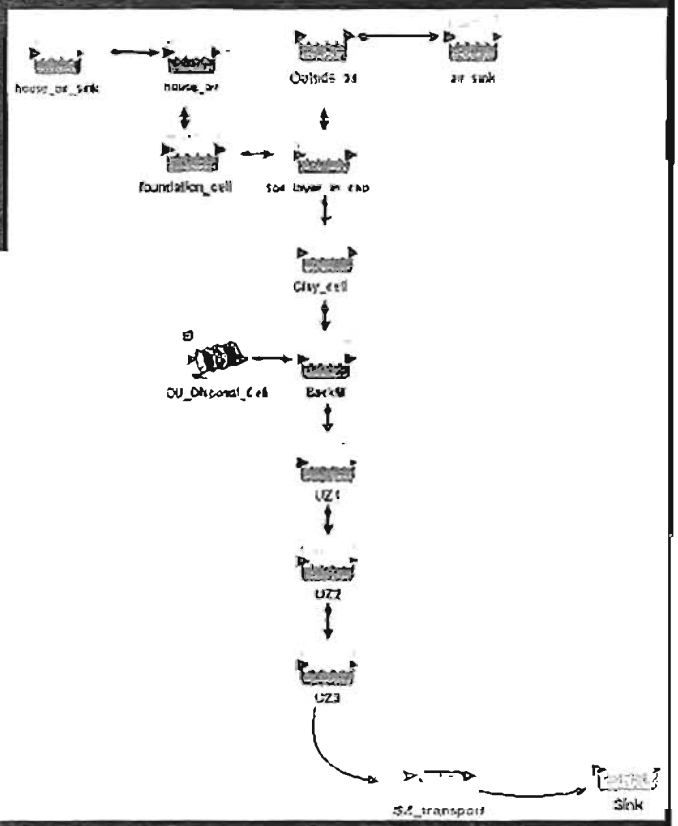
GoldSim
DU Disposal Model





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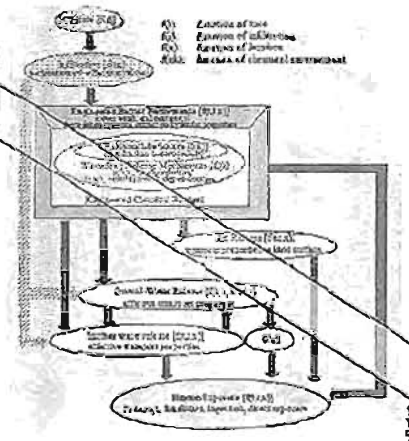
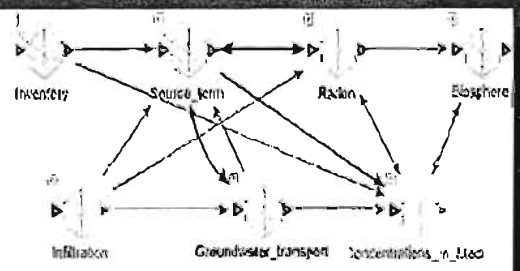
PA Approach: Representation of LLW System, Conceptual & Mathematical Models, and Estimated Performance

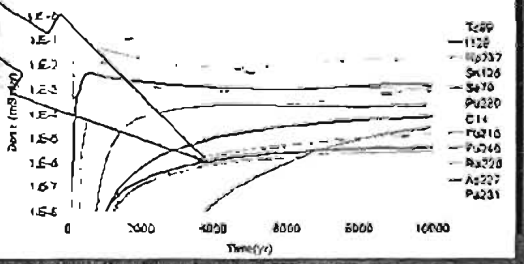
Real system



Mathematical model



Estimated future performance



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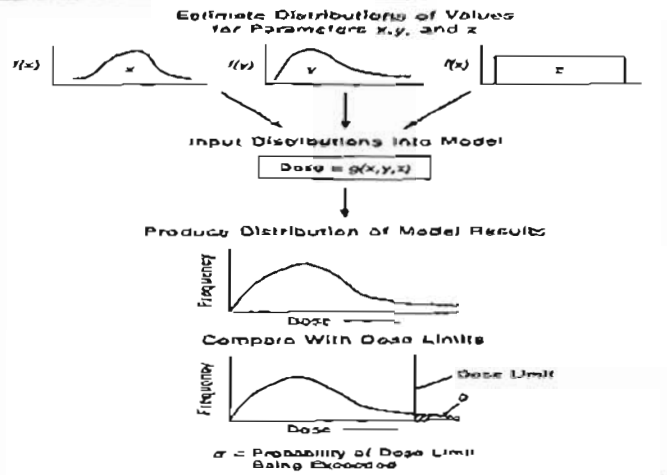
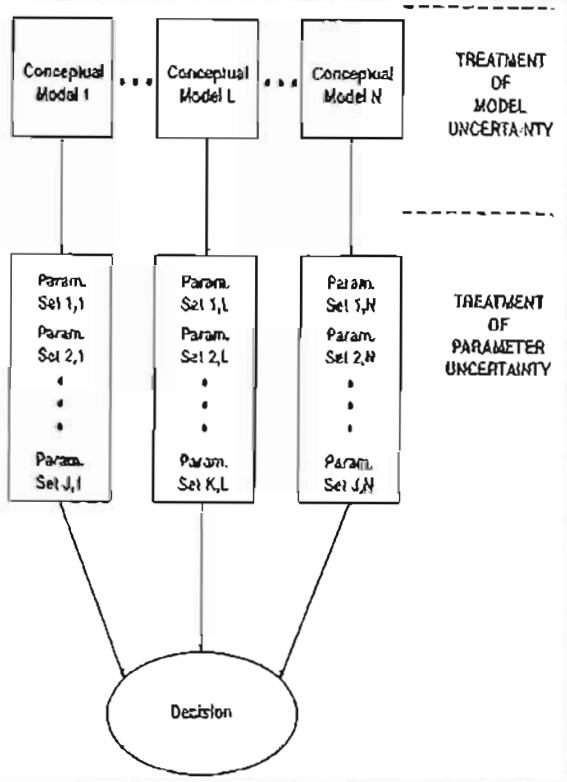
An Approach to Uncertainty Analysis





$$\text{Max}[\text{Mean}(t)] \leq \text{Regulatory Limit}$$

where:

$$\text{Mean}(t) = \frac{\sum_{k=1}^{N} \text{Dose}_k(t)}{N}$$

$\text{Dose}_k(t) \equiv$ doses at time t, for run k

$N \equiv$ number of Monte Carlo runs

$t \equiv$ time

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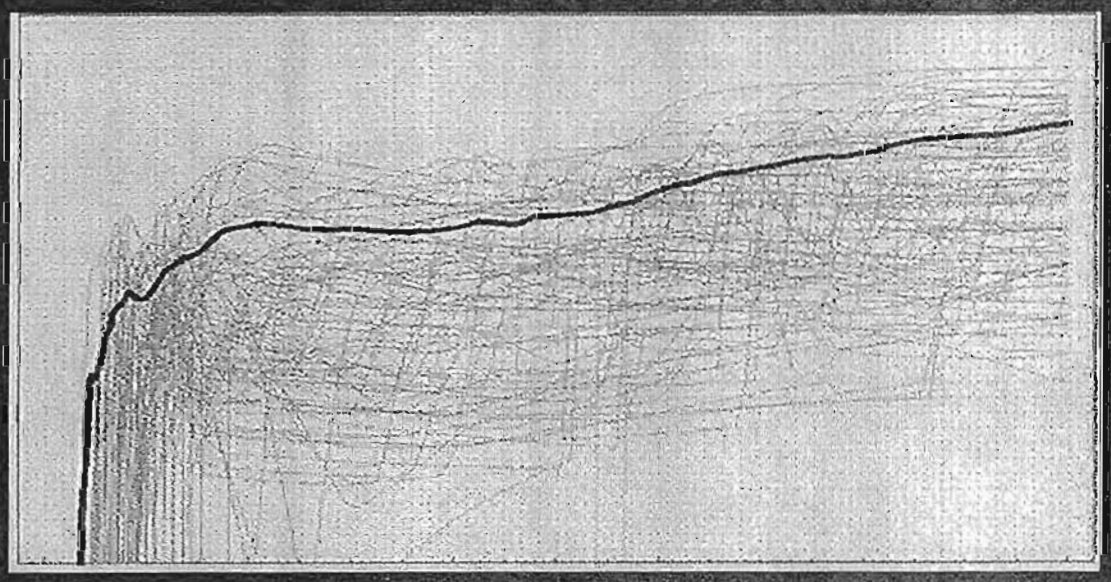
Dose - Time PA Outputs



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PA & Integrated Risk Regulatory Issues

- How to treat future site conditions, processes, events, and climate change
- Exposure scenarios and compliance dose criteria
- Performance of engineered barriers
- Timeframe for LLW performance assessment
- Treatment of sensitivity and uncertainty
- Role of performance assessment during operational and post-closure periods
- Overall integration of site characterization, facility design performance assessment, and safety analysis
- Bench-marking and QA/QC issues
- Stakeholders inputs