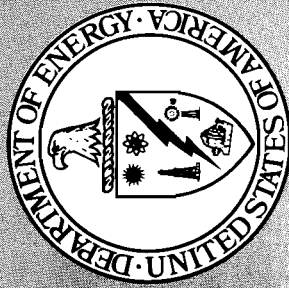


Waste Isolation Pilot Plant
Compliance Certification Application
Reference 605

Stenhouse, M.J., N.A. Chapman, and T.J. Sumerling. 1993.
SITE-94 Scenario development FEP Audit List Preparation: Methodology and
Presentation. SKI Technical Report 93:27. Stockholm: Swedish Nuclear Power
Inspectorate.

SKI-TR-93-27

A Facsimile Report



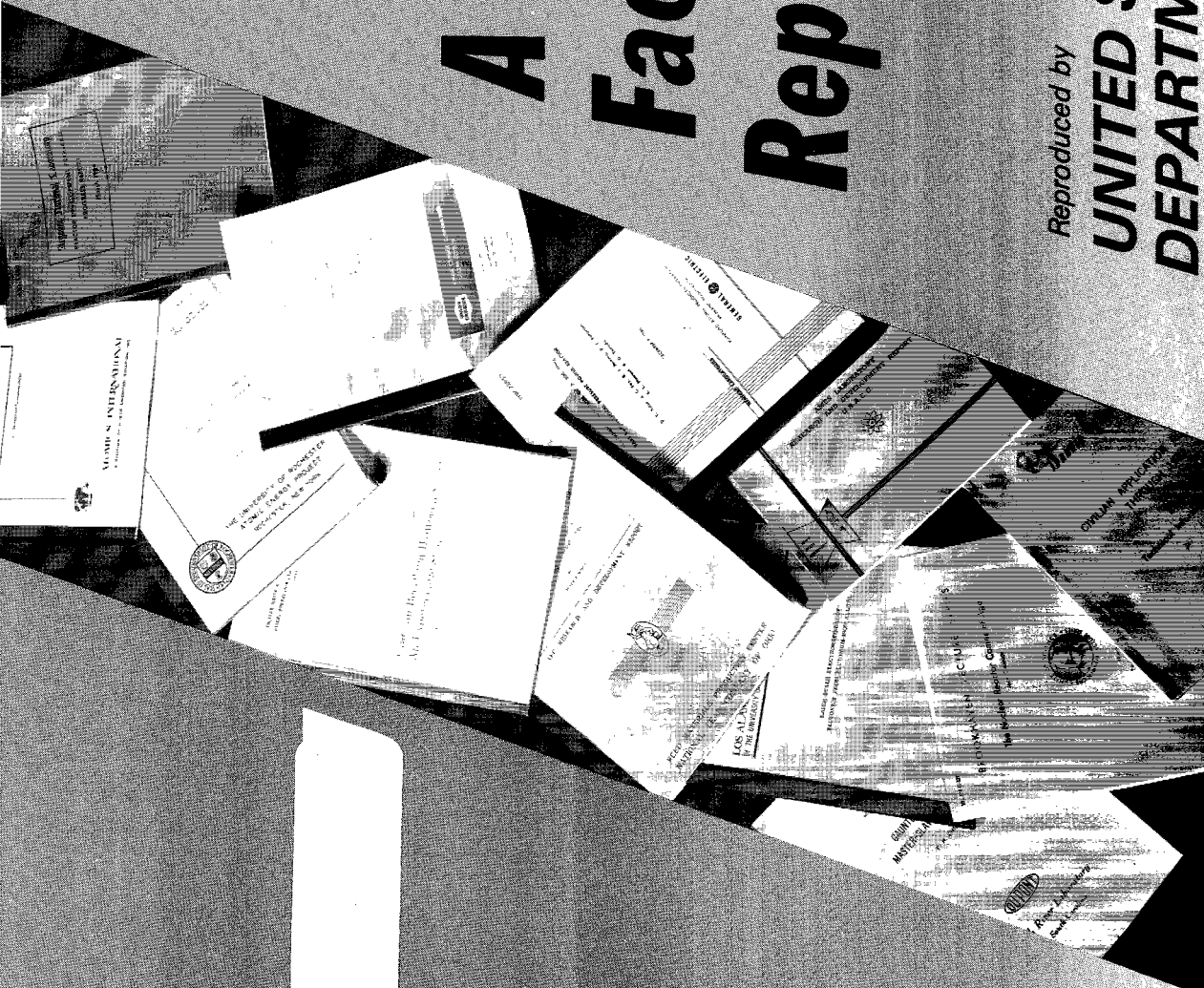
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SITE-94

154 p.

**Scenario Development
FEP Audit List Preparation:
Methodology and Presentation**

*Michael Stenhouse
Neil Chapman
Trevor Sumerling*

April 1993

SKi

STATENS KÄRNKRAFTINSPEKTION
SWEDISH NUCLEAR POWER INSPECTORATE

SKI TR 93:27

SITE-94

**Scenario Development
FEP Audit List Preparation: Methodology and Presentation**

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April 1993

This report concerns a study which has been conducted for the Swedish Nuclear Power Inspectorate (SKI). The conclusions and viewpoints presented in the report are those of the author(s) and do not necessarily coincide with those of the SKI.

PREFACE

This report concerns a study which is part of the SKI performance assessment project SITE-94. SITE-94 is a performance assessment of a hypothetical repository at a real site. The main objective of the project is to determine how site specific data should be assimilated into the performance assessment process and to evaluate how uncertainties inherent in site characterization will influence performance assessment results. Other important elements of SITE-94 are the development of a practical and defensible methodology for defining, constructing and analyzing scenarios, the development of approaches for treatment of uncertainties, evaluation of canister integrity, and the development and application of an appropriate Quality Assurance plan for Performance Assessments.

Johan Andersson
Project Manager

SITE 94
SCENARIO DEVELOPMENT
FEP Audit List Preparation:
Methodology and Presentation

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April, 1993

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INTERA

Environmental Division

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1

Introduction

A preliminary but essential stage of the SITE 94 scenario development process is the identification of all features, events, and processes (FEPs) which are considered important to the long-term isolation of radioactive waste. These FEPs may be of natural or of human origins, and should be relevant to both the disposal site under investigation, and the timescales under consideration. Before combining FEPs into scenarios, an audit of the FEP list is desirable. Thus, the objective of this summary report is to document the specifications and methodology by which an independent FEP list was generated for audit purposes. The intention of the audit is to ensure that *all relevant natural and human-induced FEPs are identified* at this early stage of scenario development.

The SITE 94 Project considers disposal of spent nuclear fuel according to the KBS3 concept, at a site with characteristics based on the Äspö Hard Rock Laboratory site.

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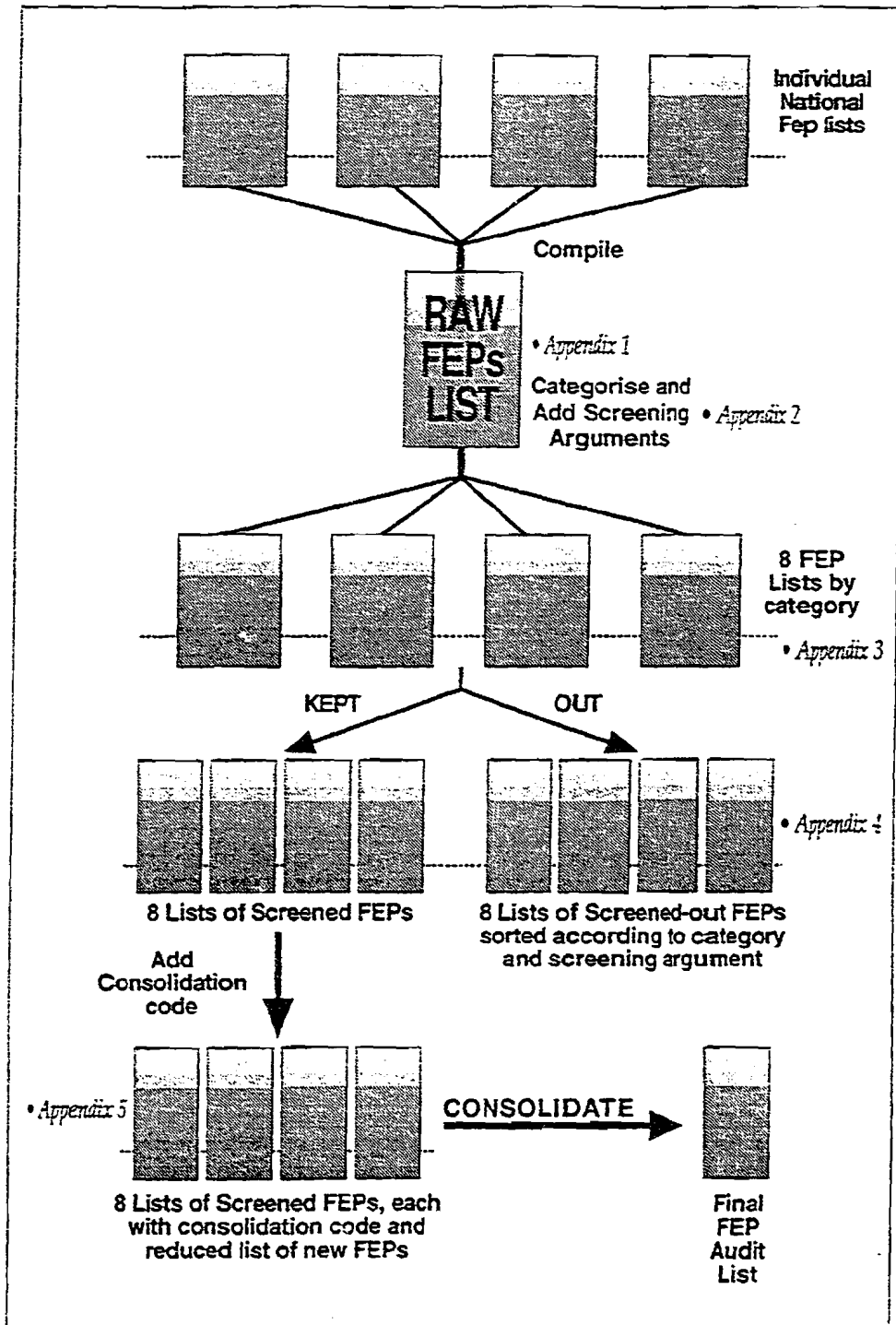
Description of Methodology

The methodology adopted for producing such a FEP audit list involved the following tasks:

- Task 1: Compile raw FEP list
- Task 2: Categorise and add screening criteria
- Task 3: Consolidation coding of screened lists
- Task 4: Perform FEP audit

The overall process in developing the FEP audit list is shown schematically in Figure 1. Each of the above tasks is discussed in detail in the subsequent sections.

Figure 1. Schematic diagram of FEP audit list generation stages



2.1 Task 1: Compile raw FEP list

Identification of FEPs has been performed previously for a variety of national radioactive waste management programmes, and resultant FEP lists apply to a number of disposal concepts and cover a range of disposal sites. As a starting point for the FEP audit list, therefore, the FEP lists from these national exercises were compiled as an electronic spreadsheet/database.

The database was compiled from the following *published* FEP lists:

- Atomic Energy of Canada Limited (AECL): spent fuel; 275 entries; Goodwin *et al.*, (1991)
- U.K. Department of Environment Dry Run 3; 305 entries; Thorne (1992)
- International Atomic Energy Agency (IAEA): Safety Series: general treatment; 56 entries; IAEA (1981)
- Nagra, Switzerland: Project Gewähr: high level waste (HLW); 44 entries; Project Gewähr (1985)
- SKI/SKB: Swedish scenario development; spent fuel; 157 entries; Andersson (1989)
- Sandia National Laboratory, U.S.A.: HLW; 29 entries; Cranwell *et al.* (1982)
- U.K. Nirex: L/ILW; 131 entries; Hodgkinson and Sumerling (1989)
- U.K. Department of Environment: Sellafield Assessment: L/ILW; 79 entries; Miller and Chapman (1992)
- Nuclear Energy Agency (NEA): Systematic Approaches to Scenario Development; 122 entries; NEA (1992)

Although Nagra is conducting a scenario development process for Kristallin-1, the FEP list was incomplete at the time of compilation. For this reason, this source of FEPs was not used. In addition, the Kemakta FEP list for the SFR assessment done for SKB was not included, as it was felt that Kemakta, who are responsible for developing the original FEP list, would be influenced by this work.

The final compilation comprises over 1200 entries and is listed in Appendix 1. The level of FEP detail for each national list is highly variable,

as indicated by the respective values for number of entries, and reflects differing degrees of generalisation. However, no screening or additional reductions were performed during this task. For some entries, text was added, but only to provide additional description to FEPs, the meaning of which would otherwise be too vague for subsequent screening.

2.2 Task 2: Categorise and add screening criteria

The list in Appendix 1 contains numerous entries which are neither relevant to the Swedish disposal concept nor to the disposal site. In addition, duplications abound in the raw list. Thus, to make the subsequent screening process easier, the first stage of this task was to separate entries into arbitrary categories. Eight categories were selected in total, viz.:

Waste [W]	Container [C]
Buffer/Backfill [B]	Repository [R]
Far-field [F]	Biosphere [L]
Human actions [H]	Geological/climatic evolution [G]

The letters in parentheses were used to code individual entries, and an attempt was made to classify FEPs according to *where the FEP occurs* (W; C; B; R; F; L) or *which category is the responsible agent* (G; H). Occasionally, it was difficult to categorise FEPs in this way, in which case the coding applies more to the category which is *affected* by the FEP. In addition, more than one code letter was applied to a FEP if it was considered to apply to one or more of the categories designated. It should be emphasised that assigning FEPs to the above categories was performed as a matter of convenience, and that this separation process is relatively arbitrary, given the different origins of the original FEP list (Appendix 1).

Screening criteria were then added to identify and to subsequently remove *only those FEPs which are irrelevant to the Swedish disposal concept and disposal site*. The criteria which were used are based on those applied by Nagra and presented in Sumerling *et al.* (1993). The preliminary "criteria" – referred to as screening *arguments*, are presented in Appendix 2. Included in Appendix 2 are NOTES: specific modifications to certain screening arguments, based on consultation with SKI (Johan Andersson, personal communication). An additional code was provided for those FEPs which were either too vague or all-encompassing to be useful. It should be stressed, however, that no FEP entries were destroyed as a result of the screening process – only removed to a separate appendix.

The modified screening arguments are summarised in Table 1, each argument having a corresponding code (for convenience, the subsection number of appropriate text in Appendix 2). The FEP lists, sorted by category, and with screening code added, are shown in Appendix 3. Finally, the screening process was performed on the eight category lists of FEPs to separate entries with screening codes from those without. As mentioned previously, no FEPs were removed permanently, screened-out FEPs being compiled in Appendix 4.

2.3 Task 3: Consolidation coding of screened lists

Eight lists of screened FEPs were produced from the screening process performed in Task 2 (in addition to the 8 lists of screened-out FEPs in Appendix 4). In order to consolidate these 8 lists of screened FEPs, an additional consolidation code was added, as shown in Appendix 5 (CON. CODE). The purpose of this consolidation code was to create a reduced set of 'processes' which included *all* screened FEPs, but which had a sufficiently small number to be manageable. Reduced sets in the range 10-15 'processes' were considered an acceptable compromise - small enough to be manageable, but large enough to retain specific characteristics of the individual FEPs, *i.e.* not too general.

Accordingly, Appendix 5 contains the 8 lists of screened FEPs, each category list prefaced by the set of consolidated 'processes'. For ease of review, individual, screened FEPs are grouped according to consolidation code.

Table 1: Summary of FEP Screening Arguments

Code	Screening Argument	Specifically Excluded Phenomena relating to:
<u>Site and Disposal Concept</u>		
2.1	Waste form and packaging	L/ILW, organic wastes; vitrified waste
2.2	Emplacement and repository	cementitious backfill;
2.3	Host geology	salt deposits; clays; near-surface disposal phenomena
2.4	Local and regional surface environment	thick soil/sediment sequences; large topographic influences; oceanic processes
2.5	Geo-climatic development	arid climate; coastal, fluvial erosion
<u>Assessment Basis</u>		
3.1	Repository design/closure	operational phase; retrievability; major design changes
3.2	Global/regional disasters	meteorites TREATED SEPARATELY*
3.3	Acts of war/sabotage	nuclear war; terrorism TREATED SEPARATELY*
3.4	Deliberate intrusion	—
3.5	Future human society and technology	futuristic assumptions about human behaviour and technology
3.6	Post-closure radiological assessment	chemical toxicity impacts to flora/fauna
3.7	Future life evolution	radiation sensitivity; metabolism changes
<u>Other</u>		
4	General issues	too vague, general; incomprehensible philosophical

*: Arguments 3.2 and 3.3 were assigned screening code 'D'

2.4 Task 4: Perform FEP audit

The FEP lists contained in Appendix 5 were used to perform an audit of the Kemakta FEP list (in Stockholm, April 21st, 1993). Participants in the audit were Neil Chapman and Michael Stenhouse of Intera, and Kristina Skagius and Marie Wiborg of Kemakta (primarily responsible for developing the Kemakta system). The objective of this exercise was to ensure that all relevant features, events and processes had either been incorporated in the influence diagrams already generated by Kemakta (principally of the waste and the engineered systems), or were available for construction of influence diagrams of other parts of the Process System.

During the audit, each FEP in the Intera lists was examined within each category. A tick mark was added if it had been included in the Kemakta list, either as a FEP or as a 'LINK' between two FEPs. Duplicates in the Intera list were eliminated at this stage, and external FEPs were identified as 'EFEP'. For each FEP which was identified for inclusion in the Kemakta system, either as a new FEP or new LINK, a note was made of the addition, together with its cause and effect.

At the time of the audit, the near-field FEPs had been identified and fully documented, and the Intera categories which were used for comparison were WASTE, CANISTER, BUFFER/BACKFILL and REPOSITORY. Similar treatments for the far field and biosphere systems were incomplete, although the format of the influence diagram was expected to be similar to that of the near field. As a result, all Intera FEP categories except BIOSPHERE were examined in detail. For the biosphere, duplicates were identified and eliminated. Occasionally, where two slightly different FEPs overlapped in terms of description, they were combined, thereby reducing the overall number.

The end product of the audit was a final list of all FEPs, still retained under the 8 categories, which have to be considered in the scenario development for the Swedish waste disposal concept. This list is shown in Appendix 6, and the *main headings* for these FEPs are included in Table 2.

Table 2. Final FEP List Headings

FEP NAME: HEADER	
1. WASTE CATEGORY	Waste characteristics: initial (SYSTEM DESCRIPTION) Radionuclide decay and growth Radiological/radiation effects Gas generation and effects Heat generation Thermo-mechanical effects Thermo-chemical effects Electro-chemical effects Waste degradation/corrosion/dissolution Geochemical reactions/regime Radionuclide chemistry Specific factors
2. CANISTER CATEGORY	Canister materials/construction (SYSTEM DESCRIPTION) Corrosion/degradation processes Gas production and effects Microbiological effects/microbial activity Thermo-mechanical effects Electro-chemical effects Stress/mechanical effects Geochemical reactions/regime Radionuclide transport through containers Specific factors
3. BUFFER/BACKFILL CATEGORY	Buffer/backfill characteristics (SYSTEM DESCRIPTION) Resaturation/desaturation Mechanical effects Thermal effects Electro-chemical effects Gas effects Microbiological effects/microbial activity Backfill degradation Geochemical regime Radionuclide transport processes Radionuclide chemistry Specific factors
4. REPOSITORY/NEAR-FIELD ROCK CATEGORY	Near-field rock; repository elements/materials (SYSTEM) Repository degradation Hydraulic effects/groundwater flow Mechanical effects Thermal effects Gas effects and transport Microbiological/biological activity Geochemical regime Radionuclide chemistry Radionuclide transport processes Specific factors

Table 2. Final FEP List Headings

FEP NAME: HEADER	
5. FAR FIELD CATEGORY	<ul style="list-style-type: none"> Rock properties (SYSTEM DESCRIPTION) Hydrogeological effects Physical/mechanical effects Thermal effects Gas effects and transport Microbiological/biological activity Geochemical regime Radionuclide chemistry Radionuclide transport processes Specific factors
6. BIOSPHERE CATEGORY	<ul style="list-style-type: none"> Human considerations Ecological factors Soil/sediment effects Surface/near-surface water processes Coastal water/ocean processes Gas effects Microbiological/biological activity Geochemical regime (general) Radionuclide chemistry Radionuclide transport processes Radiological factors Specific factors
7. GEOLOGY/CLIMATE CATEGORY	<ul style="list-style-type: none"> Seismic events/major land movement Rock deformation Metamorphic processes Erosion/weathering (surface) Groundwater flow and effects Surface water flow and effects Sea-level effects Magnetic effects Glaciation/glacial effects Climate effects (natural) Specific factors
8. HUMAN INFLUENCES CATEGORY	<ul style="list-style-type: none"> Inadvertent intrusion into repository Surface activities Subsurface activities Water use Agricultural and fisheries practices Specific factors

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NEA, 1992. Systematic Approaches to Scenario Development: Safety Assessment of Radioactive Waste Repositories. Report of the Nuclear Energy Agency Working Group on the Identification and Selection of Scenarios for the Safety Assessment of Radioactive Waste Disposal. NEA, ODCE/OECD, Paris.

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APPENDIX 1
Raw FEPs List

Appendix 1. Raw FEPs List

The composite list presented in the following pages (19) contains all FEPs from the following national exercises, listed in order of appearance (the initial letter coding, *e.g.* AECL, identifies the respective exercises):

- AECL: Canada
- DOE: Dry Run 3, U.K. Department of Environment
- IAEA: Safety Series
- PGA:Nagra, Switzerland
- SKI: SKI/SKB: Sweden
- SNL: Sandia, U.S.
- UKN: U.K. Nirex L/ILW
- HMIP: Sellafield Assessment, U.K. Department of Environment
- NEA: Safety Assessment

NOTE

References for the above lists are given in the main text (page 3). In the 'DOE' list, FEPs often exist at the quaternary level (W.X.Y.Z) and, for such cases, the corresponding tertiary heading (W.X.Y) has been incorporated in each FEP as additional description. As a result, these tertiary entries (shaded) become redundant and are excluded from subsequent edited lists. In the same way, AECL primary (X.), and HMIP primary (W.) and secondary (W.X), headers have been retained for clarity, but are excluded from the reduced lists.

RAW FEPs LIST

IDENTIFIER	FEP NAME
AECL1 VAULT FACTORS	
AECL1.1	Backfill characteristics
AECL1.2	Backfill evolution
AECL1.3	Biological activity
AECL1.4	Boundary conditions
AECL1.5	Buffer additives
AECL1.6	Buffer characteristics
AECL1.7	Buffer evolution
AECL1.8	Cave ins
AECL1.9	Chemical gradients
AECL1.10	Chemical interactions (expected)
AECL1.11	Chemical interactions (long-term)
AECL1.12	Chemical interactions (other)
AECL1.13	Chemical kinetics
AECL1.14	Climate change
AECL1.15	Colloids
AECL1.16	Complexation by organics
AECL1.17	Concrete
AECL1.18	Container corrosion products
AECL1.19	Container failure (early)
AECL1.20	Container failure (long-term)
AECL1.21	Container failure (other long-term processes)
AECL1.22	Container healing
AECL1.23	Containers - partial corrosion
AECL1.24	Convection
AECL1.25	Correlation
AECL1.26	Corrosion
AECL1.27	Coupled processes
AECL1.28	Criticality
AECL1.29	Diffusion
AECL1.30	Dispersion
AECL1.31	Earthquakes
AECL1.32	Electrochemical gradients
AECL1.33	Evolution of buffer
AECL1.34	Excessive hydrostatic pressures
AECL1.35	Explosions
AECL1.36	Faulty buffer emplacement
AECL1.37	Formation of cracks
AECL1.38	Formation of gases
AECL1.39	Galvanic coupling
AECL1.40	Geochemical pump
AECL1.41	Glaciation
AECL1.42	Global effects
AECL1.43	Hydraulic conductivity
AECL1.44	Hydraulic head
AECL1.45	Hydride cracking
AECL1.46	Hydrothermal alteration
AECL1.47	Improper operation
AECL1.48	Incomplete closure
AECL1.49	Incomplete filling of containers
AECL1.50	Interfaces (boundary conditions)
AECL1.51	Intrusion (animal)
AECL1.52	Intrusion (human)
AECL1.53	Inventory
AECL1.54	Other wastes (other than vitrified HLW)
AECL1.55	Long-term physical stability
AECL1.56	Long-term transients
AECL1.57	Methylation
AECL1.58	Microbes
AECL1.59	Microorganisms
AECL1.60	Monitoring and remedial activities
AECL1.61	Mutation
AECL1.62	Percolation in shafts
AECL1.63	Pitting
AECL1.64	Preclosure events
AECL1.65	Precipitation and dissolution
AECL1.66	Pseudo-colloids
AECL1.67	Radiation damage
AECL1.68	Radioactive decay
AECL1.69	Radiolysis

RAW FEPs LIST

IDENTIFIER	FEP NAME
AECL1.70	Recharge groundwater
AECL1.71	Reflooding
AECL1.72	Retrievability
AECL1.73	Sabotage and improper operation
AECL1.74	Seal evolution
AECL1.75	Seal failure
AECL1.76	Sorption
AECL1.77	Sorption: non-linear
AECL1.78	Source terms (expected)
AECL1.79	Source terms (other)
AECL1.80	Speciation
AECL1.81	Stability
AECL1.82	Stability of glass
AECL1.83	Swelling pressure
AECL1.84	Temperature rises (unexpected effects)
AECL1.85	Time dependence
AECL1.86	Transport in gases or of gases
AECL1.87	Uncertainties
AECL1.88	Uniform corrosion
AECL1.89	Unmodelled design features
AECL1.90	Unsaturated transport
AECL1.91	Vault geometry
AECL2: GEOSPHERE FACTORS	
AECL2.1	Blasting and vibration
AECL2.2	Bomb blast
AECL2.3	Borehole - well
AECL2.4	Borehole seal failure/open boreholes
AECL2.5	Boreholes - exploration
AECL2.6	Boreholes - unsealed
AECL2.7	Cavitation
AECL2.8	Climate change
AECL2.9	Colloid formation
AECL2.10	Complexation by organics
AECL2.11	Conceptual model - hydrology
AECL2.12	Correlation
AECL2.13	Dams
AECL2.14	Dewatering
AECL2.15	Diffusion
AECL2.16	Discharge zones
AECL2.17	Dispersion
AECL2.18	Drought
AECL2.19	Earthmoving
AECL2.20	Earthquakes
AECL2.21	Erosion
AECL2.22	Explosion
AECL2.23	Faulting
AECL2.24	Flood
AECL2.25	Fulvic acid
AECL2.26	Gases and gas transport
AECL2.27	Geothermal gradient effects
AECL2.28	Glaciation
AECL2.29	Greenhouse effect
AECL2.30	Groundwater - evolution
AECL2.31	Groundwater composition change
AECL2.32	Humic acid
AECL2.33	Hydraulic properties - evolution
AECL2.34	Intrusion (magmatic)
AECL2.35	Intrusion (mines)
AECL2.36	Isostatic rebound
AECL2.37	Magmatic activity
AECL2.38	Magnetic poles
AECL2.39	Matrix diffusion
AECL2.40	Metamorphic activity
AECL2.41	Meteorite
AECL2.42	Methane
AECL2.43	Microbes
AECL2.44	Mines
AECL2.45	Ozone layer
AECL2.46	Precipitation - dissolution
AECL2.47	Pseudo-colloids

RAW FEPs LIST

IDENTIFIER	FEP NAME
AECL2.48	Radioactive decay
AECL2.49	Radiolysis, radiation damage
AECL2.50	Recharge groundwater
AECL2.51	Rock properties
AECL2.52	Rock properties - undetected features
AECL2.53	Sabotage
AECL2.54	Salinity effects on flow
AECL2.55	Saturation
AECL2.56	Shaft seal failure
AECL2.57	Solution mining
AECL2.58	Sorption
AECL2.59	Sorption - non-linear
AECL2.60	Speciation
AECL2.61	Topography - current
AECL2.62	Topography - future
AECL2.63	Turbulence
AECL2.64	Uncertainties
AECL2.65	Unsaturated rock
AECL2.66	Vault closure (incomplete)
AECL2.67	Vault heating effects
AECL2.68	Vulcanism
AECL2.69	Wells
AECL2.70	Wells (high demand)
AECL3 BIOSPHERE FACTORS	
AECL3.1	Acid rain
AECL3.2	Alkali flats
AECL3.3	Animal grooming and fighting
AECL3.4	Animal soil ingestion
AECL3.5	Animals' diets
AECL3.6	Artificial lake mixing
AECL3.7	Ashes and sewage sludge
AECL3.8	Bacteria and microbes (soil)
AECL3.9	Bioconcentration
AECL3.10	Biogas production
AECL3.11	Biological evolution
AECL3.12	Biotoxicity
AECL3.13	Bioturbation of soils and sediments
AECL3.14	Building materials
AECL3.15	Burrowing animals
AECL3.16	Capillary rise in soil
AECL3.17	Carcasses
AECL3.18	Carcinogenic contaminants
AECL3.19	Charcoal production
AECL3.20	Chemical precipitation
AECL3.21	Chemical toxicity
AECL3.22	Climate
AECL3.23	Climate - evolution
AECL3.24	Collisions, explosions, impacts
AECL3.25	Colloids
AECL3.26	Convection, turbulence and diffusion (atmospheric)
AECL3.27	Correlation
AECL3.28	Critical group - agricultural labour
AECL3.29	Critical group - clothing and home furnishings
AECL3.30	Critical group - evolution
AECL3.31	Critical group - house location
AECL3.32	Critical group - individuality
AECL3.33	Critical group - leisure pursuits
AECL3.34	Critical group - pets
AECL3.35	Crop fertilization
AECL3.36	Crop storage
AECL3.37	Cure for cancer
AECL3.38	Deposition (wet and dry)
AECL3.39	Dermal sorption - nuclides other than tritium
AECL3.40	Dermal sorption - tritium
AECL3.41	Dispersion
AECL3.42	Dust storms and desertification (massive)
AECL3.43	Earthmoving projects (major)
AECL3.44	Earthquakes
AECL3.45	Erosion - lateral transport
AECL3.46	Erosion - wind

RAW FEPS LIST

IDENTIFIER	FEP NAME
AECL3.47	Fires (agricultural)
AECL3.48	Fires (forest and grass)
AECL3.49	Fish farming
AECL3.50	Flipping of earth's magnetic poles
AECL3.51	Flood (short-term)
AECL3.52	Flushing of water bodies
AECL3.53	Food preparation
AECL3.54	Game ranching
AECL3.55	Gas leakage into underground living space
AECL3.56	Glaciation
AECL3.57	Greenhouse (food production)
AECL3.58	Greenhouse effect
AECL3.59	Groundshine, treeshine
AECL3.60	Heat storage in lakes or underground
AECL3.61	Herbicides, pesticides, fungicides
AECL3.62	Household dust and fumes
AECL3.63	Houseplants
AECL3.64	Human diet
AECL3.65	Human soil ingestion
AECL3.66	Hydroponics
AECL3.67	Industrial use of water
AECL3.68	Inject/ingest/inhaling locally produced drugs
AECL3.69	Intrusion (deliberate)
AECL3.70	Intrusion (inadvertent)
AECL3.71	Ionic exchange in soil
AECL3.72	Irrigation
AECL3.73	Lake infilling
AECL3.74	Mutagenic contaminants
AECL3.75	Outdoor spraying of water
AECL3.76	Ozone layer failure
AECL3.77	Peat and leaf litter harvesting
AECL3.78	Plant root systems
AECL3.79	Precipitation (meteoric)
AECL3.80	Radioactive decay
AECL3.81	Radiotoxic contaminants
AECL3.82	Radon emission
AECL3.83	Rivercourse meander
AECL3.84	Runoff
AECL3.85	Saltation
AECL3.86	Scavengers and predators
AECL3.87	Seasons
AECL3.88	Sediment resuspension in water bodies
AECL3.89	Sedimentation in water bodies
AECL3.90	Sensitization to radiation
AECL3.91	Showers and humidifiers
AECL3.92	Smoking
AECL3.93	Soil
AECL3.94	Soil depth
AECL3.95	Soil leaching
AECL3.96	Soil porewater pH
AECL3.97	Soil sorption
AECL3.98	Soil type
AECL3.99	Space heating
AECL3.100	Surface water bodies
AECL3.101	Surface water pH
AECL3.102	Suspension in air
AECL3.103	Technological advances in food production
AECL3.104	Teratogenic contaminants
AECL3.105	Terrestrial surface
AECL3.106	Toxicity of mined rock
AECL3.107	Tree sap
AECL3.108	Uncertainties
AECL3.109	Urbanization on the discharge site
AECL3.110	Water leak into underground living space
AECL3.111	Water management projects (major)
AECL3.112	Water source
AECL3.113	Wetlands
AECL3.114	Wind

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE1.1.1	Structural container metal corrosion
DOE1.1.1.1	Structural container metal corrosion: Localised
DOE1.1.1.2	Structural container metal corrosion: Bulk
DOE1.1.1.3	Structural container metal corrosion: Crevice
DOE1.1.1.4	Structural container metal corrosion: Stress corrosion cracking
DOE1.1.2	Physical degradation of concrete
DOE1.1.2.1	Cracking: concrete
DOE1.1.2.2	Sealing of cracks: concrete
DOE1.1.2.3	Pore blockage: concrete
DOE1.1.2.4	Alkali-aggregate reaction: concrete
DOE1.1.2.5	Cement-sulphate reaction: concrete
DOE1.1.3	Chemical degradation of concrete
DOE1.1.3.1	Changes in pore water composition, pH, Eh: concrete
DOE1.1.3.2	Exchange capacity exceeded: concrete
DOE1.1.3.3	Alkali-aggregate reaction: concrete
DOE1.1.3.4	Cement-sulphate reaction: concrete
DOE1.1.4	Degradation of wastes
DOE1.1.4.1	Metal corrosion: wastes
DOE1.1.4.2	Leaching: wastes
DOE1.1.4.3	Complex formation: wastes
DOE1.1.4.4	Colloid formation: wastes
DOE1.1.4.5	Microbial degradation of organic wastes: wastes
DOE1.1.4.6	Microbial corrosion: wastes
DOE1.1.4.7	Radiolysis: wastes
DOE1.2.1	Hydrogen by metal corrosion
DOE1.2.1.1	Hydrogen: corrosion of structural steel
DOE1.2.1.2	Hydrogen: corrosion of container steel
DOE1.2.1.3	Hydrogen: corrosion of waste steel
DOE1.2.1.4	Hydrogen: corrosion of waste Magnox
DOE1.2.1.5	Hydrogen: corrosion of waste aluminium
DOE1.2.1.6	Hydrogen: corrosion of waste Zircaloy
DOE1.2.1.7	Hydrogen: corrosion of other waste metals
DOE1.2.1.8	Hydrogen: effects of microbial growth on concrete
DOE1.2.2	Methane and carbon dioxide by microbial degradation
DOE1.2.2.1	Methane/CO ₂ : degradation of Cellulosics
DOE1.2.2.2	Methane/CO ₂ : degradation of Other susceptible organic materials
DOE1.2.2.3	Methane/CO ₂ production: Aerobic degradation
DOE1.2.2.4	Methane/CO ₂ production: Anaerobic degradation
DOE1.2.2.5	Methane/CO ₂ production: Effects of temperature
DOE1.2.2.6	Methane/CO ₂ production: Effects of lithostatic pressure
DOE1.2.2.7	Methane/CO ₂ production: Effects of microbial growth on properties of concrete
DOE1.2.2.8	Methane/CO ₂ production: Effects of biofilms
DOE1.2.2.9	Methane/CO ₂ production: Effects of hydrogen from metal corrosion
DOE1.2.2.10	Methane/CO ₂ production: Inhibition due to the pressure of toxic materials
DOE1.2.2.11	Methane/CO ₂ production: Carbonate/bicarbonate exchange with concrete
DOE1.2.2.12	Methane/CO ₂ production: Energy and nutrient control of metabolism
DOE1.2.2.13	Methane/CO ₂ production: Effects of radiation on microbial populations
DOE1.2.3	Gas generation from concrete
DOE1.2.4	Active gases
DOE1.2.4.1	Tritiated hydrogen
DOE1.2.4.2	Active methane and carbon dioxide
DOE1.2.4.3	Other active gases
DOE1.2.5	Toxic gases
DOE1.2.6	Gas transport
DOE1.2.6.1	Gas transport In the waste container
DOE1.2.6.2	Gas transport In the vaults between containers
DOE1.2.6.3	Gas transport Between vaults
DOE1.2.6.4	Gas transport In the near-field, including up and around access shafts and adits
DOE1.2.6.5	Gas transport Into and through the far-field
DOE1.2.7	Flammability
DOE1.2.7.1	Fires
DOE1.2.7.2	Explosions
DOE1.3.1	Radioactive decay and ingrowth
DOE1.3.2	Nuclear criticality
DOE1.4.1	Canister or container movement
DOE1.4.2	Changes in in situ stress field
DOE1.4.3	Embrittlement
DOE1.4.4	Subsidence/collapse
DOE1.4.4.1	Repository induced subsidence
DOE1.4.4.2	Natural subsidence

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE1.4.5	Rock creep
DOE1.4.6	Fracturing
DOE1.5.1	Changes in moisture content
DOE1.5.1.1	Changes in moisture content Due to dewatering
DOE1.5.1.2	Changes in moisture content Due to stress relief
DOE1.5.2	Groundwater flow (unsaturated conditions)
DOE1.5.2.1	Groundwater flow: initial conditions
DOE1.5.2.2	Groundwater flow due to gas production
DOE1.5.3	Groundwater flow (saturated conditions)
DOE1.5.4	Transport of chemically active substances into the near-field
DOE1.5.4.1	Transport of Inorganic ions into the near-field
DOE1.5.4.2	Transport of Humic and fulvic acids into the near-field
DOE1.5.4.3	Transport of Microbes into the near-field
DOE1.5.4.4	Transport of Organic complexes into the near-field
DOE1.5.4.5	Transport of Colloids into the near-field
DOE1.6.1	Differential elastic response
DOE1.6.2	Non-elastic response
DOE1.6.3	Fracture changes
DOE1.6.3.1	Fracture changes: aperture
DOE1.6.3.2	Fracture changes: length
DOE1.6.4	Hydrological changes
DOE1.6.4.1	Hydrological changes: Fluid pressure
DOE1.6.4.2	Hydrological changes: Density
DOE1.6.4.3	Hydrological changes: Viscosity
DOE1.6.5	Chemical changes
DOE1.6.5.1	Chemical changes due to Metal corrosion
DOE1.6.5.2	Chemical changes due to Concrete degradation
DOE1.6.5.3	Chemical changes due to Waste degradation
DOE1.6.5.4	Chemical changes due to Gas production
DOE1.6.5.5	Chemical changes due to Complex formation
DOE1.6.5.6	Chemical changes due to Colloid production
DOE1.6.5.7	Chemical changes due to Solubility
DOE1.6.5.8	Chemical changes due to Sorption
DOE1.6.5.9	Chemical changes due to Species equilibrium
DOE1.6.6	Microbiological effects
DOE1.6.6.1	Microbiological effects due to Cellulose degradation
DOE1.6.6.2	Microbiological effects due to Microbial activity
DOE1.6.6.3	Microbiological effects due to Microbial product reactions
DOE2.1.1	Meteorite impact
DOE2.2.1	Regional tectonic
DOE2.2.1.1	Uplift
DOE2.2.1.2	Subsidence
DOE2.2.1.3	Lateral and/or vertical flexure
DOE2.2.2	Magmatic
DOE2.2.2.1	Magmatic: Intrusive
DOE2.2.2.2	Magmatic: Extrusive
DOE2.2.2.3	Magmatic: Hydrothermal
DOE2.2.3	Metamorphism
DOE2.2.3.1	Contact metamorphism
DOE2.2.3.2	Regional metamorphism
DOE2.2.3.3	Dislocation metamorphism
DOE2.2.4	Diagenesis
DOE2.2.5	Diapirism
DOE2.2.6	Seismicity
DOE2.2.6.1	Repository-induced seismicity
DOE2.2.6.2	Externally-induced seismicity
DOE2.2.6.3	Natural seismicity
DOE2.2.7	Faulting/fracturing
DOE2.2.7.1	Faulting/fracturing: Activation
DOE2.2.7.2	Faulting/fracturing: Generation
DOE2.2.7.3	Faulting/fracturing: Change of properties
DOE2.2.8	Major incision
DOE2.2.9	Weathering
DOE2.2.10	Effects of natural gases
DOE2.2.11	Geothermal effects
DOE2.3.1	Variation in groundwater recharge
DOE2.3.2	Groundwater losses (direct evaporation, springflow)

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE2.3	Rock property changes
DOE2.3.3.1	Rock property changes: Porosity
DOE2.3.3.2	Rock property changes: Permeability
DOE2.3.3.3	Rock property changes: Microbial pore blocking
DOE2.3.3.4	Rock property changes: Channel formation/closure
DOE2.3.4	Groundwater flow
DOE2.3.4.1	Groundwater flow: Darcy
DOE2.3.4.2	Groundwater flow: Non-Darcy
DOE2.3.4.3	Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	Groundwater flow: Fracture
DOE2.3.4.5	Groundwater flow: Effects of solution channels
DOE2.3.4.6	Inorganic colloid transport: Porous media
DOE2.3.5	Inorganic colloid transport: Fractured media
DOE2.3.5.1	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	Inorganic colloid transport: Effects of ionic strength
DOE2.3.5.3	Salinity: implications of evaporite deposits/minerals
DOE2.3.6	Variations in groundwater temperature
DOE2.4.1	Advection
DOE2.4.2	Diffusion
DOE2.4.2.1	Bulk diffusion
DOE2.4.2.2	Matrix diffusion
DOE2.4.2.3	Surface diffusion
DOE2.4.3	Hydrodynamic dispersion
DOE2.4.4	Solubility constraints
DOE2.4.4.1	Solubility: effects of pH and Eh
DOE2.4.4.2	Solubility: effects of ionic strength
DOE2.4.4.3	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	Solubility: effects of naturally-occurring colloids
DOE2.4.4.6	Solubility: effects of colloids formed in the near-field
DOE2.4.4.7	Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	Solubility: Effects of microbial activity
DOE2.4.5	Sorption
DOE2.4.5.1	Linear sorption
DOE2.4.5.2	Non-linear sorption
DOE2.4.5.3	Reversible sorption
DOE2.4.5.4	Irreversible sorption
DOE2.4.5.5	Sorption: Effects of pH and Eh
DOE2.4.5.6	Sorption: Effects of ionic strength
DOE2.4.5.7	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	Sorption: effects of naturally-occurring colloids
DOE2.4.5.11	Sorption: effects of colloids formed in the near-field
DOE2.4.5.12	Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	Sorption: effects of microbial activity
DOE2.4.6	Fracture mineralisation
DOE2.4.7	Organic colloid transport
DOE2.4.7.1	Organic colloid transport in Porous media
DOE2.4.7.2	Organic colloid transport in Fractured media
DOE2.4.7.3	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	Organic colloid transport: Effects of ionic strength
DOE2.4.8	Inorganic colloid transport
DOE2.4.8.1	Inorganic colloid transport: Porous media
DOE2.4.8.2	Inorganic colloid transport: Fractured media
DOE2.4.8.3	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	Transport of radionuclides bound to microbes
DOE2.4.10	Isotopic dilution
DOE2.4.11	Gas transport
DOE2.4.11.1	Gas transport: solution
DOE2.4.11.2	Gas transport: gas phase
DOE2.4.12	Gas-induced groundwater transport
DOE2.4.13	Thermally induced groundwater transport
DOE2.4.13.1	Repository thermally-induced groundwater transport
DOE2.4.13.2	Naturally thermally-induced groundwater transport
DOE2.4.14	Biogeochemical changes

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE3.1	Transient greenhouse gas induced warming
DOE3.1.1	Greenhouse-induced Precipitation
DOE3.1.1.1	Greenhouse-induced Temperature
DOE3.1.1.2	Greenhouse-induced Sea level rise
DOE3.1.1.3	Greenhouse-induced Storm surges
DOE3.1.1.4	Greenhouse-induced Ecological effects
DOE3.1.1.5	Greenhouse-induced Potential evaporation
DOE3.1.1.6	Greenhouse-induced Ecological effects
DOE3.1.2	Glacial/interglacial cycling
DOE3.1.2.1	Glacial/interglacial cycling: Precipitation
DOE3.1.2.2	Glacial/interglacial cycling: Temperature
DOE3.1.2.3	Glacial/interglacial cycling: Sea level changes (rise/fall)
DOE3.1.2.4	Glacial/interglacial cycling: Storm surges
DOE3.1.2.5	Glacial/interglacial cycling: Ecological effects
DOE3.1.2.6	Glacial/interglacial cycling: Seasonally frozen ground
DOE3.1.2.7	Glacial/interglacial cycling: Permanently frozen ground
DOE3.1.2.8	Glacial/interglacial cycling: Deglaciation
DOE3.1.2.9	Glacial/interglacial cycling: Potential evaporation
DOE3.1.3	Exit from glacial/interglacial cycling
DOE3.1.3.1	Glacial/interglacial exit: greenhouse gas induced
DOE3.1.3.2	Glacial/interglacial exit due to other causes
DOE3.2	Generalised denudation
DOE3.2.1	Generalised denudation: Fluvial
DOE3.2.1.1	Generalised denudation: Aeolian
DOE3.2.1.2	Generalised denudation: Glacial
DOE3.2.1.3	Generalised denudation: Coastal
DOE3.2.2	Localised denudation
DOE3.2.2.1	Localised denudation: Fluvial (valley incision)
DOE3.2.2.2	Localised denudation: Fluvial (weathering/mass movement)
DOE3.2.2.3	Localised denudation: Glacial
DOE3.2.2.4	Localised denudation: Coastal
DOE3.2.3	Sediment redistribution
DOE3.2.3.1	Sediment redistribution: Fluvial
DOE3.2.3.2	Sediment redistribution: Aeolian
DOE3.2.3.3	Sediment redistribution: Glacial
DOE3.2.4	Effects of sea level change
DOE3.2.4.1	River incision/sedimentation due to sea-level change
DOE3.2.4.2	Coastal erosion due to sea-level change
DOE3.3	Soil moisture and evaporation due to sea-level change
DOE3.3.1	Soil moisture and evaporation due to sea-level change
DOE3.3.2	Near-surface runoff processes
DOE3.3.2.1	Near-surface runoff processes: Overland flow
DOE3.3.2.2	Near-surface runoff processes: Interflow
DOE3.3.2.3	Near-surface runoff processes: Return flow
DOE3.3.2.4	Near-surface runoff processes: Macropore flow
DOE3.3.2.5	Near-surface runoff processes: Variable source area response
DOE3.3.3	Groundwater recharge
DOE3.3.4	Surface flow characteristics (freshwater)
DOE3.3.4.1	Surface flow characteristics (freshwater): Stream/river flow
DOE3.3.4.2	Surface flow characteristics (freshwater): Sediment transport
DOE3.3.4.3	Surface flow characteristics (freshwater): Meander migration or other fluvial response
DOE3.3.4.4	Surface flow characteristics (freshwater): Lake formation/sedimentation
DOE3.3.4.5	Surface flow characteristics (freshwater): Effects of sea level change
DOE3.3.5	Surface flow characteristics (estuarine)
DOE3.3.5.1	Surface flow characteristics (estuarine): Tidal cycling
DOE3.3.5.2	Surface flow characteristics (estuarine): Sediment transport
DOE3.3.5.3	Surface flow characteristics (estuarine): Successional development
DOE3.3.5.4	Surface flow characteristics (estuarine): Effects of sea level change
DOE3.3.6	Coastal waters
DOE3.3.6.1	Coastal waters: Tidal mixing
DOE3.3.6.2	Coastal waters: Residual current mixing
DOE3.3.6.3	Coastal waters: Effects of sea level change
DOE3.3.7	Ocean waters
DOE3.3.7.1	Ocean waters: Water exchange
DOE3.3.7.2	Ocean waters: Effects of sea level change
DOE3.4	Terrestrial Ecological Development
DOE3.4.1	Terrestrial ecological development: Agricultural systems
DOE3.4.1.1	Terrestrial ecological development: Semi-natural systems
DOE3.4.1.2	Terrestrial ecological development: Natural systems
DOE3.4.1.3	Terrestrial ecological development: Effects of succession
DOE3.4.1.4	Terrestrial ecological development: Estuarine
DOE3.4.2	Terrestrial ecological development: Estuarine

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE3.4.3	Coastal waters
DOE3.4.4	Oceans
DOE3.5.1	Erosion
DOE3.5.1.1	Erosion: Fluvial
DOE3.5.1.2	Erosion: Aeolian
DOE3.5.1.3	Erosion: Glacial
DOE3.5.1.4	Erosion: Coastal
DOE3.5.2	Groundwater discharge to soils
DOE3.5.2.1	Groundwater discharge to soils: Advective
DOE3.5.2.2	Groundwater discharge to soils: Diffusive
DOE3.5.2.3	Groundwater discharge to soils: Biotic
DOE3.5.2.4	Groundwater discharge to soils: Volatilisation
DOE3.5.3	Groundwater discharge to wells or springs
DOE3.5.4	Groundwater discharge to freshwaters
DOE3.5.5	Groundwater discharge to estuaries
DOE3.5.6	Groundwater discharge to coastal waters
DOE3.5.7	Surface water bodies
DOE3.5.7.1	Surface water bodies: Water flow
DOE3.5.7.2	Surface water bodies: Suspended sediments
DOE3.5.7.3	Surface water bodies: Bottom sediments
DOE3.5.7.4	Surface water bodies: Effects on vegetation
DOE3.5.7.5	Surface water bodies: Effects of fluvial system development
DOE3.5.8	Estuaries
DOE3.5.8.1	Estuaries: Water flow
DOE3.5.8.2	Estuaries: Suspended sediments
DOE3.5.8.3	Estuaries: Bottom sediments
DOE3.5.8.4	Estuaries: Effects of salinity variation
DOE3.5.8.5	Estuaries: Effects on vegetation
DOE3.5.8.6	Estuaries: Effects of estuarine development
DOE3.5.8.7	Estuaries: Effects of sea-level change
DOE3.5.9	Coastal waters
DOE3.5.9.1	Coastal waters: Water transport
DOE3.5.9.2	Coastal waters: Suspended sediment transport
DOE3.5.9.3	Coastal waters: Bottom sediment transport
DOE3.5.9.4	Coastal waters: Effects of sea level change
DOE3.5.9.5	Coastal waters: Effects of estuarine development
DOE3.5.9.6	Coastal waters: Effects of coastal erosion
DOE3.5.9.7	Coastal waters: Effects of sea-level change
DOE3.5.10	Plants
DOE3.5.10.1	Plants: Root uptake
DOE3.5.10.2	Plants: Deposition on surfaces
DOE3.5.10.3	Plants: Vapour uptake
DOE3.5.10.4	Plants: Internal translocation and retention
DOE3.5.10.5	Plants: Washoff and leaching by rainfall
DOE3.5.10.6	Plants: Leaf-fall and senescence
DOE3.5.10.7	Plants: Cycling processes
DOE3.5.11	Animals
DOE3.5.11.1	Animals: Uptake by ingestion
DOE3.5.11.2	Animals: Uptake by inhalation
DOE3.5.11.3	Animals: Internal translocation and retention
DOE3.5.11.4	Animals: Cycling processes
DOE3.5.11.5	Animals: Effects of relocation and migration
DOE3.6.1	External exposure
DOE3.6.1.1	External exposure: Land
DOE3.6.1.2	External exposure: Sediments
DOE3.6.1.3	External exposure: Water bodies
DOE3.6.2	Ingestion
DOE3.6.2.1	Ingestion and Drinking water
DOE3.6.2.2	Ingestion and Agricultural crops
DOE3.6.2.3	Ingestion and Domestic animal products
DOE3.6.2.4	Ingestion and Wild plants
DOE3.6.2.5	Ingestion and Wild animals
DOE3.6.2.6	Ingestion and Soils and sediments
DOE3.6.3	Inhalation
DOE3.6.3.1	Inhalation and Soils and sediments
DOE3.6.3.2	Inhalation and Gases and vapours (indoor)
DOE3.6.3.3	Inhalation and Gases and vapours (outdoor)
DOE3.6.3.4	Inhalation and Biotic material
DOE3.6.3.5	Inhalation and Salt particles

RAW FEPs LIST

IDENTIFIER	FEP NAME
DOE4.1.1	Investigation borehole seal
DOE4.1.1.1	Borehole seal failure
DOE4.1.1.2	Borehole seal degradation
DOE4.1.2	Shaft or access tunnel seal
DOE4.1.2.1	Shaft/tunnel seal failure
DOE4.1.2.2	Shaft/tunnel seal degradation
DOE4.1.3	Subsidence
DOE4.1.3.1	Subsidence and fault/fracture induction
DOE4.2.1	Deliberate recovery of wastes or associated materials
DOE4.2.2	Malicious intrusion
DOE4.2.3	Exploratory drilling
DOE4.2.4	Exploitation drilling
DOE4.2.5	Geothermal energy production
DOE4.2.6	Resource mining
DOE4.2.7	Tunnelling
DOE4.2.8	Construction of underground storage/disposal facilities
DOE4.2.9	Construction of underground dwellings/shelters
DOE4.2.10	Archaeological investigations
DOE4.2.11	Injection of liquid wastes
DOE4.2.12	Groundwater abstraction
DOE4.2.13	Underground weapons testing

RAW FEPs LIST

IDENTIFIER	FEP NAME
IAEA1.1	Climatic change
IAEA1.2	Hydrological change
IAEA1.3	Sea level change
IAEA1.4	Denudation
IAEA1.5	Stream erosion
IAEA1.6	Glacial erosion
IAEA1.7	Flooding
IAEA1.8	Sedimentation
IAEA1.9	Diagenesis
IAEA1.10	Diapirism
IAEA1.11	Faulting/seismicity
IAEA1.12	Geochemical change
IAEA1.13.1	Fluid interactions: Groundwater flow
IAEA1.13.2	Fluid interactions: Dissolution
IAEA1.13.3	Fluid interactions: Brine pockets
IAEA1.14.1	Uplift/Subsidence: Orogenic
IAEA1.14.2	Uplift/Subsidence: Epeirogenic
IAEA1.14.3	Uplift/Subsidence: Isostatic
IAEA1.15.1	Undetected features: Faults, shear zones
IAEA1.15.2	Undetected features: Breccia pipes
IAEA1.15.3	Undetected features: Lava tubes
IAEA1.15.4	Undetected features: Intrusive dykes
IAEA1.15.5	Undetected features: Gas or brine pockets
IAEA1.16.1	Magmatic activity: Extrusive
IAEA1.17	Meteorite impact
IAEA2.1.1	Undetected past intrusion: Boreholes
IAEA2.1.2	Undetected past intrusion: Mine shafts
IAEA2.2.1	Inadequate design: Shaft seal failure
IAEA2.2.2	Inadequate design: Exploration borehole seal failure
IAEA2.3	Improper operation: Improper waste emplacement
IAEA2.4.1	Transport agent introduction: Irrigation
IAEA2.4.2	Transport agent introduction: Reservoirs
IAEA2.4.3	Transport agent introduction: Intentional artificial groundwater Recharge or withdrawal
IAEA2.4.4	Transport agent introduction: Chemical liquid waste disposal
IAEA2.5	Climatic change (including climate control)
IAEA2.6	Large-scale hydrological change
IAEA2.7.1	Intentional intrusion: War
IAEA2.7.2	Intentional intrusion: Sabotage
IAEA2.7.3	Intentional intrusion: Waste recovery
IAEA2.8.1	Inadvertent future intrusion: Exploratory drilling
IAEA2.8.2	Inadvertent future intrusion: Archaeological exhumation
IAEA2.8.3	Inadvertent future intrusion: Resource mining (mineral, water, hydrocarbon, geothermal, salt, etc.)
IAEA3.1.1	Thermal effects: Differential elastic response
IAEA3.1.2	Thermal effects: Non-elastic response
IAEA3.1.3	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	Thermal effects: Fluid migration
IAEA3.2.1	Chemical effects: Corrosion
IAEA3.2.2	Chemical effects: Interactions of waste package and rock
IAEA3.2.3	Chemical effects: Gas generation
IAEA3.2.4	Chemical effects: Geochemical change
IAEA3.3.1	Mechanical effects: Canister movement
IAEA3.3.2	Mechanical effects: Local fracturing
IAEA3.4.1	Radiological effects: Material property changes
IAEA3.4.2	Radiological effects: Radiolysis
IAEA3.4.3	Radiological effects: Decay product gas generation
IAEA3.4.4	Radiological effects: Nuclear criticality

RAW FEPs LIST

IDENTIFIER	FEP NAME
PGA1	SEW/NATURAL PROCESSES
PGA1.1	Climate changes
PGA1.2	Sea-level changes
PGA1.3	Erosion (fluvial and glacial)
PGA1.4	Sedimentation
PGA1.5	Tectonic crustal movements
PGA1.6	Magma intrusion
PGA1.7	Volcanism
PGA1.8	Diapirism
PGA1.9	Diagenesis
PGA1.10	Metamorphosis
PGA1.11	Weathering, mineralisation
PGA1.12	Groundwater changes
PGA2	RAPID NATURAL EVENTS
PGA2.1	Earthquakes
PGA2.2	Volcanic eruption
PGA2.3	Meteor impact
PGA2.4	Flooding with extreme erosion
PGA2.5	Hurricane, storms
PGA2.6	Movements at faults
PGA2.7	Formation of new faults
PGA3	CAUSED BY DISPOSAL OF WASTE
PGA3.1	Radiation damage of the matrix
PGA3.2	Radiolysis
PGA3.3	Nuclear criticality
PGA3.4	Canister movement in backfill
PGA3.5	Decompressed zones from mining
PGA3.6	Mechanical canister damage
PGA3.7.1	Differing thermal expansion of glass matrix and canister
PGA3.7.2	Differing thermal expansion of canister and backfill
PGA3.7.3	Differing thermal expansion of backfill and host rock
PGA3.7.4	Differing thermal expansion of host rock zones
PGA3.8	Thermal convection
PGA3.9	Thermally induced chemical changes
PGA3.10	Chemical changes due to corrosion
PGA3.11	Drying out and re-saturation
PGA3.12.1	Geochemical changes in backfill
PGA3.12.2	Geochemical changes in host rock
PGA3.13	Physico-chemical phenomena/effects (eg. colloid formation)
PGA3.14	Microbiological phenomena/effects
PGA3.15	Gas production
PGA3.16	Failure of shaft sealing
PGA4	CAUSED BY MAN
PGA4.1	Direct alterations in hydrogeology
PGA4.2	Injection of liquid waste
PGA4.3.1	Drilling: in sediments
PGA4.3.2	Drilling: in host rock
PGA4.4	Geothermal energy production in crystalline rock

IDENTIFIER	FEP NAME
SK11.1	Criticality
SK11.12	Radioactive decay; heat
SK11.13	Recoil of alpha-decay
SK11.14	Gas generation; He production
SK11.21	Radlyss
SK11.22	H2/O2 explosions
SK11.23	Pb-1 reactions
SK11.24	Gas generation
SK11.25	I, Cs-migration to glass surface
SK11.26	Solubility within fuel matrix
SK11.27	Recrystallization
SK11.28	Redox potential
SK11.29	Dissolution chemistry
SK11.3	Damaged or deviating fuel
SK11.4	Sudden energy release
SK11.5	Release of radionuclides from the failed canister
SK12.11	Chemical reactions (copper corrosion)
SK12.12	Coupled effects (electrophoresis)
SK12.13	Internal corrosion due to waste
SK12.14	Role of the eventual channelling within the canister
SK12.15	Role of chlorides in copper corrosion
SK12.16.1	Repository induced Pb/Cu electrochemical reactions
SK12.16.2	Natural telluric electrochemical reactions
SK12.17	Pitting
SK12.18	Corrosive agents, Sulphides, oxygen etc
SK12.19	Backfill effects on Cu corrosion
SK12.1.10	Microbes
SK12.2	Creeping of copper
SK12.3.1	Thermal cracking
SK12.3.2	Electro-chemical cracking
SK12.3.3	Stress corrosion cracking
SK12.3.4	Loss of ductility
SK12.3.5	Radiation effects on canister
SK12.3.6	Cracking along welds
SK12.3.7.1	External stress
SK12.3.7.2	Hydrostatic pressure on canister
SK12.3.8	Internal pressure
SK12.4	Voids in the lead filling
SK12.5.1	Random canister defects - quality control
SK12.5.2	Common cause canister defects - quality control
SK13.1.1	Degradation of the bentonite by chemical reactions
SK13.1.2	Saturation of sorption sites
SK13.1.3	Effects of bentonite on groundwater chemistry
SK13.1.4	Colloid generation - source
SK13.1.5	Coagulation of bentonite
SK13.1.6	Sedimentation of bentonite
SK13.1.7	Reactions with cement pore water
SK13.1.8	Near field buffer chemistry
SK13.1.9	Radlyss
SK13.1.10	Interactions with corrosion products and waste
SK13.1.11	Redox front
SK13.1.12	Perturbed buffer material chemistry
SK13.1.13	Radiation effects on bentonite
SK13.2.1	NO ENTRY
SK13.2.1.1	Swelling of bentonite into tunnels and cracks
SK13.2.1.2	Uneven swelling of bentonite
SK13.2.2	Movement of canister in buffer/backfill
SK13.2.3	Mechanical failure of buffer/backfill
SK13.2.4	Erosion of buffer/backfill
SK13.2.5	Thermal effects on the buffer material
SK13.2.6	Diffusion - surface diffusion
SK13.2.7	Swelling of corrosion products
SK13.2.8	Preferential pathways in the buffer/backfill
SK13.2.9	Flow through buffer/backfill
SK13.2.10	Soret effect
SK13.2.11	Backfill material deficiencies
SK13.2.12	Gas transport in bentonite

RAW FEPS LIST

IDENTIFIER	FEP NAME
SK14.1.1	Oxidizing conditions
SK14.1.2	pH-deviations
SK14.1.3	Colloids, complexing agents
SK14.1.4	Sorption
SK14.1.5	Matrix diffusion
SK14.1.6	Reconcentration
SK14.1.7	Thermochemical changes
SK14.1.8	Change of groundwater chemistry in nearby rock
SK14.1.9	Complexing agents
SK14.2.1	Mechanical failure of repository
SK14.2.2	[NO ENTRY]
SK14.2.2.1	Excavation/backfilling effects on nearby rock
SK14.2.2.2	Hydraulic conductivity change - Excavation/backfilling effect
SK14.2.2.3	Mechanical effects - Excavation/backfilling effects
SK14.2.3	Extreme channel flow of oxidants and nuclides
SK14.2.4	Thermal buoyancy
SK14.2.5	Changes of groundwater flow
SK14.2.6	Faulting
SK14.2.7	Thermo-hydro-mechanical effects
SK14.2.8	Enhanced rock fracturing
SK14.2.9	Creeping of rock mass
SK14.2.10	Chemical effects of rock reinforcement
SK15.1	Saline (or fresh) groundwater intrusion
SK15.2	Non-sealed repository
SK15.3	Stray materials left
SK15.4	Decontamination materials left
SK15.5	Chemical sabotage
SK15.6	Co-storage of other waste
SK15.7	Poorly designed repository
SK15.8	Poorly constructed repository
SK15.9	Unsealed boreholes and/or shafts
SK15.10	Accidents during operation
SK15.11	Degradation of hole- and shaft seals
SK15.12	Near storage of other waste
SK15.13	Volcanism
SK15.14	Resaturation
SK15.15	Earthquakes
SK15.16	Uplift and subsidence
SK15.17	Permafrost
SK15.18	Enhanced groundwater flow
SK15.19	Effect of plate movements
SK15.20	Changes of the magnetic field
SK15.21	Future boreholes and undetected past boreholes
SK15.22	Accumulation of gases under permafrost
SK15.23	Changed hydrostatic pressure on canister
SK15.24	Stress changes of conductivity
SK15.25	Dissolution of fracture fillings/precipitations
SK15.26	Erosion on surface/sediments
SK15.27	Human induced actions on groundwater recharge
SK15.28	Underground dwellings
SK15.29	Meteorite
SK15.30	Underground test of nuclear devices
SK15.31	Change in sealevel
SK15.32	Desert and unsaturation
SK15.33	Waste retrieval, mining
SK15.34	Geothermal energy production
SK15.35	Other future uses of crystalline rock
SK15.36	Reuse of boreholes
SK15.37	Archaeological intrusion
SK15.38	Explosions
SK15.39	Postclosure monitoring
SK15.40	Unsuccessful attempt of site improvement
SK15.41	Water producing well
SK15.42	Glaciation
SK15.43	Methane intrusion
SK15.44	Solubility and precipitation
SK15.45	Colloid generation and transport
SK15.46	Groundwater recharge/discharge

RAW FEPs LIST

IDENTIFIER	FEP NAME
SKI6.1	Undetected fracture zones
SKI6.2	Gas transport
SKI6.3	Far field hydrochemistry - acids, oxidants, nitrate
SKI6.4	Dispersion
SKI6.5	Dilution
SKI6.6	Weathering of flow paths
SKI6.7	Nuclear war
SKI6.8	Human induced climate change
SKI6.9	River meandering
SKI6.10	No ice age
SKI6.11	Intruding dykes
SKI6.12	Undetected discontinuities
SKI6.13	Geothermally induced flow
SKI6.14	Tectonic activity - large scale
SKI7.1	Accumulation in sediments
SKI7.2	Accumulation in peat
SKI7.3	Intrusion in accumulation zone in the biosphere
SKI7.4	Chemical toxicity of wastes
SKI7.5	Isotopic dilution
SKI7.6	[NO ENTRY]
SKI7.7	Human induced changes in surface hydrology
SKI7.8	Altered surface water chemistry by humans
SKI7.9	Loss of records
SKI7.10	Diagenesis
SKI7.11	City on the site

RAW FEPs LIST

IDENTIFIER	FEP NAME
SNL1.1	Meteorite Impact
SNL2.1	Erosion/Sedimentation
SNL2.2	Glaciation
SNL2.3	Pluvial Periods
SNL2.4	Sea-Level Variations
SNL2.5	Hurricanes
SNL2.6	Seiches
SNL2.7	Tsunamis
SNL2.8	Regional Subsidence or Uplift (also applies to subsurface)
SNL2.9	Mass Wasting
SNL2.10	Flooding
SNL3.1	Diapirism
SNL3.2	Seismic Activity
SNL3.3	Volcanic Activity
SNL3.4	Magmatic Activity
SNL3.5	Formation of Dissolution Cavities
SNL3.6	Formation of Interconnected Fracture Systems
SNL3.7	Faulting
SNL4.1	Inadvertent Intrusions: Explosions
SNL4.2	Inadvertent Intrusions: Drilling
SNL4.3	Inadvertent Intrusions: Mining
SNL4.4	Inadvertent Intrusions: Injection Wells
SNL4.5	Inadvertent Intrusions: Withdrawal Wells
SNL5.1	Hydrologic Stresses: Irrigation
SNL5.2	Hydrologic Stresses: Damming of Streams or Rivers
SNL6.1	Subsidence and Caving
SNL6.2	Shaft and Borehole Seal Degradation
SNL6.3	Thermally Induced Stress/Fracturing in Host Rock
SNL6.4	Excavation-Induced Stress/Fracturing in Host Rock

RAW FEPs LIST

IDENTIFIER	FEP NAME
UKN1.1.1	Meteorite impact
UKN1.1.2	Solar insolation
UKN1.2.1	Plate movement/tectonic change
UKN1.2.2	Changes in the Earth's magnetic field
UKN1.2.3	Magmatic activity (intrusive, extrusive)
UKN1.2.4	Metamorphic activity
UKN1.2.5	Diagenesis
UKN1.2.6	Uplift and subsidence (e.g. orogenic, isostatic)
UKN1.2.7	Diapirism
UKN1.2.8	Seismicity
UKN1.2.9	Fault activation
UKN1.2.10	Fault generation
UKN1.2.11	Rock heterogeneity (e.g. permeability, mineralogy) affecting water and gas flow
UKN1.2.12	Undetected features (e.g. faults, fracture networks, shear zones, brecciation, gas pockets)
UKN1.2.13	Natural gas intrusion
UKN1.3.1	Precipitation, temperature and soil water balance
UKN1.3.2	Extremes of precipitation, snow melt and associated flooding
UKN1.3.3	Coastal surge, storms and hurricanes
UKN1.3.4	Sea-level rise/fall
UKN1.3.5	Periglacial effects (eg. permafrost, high seasonality)
UKN1.3.6	Glaciation (erosion/deposition, glacial loading, hydrogeological change)
UKN1.3.7	No ice age
UKN1.4.1	Land slide
UKN1.4.2	Denudation (aeolian and fluvial)
UKN1.4.3	River, stream, channel erosion (downcutting)
UKN1.4.4	River meander
UKN1.4.5	Freshwater sediment transport and deposition
UKN1.4.6	Coastal erosion and estuarine development
UKN1.4.7	Marine sediment transport and deposition
UKN1.4.8	Frost weathering and scilfuction
UKN1.4.9	Chemical denudation and weathering
UKN1.4.10	Frost weathering
UKN1.5.1	River flow and lake level changes
UKN1.5.2	Site flooding
UKN1.5.3	Recharge to groundwater
UKN1.5.4	Groundwater discharge (to surface water, to springs, to soils, to wells, to marine)
UKN1.5.5	Groundwater flow (Darcy, non-Darcy, intergranular fracture, channelling and preferential pathways)
UKN1.5.6	Groundwater conditions (saturated/unsaturated)
UKN1.5.7	Saline or freshwater intrusion
UKN1.5.8	Effects at saline-freshwater interface
UKN1.5.9	Natural thermal effects
UKN1.6.1	Advection and dispersion
UKN1.6.2	Diffusion
UKN1.6.3	Matrix diffusion
UKN1.6.4	Gas mediated transport
UKN1.6.5	Multiphase flow and gas driven flow
UKN1.6.6	Solubility limit
UKN1.6.7	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	Dissolution, precipitation and crystallisation
UKN1.6.9	Colloid formation, dissolution and transport
UKN1.6.10	Complexing agents
UKN1.6.11	Fracture mineralisation and weathering
UKN1.6.12	Accumulation in soils and organic debris
UKN1.6.13	Mass, isotopic and species dilution
UKN1.6.14	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.1	Plant uptake
UKN1.7.2	Animal uptake
UKN1.7.3	Uptake by deep rooting species
UKN1.7.4	Soil and sediment bioturbation
UKN1.7.5	Pedogenesis
UKN1.7.6	Chemical transformations
UKN1.7.7	Microbial interactions
UKN1.7.8	Ecological change, eg. forest fire cycles
UKN1.7.9	Ecological response to climate, eg. desert formation
UKN1.7.10	Plant and animal evolution
UKN2.1.1	Undetected past intrusions, (eg. boreholes, mining)
UKN2.1.2	Investigation borehole seal failure and degradation
UKN2.1.3	Shaft or access tunnel seal failure and degradation
UKN2.1.4	Stress field changes, settling, subsidence or caving
UKN2.1.5	Dewatering of host rock

RAW FEPS LIST

IDENTIFIER	FEP NAME
UKN2.1.6	Material defects, e.g. early canister failure
UKN2.1.7	Common cause failures
UKN2.1.8	Poor quality construction
UKN2.1.9	Design modification
UKN2.1.10	Thermal effects (eg. concrete hydration)
UKN2.2.1	Radioactive waste disposal error
UKN2.2.2	Inadequate backfill or compaction, voidage
UKN2.2.3	Co-disposal of reactive wastes (deliberate)
UKN2.2.4	Inadvertent inclusion of undesirable materials
UKN2.2.5	Heterogeneity of waste forms (chemical, physical)
UKN2.2.6	Accidents during operation
UKN2.2.7	Sabotage
UKN2.2.8	Repository flooding during operation
UKN2.2.9	Abandonment of unsealed repository
UKN2.2.10	Poor closure
UKN2.2.11	Post-closure monitoring
UKN2.2.12	Effects of phased operation
UKN2.3.1	Recovery of repository materials
UKN2.3.2	Malicious intrusion, e.g. sabotage, act of war
UKN2.3.3	Exploratory drilling
UKN2.3.4	Exploitation drilling
UKN2.3.5	Geothermal energy production
UKN2.3.6	Resource mining
UKN2.3.7	Tunnelling
UKN2.3.8	Underground construction
UKN2.3.9	Archaeological investigation
UKN2.3.10	Injection of liquid wastes
UKN2.3.11	Groundwater abstraction
UKN2.3.12	Underground nuclear testing
UKN2.4.1	Loss of records
UKN2.4.2	Dams and reservoirs, built/draind
UKN2.4.3	River rechannelled
UKN2.4.4	Irrigation
UKN2.4.5	Altered soil or surface water chemistry
UKN2.4.6	Land use changes
UKN2.4.7	Agricultural and fisheries practice changes
UKN2.4.8	Demographic change, urban development
UKN2.4.9	Anthropogenic climate change (greenhouse effect)
UKN2.4.10	Quarrying, peat extraction
UKN3.1.1	Differential elastic response
UKN3.1.2	Non-elastic response
UKN3.1.3	Host rock fracture aperture changes
UKN3.1.4	Induced hydrological changes (fluid pressure, density convection, viscosity)
UKN3.1.5	Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
UKN3.2.1	Metallic corrosion (pitting/uniform, internal and external agents, gas generation eg. H ₂)
UKN3.2.2	Interactions of host materials and groundwater with repository material (eg. concrete carbonation, ...)
UKN3.2.3	Interactions of waste and repository materials with host materials (eg. electrochemical, corrosive ag...)
UKN3.2.4	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)
UKN3.2.5	Cellulosic degradation
UKN3.2.6	Introduced complexing agents and celluloseics
UKN3.2.7	Microbiological effects (on corrosion/degradation, on solubility/complexation, gas generation e.g. C...)
UKN3.3.1	Canister or container movement
UKN3.3.2	Changes in in-situ stress field
UKN3.3.3	Embrittlement and cracking
UKN3.3.4	Subsidence/collapse
UKN3.3.5	Fracturing
UKN3.3.6	Gas effects (pressurization, disruption, explosion, fire)
UKN3.4.1	Radiolysis
UKN3.4.2	Material property changes
UKN3.4.3	Nuclear criticality
UKN3.4.4	Radioactive decay and ingrowth (chain decay)

RAW FEPs LIST

IDENTIFIER	FEP NAME
HMIP1: NEAR-FIELD	
HMIP1.1 Chemical/physical degradation	
HMIP1.1.1	Container metal corrosion
HMIP1.1.2	Physico-chemical degradation of concrete
HMIP1.1.3	Physico-chemical degradation of wastes and transport to the far-field
HMIP1.1.4	Electrical effects of metal corrosion
HMIP1.2 Gas production, transport and flammability	
HMIP1.2.1	Hydrogen by metal corrosion
HMIP1.2.2	Methane and carbon dioxide by microbial degradation
HMIP1.2.3	Gas generation from concrete
HMIP1.2.4	Radioactive gases
HMIP1.2.5	Chemotoxic gases
HMIP1.2.6	Gas transport
HMIP1.2.7	Flammability
HMIP1.2.8	Thermo-chemical effects
HMIP1.3 Radiation phenomena	
HMIP1.3.1	Radioactive decay and ingrowth
HMIP1.3.2	Nuclear criticality
HMIP1.4 Structural integrity	
HMIP1.4.1	Waste-form and backfill consolidation
HMIP1.4.2	Vault collapse
HMIP1.5 Hydrogeological effects	
HMIP1.5.1	Desaturation (pumping) effects
HMIP1.5.2	Disturbed zone (hydromechanical) effects
HMIP1.5.3	Gas production (unsaturated flow)
HMIP1.5.4	Saturated groundwater flow
HMIP1.5.5	Transport of chemically active substances into the near-field
HMIP1.6 Thermal Effects	
HMIP1.6.1	Thermal effects and Rock-mass changes
HMIP1.6.2	Thermal effects and Hydrogeological changes
HMIP1.6.3	Thermal effects and Chemical changes
HMIP1.6.4	Thermal effects and Transport (diffusion) effects
HMIP2: FAR-FIELD	
HMIP2.1 Geological	
HMIP2.1.1	Regional tectonic
HMIP2.1.2	Magmatic activity
HMIP2.1.3	Metamorphism
HMIP2.1.4	Diagenesis
HMIP2.1.5	Diapirism
HMIP2.1.6	Seismicity
HMIP2.1.7	Faulting/fracturing
HMIP2.1.8	Major incision
HMIP2.1.9	Effects of natural gases
HMIP2.2 Hydrogeological	
HMIP2.2.1	Changes in geometry and driving forces of the flow system
HMIP2.2.2	Rock property changes
HMIP2.2.3	Groundwater flow
HMIP2.3 Transport and geochemical	
HMIP2.3.1	Advection
HMIP2.3.2	Diffusion
HMIP2.3.3	Hydrodynamic dispersion
HMIP2.3.4	Solubility constraints
HMIP2.3.5	Sorption including ion-exchange
HMIP2.3.6	Changes in sorptive surfaces
HMIP2.3.7	Changes in groundwater chemistry and flow direction
HMIP2.3.8	Colloid transport
HMIP2.3.9	Transport of radionuclides bound to microbes
HMIP2.3.10	Transport of active gases
HMIP2.3.11	Gas induced groundwater transport
HMIP2.3.12	Thermal effects on hydrochemistry
HMIP2.3.13	Biogeochemical changes

RAW FEPs LIST

IDENTIFIER	FEP NAME
HIMP2.4: Geomorphology	
HIMP2.4.1	Generalised denudation
HIMP2.4.2	Localised denudation
HIMP3: CLIMATOLOGY	
HIMP3.1: Climate change	
HIMP3.1.1	Human induced climate change
HIMP3.1.2	Natural climate change
HIMP3.1.3	Exit from glacial/interglacial cycling
HIMP3.1.4	Intensification of natural climate change
HIMP4: BIOSPHERE	
HIMP4.1: Radionuclide entry points to the biosphere	
HIMP4.1.1	Groundwater discharge to soils and surface waters
HIMP4.1.2	Solid discharge via erosional processes
HIMP4.1.3	Gas discharge
HIMP4.2: Transfer (concentration/dilution) mechanisms	
HIMP4.2.1	Soil moisture and evaporation
HIMP4.2.2	Surface water mixing
HIMP4.2.3	Sediment transport including bioturbation
HIMP4.2.4	Sediment/water/gas interaction with the atmosphere
HIMP4.2.5	Bioaccumulation and translocation
HIMP4.2.6	Biogeochemical processes
HIMP4.3: Land and surface water use	
HIMP4.3.1	Terrestrial water use
HIMP4.3.2	Estuarine water use
HIMP4.3.3	Coastal waters and water use
HIMP4.3.4	Seas and water use
HIMP4.4: Human exposure	
HIMP4.4.1	External exposure
HIMP4.4.2	Ingestion
HIMP4.4.3	Inhalation
HIMP5: SHORT CIRCUIT PATHWAYS	
HIMP5.1: Related to repository construction	
HIMP5.1.1	Loss of integrity of borehole seals
HIMP5.1.2	Loss of integrity of shaft or access tunnel seals
HIMP5.1.3	Incomplete near-field chemical conditioning
HIMP5.2: Unrelated to repository construction	
HIMP5.2.1	Meteorite impact
HIMP5.2.2	Deliberate intrusion
HIMP5.2.3	Malicious intrusion
HIMP5.2.4	Accidental intrusion

RAW FEPs LIST

IDENTIFIER	FEP NAME
NEA1. NATURAL PHENOMENA	
NEA1.1. EXTRA TERRESTRIAL	
NEA1.1.1	Meteorite impact
NEA1.1.2	Solar insolation
NEA1.2. GEOLOGICAL	
NEA1.2.1	Plate movement/tectonic change
NEA1.2.2	Changes in the Earth's magnetic field
NEA1.2.3	Magmatic activity (intrusive, extrusive)
NEA1.2.4	Metamorphic activity
NEA1.2.5	Diagenesis
NEA1.2.6	Uplift and subsidence (orogenic, isostatic)
NEA1.2.7	Diapirism
NEA1.2.8	Seismicity
NEA1.2.9	Fault activation
NEA1.2.10	Fault generation
NEA1.2.11	Rock heterogeneity (permeability, mineralogy), affecting water and gas flow
NEA1.2.12	Undetected features (faults, fracture networks, shear zones, brecciation, gas pockets)
NEA1.2.13	Natural gas intrusion
NEA1.3. CLIMATOLOGICAL	
NEA1.3.1	Precipitation, temperature, and soil water balance
NEA1.3.2	Extremes of precipitation, snow melt and associated flooding
NEA1.3.3	Coastal surge, storms, and hurricanes
NEA1.3.4	Sea-level rise/fall
NEA1.3.5	Periglacial effects (permafrost, high seasonality)
NEA1.3.6	Glaciation (erosion/deposition, glacial loading, hydrogeological change)
NEA1.3.7	No ice age
NEA1.4. GEOMORPHOLOGICAL	
NEA1.4.1	Land slide
NEA1.4.2	Denudation (aeolian and fluvial)
NEA1.4.3	River, stream, channel erosion (downcutting)
NEA1.4.4	River meander
NEA1.4.6	Freshwater sediment transport and deposition
NEA1.4.7	Marine sediment transport and deposition
NEA1.4.8	River meander (REPEAT! -- SEE 1.4.4))
NEA1.4.9	Chemical denudation and weathering
NEA1.4.10	Frost weathering
NEA1.5. HYDROLOGICAL	
NEA1.5.1	River flow and lake level changes
NEA1.5.2	Site flooding
NEA1.5.3	Recharge to groundwater
NEA1.5.4	Groundwater discharge (to surface water, springs, soils, wells, and marine)
NEA1.5.5	Groundwater flow (Darcy, non-Darcy, intergranular fracture, channeling and preferential pathways)
NEA1.5.6	Groundwater conditions (saturated/unsaturated)
NEA1.5.7	Saline or freshwater intrusion
NEA1.5.8	Effects at saline-freshwater interface
NEA1.5.9	Natural thermal effects
NEA1.6. TRANSPORT AND GEOCHEMICAL	
NEA1.6.1	Advection and dispersion
NEA1.6.2	Diffusion
NEA1.6.3	Matrix diffusion
NEA1.6.4	Gas mediated transport
NEA1.6.5	Multiphase flow and gas-driven flow
NEA1.6.6	Solubility limit
NEA1.6.7	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	Dissolution, precipitation, and crystallisation
NEA1.6.9	Colloid formation, dissolution, and transport
NEA1.6.10	Complexing agents
NEA1.6.11	Fracture mineralisation
NEA1.6.12	Accumulation in soils and organic debris
NEA1.6.13	Mass, isotopic and species dilution
NEA1.6.14	Chemical gradients (electrochemical effects and osmosis)

RAW FEPs LIST

IDENTIFIER	FEP NAME
NEA1.7: ECOLOGICAL	
NEA1.7.1	Plant uptake
NEA1.7.2	Animal uptake
NEA1.7.3	Uptake by deep rooting species
NEA1.7.4	Soil and sediment bioturbation
NEA1.7.5	Pedogenesis
NEA1.7.6	Chemical transformations
NEA1.7.7	Microbial interactions
NEA1.7.8	Ecological change (e.g. forest fire cycles)
NEA1.7.9	Ecological response to climate (e.g. desert formation)
NEA1.7.10	Plant and animal evolution
2. HUMAN ACTIVITIES	
2.1 DESIGN AND CONSTRUCTION	
NEA2.1.1	Undetected past intrusions (boreholes, mining)
NEA2.1.2	Investigation borehole seal failure and degradation
NEA2.1.3	Shaft or access tunnel seal failure and degradation
NEA2.1.4	Stress field changes, settling, subsidence or caving
NEA2.1.5	Dewatering of host rock
NEA2.1.6	Material defects (e.g. early canister failure)
NEA2.1.7	Common cause failures
NEA2.1.8	Poor quality construction
NEA2.1.9	Design modification
NEA2.1.10	Thermal effects
NEA2.2 OPERATION AND CLOSURE	
NEA2.2.1	Radioactive waste disposal error
NEA2.2.2	Inadequate backfill or compaction voidage
NEA2.2.3	Co-disposal of reactive wastes (deliberate)
NEA2.2.4	Inadvertent inclusion of undesirable materials
NEA2.2.5	Heterogeneity of waste forms (chemical, physical)
NEA2.2.6	Accidents during operation
NEA2.2.7	Sabotage
NEA2.2.8	Repository flooding during operation
NEA2.2.9	Abandonment of unsealed repository
NEA2.2.10	Poor closure
NEA2.2.11	Post-closure monitoring
NEA2.2.12	Effects of phased operation
2.3 POST-CLOSURE SUBSURFACE ACTIVITIES (INTRUSION)	
NEA2.3.1	Recovery of repository materials
NEA2.3.2	Malicious intrusion (sabotage, act of war)
NEA2.3.3	Exploratory drilling
NEA2.3.4	Exploitation drilling
NEA2.3.5	Geothermal energy production
NEA2.3.6	Resource mining
NEA2.3.7	Tunneling
NEA2.3.8	Underground construction
NEA2.3.9	Archaeological investigation
NEA2.3.10	Injection of liquid wastes
NEA2.3.11	Groundwater abstraction
NEA2.3.12	Underground nuclear testing
2.4 POST-CLOSURE SURFACE ACTIVITIES	
NEA2.4.1	Loss of records
NEA2.4.2	Dams and reservoirs, built/draind
NEA2.4.3	Rivers rechanneled
NEA2.4.4	Irrigation
NEA2.4.5	Altered soil or surface water chemistry
NEA2.4.6	Land use changes
NEA2.4.7	Agricultural and fisheries practice changes
NEA2.4.8	Demographic change, urban development
NEA2.4.9	Anthropogenic climate change (greenhouse effect)
NEA2.4.10	Quarrying, near surface extraction

RAW FEPs LIST

IDENTIFIER	FEP NAME
3. WASTE AND REPOSITORY EFFECTS	
3.1 THERMAL	
NEA3.1.1	Differential elastic response
NEA3.1.2	Non-elastic response
NEA3.1.3	Host rock fracture aperture changes
NEA3.1.4	Induced hydrological changes (fluid pressure, density convection, viscosity)
NEA3.1.5	Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
NEA3.2 CHEMICAL	
NEA3.2.1	Metallic corrosion (pitting/uniform, internal and external agents, gas generation e.g.H ₂)
NEA3.2.2	Interactions of host materials and groundwater with repository material (e.g. concrete carbonation)
NEA3.2.3	Interactions of waste and repository materials with host materials (electrochemical, corrosive agents)
NEA3.2.4	Non-radioactive solute plume in geosphere (effect of redox, pH, and sorption)
NEA3.2.5	Cellulosic degradation
NEA3.2.6	Introduced complexing agents and cellulosics
NEA3.2.7	Microbiological (effects on corrosion/degradation, solubility/complexation, gas generation, e.g. CH ₄)
NEA3.3 MECHANICAL	
NEA3.3.1	Canister or container movement
NEA3.3.2	Changes in in-situ stress field
NEA3.3.3	Embrittlement and cracking
NEA3.3.4	Subsidence/collapse
NEA3.3.5	Fracturing
NEA3.3.6	Gas effects (pressurisation, disruption, explosion, fire)
NEA3.4 RADIOLOGICAL	
NEA3.4.1	Radiolysis
NEA3.4.2	Material property changes
NEA3.4.3	Nuclear criticality
NEA3.4.4	Radioactive decay and ingrowth (chain decay)

APPENDIX 2

Screening Arguments Applied to FEPs

Screening Arguments for SITE 94 Scenario Development

1. INTRODUCTION

This Letter Report presents proposed screening arguments for use in the SKI SITE 94 scenario development project. These will be used to screen out features, events and processes (FEPs) from a comprehensive catalogue compiled from a number of published and available lists and catalogues.

Screening arguments developed for Nagra for use in safety assessments for the Kristallin-1 project (Sumerling et al. 1993) have been taken as a starting point. This project considers disposal of vitrified high-level waste from nuclear fuel reprocessing in crystalline basement rock in northern Switzerland. The arguments have been adapted to be appropriate to the SITE 94 project, which considers disposal of spent nuclear fuel according to the KBS3 concept at a site with characteristics based on the Äspö Hard Rock Laboratory site, and also to take account of the assessment scope for SITE 94 which differs from the Kristallin-1 project.

Two groups of screening arguments are defined.

1. Site and Disposal Concept – These allow phenomena that are physically impossible or irrelevant for the given site and disposal concept to be screened out.
2. Assessment Basis – These define the scope of the safety assessment and allow phenomena outside that scope to be screened out.

Note that the term *argument* is preferred to *criterion* because the conditions for screening are arguments taking account of knowledge of the site and disposal concept, and the desired scope of the assessment. They are not strict 'yes/no' or quantitative criteria that can be rigidly applied rather they are guidance for the scenario development and screening of FEPs. The screening arguments are presented in the following sections.

2. SITE AND DISPOSAL CONCEPT

2.1 Waste Form and Packaging

The waste is spent nuclear fuel rods from BWR and PWR reactors. The fuel rods consist of cylindrical pellets of uranium dioxide in zirconium alloy (zircaloy) cladding tubes. These are bound together in fuel assemblies designed to be handled as a unit from supply to the reactor to final disposal. For disposal 6 to 9 fuel assemblies (depending on fuel type and respecting thermal loading limits) are contained in a steel canister with copper overpack of external dimensions 4.5m x 0.8m diameter. Voids within the canister are filled with copper powder or lead. The wastes will be heat generating.

Phenomena related specifically to other wastes types, eg. L/ILW, organic wastes and vitrified wastes, can be screened out or modified (if possible) to apply to the above concept.

[NOTE ADDED:

Consideration should be given to the possibility of voids within the canister.]

2.2 Emplacement and Repository

The copper-steel canisters (containing the wastes) are emplaced individually in vertical deposition holes (7.5m depth x 1.5m diameter) drilled in the floor of self-supporting horizontal tunnels (3.3m width x 4.5m height). The space between waste canister and deposition hole walls (~0.5m) and the upper part of the deposition hole is filled with blocks of highly-compacted sodium bentonite. The horizontal tunnels are backfilled with a sand-bentonite mix. There will be an axial decompressed/damaged zone around the horizontal tunnels which may be excavated by blasting. The disposal tunnels will be arranged in several panels each consisting of tunnels on a more or less parallel grid but avoiding significant water bearing features. Tunnels and shafts will be sealed with highly compacted bentonite and/or concrete and concrete shotcrete and steel rockbolts may be used to improve stability of the tunnels during the operational period.

Phenomena related specifically to cementitious backfill can be screened out (or modified) but cement-bentonite reactions may be relevant. Phenomena related to interaction between canisters/waste packages can be screened out.

NOTE ADDED:

Although phenomena related specifically to cementitious backfill should be screened out, interactions between structural concrete in the repository and bentonite should be considered.

2.3 Host Geology

The repository will be sited in crystalline (granitic) basement rock at a depth of about 500 metres below ground. The basement rock includes regional fracture zones with a spacing of one to a few kilometres, ranging from metres to tens of metres in width, plus connected 2nd order fracture zones at spacings of typically 500m. a 'respect zone' of 100 m is assumed between disposal tunnels and any such feature. Groundwater at depth includes both saline and freshwater zones.

Phenomena related specifically to other host rocks, eg salt deposits, clays etc., can be screened out. Phenomena related to near-surface disposal, eg. hurricanes, burrowing animals etc., can be screened out.

2.4 Local and Regional Surface Environment

The Åspö site is located below a small island within a sea area enclosed by other small islands on the Baltic coast of Sweden. The region is low topography glaciated basement rock with thin discontinuous soil cover supporting mainly coniferous woodland. Under present-day conditions, possible leakage from the repository is most likely to occur to the marine environments with associated dose pathways. Doses through other pathways are also possible, eg. via a local well.

Phenomena related to large topographic influences, thick soil/sediment sequences, perched water tables, [high yield wells] and oceanic processes can be screened out.

[NOTE ADDED:

Remove high-yield wells from the previous paragraph.]

2.5 Geo-climatic Development

The Scandinavian shield is rising at the present time due to isostatic rebound following the last glaciation. This will result in a relative sea-level fall so that the region will become terrestrial with numerous shallow freshwater lakes in the order of one to a few thousand years in the future. Assuming a continuation of the glacial-interglacial climate cycling observed in the last 0.8 My, the site is expected to be periodically covered by ice in the future, up to a depth of a few kilometres. The basement rock will resist significant erosion and soil/sediment covers (where present) will be thin and transient.

Phenomena related to warm climates can be screened out. Phenomena related to coastal and fluvial erosion can be screened out.

[NOTE ADDED:

Although arid climates can be excluded, the possibility of a greenhouse-induced warmer, wetter climate should be considered.]

3. Assessment Basis or "Ground-rules"

3.1 Repository Design and Closure

It is assumed that the repository is constructed and operated, as planned, as a final disposal facility for spent nuclear fuel. No other wastes will be disposed in the facility. Some local variation in quality and minor deviations are expected. No repository monitoring or remedial activities are expected.

Phenomena related to operational accidents (which should be dealt with in an assessment of the operational phase), major design changes and disposal of other wastes in the repository can be screened out. However, long-term effects due to the expected operation of the repository should be considered. Retrievability of the wastes is not a consideration. The consequences of possible non-closure or improper closure of the repository should be considered.

[NOTE ADDED:

Failure of repository due to poor quality assurance should be considered.]

3.2 Global and Regional Disasters

It is not reasonable to make assessments of the radiological impacts from a repository for conditions which are associated with some global or regional catastrophe or serious accident that has immediate impacts that are orders of magnitude more serious, eg. in terms of loss of human life. All human endeavours are at risk from extreme natural and human induced events that are not usually accounted for in safety assessments of industrial developments.

Phenomena such as nuclear war, massive sea level rise due to global ice-cap melting and large meteorite strike on the site can be screened out.

[NOTE ADDED:

FEPs in this category will not be coupled to the Process System, and can be separated out for direct treatment. This applies also to 3.3]

3.3 Acts of War and Sabotage

Acts of war, should be excluded from the assessment. Malicious human acts, eg. terrorist acts, aimed at damaging the repository should be considered. However, in the pre-closure period, security measures will be in force to minimise the risk of successful attack; risks in this period might be considered in the assessment of operational plans and impacts; in the post-closure period, a closed repository will be an extraordinarily hard target to damage and a considerably less attractive target than surface industrial installations or civilian targets.

3.2 Acts of War and Sabotage (continued)

Phenomena related to acts of war should be screened out.

[NOTE ADDED:

See previous note (3.3).]

3.4 Deliberate Intrusion

Future deliberate intrusive actions, taken with full knowledge of the nature and content of the repository, eg. to retrieve valuable materials, are excluded from the assessment. It is assumed that any such action would be undertaken after due consideration of safety aspects and with regard to the economic and environmental values of the time.

Phenomena related specifically to deliberate intrusion can be screened out, phenomena related to inadvertent intrusion are retained.

3.5 Future Human Society and Technology

Over the timescales considered in post-closure radiological assessment it is recognised that human civilisation and technology is likely to change considerably, but it is not possible to estimate other than in very general terms what changes may occur. Considering that a general tenet of post-closure radiological assessment is to afford future generations and individuals the same level of protection as that specified for current generations and individuals, it is appropriate to assume future human behaviours similar to that observed in the World today. Impacts to hypothetical critical groups dwelling in the future and with habits and technologies broadly similar to some group at some location in the World today can then be regarded as indicators of safety.

The possibility of cure for cancer is not relevant since the aim is to ensure environmental and human protection (good public health management should be based on prevention not cure).

Phenomena related to extreme futuristic assumptions about human behaviour and technology can be screened out.

3.6 Post-Closure Radiological Assessment

The scenario analysis is aimed at providing a framework for calculations of radiological impact (only) to human individuals and populations represented by a critical group. It is assumed that protection of human individuals ensures protection of the environment, see IAEA 1992.

Consideration of radiological impacts to flora and fauna should be screened out. Chemical toxicity effects of the disposed wastes may be addressed as a separate issue and can be screened out of the radiological assessment.

[NOTE ADDED:

FEPs in this category will not be considered in the SITE 94 scenario development process, and can be screened out as a separate item.]

3.7 Future Life Evolution

Humans and plant and animal species may evolve. Especially evolution of food plant and domesticated animals is to be expected. Hence metabolism, radionuclide uptake and radiation sensitivity may change. These changes cannot be anticipated and should not be accounted for in quantitative assessments (see also 2.5).

Assessments should be carried out assuming metabolic and physiological characteristics and radiosensitivity of humans, animals and plants similar to that observed today.

4. REFERENCES

IAEA (1992). Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards. Technical Series No. 332, IAEA Vienna.

Sumerling T J, Zuidema P, Grogan H A and van Dorp F (1993). Scenario development for safety demonstration for deep geological disposal in Switzerland, in proc. International Conference on High-level Radioactive Waste Management, Las Vegas 1993.

APPENDIX 3
FEP Lists by Category
including screening arguments

Appendix 3. FEP Lists by Category

The 8 FEP lists in the following pages have been sorted according to the categories identified in section 2.2. The additional coding "XXXX" which occasionally appears under the "ARGUMENT" column is used to screen out those FEPs which, after additional examination, do not belong to the assigned category, or which are obvious duplicates within the same national FEP list. In such cases, the duplicate is identified under the "COMMENTS" column.

FEPs LIST: WASTE CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.3	WCBR		Biological activity	
AECL1.4	WCBR	4	Boundary conditions	
AECL1.5	WB	2.1	Buffer additives	
AECL1.9	WBR		Chemical gradients	
AECL1.10	WCBR	4	Chemical interactions (expected)	
AECL1.11	WCBR	4	Chemical interactions (long-term)	
AECL1.12	WCBR	4	Chemical interactions (other)	
AECL1.13	WCBR		Chemical kinetics	
AECL1.25	WCBR	4	Correlation	Incomprehensi
AECL1.27	WCB		Coupled processes	
AECL1.28	W	3.1?	Criticality	
AECL1.32	WCB		Electrochemical gradients	
AECL1.38	W		Formation of gases	
AECL1.39	WC	2.1	Galvanic coupling	
AECL1.40	WBR		Geochemical pump	SEE AECL1.9
AECL1.50	WCBR	4	Interfaces (boundary conditions)	SEE AECL1.4
AECL1.53	WCR		Inventory	(DESCRIPTION
AECL1.54	W	3.1	Other wastes (other than vitrified HLW)	
AECL1.55	WCB		Long-term physical stability	
AECL1.56	WR	4	Long-term transients	
AECL1.65	WCBR		Precipitation and dissolution	
AECL1.67	WC?		Radiation damage	
AECL1.68	W		Radioactive decay	
AECL1.69	W?		Radiolysis	
AECL1.78	W		Source terms (expected)	
AECL1.79	W		Source terms (other)	
AECL1.80	WCBR		Speciation	
AECL1.81	BCWR		Stability	
AECL1.82	W	2.1	Stability of glass	UO2!!
AECL1.84	WCBR		Temperature rises (unexpected effects)	
AECL1.85	WCBR	4	Time dependence	
AECL3.80	WL?	XXXX	Radioactive decay	SEE AECL1.68
AECL3.81	WL?		Radionuclide contaminants	
AECL3.104	W	3.6	Teratogenic contaminants	
DOE1.1.4.1	W		Metal corrosion: wastes	
DOE1.1.4.2	W		Leaching: wastes	
DOE1.1.4.3	W		Complex formation: wastes	
DOE1.1.4.4	W		Colloid formation: wastes	
DOE1.1.4.5	W	2.1	Microbial degradation of organic wastes: wastes	
DOE1.1.4.6	W		Microbial corrosion: wastes	
DOE1.1.4.7	W		Radiolysis: wastes	
DOE1.2.1.3	W	2.1	Hydrogen: corrosion of waste steel	
DOE1.2.1.4	W	2.1	Hydrogen: corrosion of waste Magnox	
DOE1.2.1.5	W	2.1	Hydrogen: corrosion of waste aluminium	
DOE1.2.1.6	W		Hydrogen: corrosion of waste Zircaloy	
DOE1.2.1.7	W	2.1	Hydrogen: corrosion of other waste metals	
DOE1.2.1.8	WB	2.1	Hydrogen: effects of microbial growth on concrete	
DOE1.2.2.1	W	2.1	Methane/CO2: degradation of Cellulosics	
DOE1.2.2.2	W	2.1	Methane/CO2: degradation of Other susceptible organic materials	
DOE1.2.2.3	W	2.1	Methane/CO2 production: Aerobic degradation	
DOE1.2.2.4	W	2.1?	Methane/CO2 production: Anaerobic degradation	
DOE1.2.2.5	W	2.1	Methane/CO2 production: Effects of temperature	
DOE1.2.2.6	WR	2.1	Methane/CO2 production: Effects of lithostatic pressure	
DOE1.2.2.8	WB	2.2	Methane/CO2 production: Effects of biofilms	
DOE1.2.2.10	W	2.1?	Methane/CO2 production: Inhibition due to the presence of toxic materials	
DOE1.2.2.11	WB	2.2	Methane/CO2 production: Carbonate/bicarbonate exchange with concrete	
DOE1.2.2.12	WR	2.1	Methane/CO2 production: Energy and nutrient control of metabolism	
DOE1.2.2.13	WR	2.1	Methane/CO2 production: Effects of radiation on microbial populations	
DOE1.2.3	WB	2.2	Gas generation from concrete	
DOE1.2.4.1	W	2.1	Tritiated hydrogen	
DOE1.2.4.2	W		Active methane and carbon dioxide	
DOE1.2.4.3	W		Other active gases	
DOE1.2.5	W	2.1	Toxic gases	
DOE1.3.1	W		Radioactive decay and ingrowth	
DOE1.3.2	W	3.1?	Nuclear criticality	
DOE1.4.3	WC		Embrittlement	
DOE1.6.5.1	WCR		Chemical changes due to Metal corrosion	
DOE1.6.5.3	WBR		Chemical changes due to Waste degradation	
DOE1.6.5.4	WBR		Chemical changes due to Gas production	
DOE1.6.6.1	W	2.1	Microbiological effects due to Cellulose degradation	

FEPs LIST: WASTE CATEGORY

DOE1.6.6.2	WBF		Microbial activity	
DOE1.6.6.3	WBF		Microbiological effects due to Microbial product reactions	
IAEA3.2.1	WC		Chemical effects: Corrosion	
IAEA3.2.2	WCR		Chemical effects: Interactions of waste package and rock	
IAEA3.2.3	WB		Chemical effects: Gas generation	
IAEA3.2.4	WBR		Chemical effects: Geochemical change	
IAEA3.4.1	W		Radiological effects: Material property changes	
IAEA3.4.2	W		Radiological effects: Radiolysis	
IAEA3.4.3	W		Radiological effects: Decay product gas generation	
IAEA3.4.4	W	3.1?	Radiological effects: Nuclear criticality	
PGA3.1	W		Radiation damage of the matrix	
PGA3.2	W		Radiolysis	
PGA3.3	W	3.1?	Nuclear criticality	
PGA3.7.1	WC	2.1	Differing thermal expansion of glass matrix and canister	
PGA3.9	WB		Thermally induced chemical changes	
PGA3.10	WCB		Chemical changes due to corrosion	
PGA3.15	W		Gas production	
SKI1.1.1	W	3.1?	Criticality	
SKI1.1.2	W		Radioactive decay: heat	
SKI1.1.3	W		Recoil of alpha-decay	
SKI1.1.4	W		Gas generation: He production	
SKI1.2.1	W		Radiolysis	
SKI1.2.2	WR	2.2	H ₂ /O ₂ explosions	
SKI1.2.3	WC		Pb-I reactions	
SKI1.2.4	W		Gas generation	
SKI1.2.5	W		I, Cs-migration to glass surface	
SKI1.2.6	W		Solubility within fuel matrix	
SKI1.2.7	W		Recrystallization	
SKI1.2.8	W		Redox potential	
SKI1.2.9	W		Dissolution chemistry	
SKI1.3	W		Damaged or deviating fuel	
SKI1.4	W?H	D	Sudden energy release	
SKI2.1.3	W		Internal corrosion due to waste	
SKI2.1.4	WC		Role of the eventual channeling within the canister	
SKI2.3.1	WC		Thermal cracking	
SK3.1.9	WB	XXXX	Radiolysis	SEE SK1.2.1
SK3.1.10	WB		Interactions with corrosion products and waste	
SK5.6	W	3.1	Co-storage of other waste	
SK5.44	WR		Solubility and precipitation	
SK7.4	W	3.6	Chemical toxicity of wastes	
UKN1.6.14	WCBF		Chemical gradients (electrochemical effects and osmosis)	
UKN1.7.6	WBF		Chemical transformations	
UKN1.7.7	WBF		Microbial interactions	
UKN2.2.3	WH	3.1	Co-disposal of reactive wastes (deliberate)	
UKN2.2.4	WH		Inadvertent inclusion of undesirable materials	
UKN2.2.5	W		Heterogeneity of waste forms (chemical, physical)	
UKN3.1.5	WB		Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)	
UKN3.2.1	WC		Metallic corrosion (pitting/uniform, internal and external agents, gas generation eg. H ₂)	
UKN3.2.2	WCBR		Interactions of host materials and groundwater with repository material (eg. concrete carbon)	
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corros)	
UKN3.2.5	W	2.1	Cellulosic degradation	
UKN3.2.6	W	2.1	Introduced complexing agents and cellulosics	
UKN3.2.7	WC		Microbiological effects (on corrosion/degradation, on solubility/complexation, gas generation)	
UKN3.3.6	WC	2.1	Gas effects (pressurization, disruption, explosion, fire)	
UKN3.4.1	W		Radiolysis	
UKN3.4.2	W		Material property changes	
UKN3.4.3	W	3.1	Nuclear criticality	
UKN3.4.4	W		Radioactive decay and ingrowth (chain decay)	
HMIP1.1.3	W		Physico-chemical degradation of wastes and transport to the far-field	
HMIP1.1.4	WC		Electrical effects of metal corrosion	
HMIP1.2.1	WC		Hydrogen by metal corrosion	
HMIP1.2.2	W	2.1	Methane and carbon dioxide by microbial degradation	
HMIP1.2.3	WB	2.1	Gas generation from concrete	
HMIP1.2.4	W		Radioactive gases	
HMIP1.2.5	W		Chemotoxic gases	
HMIP1.2.7	W	2.1	Flammability	
HMIP1.2.8	WBR		Thermo-chemical effects	
HMIP1.3.1	W		Radioactive decay and ingrowth	
HMIP1.3.2	W	3.1	Nuclear criticality	
HMIP1.4.1	WCB		Waste-form and backfill consolidation	
NEA2.2.3	WR	3.1	Co-disposal of reactive wastes (deliberate)	

FEPs LIST: WASTE CATEGORY

NEA2.2.4	WR		Inadvertent inclusion of undesirable materials
NEA2.2.5	W		Heterogeneity of waste forms (chemical, physical)
NEA3.2.5	W	2.1	Cellulosic degradation
NEA3.2.6	W	2.1	Introduced complexing agents and cellulose
NEA3.2.7	W		Microbiological (effects on corrosion/degradation, solubility/complexation, gas generation, e.g.
NEA3.3.5	WC		Fracturing
NEA3.4.1	W		Radiolysis
NEA3.4.2	W		Material property changes
NEA3.4.3	W	3.1	Nuclear criticality
NEA3.4.4	W		Radioactive decay and ingrowth (chain decay)

FEPs LIST: CONTAINER CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.3	WCBR		Biological activity	
AECL1.4	WCBR	4	Boundary conditions	
AECL1.10	WCBR	4	Chemical interactions (expected)	
AECL1.11	WCBR	4	Chemical interactions (long-term)	
AECL1.12	WCBR	4	Chemical interactions (other)	
AECL1.13	WCBR		Chemical kinetics	
AECL1.18	C		Container corrosion products	
AECL1.19	C		Container failure (early)	
AECL1.20	C		Container failure (long-term)	
AECL1.21	C		Container failure (other long-term processes)	
AECL1.22	C		Container healing	
AECL1.23	C		Containers - partial corrosion	
AECL1.25	WCBR	4	Correlation	Incomprehens
AECL1.26	C		Corrosion	
AECL1.27	WCB		Coupled processes	
AECL1.32	WCB		Electrochemical gradients	
AECL1.39	WC	2.1	Galvanic coupling	
AECL1.45	C	2.1?	Hydride cracking	
AECL1.49	C	3.1	Incomplete filling of containers	
AECL1.50	WCBR	4	Interfaces (boundary conditions)	SEE AECL1.4
AECL1.53	WCR		Inventory	(DESCRIPTION)
AECL1.55	WCB		Long-term physical stability	
AECL1.58	CBR		Microbes	SEE AECL1.3
AECL1.59	CBR		Microorganisms	SEE AECL1.3
AECL1.63	C		Pitting	SEE AECL1.1
AECL1.65	WCBR		Precipitation and dissolution	
AECL1.67	WC?		Radiation damage	
AECL1.90	WCBR		Speciation	
AECL1.81	BCWR		Stability	
AECL1.84	WCBR		Temperature rises (unexpected effects)	
AECL1.85	WCBR	4	Time dependence	
AECL1.88	C		Uniform corrosion	
DOE1.1.1.1	C		Structural container metal corrosion: Localised	
DOE1.1.1.2	C		Structural container metal corrosion: Bulk	
DOE1.1.1.3	C		Structural container metal corrosion: Crevice	
DOE1.1.1.4	C		Structural container metal corrosion: Stress corrosion cracking	
DOE1.2.1.2	C		Hydrogen: corrosion of container steel	
DOE1.2.6.1	C		Gas transport in the waste container	
DOE1.4.1	C		Canister or container movement	
DOE1.4.3	WC		Embrittlement	
DOE1.6.5.1	WCR		Chemical changes due to Metal corrosion	
IAEA3.2.1	WC		Chemical effects: Corrosion	
IAEA3.2.2	WCR		Chemical effects: Interactions of waste package and rock	
IAEA3.3.1	CB		Mechanical effects: Canister movement	
PGA3.4	CB		Canister movement in backfill	
PGA3.6	C		Mechanical canister damage	
PGA3.7.1	WC	2.1	Differing thermal expansion of glass matrix and canister	
PGA3.7.2	CB		Differing thermal expansion of canister and backfill	
PGA3.10	WCB		Chemical changes due to corrosion	
SKI1.2.3	WC		Pb-I reactions	
SKI1.5	C		Release of radionuclides from the failed canister	
SKI2.1.1	C		Chemical reactions (copper corrosion)	
SKI2.1.2	C		Coupled effects (electrophoresis)	
SKI2.1.4	WC		Role of the eventual channeling within the canister	
SKI2.1.5	C		Role of chlorides in copper corrosion	
SKI2.1.6.1	C		Repository induced Pb/Cu electrochemical reactions	
SKI2.1.6.2	CB		Natural telluric electrochemical reactions	
SKI2.1.7	C		Pitting	

FEPs LIST: CONTAINER CATEGORY

SK12.1.8	C		Corrosive agents, Sulphides, oxygen etc	
SK12.1.9	BC		Backfill effects on Cu corrosion	
SK12.1.10	C		Microbes	
SK12.2	C		Creeping of copper	
SK12.3.1	WC		Thermal cracking	
SK12.3.2	C	XXXX	Electro-chemical cracking	SEE SK12.1.1
SK12.3.3	C		Stress corrosion cracking	
SK12.3.4	C		Loss of ductility	
SK12.3.5	C		Radiation effects on canister	
SK12.3.6	C		Cracking along welds	
SK12.3.7.1	C		External stress	
SK12.3.7.2	C		Hydrostatic pressure on canister	
SK12.3.8	C		Internal pressure	
SK12.4	C		Voids in the lead filling	
SK12.5.1	C		Random canister defects - quality control	
SK12.5.2	C		Common cause canister defects - quality control	
SK13.2.2	CB		Movement of canister in buffer/backfill	
SK13.2.7	CB		Swelling of corrosion products	
SK15.23	C	XXXX	Changed hydrostatic pressure on canister	SEE SK12.3.7.2
UKN1.6.14	WCBF		Chemical gradients (electrochemical effects and osmosis)	
UKN2.1.6	C		Material defects, e.g. early canister failure	
UKN3.2.1	WC		Metallic corrosion (pitting/uniform, internal and external agents, gas generation e.g. H ₂)	
UKN3.2.2	WCBR		Interactions of host materials and groundwater with repository material (eg. concrete carbonation)	
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corrosion)	
UKN3.2.7	WC		Microbiological effects (on corrosion/degradation, on solubility/complexation, gas generation)	
UKN3.3.1	C		Canister or container movement	
UKN3.3.3	C		Embrittlement and cracking	
UKN3.3.4	C		Subsidence/collapse	
UKN3.3.5	C		Fracturing	
UKN3.3.6	WC	2.1	Gas effects (pressurisation, disruption, explosion, fire)	
HMIP1.1.1	C		Container metal corrosion	
HMIP1.1.4	WC		Electrical effects of metal corrosion	
HMIP1.2.1	WC		Hydrogen by metal corrosion	
HMIP1.4.1	WCB		Waste-form and backfill consolidation	
NEA2.1.6	CR		Material defects (e.g. early canister failure)	
NEA3.2.1	C		Metallic corrosion (pitting/uniform, internal and external agents, gas generation e.g. H ₂)	
NEA3.3.1	C		Canister or container movement	
NEA3.3.2	C		Changes in in-situ stress field	
NEA3.3.3	C		Embrittlement and cracking	
NEA3.3.4	C		Subsidence/collapse	
NEA3.3.5	WC		Fracturing	
NEA3.3.6	C	2.1	Gas effects (pressurisation, disruption, explosion, fire)	

FEPs LIST: BUFFER/BACKFILL CATEGORY

ID NUMBER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1	B		Backfill characteristics	
AECL1.2	B		Backfill evolution	
AECL1.3	WCBR		Biological activity	
AECL1.4	WCBR	4	Boundary conditions	
AECL1.5	WB	2.1	Buffer additives	
AECL1.6	B		Buffer characteristics	
AECL1.7	B		Buffer evolution	
AECL1.9	WBR		Chemical gradients	
AECL1.10	WCBR	4	Chemical interactions (expected)	
AECL1.11	WCBR	4	Chemical interactions (long-term)	
AECL1.12	WCBR	4	Chemical interactions (other)	
AECL1.13	WCBR		Chemical kinetics	
AECL1.17	B	2.2	Concrete	
AECL1.24	BR		Convection	
AECL1.25	WCBR	4	Corrosion	Incomprehens
AECL1.27	WCBR		Coupled processes	
AECL1.28	WB		Criticality	
AECL1.29	BR		Diffusion	
AECL1.30	BR		Dispersion	
AECL1.32	WCB		Electrochemical gradients	
AECL1.33	B	XXXX	Evolution of buffer	SEE AECL1.7
AECL1.36	B		Faulty buffer emplacement	
AECL1.37	BR		Formation of cracks	
AECL1.40	WBR		Geochemical pump	SEE AECL1.9
AECL1.43	BR		Hydraulic conductivity	
AECL1.46	BR		Hydrothermal alteration	
AECL1.50	WCBR	4	Interfaces (boundary conditions)	SEE AECL1.4
AECL1.55	WCB		Long-term physical stability	
AECL1.58	CBR		Microbes	SEE AECL1.3
AECL1.59	CBR		Microorganisms	SEE AECL1.3
AECL1.65	WCBR		Precipitation and dissolution	
AECL1.76	BR		Sorption	
AECL1.77	BR		Sorption non-linear	
AECL1.80	WCBR		Speciation	
AECL1.81	BCWR		Stability	
AECL1.83	B		Swelling pressure	
AECL1.84	WCBR		Temperature rises (unexpected effects)	
AECL1.85	WCBR	4	Time dependence	
AECL1.86	BR		Transport in gases or of gases	
AECL1.90	BR		Unsaturated transport	
DOE1.1.21	B	2.2	Cracking: concrete	
DOE1.1.22	B	2.2	Sealing of cracks: concrete	
DOE1.1.24	B	2.2	Alkali-aggregate reaction: concrete	
DOE1.1.32	B	2.2	Exchange capacity exceeded: concrete	
DOE1.1.33	B	2.2	Alkali-aggregate reaction: concrete	
DOE1.1.34	B	2.2	Cement-sulphate reaction: concrete	
DOE1.2.18	WB	2.1	Hydrogen: effects of microbial growth on concrete	
DOE1.2.28	WB	2.2	Methane/CO2 production: Effects of biofilms	
DOE1.2.29	BR	2.1	Methane/CO2 production: Effects of hydrogen from metal corrosion	
DOE1.2.2.11	WB	2.2	Methane/CO2 production: Carbonate/bicarbonate exchange with concrete	

FEPs LIST: BUFFER/BACKFILL CATEGORY

DOE1.2.3	WB	2.2	Gas generation from concrete
DOE1.5.2.1	BR	2.3	Groundwater flow: initial conditions
DOE1.5.2.2	BR		Groundwater flow due to gas production
DOE1.5.3	BFF		Groundwater flow (saturated conditions)
DOE1.6.5.3	WBR		Chemical changes due to Waste degradation
DOE1.6.5.4	WBR		Chemical changes due to Gas production
DOE1.6.5.5	BFF		Chemical changes due to Complex formation
DOE1.6.5.6	BFF		Chemical changes due to Colloid production
DOE1.6.5.7	BFF		Chemical changes due to Solubility
DOE1.6.5.8	BFF		Chemical changes due to Sorption
DOE1.6.5.9	BFF		Chemical changes due to Species equilibrium
DOE1.6.6.2	WBFF		Microbial activity
DOE1.6.6.3	WBFF		Microbiological effects due to Microbial product reactions
DOE2.3.4.4	BFF		Groundwater flow: Fracture
DOE2.3.4.5	BFF		Groundwater flow: Effects of solution channels
DOE2.3.5.1	BFF		Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BFF		Inorganic colloid transport: Effects of ionic strength
DOE2.3.6	BFF		Variations in groundwater temperature
DOE2.4.1	BFF		Advection
DOE2.4.2.1	BFF		Bulk diffusion
DOE2.4.2.2	BFF		Matrix diffusion
DOE2.4.2.3	B		Surface diffusion
DOE2.4.3	BFF		Hydrodynamic dispersion
DOE2.4.4.1	BFFL		Solubility: effects of pH and Eh
DOE2.4.4.2	BFFL		Solubility: effects of ionic strength
DOE2.4.4.3	BFFL		Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	BR		Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	BFFL		Solubility: effects of naturally-occurring colloids
DOE2.4.4.6	BR		Solubility: effects of colloids formed in the near-field
DOE2.4.4.8	BFFL		Solubility: Effects of microbial activity
DOE2.4.5.1	BFFL		Linear sorption
DOE2.4.5.2	BFFL		Non-linear sorption
DOE2.4.5.3	BFFL		Reversible sorption
DOE2.4.5.4	BFFL		Irreversible sorption
DOE2.4.5.5	BFFL		Sorption: Effects of pH and Eh
DOE2.4.5.6	BFFL		Sorption: Effects of ionic strength
DOE2.4.5.7	BFFL		Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BFFL		Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	BR		Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BFFL		Sorption: effects of naturally-occurring colloids
DOE2.4.5.11	BR		Sorption: effects of colloids formed in the near-field
DOE2.4.5.13	BFFL		Sorption: effects of microbial activity
DOE2.4.7.1	BFFL		Organic colloid transport in Porous media
DOE2.4.7.2	BFFL		Organic colloid transport in Fractured media
DOE2.4.7.3	BFFL		Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BFFL		Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BFFL		Inorganic colloid transport: Porous media
DOE2.4.8.2	BFFL		Inorganic colloid transport: Fractured media
DOE2.4.8.3	BFFL		Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BFFL		Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	BFFL		Transport of radionuclides bound to microbes
DOE2.4.10	BFFL		Isotopic dilution
DOE2.4.11.1	BFFL		Gas transport: solution
DOE2.4.11.2	BFFL		Gas transport: gas phase
DOE2.4.12	BFF		Gas-induced groundwater transport
DOE2.4.13.1	BR		Repository thermally-induced groundwater transport
DOE2.4.13.2	BFF		Naturally thermally-induced groundwater transport
IAEA1.13.1	BFF		Fluid interactions: Groundwater flow
IAEA1.13.2	BFFL		Fluid interactions: Dissolution
IAEA1.13.3	BFF		Fluid interactions: Brine pockets
IAEA3.1.3	BFF		Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BFF		Thermal effects: Fluid migration
IAEA3.2.3	WB		Chemical effects: Gas generation
IAEA3.2.4	WBR		Chemical effects: Geochemical change
IAEA3.3.1	CB		Mechanical effects: Canister movement
IAEA3.3.2	BR		Mechanical effects: Local fracturing

FEPs LIST: BUFFER/BACKFILL CATEGORY

PGA3.4	OB		Canister movement in backfill	
PGA3.7.2	OB		Differing thermal expansion of canister and backfill	
PGA3.7.3	BR		Differing thermal expansion of backfill and host rock	
PGA3.9	WB		Thermally induced chemical changes	
PGA3.10	WCB		Chemical changes due to corrosion	
PGA3.12.1	B		Geochemical changes in backfill	
PGA3.13	BRFL		Physico-chemical phenomena/effects (eg. colloid formation)	
PGA3.14	BRFL		Microbiological phenomena/effects	
SKI2.1.6.2	OB		Natural telluric electrochemical reactions	
SKI2.1.9	BC		Backfill effects on Cu corrosion	
SKI3.1.1	B		Degradation of the bentonite by chemical reactions	
SKI3.1.2	B		Saturation of sorption sites	
SKI3.1.3	B		Effects of bentonite on groundwater chemistry	
SKI3.1.4	B		Colloid generation - source	
SKI3.1.5	B		Coagulation of bentonite	
SKI3.1.6	B		Sedimentation of bentonite	
SKI3.1.7	B		Reactions with cement pore water	
SKI3.1.8	B	4	Near field buffer chemistry	
SKI3.1.9	WB	XXXX	Radiolysis	SEE SKI1.2.1
SKI3.1.10	WB		Interactions with corrosion products and waste	
SKI3.1.11	B		Redox iron	
SKI3.1.12	B	XXXX	Perturbed buffer material chemistry	SEE SKI3.1.1
SKI3.1.13	B		Radiation effects on bentonite	
SKI3.2.1.1	BR		Swelling of bentonite into tunnels and cracks	
SKI3.2.1.2	BR		Uneven swelling of bentonite	
SKI3.2.2	OB		Movement of canister in buffer/backfill	
SKI3.2.3	B		Mechanical failure of buffer/backfill	
SKI3.2.4	B		Erosion of buffer/backfill	
SKI3.2.5	B		Thermal effects on the buffer material	
SKI3.2.6	B		Diffusion - surface diffusion	
SKI3.2.7	OB		Swelling of corrosion products	
SKI3.2.8	B		Preferential pathways in the buffer/backfill	
SKI3.2.9	B		Flow through buffer/backfill	
SKI3.2.10	B		Soret effect	
SKI3.2.11	BR	3.1	Backfill material deficiencies	
SKI3.2.12	B		Gas transport in bentonite	SEE SKI3.2.8
SKI4.1.1	BRFL		Oxidizing conditions	
SKI4.1.2	BRFL		pH-deviations	
SKI4.1.3	BRFL	XXXX	Colloids, complexing agents	SEE SKI5.45
SKI4.1.4	BRFL		Sorption	
SKI4.1.6	BRFL		Reconcentration	
SKI4.1.7	BR		Thermochemical changes	
SKI4.1.9	BRFL		Complexing agents	ALSO SKI4.1.3
SKI4.2.3	BRF		Extreme channel flow of oxidants and radionuclides	
SKI4.2.4	BR		Thermal buoyancy	
SKI4.2.5	BRF		Changes of groundwater flow	
SKI4.2.10	BR		Chemical effects of rock reinforcement	
SKI5.1	BRF		Saline (or fresh) groundwater intrusion	
SKI5.14	BR		Resaturation	
SKI5.18	BRF	XXXX	Enhanced groundwater flow	SEE SKI4.2.5
SKI6.2	BRF		Gas transport	
SKI6.4	BRFL		Dispersion	
SKI6.5	BRFL		Dilution	
SNL6.1	BR		Subsidence and Caving	

FEPs LIST: BUFFER/BACKFILL CATEGORY

UKN1.5.7	BFF		Saline or freshwater intrusion
UKN1.5.8	BFF		Effects at saline-freshwater interface
UKN1.5.9	BFF		Natural thermal effects
UKN1.6.1	BAFL		Advection and dispersion
UKN1.6.2	BAFL		Diffusion
UKN1.6.3	BAFL		Matrix diffusion
UKN1.6.4	BAFL		Gas mediated transport
UKN1.6.5	BAFL		Multiphase flow and gas driven flow
UKN1.6.6	BAFL		Solubility limit
UKN1.6.7	BAFL		Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BAFL		Dissolution, precipitation and crystallisation
UKN1.6.9	BAFL		Colloid formation, dissolution and transport
UKN1.6.10	BAFL		Complexing agents
UKN1.6.13	BAFL		Mass, isotopic and species dilution
UKN1.6.14	WCBRF		Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBAFL		Chemical transformations
UKN1.7.7	WBAFL		Microbial interactions
UKN2.1.10	ER		Thermal effects (eg. concrete hydration)
UKN2.2.2	HB		Inadequate backfill or compaction, voidage
UKN3.1.5	WB		Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
UKN3.2.2	WCBR		Interactions of host materials and groundwater with repository material (eg. concrete carbonation)
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corrosion)
HMIP1.2.3	WB	2.1	Gas generation from concrete
HMIP1.2.6	BFF		Gas transport
HMIP1.2.8	WBR		Thermo-chemical effects
HMIP1.4.1	WCB		Waste-form and backfill consolidation
HMIP1.5.3	ER		Gas production (unsaturated flow)
HMIP1.5.4	BFF		Saturated groundwater flow
HMIP1.5.5	ER		Transport of chemically active substances into the near-field
HMIP1.6.1	ER		Thermal effects and Rock-mass changes
HMIP1.6.2	ER		Thermal effects and Hydrogeological changes
HMIP1.6.3	ER		Thermal effects and Chemical changes
HMIP1.6.4	ER		Thermal effects and Transport (diffusion) effects
HMIP2.3.1	BAFL		Advection
HMIP2.3.2	BAFL		Diffusion
HMIP2.3.3	BAFL		Hydrodynamic dispersion
HMIP2.3.4	BAFL		Solubility constraints
HMIP2.3.5	BAFL		Sorption including ion-exchange
HMIP2.3.6	BAFL		Changes in sorptive surfaces
HMIP2.3.7	BAFL		Changes in groundwater chemistry and flow direction
HMIP2.3.8	BAFL		Colloid transport
HMIP2.3.9	BAFL		Transport of radionuclides bound to microbes
HMIP2.3.10	BAFL		Transport of active gases
HMIP2.3.11	BAFL		Gas induced groundwater transport
HMIP2.3.12	BAFL		Thermal effects on hydrochemistry
HMIP2.3.13	BAFL		Biogeochemical changes
NEA1.6.1	BAFL		Advection and dispersion
NEA1.6.2	BAFL		Diffusion
NEA1.6.3	BAFL		Matrix diffusion
NEA1.6.4	BAFL		Gas mediated transport
NEA1.6.5	BAFL		Multiphase flow and gas-driven flow
NEA1.6.6	BAFL		Solubility limit
NEA1.6.7	BAFL		Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BAFL		Dissolution, precipitation, and crystallisation
NEA1.6.9	BAFL		Colloid formation, dissolution, and transport
NEA1.6.10	BAFL		Complexing agents
NEA1.6.13	BAFL		Mass, isotopic and species dilution
NEA1.6.14	BAFL		Chemical gradients (electrochemical effects and osmosis)
NEA2.2.2	ER		Inadequate backfill or compaction voidage
NEA3.1.1	ER		Differential elastic response
NEA3.1.2	ER		Non-elastic response
NEA3.1.4	BFF		Induced hydrological changes (fluid pressure, density convection, viscosity)
NEA3.1.5	ER		Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)

FEPs LIST: REPOSITORY CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.3	WCBR		Biological activity	
AECL1.4	WCBR	4	Boundary conditions	
AECL1.8	R		Cave ins	
AECL1.9	WBR		Chemical gradients	
AECL1.10	WCBR	4	Chemical interactions (expected)	
AECL1.11	WCBR	4	Chemical interactions (long-term)	
AECL1.12	WCBR	4	Chemical interactions (other)	
AECL1.13	WCBR		Chemical kinetics	
AECL1.15	R		Colloids	
AECL1.16	R	2.1?	Complexation by organics	
AECL1.24	ER		Convection	
AECL1.25	WCBR	4	Correlation	Incomprehens
AECL1.29	ER		Diffusion	
AECL1.30	ER		Dispersion	
AECL1.34	R		Excessive hydrostatic pressures	
AECL1.35	R	3.1	Explosions	H
AECL1.37	ER		Formation of cracks	
AECL1.40	WBR		Geochemical pump	SEE AECL1.9
AECL1.43	ER		Hydraulic conductivity	
AECL1.44	R		Hydraulic head	
AECL1.46	ER		Hydrothermal alteration	
AECL1.47	R	3.1	Improper operation	H
AECL1.48	R		Incomplete closure	
AECL1.50	WCBR	4	Interfaces (boundary conditions)	SEE AECL1.4
AECL1.53	WCR		Inventory	(DESCRIPTION
AECL1.56	WR	4	Long-term transients	
AECL1.57	R	2.1	Methylation	SEE AECL1.16
AECL1.58	CBR		Microbes	SEE AECL1.3
AECL1.59	CBR		Microorganisms	SEE AECL1.3
AECL1.60	R	3.1	Monitoring and remedial activities	
AECL1.61	R	3.7	Mutation	
AECL1.62	R		Percolation in shafts	
AECL1.64	R	3.1	Preclosure events	
AECL1.65	WCBR		Precipitation and dissolution	
AECL1.66	R		Pseudo-colloids	SEE AECL1.15
AECL1.70	R		Recharge groundwater	
AECL1.71	R		Reflooding	
AECL1.72	R	3.1	Retrievability	
AECL1.74	R		Seal evolution	
AECL1.75	R		Seal failure	
AECL1.76	ER		Sorption	
AECL1.77	ER		Sorption: non-linear	
AECL1.80	WCBR		Speciation	
AECL1.81	BCWR		Stability	
AECL1.84	WCBR		Temperature rises (unexpected effects)	
AECL1.85	WCBR	4	Time dependence	
AECL1.86	ER		Transport in gases or of gases	
AECL1.89	R		Unmodelled design features	
AECL1.90	ER		Unsaturated transport	
AECL1.91	R		Vault geometry	
AECL2.1	HR	3.1	Blasting and vibration	
AECL2.4	FF		Borehole seal failure/open boreholes	
AECL2.6	FF		Boreholes - unsealed	SEE AECL2.4
AECL2.7	FF	2.3	Cavitation	
AECL2.67	FF?		Vault heating effects	
DOE1.1.2.3	R		Pore blockage: concrete	
DOE1.1.2.5	R		Cement-sulphate reaction: concrete	
DOE1.1.3.1	R		Changes in pore water composition, pH, Eh: concrete	
DOE1.2.1.1	R		Hydrogen: corrosion of structural steel	
DOE1.2.2.6	WR	2.1	Methane/CO2 production: Effects of lithostatic pressure	
DOE1.2.2.7	R		Methane/CO2 production: Effects of microbial growth on properties of concrete	
DOE1.2.2.9	ER	2.1	Methane/CO2 production: Effects of hydrogen from metal corrosion	
DOE1.2.2.12	WR	2.1	Methane/CO2 production: Energy and nutrient control of metabolism	
DOE1.2.2.13	WR	2.1	Methane/CO2 production: Effects of radiation on microbial populations	
DOE1.2.6.2	R		Gas transport in the vaults between containers	
DOE1.2.6.3	R		Gas transport Between vaults	
DOE1.2.6.4	R		Gas transport in the near-field, including up and around access shafts and adits	
DOE1.2.7.1	R	3.1	Fires	
DOE1.2.7.2	R	3.1	Explosions	
DOE1.4.2	R		Changes in in-situ stress field	

FEPs LIST: REPOSITORY CATEGORY

DOE1.4.4.1	R		Repository-induced subsidence
DOE1.4.5	FF	2.3?	Rock creep
DOE1.5.1.1	FF		Changes in moisture content due to dewatering
DOE1.5.1.2	FF		Changes in moisture content due to stress relief
DOE1.5.2.1	BR	2.3	Groundwater flow: initial conditions
DOE1.5.2.2	BR		Groundwater flow due to gas production
DOE1.5.3	BFF		Groundwater flow (saturated conditions)
DOE1.5.4.1	R		Transport of Inorganic ions into the near-field
DOE1.5.4.2	R		Transport of Humic and fulvic acids into the near-field
DOE1.5.4.3	R		Transport of Microbes into the near-field
DOE1.5.4.4	R		Transport of Organic complexes into the near-field
DOE1.5.4.5	R		Transport of Colloids into the near-field
DOE1.6.1	FF		Differential elastic response
DOE1.6.2	FF		Non-elastic response
DOE1.6.3.1	FF		Fracture changes: aperture
DOE1.6.3.2	FF		Fracture changes: length
DOE1.6.5.1	WCR		Chemical changes due to Metal corrosion
DOE1.6.5.2	R		Chemical changes due to Concrete degradation
DOE1.6.5.3	WBR		Chemical changes due to Waste degradation
DOE1.6.5.4	WBR		Chemical changes due to Gas production
DOE1.6.5.5	BFF		Chemical changes due to Complex formation
DOE1.6.5.6	BFF		Chemical changes due to Colloid production
DOE1.6.5.7	BFF		Chemical changes due to Solubility
DOE1.6.5.8	BFF		Chemical changes due to Sorption
DOE1.6.5.9	BFF		Chemical changes due to Species equilibrium
DOE1.6.6.2	WBRF		Microbial activity
DOE1.6.6.3	WBRF		Microbiological effects due to Microbial product reactions
DOE2.2.6.1	FF		Repository-induced seismicity
DOE2.2.6.2	FRG		Externally-induced seismicity
DOE2.3.3.1	FF		Rock property changes: Porosity
DOE2.3.3.2	FF		Rock property changes: Permeability
DOE2.3.3.3	FF		Rock property changes: Microbial pore blocking
DOE2.3.3.4	FF		Rock property changes: Channel formation/closure
DOE2.3.4.1	FF		Groundwater flow: Darcy
DOE2.3.4.2	FF		Groundwater flow: Non-Darcy
DOE2.3.4.3	FF		Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	BFF		Groundwater flow: Fracture
DOE2.3.4.5	BFF		Groundwater flow: Effects of solution channels
DOE2.3.4.6	FF		Inorganic colloid transport: Porous media
DOE2.3.5.1	BFF		Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BFF		Inorganic colloid transport: Effects of ionic strength
DOE2.3.6	BFF		Variations in groundwater temperature
DOE2.4.1	BFF		Advection
DOE2.4.2.1	BFF		Bulk diffusion
DOE2.4.2.2	BFF		Matrix diffusion
DOE2.4.3	BFF		Hydrodynamic dispersion
DOE2.4.4.1	BRFL		Solubility: effects of pH and Eh
DOE2.4.4.2	BRFL		Solubility: effects of ionic strength
DOE2.4.4.3	BRFL		Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	BR		Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	BRFL		Solubility: effects of naturally-occurring colloids
DOE2.4.4.6	BR		Solubility: effects of colloids formed in the near-field
DOE2.4.4.7	FF		Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	BRFL		Solubility: Effects of microbial activity
DOE2.4.5.1	BRFL		Linear sorption
DOE2.4.5.2	BRFL		Non-linear sorption
DOE2.4.5.3	BRFL		Reversible sorption
DOE2.4.5.4	BRFL		Irreversible sorption
DOE2.4.5.5	BRFL		Sorption: Effects of pH and Eh
DOE2.4.5.6	BRFL		Sorption: Effects of ionic strength
DOE2.4.5.7	BRFL		Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRFL		Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	BR		Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BRFL		Sorption: effects of naturally-occurring colloids
DOE2.4.5.11	BR		Sorption: effects of colloids formed in the near-field
DOE2.4.5.12	FF		Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	BRFL		Sorption: effects of microbial activity

FEPs LIST: REPOSITORY CATEGORY

DOE2.4.6	FF		Fracture mineralisation	
DOE2.4.7.1	BRFL		Organic colloid transport in Porous media	
DOE2.4.7.2	BRFL		Organic colloid transport in Fractured media	
DOE2.4.7.3	BRFL		Organic colloid transport: Effects of pH and Eh	
DOE2.4.7.4	BRFL		Organic colloid transport: Effects of ionic strength	
DOE2.4.8.1	BRFL		Inorganic colloid transport: Porous media	
DOE2.4.8.2	BRFL		Inorganic colloid transport: Fractured media	
DOE2.4.8.3	BRFL		Inorganic colloid transport: Effects of pH and Eh	
DOE2.4.8.4	BRFL		Inorganic colloid transport: Effects of ionic strength	
DOE2.4.9	BRFL		Transport of radionuclides bound to microbes	
DOE2.4.10	BRFL		Isotopic dilution	
DOE2.4.11.1	BRFL		Gas transport: solution	
DOE2.4.11.2	BRFL		Gas transport: gas phase	
DOE2.4.12	BFF		Gas-induced groundwater transport	
DOE2.4.13.1	BR		Repository thermally-induced groundwater transport	
DOE2.4.13.2	BFF		Naturally thermally-induced groundwater transport	
DOE2.4.14	RFL		Biogeochemical changes	
DOE4.1.1.1	RFL		Borehole seal failure	
DOE4.1.1.2	RFL		Borehole seal degradation	
DOE4.1.2.1	R		Shaft/tunnel seal failure	
DOE4.1.2.2	R		Shaft/tunnel seal degradation	
IAEA1.13.1	BFF		Fluid interactions: Groundwater flow	
IAEA1.13.2	BRFL		Fluid interactions: Dissolution	
IAEA1.13.3	BFF		Fluid interactions: Brine pockets	
IAEA2.2.1	FF		Inadequate design: Shaft seal failure	
IAEA2.2.2	RFL		Inadequate design: Exploration borehole seal failure	
IAEA2.3	R	3.1	Improper operation: Improper waste emplacement	
IAEA3.1.1	FF		Thermal effects: Differential elastic response	
IAEA3.1.2	FF		Thermal effects: Non-elastic response	
IAEA3.1.3	BFF		Thermal effects: Fluid pressure, density, viscosity changes	
IAEA3.1.4	BFF		Thermal effects: Fluid migration	
IAEA3.2.2	WCR		Chemical effects: Interactions of waste package and rock	
IAEA3.2.4	WBR		Chemical effects: Geochemical change	
IAEA3.3.2	BR		Mechanical effects: Local fracturing	
PGA3.5	R		Decompressed zones from mining	
PGA3.7.3	BR		Differing thermal expansion of backfill and host rock	
PGA3.7.4	FF		Differing thermal expansion of host rock zones	
PGA3.8	FF		Thermal convection	
PGA3.12.2	FF		Geochemical changes in host rock	
PGA3.13	BRFL		Physico-chemical phenomena/effects (eg. colloid formation)	
PGA3.14	BRFL		Microbiological phenomena/effects	
PGA3.15	R		Failure of shaft sealing	
PGA4.1	FF		Direct alterations in hydrogeology	
PGA4.2	R		Injection of liquid waste	
SKI1.2.2	WR	2.2	H ₂ O ₂ explosions	
SKI3.2.1.1	BR		Swelling of bentonite into tunnels and cracks	
SKI3.2.1.2	BR		Uneven swelling of bentonite	
SKI4.1.1	BRFL		Oxidizing conditions	
SKI4.1.2	BRFL		pH-deviations	
SKI4.1.3	BRFL	XXXX	Colloids, complexing agents	SEE SKI5.45
SKI4.1.4	BRFL		Sorption	
SKI4.1.5	FF		Matrix diffusion	
SKI4.1.6	BRFL		Reconcentration	
SKI4.1.7	BR		Thermochemical changes	
SKI4.1.8	R		Change of groundwater chemistry in nearby rock	
SKI4.1.9	BRFL		Complexing agents	ALSO SKI4.1.3
SKI4.2.1	R		Mechanical failure of repository	
SKI4.2.2.1	R		Excavation/backfilling effects on nearby rock	
SKI4.2.2.2	R	XXXX	Hydraulic conductivity change - Excavation/backfilling effect	SEE SKI4.2.2.1
SKI4.2.2.3	R	XXXX	Mechanical effects - Excavation/backfilling effects	SEE SKI4.2.2.1
SKI4.2.3	BFF		Extreme channel flow of oxidants and nuclides	
SKI4.2.4	BR		Thermal buoyancy	
SKI4.2.5	BFF		Changes of groundwater flow	
SKI4.2.7	R		Thermo-hydro-mechanical effects	
SKI4.2.8	R		Enhanced rock fracturing	
SKI4.2.9	R		Creeping of rock mass	
SKI4.2.10	BR		Chemical effects of rock reinforcement	

FEPs LIST: REPOSITORY CATEGORY

SKI5.1	BFF		Saline (or fresh) groundwater intrusion	
SKI5.11	FF		Degradation of hole- and shaft seals	
SKI5.14	ER		Resaturation	
SKI5.18	BFF	XXXX	Enhanced groundwater flow	SEE SKI4.2.5
SKI5.22	GR		Accumulation of gases under permafrost	
SKI5.24	R	XXXX	Stress changes of conductivity	SEE SKI 4.2.2
SKI5.43	GR		Methane intrusion	SEE SKI5.22
SKI5.44	WR		Solubility and precipitation	
SKI5.45	FF		Colloid generation and transport	
SKI6.2	BFF		Gas transport	
SKI6.4	BRFL		Dispersion	
SKI6.5	BRFL		Dilution	
SKI6.13	FF		Geothermally induced flow	SEE 6.1
SKI7.5	RFL		Isotopic dilution	
SNL6.1	SR		Subsidence and Caving	
SNL6.2	RFL		Shaft and Borehole Seal Leakage	
SNL6.3	FF		Thermally Induced Stress/Fracturing in Host Rock	
SNL6.4	FF		Excavation-Induced Stress/Fracturing in Host Rock	
UKN1.2.13	R		Natural gas intrusion	
UKN1.5.2	R	2.3?	Site flooding	
UKN1.5.7	BFF		Saline or freshwater intrusion	
UKN1.5.8	BFF		Effects at saline-freshwater interface	
UKN1.5.9	BFF		Natural thermal effects	
UKN1.6.1	BRFL		Advection and dispersion	
UKN1.6.2	BRFL		Diffusion	
UKN1.6.3	BRFL		Matrix diffusion	
UKN1.6.4	BRFL		Gas mediated transport	
UKN1.6.5	BRFL		Multiphase flow and gas driven flow	
UKN1.6.6	BRFL		Solubility limit	
UKN1.6.7	BRFL		Sorption (linear/non-linear, reversible/irreversible)	
UKN1.6.8	BRFL		Dissolution, precipitation and crystallisation	
UKN1.6.9	BRFL		Colloid formation, dissolution and transport	
UKN1.6.10	BRFL		Complexing agents	
UKN1.6.11	FF		Fracture mineralisation and weathering	
UKN1.6.13	BRFL		Mass, isotopic and species dilution	
UKN1.6.14	WCBRF		Chemical gradients (electrochemical effects and osmosis)	
UKN1.7.6	WBRFL		Chemical transformations	
UKN1.7.7	WBRFL		Microbial interactions	
UKN2.1.2	RFL		Investigation borehole seal failure and degradation	
UKN2.1.3	FF		Shaft or access tunnel seal failure and degradation	
UKN2.1.4	R		Stress field changes, settling, subsidence or caving	
UKN2.1.5	FF		Dewatering of host rock	
UKN2.1.8	HR	3.1	Poor quality construction	
UKN2.1.9	HR	3.1	Design modification	
UKN2.1.10	ER		Thermal effects (eg. concrete hydration)	
UKN2.2.8	R	3.1	Repository flooding during operation	
UKN2.2.10	PH		Poor closure	
UKN3.1.1	FF		Differential elastic response	
UKN3.1.2	FF		Non-elastic response	
UKN3.1.3	FF		Host rock fracture aperture changes	
UKN3.1.4	FF		Induced hydrological changes (fluid pressure, density convection, viscosity)	
UKN3.2.2	WCBR		Interactions of host materials and groundwater with repository material (eg. concrete carbonation)	
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corrosion)	
UKN3.2.4	FF		Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)	
UKN3.3.2	R		Changes in in-situ stress field	

FEPs LIST: REPOSITORY CATEGORY

HMIP1.1.2	R		Physico-chemical degradation of concrete
HMIP1.2.6	BFF		Gas transport
HMIP1.2.8	WBR		Thermo-chemical effects
HMIP1.4.2	R		Vault collapse
HMIP1.5.1	R		Desaturation (pumping) effects
HMIP1.5.2	R		Disturbed zone (hydromechanical) effects
HMIP1.5.3	BR		Gas production (unsaturated flow)
HMIP1.5.4	BFF		Saturated groundwater flow
HMIP1.5.5	BR		Transport of chemically active substances into the near-field
HMIP1.6.1	BR		Thermal effects and Rock-mass changes
HMIP1.6.2	BR		Thermal effects and Hydrogeological changes
HMIP1.6.3	BR		Thermal effects and Chemical changes
HMIP1.6.4	BR		Thermal effects and Transport (diffusion) effects
HMIP2.3.1	BRFL		Advection
HMIP2.3.2	BRFL		Diffusion
HMIP2.3.3	BRFL		Hydrodynamic dispersion
HMIP2.3.4	BRFL		Solubility constraints
HMIP2.3.5	BRFL		Sorption including ion-exchange
HMIP2.3.6	BRFL		Changes in sorptive surfaces
HMIP2.3.7	BRFL		Changes in groundwater chemistry and flow direction
HMIP2.3.8	BRFL		Colloid transport
HMIP2.3.9	BRFL		Transport of radionuclides bound to microbes
HMIP2.3.10	BRFL		Transport of active gases
HMIP2.3.11	BRFL		Gas induced groundwater transport
HMIP2.3.12	BRFL		Thermal effects on hydrochemistry
HMIP2.3.13	BRFL		Biogeochemical changes
HMIP5.1.1	FR		Loss of integrity of borehole seals
HMIP5.1.2	R		Loss of integrity of shaft or access tunnel seals
HMIP5.1.3	R		Incomplete near-field chemical conditioning
NEA1.2.13	FF		Natural gas intrusion
NEA1.6.1	BRFL		Advection and dispersion
NEA1.6.2	BRFL		Diffusion
NEA1.6.3	BRFL		Matrix diffusion
NEA1.6.4	BRFL		Gas mediated transport
NEA1.6.5	BRFL		Multiphase flow and gas-driven flow
NEA1.6.6	BRFL		Solubility limit
NEA1.6.7	BRFL		Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRFL		Dissolution, precipitation, and crystallisation
NEA1.6.9	BRFL		Colloid formation, dissolution, and transport
NEA1.6.10	BRFL		Complexing agents
NEA1.6.11	FF		Fracture mineralisation
NEA1.6.13	BRFL		Mass, isotopic and species dilution
NEA1.6.14	BRFL		Chemical gradients (electrochemical effects and osmosis)
NEA2.1.2	HR		Investigation borehole seal failure and degradation
NEA2.1.3	HR		Shaft or access tunnel seal failure and degradation
NEA2.1.4	HR		Stress field changes, settling, subsidence or caving
NEA2.1.5	HR		Dewatering of host rock
NEA2.1.6	CR		Material defects (e.g. early canister failure)
NEA2.1.7	HR		Common cause failures
NEA2.1.8	HR		Poor quality construction
NEA2.1.10	R		Thermal effects
NEA2.2.1	R		Radioactive waste disposal error
NEA2.2.2	BR		Inadequate backfill or compaction voidage
NEA2.2.3	WR	3.1	Co-disposal of reactive wastes (deliberate)
NEA2.2.4	WR		Inadvertent inclusion of undesirable materials
NEA2.2.6	R	3.1	Accidents during operation
NEA2.2.7	R	D	Sabotage
NEA2.2.8	R	3.1	Repository flooding during operation
NEA2.2.9	R		Abandonment of unsealed repository
NEA2.2.10	R		Poor closure
NEA2.2.11	R	3.1	Post-closure monitoring
NEA2.2.12	R		Effects of phased operation
NEA3.1.1	BR		Differential elastic response
NEA3.1.2	BR		Non-elastic response
NEA3.1.3	R		Host rock fracture aperture changes
NEA3.1.4	BFF		Induced hydrological changes (fluid pressure, density convection, viscosity)
NEA3.1.5	BR		Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
NEA3.2.2	R		Interactions of host materials and groundwater with repository material (e.g. concrete carbon)
NEA3.2.3	FF		Interactions of waste and repository materials with host materials (electrochemical, corrosive)

FEPs LIST: FAR-FIELD CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL2.3	HF	2.4	Borehole - well	
AECL2.4	FF		Borehole seal failure/open boreholes	
AECL2.6	FFF		Boreholes - unsealed	SEE AECL2.4
AECL2.7	FF	2.3	Cavitation	
AECL2.9	F		Colloid formation	
AECL2.10	F		Complexation by organics	
AECL2.11	F		Conceptual model - hydrology	
AECL2.12	F	4	Correlation	OF PARAMETER
AECL2.14	HF		Dewatering	
AECL2.15	F		Diffusion	
AECL2.16	FL		Discharge zones	
AECL2.17	F		Dispersion	
AECL2.22	FF	D	Explosion	SEE AECL2.2
AECL2.25	F		Fulvic acid	SEE AECL2.10
AECL2.26	F		Gases and gas transport	
AECL2.27	F		Geothermal gradient effects	
AECL2.30	F		Groundwater - evolution	
AECL2.31	F		Groundwater composition change	
AECL2.32	F		Humic acid	SEE AECL2.10
AECL2.33	F		Hydraulic properties - evolution	
AECL2.39	F		Matrix diffusion	
AECL2.42	F		Methane	IN DEEP GW
AECL2.43	F		Microbes	
AECL2.46	F		Precipitation - dissolution	
AECL2.47	F		Pseudo-colloids	SEE AECL2.9
AECL2.48	F	XXXX	Radioactive decay	SEE AECL1.68
AECL2.49	F	2.2	Radiolysis, radiation damage	SEE AECL1.68
AECL2.50	F		Recharge groundwater	
AECL2.51	F		Rock properties	
AECL2.52	F		Rock properties - undetected features	
AECL2.54	F		Salinity effects on flow	
AECL2.55	F		Saturation	
AECL2.56	F		Shaft seal failure	
AECL2.58	F		Sorption	
AECL2.59	F		Sorption - non-linear	
AECL2.60	F		Speciation	
AECL2.63	F		Turbulence	GW
AECL2.65	F		Unsaturated rock	
AECL2.66	HF		Vault closure (incomplete)	
AECL2.67	FF?		Vault heating effects	
DOE1.2.6.5	F		Gas transport into and through the far-field	
DOE1.4.5	FF	2.3?	Rock creep	
DOE1.5.1.1	FF		Changes in moisture content due to dewatering	
DOE1.5.1.2	FF		Changes in moisture content due to stress relief	
DOE1.5.3	FFF		Groundwater flow (saturated conditions)	
DOE1.6.1	FF		Differential elastic response	
DOE1.6.2	FF		Non-elastic response	
DOE1.6.3.1	FF		Fracture changes: aperture	
DOE1.6.3.2	FF		Fracture changes: length	
DOE1.6.4.1	F		Hydrological changes: Fluid pressure	
DOE1.6.4.2	F		Hydrological changes: Density	
DOE1.6.4.3	F		Hydrological changes: Viscosity	
DOE1.6.5.5	FFF		Chemical changes due to Complex formation	
DOE1.6.5.6	FFF		Chemical changes due to Colloid production	
DOE1.6.5.7	FFF		Chemical changes due to Solubility	
DOE1.6.5.8	FFF		Chemical changes due to Sorption	
DOE1.6.5.9	FFF		Chemical changes due to Species equilibrium	
DOE1.6.6.2	WFFF		Microbial activity	
DOE1.6.6.3	WFFF		Microbiological effects due to Microbial product reactions	

FEPs LIST: FAR-FIELD CATEGORY

DOE2.2.6.1	FF		Repository-induced seismicity
DOE2.2.6.2	FRG		Externally-induced seismicity
DOE2.2.6.3	FG		Natural seismicity
DOE2.3.3.1	FF		Rock property changes: Porosity
DOE2.3.3.2	FF		Rock property changes: Permeability
DOE2.3.3.3	FF		Rock property changes: Microbial pore blocking
DOE2.3.3.4	FF		Rock property changes: Channel formation/closure
DOE2.3.4.1	FF		Groundwater flow: Darcy
DOE2.3.4.2	FF		Groundwater flow: Non-Darcy
DOE2.3.4.3	FF		Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	EFF		Groundwater flow: Fracture
DOE2.3.4.5	EFF		Groundwater flow: Effects of solution channels
DOE2.3.4.6	FF		Inorganic colloid transport: Porous media
DOE2.3.5.1	EFF		Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	EFF		Inorganic colloid transport: Effects of ionic strength
DOE2.3.5.3	F	2.3	Salinity: implications of evaporite deposits/minerals
DOE2.3.6	EFF		Variations in groundwater temperature
DOE2.4.1	EFF		Advection
DOE2.4.2.1	EFF		Bulk diffusion
DOE2.4.2.2	EFF		Matrix diffusion
DOE2.4.3	EFF		Hydrodynamic dispersion
DOE2.4.4.1	EFF		Solubility: effects of pH and Eh
DOE2.4.4.2	EFF		Solubility: effects of ionic strength
DOE2.4.4.3	EFF		Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.5	EFF		Solubility: effects of naturally-occurring colloids
DOE2.4.4.7	FF		Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	EFF		Solubility: Effects of microbial activity
DOE2.4.5.1	EFF		Linear sorption
DOE2.4.5.2	EFF		Non-linear sorption
DOE2.4.5.3	EFF		Reversible sorption
DOE2.4.5.4	EFF		Irreversible sorption
DOE2.4.5.5	EFF		Sorption: Effects of pH and Eh
DOE2.4.5.6	EFF		Sorption: Effects of ionic strength
DOE2.4.5.7	EFF		Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	EFF		Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.10	EFF		Sorption: effects of naturally-occurring colloids
DOE2.4.5.12	FF		Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	EFF		Sorption: effects of microbial activity
DOE2.4.6	FF		Fracture mineralisation
DOE2.4.7.1	EFF		Organic colloid transport in Porous media
DOE2.4.7.2	EFF		Organic colloid transport in Fractured media
DOE2.7.3	EFF		Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	EFF		Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	EFF		Inorganic colloid transport: Porous media
DOE2.4.8.2	EFF		Inorganic colloid transport: Fractured media
DOE2.4.8.3	EFF		Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	EFF		Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	EFF		Transport of radionuclides bound to microbes
DOE2.4.10	EFF		Isotopic dilution
DOE2.4.11.1	EFF		Gas transport: sorption
DOE2.4.11.2	EFF		Gas transport: gas phase
DOE2.4.12	EFF		Gas-induced groundwater transport
DOE2.4.13.2	EFF		Naturally thermally-induced groundwater transport
DOE2.4.14	EFF		Biogeochemical changes
DOE3.3.2.4	FL		Near-surface runoff processes: Macropore flow
DOE3.3.2.5	FL		Near-surface runoff processes: Variable source area response
DOE3.3.3	F		Groundwater recharge
DOE4.1.1.1	EFF		Borehole seal failure
DOE4.1.1.2	EFF		Borehole seal degradation

FEPs LIST: FAR-FIELD CATEGORY

IAEA1.13.1	BRF	Fluid interactions: Groundwater flow
IAEA1.13.2	BRF	Fluid interactions: Dissolution
IAEA1.13.3	BRF	Fluid interactions: Brine pockets
IAEA2.2.1	FF	Inadequate design: Shaft seal failure
IAEA2.2.2	FFL	Inadequate design: Exploration borehole seal failure
IAEA3.1.1	FF	Thermal effects: Differential elastic response
IAEA3.1.2	FF	Thermal effects: Non-elastic response
IAEA3.1.3	BRF	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BRF	Thermal effects: Fluid migration
PGA1.11	FL	Weathering, mineralisation
PGA1.12	F	Groundwater changes
PGA3.7.4	FF	Differing thermal expansion of host rock zones
PGA3.8	FF	Thermal convection
PGA3.12.2	FF	Geochemical changes in host rock
PGA3.13	BRF	Physico-chemical phenomena/effects (eg. colloid formation)
PGA3.14	BRF	Microbiological phenomena/effects
PGA4.1	FF	Direct alterations in hydrogeology
SK4.1.1	BRF	Oxidizing conditions
SK4.1.2	BRF	pH-deviations
SK4.1.3	BRF	Colloids, complexing agents
SK4.1.4	BRF	Sorption
SK4.1.5	FF	Matrix diffusion
SK4.1.6	BRF	Reconcentration
SK4.1.9	BRF	Complexing agents
SK4.2.3	BRF	Extreme channel flow of oxidants and nucleides
SK4.2.5	BRF	Changes of groundwater flow
SK5.1	BRF	Saline (or fresh) groundwater intrusion
SK5.11	FF	Degradation of hole- and shaft seals
SK5.18	BRF	Enhanced groundwater flow
SK5.25	F	Dissolution of fracture fillings/precipitations
SEE SK4.2.5		
SK5.45	FF	Colloid generation and transport
SK5.46	F	Groundwater recharge/discharge
SK6.1	F	Undetected fracture zones
SK6.2	BRF	Gas transport
SK6.3	F	Far field hydrochemistry - acids, oxidants, nitrate
SK6.4	BRF	Dispersion
SK6.5	BRF	Dilution
SK6.6	F	Weathering of flow paths
SEE SK5.25		
SK6.12	F	Undetected discontinuities
SK6.13	FF	Geothermally induced flow
SK7.5	BRF	Isotopic dilution
SNL6.2	FFL	Shaft and Borehole Seal Degradation
SNL6.3	FF	Thermally induced Stress/Fracturing in Host Rock
SNL6.4	FF	Excavation-induced Stress/Fracturing in Host Rock
UKN1.2.9	GF	Fault activation
UKN1.2.12	FG	Undetected features (e.g. faults, fracture networks, shear zones, brecciation, gas pockets)
UKN1.5.3	F	Recharge to groundwater
UKN1.5.4	FL	Groundwater discharge (to surface water, to springs, to soils, to wells, to marine)
UKN1.5.5	F	Groundwater flow (Darcy, non-Darcy, integratlar fracture, channeling and preferential paths)
UKN1.5.6	F	Groundwater conditions (saturated/unsaturated)
UKN1.5.7	BRF	Saline or freshwater intrusion
UKN1.5.8	BRF	Effects at saline-freshwater interface
UKN1.5.9	BRF	Natural thermal effects
UKN1.6.1	BRF	Advection and dispersion
UKN1.6.2	BRF	Diffusion
UKN1.6.3	BRF	Matrix diffusion
UKN1.6.4	BRF	Gas mediated transport
UKN1.6.5	BRF	Multiphase flow and gas driven flow
UKN1.6.6	BRF	Solubility limit
UKN1.6.7	BRF	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BRF	Dissolution, precipitation and crystallisation

FEPs LIST: FAR-FIELD CATEGORY

UKN1.6.9	BRFL		Colloid formation, dissolution and transport
UKN1.6.10	BRFL		Complexing agents
UKN1.6.11	FF		Fracture mineralisation and weathering
UKN1.6.13	BRFL		Mass, isotopic and species dilution
UKN1.6.14	WCBRF		Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBRFL		Chemical transformations
UKN1.7.7	WBRFL		Microbial interactions
UKN2.1.2	RFL		Investigation borehole seal failure and degradation
UKN2.1.3	FF		Shaft or access tunnel seal failure and degradation
UKN2.1.5	FF		Dewatering of host rock
UKN3.1.1	FF		Differential elastic response
UKN3.1.2	FF		Non-elastic response
UKN3.1.3	FF		Host rock fracture aperture changes
UKN3.1.4	FF		Induced hydrological changes (fluid pressure, density convection, viscosity)
UKN3.2.4	FF		Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)
HMIP1.2.6	BRF		Gas transport
HMIP1.5.4	BRF		Saturated groundwater flow
HMIP2.1.9	F		Effects of natural gases
HMIP2.2.1	F		Changes in geometry and driving forces of the flow system
HMIP2.2.2	F		Rock property changes
HMIP2.2.3	F		Groundwater flow
HMIP2.3.1	BRFL		Advection
HMIP2.3.2	BRFL		Diffusion
HMIP2.3.3	BRFL		Hydrodynamic dispersion
HMIP2.3.4	BRFL		Solubility constraints
HMIP2.3.5	BRFL		Sorption including ion-exchange
HMIP2.3.6	BRFL		Changes in sorptive surfaces
HMIP2.3.7	BRFL		Changes in groundwater chemistry and flow direction
HMIP2.3.8	BRFL		Colloid transport
HMIP2.3.9	BRFL		Transport of radionuclides bound to microbes
HMIP2.3.10	BRFL		Transport of active gases
HMIP2.3.11	BRFL		Gas induced groundwater transport
HMIP2.3.12	BRFL		Thermal effects on hydrochemistry
HMIP2.3.13	BRFL		Biogeochemical changes
HMIP5.1.1	RFL		Loss of integrity of borehole seals
NEA1.2.13	FF		Natural gas intrusion
NEA1.5.3	F		Recharge to groundwater
NEA1.5.5	F		Groundwater flow (Darcy, non-Darcy, intergranular fracture, channeling and preferential paths)
NEA1.5.6	F		Groundwater conditions (saturated/unsaturated)
NEA1.5.7	F		Saline or freshwater intrusion
NEA1.5.8	F		Effects at saline-freshwater interface
NEA1.5.9	F		Natural thermal effects
NEA1.6.1	BRFL		Advection and dispersion
NEA1.6.2	BRFL		Diffusion
NEA1.6.3	BRFL		Matrix diffusion
NEA1.6.4	BRFL		Gas mediated transport
NEA1.6.5	BRFL		Multiphase flow and gas-driven flow
NEA1.6.6	BRFL		Solubility limit
NEA1.6.7	BRFL		Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRFL		Dissolution, precipitation, and crystallisation
NEA1.6.9	BRFL		Colloid formation, dissolution, and transport
NEA1.6.10	BRFL		Complexing agents
NEA1.6.11	FF		Fracture mineralisation
NEA1.6.13	BRFL		Mass, isotopic and species dilution
NEA1.6.14	BRFL		Chemical gradients (electrochemical effects and osmosis)
NEA3.1.4	BRF		Induced hydrological changes (fluid pressure, density convection, viscosity)
NEA3.2.3	FF		Interactions of waste and repository materials with host materials (electrochemical, corrosive)
NEA3.2.4	F	2.2	Non-radioactive solute plume in geosphere (effect of redox, pH, and sorption)

FEPs LIST: BIOSPHERE CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.51	L	2.3	Intrusion (animal)	
AECL2.13	HL	2.4	Dams	
AECL2.16	FL		Discharge zones	
AECL3.1	HGL	D	Acid rain	
AECL3.2	GL	2.4	Alkali flats	
AECL3.3	L		Animal grooming and fighting	
AECL3.4	L		Animal soil ingestion	
AECL3.5	L		Animals' diets	
AECL3.6	HL	2.3?	Artificial lake mixing	
AECL3.8	L		Bacteria and microbes (soil)	
AECL3.9	L		Bioconcentration	
AECL3.11	L	3.7	Biological evolution	
AECL3.12	L		Biotoxicity	
AECL3.13	L		Bioturbation of soils and sediments	
AECL3.14	L		Building materials	
AECL3.15	L		Burrowing animals	
AECL3.16	L		Capillary rise in soil	
AECL3.17	L		Carcasses	
AECL3.18	L		Carcinogenic contaminants	
AECL3.19	HL		Charcoal production	
AECL3.20	L		Chemical precipitation	
AECL3.21	L	3.6	Chemical toxicity	SEE 3.21
AECL3.25	L		Colloids	
AECL3.26	L		Convection, turbulence and diffusion (atmospheric)	
AECL3.27	L	4	Correlation	OF PARAMETER
AECL3.28	L		Critical group - agricultural labour	
AECL3.29	L		Critical group - clothing and home furnishings	
AECL3.30	L		Critical group - evolution	
AECL3.31	L		Critical group - house location	
AECL3.32	L		Critical group - individuality	
AECL3.33	L		Critical group - leisure pursuits	
AECL3.34	L		Critical group - pets	
AECL3.35	HL	2.3?	Crop fertilization	
AECL3.36	HL	2.3?	Crop storage	
AECL3.38	L		Deposition (wet and dry)	
AECL3.39	L		Dermal sorption - nuclides other than tritium	
AECL3.40	L	2.1	Dermal sorption - tritium	
AECL3.41	L		Dispersion	
AECL3.46	GL	2.5	Erosion - wind	
AECL3.47	L	2.3?	Fires (agricultural)	
AECL3.48	L	2.3?	Fires (forest and grass)	
AECL3.49	HL		Fish farming	
AECL3.51	GL	2.3	Flood (short-term)	
AECL3.52	L		Flushing of water bodies	
AECL3.54	HL		Game ranching	
AECL3.55	L		Gas leakage into underground living space	
AECL3.57	GL		Greenhouse (food production)	
AECL3.60	HL		Heat storage in lakes or underground	
AECL3.61	HL	2.3?	Herbicides, pesticides, fungicides	
AECL3.62	L		Household dust and fumes	
AECL3.63	L		Houseplants	
AECL3.64	L		Human diet	
AECL3.65	L		Human soil ingestion	
AECL3.66	HL	3.5	Hydroponics	
AECL3.71	L		Ionic exchange in soil	
AECL3.72	L		Irrigation	
AECL3.73	HL	2.4?	Lake infilling	
AECL3.74	L	3.6	Mutagenic contaminants	
AECL3.75	HL		Outdoor spraying of water	

AECL3.76	G	D	Ozone layer failure
AECL3.77	H	2.37	Peat and leaf litter harvesting
AECL3.78	L		Plant root systems
AECL3.79	L		Precipitation (meteoric)
AECL3.80	WL?	XXXX	Radioactive decay
AECL3.81	WL?		Radioxic contaminants
AECL3.82	L		Radon emission
AECL3.83	G	2.4	Rivercourse meander
AECL3.84	L		Runoff
AECL3.85	L	2.37	Saturation
AECL3.86	L		Scavengers and predators
AECL3.87	L	4	Seasons
AECL3.88	L		Sediment resuspension in water bodies
AECL3.89	L		Sedimentation in water bodies
AECL3.90	L	3.5	Sensitization to radiation
AECL3.91	H		Showers and humidifiers
AECL3.92	H		Smoking
AECL3.93	L		Soil
AECL3.94	L		Soil depth
AECL3.95	L		Soil leaching
AECL3.96	L		Soil porewater pH
AECL3.97	L		Soil sorption
AECL3.98	L		Soil type
AECL3.99	H		Space heating
AECL3.100	L		Surface water bodies
AECL3.101	L		Surface water pH
AECL3.102	L		Suspension in air
AECL3.105	G	4	Terrstral surface
AECL3.106	L	2.47	Toxicity of mined rock
AECL3.107	L		Tree sap
AECL3.108	L	4	Uncertainties
AECL3.109	H		Urbanization on the discharge site
AECL3.110	L	2.3	Water leak into underground living space
AECL3.112	H		Water source
AECL3.113	L	2.47	Wetlands
AECL3.114	G		Wind
DOE2.4.1	BFF		Solubility: effects of pH and Eh
DOE2.4.2	BFF		Solubility: effects of ionic strength
DOE2.4.3	BFF		Solubility: effects of naturally-occurring complexing agents
DOE2.4.4	BFF		Solubility: effects of naturally-occurring colloids
DOE2.4.8	BFF		Solubility: Effects of microbial activity
DOE2.4.5.1	BFF		Linear sorption
DOE2.4.5.2	BFF		Non-linear sorption
DOE2.4.5.3	BFF		Reversible sorption
DOE2.4.5.4	BFF		Irreversible sorption
DOE2.4.5.5	BFF		Sorption: Effects of pH and Eh
DOE2.4.5.6	BFF		Sorption: Effects of ionic strength
DOE2.4.5.7	BFF		Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BFF		Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.10	BFF		Sorption: effects of naturally-occurring colloids
DOE2.4.5.13	BFF		Sorption: effects of microbial activity
DOE2.4.7.1	BFF		Organic colloid transport in Porous media
DOE2.4.7.2	BFF		Organic colloid transport in Fractured media
DOE2.4.7.3	BFF		Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BFF		Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BFF		Inorganic colloid transport: Porous media
DOE2.4.8.2	BFF		Inorganic colloid transport: Fractured media
DOE2.4.8.3	BFF		Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BFF		Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	BFF		Transport of radionuclides bound to microbes

SOURCES OF B

SEE AECL1.68

FEPs LIST: BIOSPHERE CATEGORY

DOE2.4.10	BFFL	Isotopic dilution
DOE2.4.11.1	BFFL	Gas transport: solution
DOE2.4.11.2	BFFL	Gas transport: gas phase
DOE2.4.14	FFL	Biogeochemical changes
DOE3.1.1.5	LG	Greenhouse-induced Ecological effects
DOE3.1.2.5	LG	Glacial/interfacial cycling: Ecological effects
DOE3.3.2.1	L	Near-surface runoff processes: Overland flow
DOE3.3.2.2	L	Near-surface runoff processes: Interflow
DOE3.3.2.3	L	Near-surface runoff processes: Return flow
DOE3.3.2.4	FL	Near-surface runoff processes: Macropore flow
DOE3.3.2.5	FL	Near-surface runoff processes: Variable source area response
DOE3.3.4.1	L	Surface flow characteristics (freshwater): Stream/river flow
DOE3.3.4.2	L	Surface flow characteristics (freshwater): Sediment transport
DOE3.3.4.3	L	Surface flow characteristics (freshwater): Meander migration or other fluvial res
DOE3.3.4.4	L	Surface flow characteristics (freshwater): Lake formation/sedimentation
DOE3.3.4.5	L	Surface flow characteristics (freshwater): Effects of sea level change
DOE3.3.5.1	L	Surface flow characteristics (estuarine): Tidal cycling
DOE3.3.5.2	L	Surface flow characteristics (estuarine): Sediment transport
DOE3.3.5.3	L	Surface flow characteristics (estuarine): Successional development
DOE3.3.5.4	L	Surface flow characteristics (estuarine): Effects of sea level change
DOE3.3.6.1	L	Coastal waters: Tidal mixing
DOE3.3.6.2	L	Coastal waters: Residual current mixing
DOE3.3.6.3	L	Coastal waters: Effects of sea level change
DOE3.3.7.1	L	Ocean waters: Water exchange
DOE3.3.7.2	L	Ocean waters: Effects of sea level change
DOE3.4.1.1	L	Terrestrial ecological development: Agricultural systems
DOE3.4.1.2	L	Terrestrial ecological development: Semi-natural systems
DOE3.4.1.3	L	Terrestrial ecological development: Natural systems
DOE3.4.1.4	L	Terrestrial ecological development: Effects of succession
DOE3.4.2	L	Terrestrial ecological development: Estuarine
DOE3.4.3	L	Coastal waters
DOE3.4.4	L	Oceans
DOE3.5.2.1	L	Groundwater discharge to soils: Advective
DOE3.5.2.2	L	Groundwater discharge to soils: Diffusive
DOE3.5.2.3	L	Groundwater discharge to soils: Biotic
DOE3.5.2.4	L	Groundwater discharge to soils: Volatilisation
DOE3.5.3	L	Groundwater discharge to wells or springs
DOE3.5.4	L	Groundwater discharge to freshwaters
DOE3.5.5	L	Groundwater discharge to estuaries
DOE3.5.6	L	Groundwater discharge to coastal waters
DOE3.5.7.1	L	Surface water bodies: Water flow
DOE3.5.7.2	L	Surface water bodies: Suspended sediments
DOE3.5.7.3	L	Surface water bodies: Bottom sediments
DOE3.5.7.4	L	Surface water bodies: Effects on vegetation
DOE3.5.7.5	L	Surface water bodies: Effects of fluvial system development
DOE3.5.8.1	L	Estuaries: Water flow
DOE3.5.8.2	L	Estuaries: Suspended sediments
DOE3.5.8.3	L	Estuaries: Bottom sediments
DOE3.5.8.4	L	Estuaries: Effects of salinity variation
DOE3.5.8.5	L	Estuaries: Effects on vegetation
DOE3.5.8.6	L	Estuaries: Effects of estuarine development
DOE3.5.8.7	L	Estuaries: Effects of sea-level change
DOE3.5.9.1	L	Coastal waters: Water transport
DOE3.5.9.2	L	Coastal waters: Suspended sediment transport
DOE3.5.9.3	L	Coastal waters: Bottom sediment transport
DOE3.5.9.4	L	Coastal waters: Effects of sea level change
DOE3.5.9.5	L	Coastal waters: Effects of estuarine development
DOE3.5.9.6	L	Coastal waters: Effects of coastal erosion
DOE3.5.9.7	L	Coastal waters: Effects of sea-level change
DOE3.5.10.1	L	Plants: Root uptake

FEPs LIST: BIOSPHERE CATEGORY

DOE3.5.10.2	L		Plants: Deposition on surfaces	
DOE3.5.10.3	L		Plants: Vapour uptake	
DOE3.5.10.4	L		Plants: Internal translocation and retention	
DOE3.5.10.5	L		Plants: Washoff and leaching by rainfall	
DOE3.5.10.6	L		Plants: Leaf-fall and senescence	
DOE3.5.10.7	L		Plants: Cycling processes	
DOE3.5.11.1	L		Animals: Uptake by ingestion	
DOE3.5.11.2	L		Animals: Uptake by inhalation	
DOE3.5.11.3	L		Animals: Internal translocation and retention	
DOE3.5.11.4	L		Animals: Cycling processes	
DOE3.5.11.5	L		Animals: Effects of relocation and migration	
DOE3.6.1.1	L		External exposure: Land	
DOE3.6.1.2	L		External exposure: Sediments	
DOE3.6.1.3	L		External exposure: Water bodies	
DOE3.6.2.1	L		Ingestion and Drinking water	
DOE3.6.2.2	L		Ingestion and Agricultural crops	
DOE3.6.2.3	L		Ingestion and Domestic animal products	
DOE3.6.2.4	L		Ingestion and Wild plants	
DOE3.6.2.5	L		Ingestion and Wild animals	
DOE3.6.2.6	L		Ingestion and Soils and sediments	
DOE3.6.3.1	L		Inhalation and Soils and sediments	
DOE3.6.3.2	L		Inhalation and Gases and vapours (indoor)	
DOE3.6.3.3	L		Inhalation and Gases and vapours (outdoor)	
DOE3.6.3.4	L		Inhalation and Biotic material	
DOE3.6.3.5	L		Inhalation and Salt particles	
DOE4.1.1.1	RFL		Borehole seal failure	
DOE4.1.1.2	RFL		Borehole seal degradation	
IAEA1.13.2	BRFL		Fluid interactions: Dissolution	
IAEA2.2.2	RFL		Inadequate design: Exploration borehole seal failure	
PGA1.11	FL		Weathering, mineralisation	
PGA3.13	BRFL		Physico-chemical phenomena/effects (eg. colloid formation)	
PGA3.14	BRFL		Microbiological phenomena/effects	
SKI4.1.1	BRFL		Oxidizing conditions	
SKI4.1.2	BRFL		pH-deviations	
SKI4.1.3	BRFL	XXXX	Colloids, complexing agents	SEE SKI5.45
SKI4.1.4	BRFL		Sorption	
SKI4.1.6	BRFL		Reconcentration	
SKI4.1.9	BRFL		Complexing agents	ALSO SKI4.1.3
SKI5.41	HL		Water producing well	
SKI6.4	BRFL		Dispersion	
SKI6.5	BRFL		Dilution	
SKI6.9	L	2.4	River meandering	
SKI7.1	L		Accumulation in sediments	
SKI7.2	L		Accumulation in peat	
SKI7.3	HL		Intrusion in accumulation zone in the biosphere	
SKI7.5	RFL		Isotopic dilution	
SNL6.2	RFL		Shaft and Borehole Seal Degradation	
UKN1.3.1	GL		Precipitation, temperature and soil water balance	
UKN1.5.4	FL		Groundwater discharge (to surface water, to springs, to soils, to wells, to marine)	
UKN1.6.1	BRFL		Advection and dispersion	
UKN1.6.2	BRFL		Diffusion	
UKN1.6.3	BRFL		Matrix diffusion	
UKN1.6.4	BRFL		Gas mediated transport	
UKN1.6.5	BRFL		Multiphase flow and gas driven flow	
UKN1.6.6	BRFL		Solubility limit	
UKN1.6.7	BRFL		Sorption (linear/non-linear, reversible/irreversible)	
UKN1.6.8	BRFL		Dissolution, precipitation and crystallisation	
UKN1.6.9	BRFL		Colloid formation, dissolution and transport	
UKN1.6.10	BRFL		Complexing agents	
UKN1.6.12	L		Accumulation in soils and organic debris	
UKN1.6.13	BRFL		Mass, isotopic and species dilution	
UKN1.7.1	L		Plant uptake	
UKN1.7.2	L		Animal uptake	
UKN1.7.3	L		Uptake by deep rooting species	
UKN1.7.4	L		Soil and sediment bioturbation	
UKN1.7.5	L		Pedogenesis	
UKN1.7.6	WBRFL		Chemical transformations	
UKN1.7.7	WBRFL		Microbial interactions	
UKN1.7.8	L	2.3?	Ecological change, eg. forest fire cycles	
UKN1.7.9	L	2.5	Ecological response to climate, eg. desert formation	

FEPs LIST: BIOSPHERE CATEGORY

UKN1.7.10	L	3.7	Plant and animal evolution
UKN2.1.2	FFL		Investigation borehole seal failure and degradation
UKN2.4.5	L		Altered soil or surface water chemistry
HMIP2.3.1	BFFL		Advection
HMIP2.3.2	BFFL		Diffusion
HMIP2.3.3	BFFL		Hydrodynamic dispersion
HMIP2.3.4	BFFL		Solubility constraints
HMIP2.3.5	BFFL		Sorption including ion-exchange
HMIP2.3.6	BFFL		Changes in sorptive surfaces
HMIP2.3.7	BFFL		Changes in groundwater chemistry and flow direction
HMIP2.3.8	BFFL		Colloid transport
HMIP2.3.9	BFFL		Transport of radionuclides bound to microbes
HMIP2.3.10	BFFL		Transport of active gases
HMIP2.3.11	BFFL		Gas induced groundwater transport
HMIP2.3.12	BFFL		Thermal effects on hydrochemistry
HMIP2.3.13	BFFL		Biogeochemical changes
HMIP4.1.1	L		Groundwater discharge to soils and surface waters
HMIP4.1.2	L	2.3	Solid discharge via erosional processes
HMIP4.1.3	L		Gas discharge
HMIP4.2.1	L		Soil moisture and evaporation
HMIP4.2.2	L		Surface water mixing
HMIP4.2.3	L		Sediment transport including bioturbation
HMIP4.2.4	L		Sediment/water/gas interaction with the atmosphere
HMIP4.2.5	L		Bioaccumulation and translocation
HMIP4.2.6	L		Biogeochemical processes
HMIP4.3.1	L		Terrestrial water use
HMIP4.3.2	L		Estuarine water use
HMIP4.3.3	L		Coastal waters and water use
HMIP4.3.4	L		Seas and water use
HMIP4.4.1	L		External exposure
HMIP4.4.2	L		Ingestion
HMIP4.4.3	L		Inhalation
HMIP5.1.1	FFL		Loss of integrity of borehole seals
NEA1.5.1	GL		River flow and lake level changes
NEA1.5.4	L		Groundwater discharge (to surface water, springs, soils, wells, and marine)
NEA1.6.1	BFFL		Advection and dispersion
NEA1.6.2	BFFL		Diffusion
NEA1.6.3	BFFL		Matrix diffusion
NEA1.6.4	BFFL		Gas mediated transport
NEA1.6.5	BFFL		Multiphase flow and gas-driven flow
NEA1.6.6	BFFL		Solubility limit
NEA1.6.7	BFFL		Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BFFL		Dissolution, precipitation, and crystallisation
NEA1.6.9	BFFL		Colloid formation, dissolution, and transport
NEA1.6.10	BFFL		Complexing agents
NEA1.6.12	L		Accumulation in soils and organic debris
NEA1.6.13	BFFL		Mass, isotopic and species dilution
NEA1.6.14	BFFL		Chemical gradients (electrochemical effects and osmosis)
NEA1.7.1	L		Plant uptake
NEA1.7.2	L		Animal uptake
NEA1.7.3	L		Uptake by deep rooting species
NEA1.7.4	L		Soil and sediment bioturbation
NEA1.7.5	L		Pedogenesis
NEA1.7.6	L		Chemical transformations
NEA1.7.7	L		Microbial interactions
NEA1.7.8	L		Ecological change (e.g. forest fire cycles)
NEA1.7.9	L		Ecological response to climate (e.g. desert formation)
NEA1.7.10	L		Plant and animal evolution
NEA2.4.5	HL		Altered soil or surface water chemistry
NEA2.4.6	HL		Land use changes
NEA2.4.7	HL		Agricultural and fisheries practice changes
NEA2.4.8	HL		Demographic change, urban development

FEPs LIST: GEOLOGIC/CLIMATIC CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.14	G		Climate change	
AECL1.31	G		Earthquakes	
AECL1.41	G		Glaciation	
AECL1.42	G	4	Global effects	
AECL2.8	G		Climate change	
AECL2.18	G	2.5	Drought	SEE AECL2.8
AECL2.20	G		Earthquakes	
AECL2.21	G		Erosion	
AECL2.23	G		Faulting	SEE AECL2.20
AECL2.24	G	2.5	Flood	SEE AECL2.8
AECL2.28	G		Glaciation	
AECL2.29	G		Greenhouse effect	SEE AECL2.8
AECL2.34	G	2.5	Intrusion (magmatic)	SEE AECL2.40
AECL2.36	G		Isostatic rebound	SEE AECL2.29
AECL2.37	G	2.5	Magmatic activity	SEE AECL2.68
AECL2.38	G		Magnetic poles	SEE AECL2.8
AECL2.40	G		Metamorphic activity	
AECL2.41	G	D	Meteorite	
AECL2.45	G	D	Ozone layer	SEE AECL2.8
AECL2.61	G		Topography - current	
AECL2.62	G		Topography - future	
AECL2.68	G	2.5	Vulcanism	
AECL3.1	HGL	D	Acid rain	
AECL3.2	GL	2.4	Alkali flats	
AECL3.22	G		Climate	
AECL3.23	G		Climate - evolution	
AECL3.24	HG	D	Collisions, explosions, impacts	
AECL3.42	G	2.5	Dust storms and desertification (massive)	
AECL3.44	G		Earthquakes	
AECL3.45	G		Erosion - lateral transport	
AECL3.46	GL	2.5	Erosion - wind	
AECL3.50	G		Flipping of earth's magnetic poles	
AECL3.51	GL	2.3	Flood (short-term)	
AECL3.56	G		Glaciation	
AECL3.57	GL		Greenhouse (food production)	
AECL3.58	G		Greenhouse effect	
AECL3.59	G		Groundshine, treeshine	
AECL3.76	GL	D	Ozone layer failure	
AECL3.83	GL	2.4	Rivercourse meander	
AECL3.105	GL	4	Terrestrial surface	
AECL3.114	GL		Wind	
DOE1.4.4.2	G	2.3	Natural subsidence	
DOE1.4.6	G		Fracturing	
DOE2.1.1	G	D	Meteorite impact	
DOE2.2.1.1	G		Uplift	
DOE2.2.1.2	G		Subsidence	
DOE2.2.1.3	G		Lateral and/or vertical flexure	
DOE2.2.2.1	G	2.5	Magmatic: Intrusive	
DOE2.2.2.2	G	2.5	Magmatic: Extrusive	
DOE2.2.2.3	G	2.5	Magmatic: Hydrothermal	
DOE2.2.3.1	G		Contact metamorphism	
DOE2.2.3.2	G		Regional metamorphism	
DOE2.2.3.3	G		Dislocation metamorphism	
DOE2.2.4	G	2.3?	Diagenesis	
DOE2.2.5	G	2.3	Diapirism	
DOE2.2.6.2	FG		Externally-induced seismicity	
DOE2.2.6.3	FG		Natural seismicity	
DOE2.2.7.1	G		Faulting/fracturing: Activation	
DOE2.2.7.2	G		Faulting/fracturing: Generation	
DOE2.2.7.3	G		Faulting/fracturing: Change of properties	
DOE2.2.8	G		Major incision	
DOE2.2.9	G		Weathering	
DOE2.2.10	G		Effects of natural gases	
DOE2.2.11	G		Geothermal effects	
DOE2.3.1	G		Variation in groundwater recharge	
DOE2.3.2	G		Groundwater losses (direct evaporation, springflow)	
DOE3.1.1.1	G		Greenhouse-induced Precipitation	
DOE3.1.1.2	G		Greenhouse-induced Temperature	
DOE3.1.1.3	G		Greenhouse-induced Sea level rise	

FEPs LIST: GEOLOGIC/CLIMATIC CATEGORY

DOE3.1.1.4	G	2.4?	Greenhouse-induced Storm surges
DOE3.1.1.5	LG		Greenhouse-induced Ecological effects
DOE3.1.1.6	G		Greenhouse-induced Potential evaporation
DOE3.1.2.1	G		Glacial/interglacial cycling: Precipitation
DOE3.1.2.2	G		Glacial/interglacial cycling: Temperature
DOE3.1.2.3	G		Glacial/interglacial cycling: Sea level changes (rise/fall)
DOE3.1.2.4	G	2.4	Glacial/interglacial cycling: Storm surges
DOE3.1.2.5	LG		Glacial/interglacial cycling: Ecological effects
DOE3.1.2.6	G		Glacial/interglacial cycling: Seasonally frozen ground
DOE3.1.2.7	G		Glacial/interglacial cycling: Permanently frozen ground
DOE3.1.2.8	G		Glacial/interglacial cycling: Glaciation
DOE3.1.2.9	G		Glacial/interglacial cycling: Deglaciation
DOE3.1.2.10	G		Glacial/interglacial cycling: Potential evaporation
DOE3.1.3.1	G		Glacial/interglacial ext. greenhouse gas induced
DOE3.1.3.2	G		Glacial/interglacial ext due to other causes
DOE3.2.1.1	G	2.5	Generalised denudation: Fluvial
DOE3.2.1.2	G	2.5	Generalised denudation: Aeolian
DOE3.2.1.3	G		Generalised denudation: Glacial
DOE3.2.2.1	G	2.5	Localised denudation: Fluvial (valley incision)
DOE3.2.2.2	G	2.5	Localised denudation: Fluvial (weathering/mass movement)
DOE3.2.2.3	G		Localised denudation: Glacial
DOE3.2.2.4	G	2.5	Localised denudation: Coastal
DOE3.2.3.1	G	2.5	Sediment redistribution: Fluvial
DOE3.2.3.2	G	2.5	Sediment redistribution: Aeolian
DOE3.2.3.3	G		Sediment redistribution: Glacial
DOE3.2.4.1	G	2.4	River incision/sedimentation due to sea-level change
DOE3.2.4.2	G		Coastal erosion due to sea-level change
DOE3.3.1	G		Soil moisture and evaporation due to sea-level change
DOE3.5.1.1	G	2.5	Erosion: Fluvial
DOE3.5.1.2	G	2.5	Erosion: Aeolian
DOE3.5.1.3	G		Erosion: Glacial
DOE3.5.1.4	G	2.5	Erosion: Coastal
DOE4.1.3.1	G		Subsidence and fault/fracture induction
IAEA1.1	G		Climatic change
IAEA1.2	G		Hydrological change
IAEA1.3	G		Sea level change
IAEA1.4	G		Denudation
IAEA1.5	G		Stream erosion
IAEA1.6	G		Glacial erosion
IAEA1.7	G		Flooding
IAEA1.8	G		Sedimentation
IAEA1.9	G	2.3?	Diagenesis
IAEA1.10	G	2.3	Diapirism
IAEA1.11	G		Faulting/seismicity
IAEA1.12	G		Geochemical change
IAEA1.14.1	G		Uplift/Subsidence: Orogenic
IAEA1.14.2	G		Uplift/Subsidence: Epeirogenic
IAEA1.14.3	G		Uplift/Subsidence: Isostatic
IAEA1.15.1	G		Undetected features: Faults, shear zones
IAEA1.15.2	G		Undetected features: Breccia pipes
IAEA1.15.3	G		Undetected features: Lava tubes
IAEA1.15.4	G		Undetected features: Intrusive dykes
IAEA1.15.5	G		Undetected features: Gas or brine pockets
IAEA1.16.1	G	2.5	Magmatic activity: Extrusive
IAEA1.17	G	D	Meteorite impact
IAEA2.5	G		Climatic change (including climate control)
IAEA2.6	G		Large-scale hydrological change

FEPs LIST: GEOLOGIC/CLIMATIC CATEGORY

PGA1.1	G		Climate changes	
PGA1.2	G		Sea-level changes	
PGA1.3	G		Erosion (fluvial and glacial)	GLACIAL
PGA1.4	G		Sedimentation	
PGA1.5	G	2.5	Tectonic crustal movements	
PGA1.6	G	2.5	Magma intrusion	
PGA1.7	G	2.5	Volcanism	
PGA1.8	G	2.3	Diapirism	
PGA1.9	G	2.3?	Diagenesis	
PGA1.10	G		Metamorphosis	
PGA2.1	G		Earthquakes	
PGA2.2	G	2.5	Volcanic eruption	
PGA2.3	G	D	Meteor impact	
PGA2.4	G	2.4	Flooding with extreme erosion	
PGA2.5	G	2.3	Hurricane, storms	
PGA2.6	G		Movements at faults	
PGA2.7	G		Formation of new faults	
SK14.2.6	G		Faulting	
SK15.13	G	2.5	Volcanism	
SK15.15	G		Earthquakes	
SK15.16	G		Uplift and subsidence	
SK15.17	G		Permafrost	
SK15.19	G	2.5	Effect of plate movements	
SK15.20	G		Changes of the magnetic field	
SK15.22	GR		Accumulation of gases under permafrost	
SK15.26	G		Erosion on surface/sediments	
SK15.29	G	D	Meteorite	
SK15.31	G		Change in sealevel	
SK15.32	G	2.5	Desert and unsaturation	
SK15.42	G		Glaciation	
SK15.43	GR		Methane intrusion	SEE SK15.22
SK16.10	G		No ice age	
SK16.11	G	2.5	Intruding dykes	
SK16.14	G	2.5	Tectonic activity - large scale	
SK17.10	G	2.3?	Diagenesis	
SNL1.1	G	D	Meteorite impact	
SNL2.1	G		Erosion/Sedimentation	
SNL2.2	G		Glaciation	
SNL2.3	G		Pluvial Periods	
SNL2.4	G		Sea-Level Variations	
SNL2.5	G	2.3	Hurricanes	
SNL2.6	G	??	Seiches	
SNL2.7	G		Tsunamis	
SNL2.8	G		Regional Subsidence or Uplift (also applies to subsurface)	
SNL2.9	G	2.3?	Mass Wasting	
SNL2.10	G	2.3?	Flooding	
SNL3.1	G	2.3	Diapirism	
SNL3.2	G		Seismic Activity	
SNL3.3	G	2.5	Volcanic Activity	
SNL3.4	G	2.5	Magmatic Activity	
SNL3.5	G	2.3	Formation of Dissolution Cavities	
SNL3.6	G		Formation of Interconnected Fracture Systems	
SNL3.7	G		Faulting	
UKN1.1.1	G	D	Meteorite impact	
UKN1.1.2	G		Solar insolation	
UKN1.2.1	G	2.5	Plate movement/tectonic change	
UKN1.2.2	G		Changes in the Earth's magnetic field	
UKN1.2.3	G	2.5	Magmatic activity (intrusive, extrusive)	
UKN1.2.4	G		Metamorphic activity	
UKN1.2.5	G	2.3?	Diagenesis	
UKN1.2.6	G		Uplift and subsidence (e.g. orogenic, isostatic)	
UKN1.2.7	G	2.3	Diapirism	
UKN1.2.8	G		Seismicity	

FEPs LIST: GEOLOGIC/CLIMATIC CATEGORY

UKN1.2.9	GF		Fault activation
UKN1.2.10	G		Fault generation
UKN1.2.11	G		Rock heterogeneity (e.g. permeability, mineralogy) affecting water and gas flow
UKN1.2.12	FG		Undetected features (e.g. faults, fracture networks, shear zones, brecciation, gas pockets)
UKN1.3.1	GL		Precipitation, temperature and soil water balance
UKN1.3.2	G		Extremes of precipitation, snow melt and associated flooding
UKN1.3.3	G	2.3	Coastal surge, storms and hurricanes
UKN1.3.4	G		Sea-level rise/fall
UKN1.3.5	G		Periglacial effects (eg. permafrost, high seasonality)
UKN1.3.6	G		Glaciation (erosion/deposition, glacial loading, hydrogeological change)
UKN1.3.7	G		No ice age
UKN1.4.1	G		Land slide
UKN1.4.2	G	2.4	Denudation (aeolian and fluvial)
UKN1.4.3	G	2.4	River, stream, channel erosion (downcutting)
UKN1.4.4	G	2.4	River meander
UKN1.4.5	G		Freshwater sediment transport and deposition
UKN1.4.6	G		Coastal erosion and estuarine development
UKN1.4.7	G		Marine sediment transport and deposition
UKN1.4.8	G		Frost weathering and solifluction
UKN1.4.9	G		Chemical denudation and weathering
UKN1.4.10	G		Frost weathering
UKN1.5.1	G		River flow and lake level changes
UKN2.4.9	FG		Anthropogenic climate change (greenhouse effect)
HMIP2.1.1	G	2.5	Regional tectonic
HMIP2.1.2	G	2.4	Magmatic activity
HMIP2.1.3	G		Metamorphism
HMIP2.1.4	G	2.3?	Diagenesis
HMIP2.1.5	G	2.3	Diapirism
HMIP2.1.6	G		Seismicity
HMIP2.1.7	G		Faulting/fracturing
HMIP2.1.8	G		Major incision
HMIP2.4.1	G		Generalised denudation
HMIP2.4.2	G		Localised denudation
HMIP3.1.1	FG		Human induced climate change
HMIP3.1.2	G		Natural climate change
HMIP3.1.3	G		Exit from glacial/interglacial cycling
HMIP3.1.4	G		Intensification of natural climate change
HMIP5.2.1	G	D	Meteorite impact
NEA1.1.1	G	D	Meteorite impact
NEA1.1.2	G		Solar insolation
NEA1.2.1	G	2.5	Plate movement/tectonic change
NEA1.2.2	G		Changes in the Earth's magnetic field
NEA1.2.3	G	2.5	Magmatic activity (intrusive, extrusive)
NEA1.2.4	G		Metamorphic activity
NEA1.2.5	G	2.3	Diagenesis
NEA1.2.6	G		Uplift and subsidence (orogenic, isostatic)
NEA1.2.7	G	2.3	Diapirism
NEA1.2.8	G		Seismicity
NEA1.2.9	G		Fault activation
NEA1.2.10	G		Fault generation
NEA1.2.11	G		Rock heterogeneity (permeability, mineralogy), affecting water and gas flow
NEA1.2.12	G		Undetected features (faults, fracture networks, shear zones, brecciation, gas pockets)
NEA1.3.1	G		Precipitation, temperature, and soil water balance
NEA1.3.2	G		Extremes of precipitation, snow melt and associated flooding
NEA1.3.3	G	2.3	Coastal surge, storms, and hurricanes
NEA1.3.4	G		Sea-level rise/fall
NEA1.3.5	G		Periglacial effects (permafrost, high seasonality)
NEA1.3.6	G		Glaciation (erosion/deposition, glacial loading, hydrogeological change)
NEA1.3.7	G		No ice age
NEA1.4.1	G		Land slide
NEA1.4.2	G	2.4	Denudation (aeolian and fluvial)
NEA1.4.3	G	2.4	River, stream, channel erosion (downcutting)
NEA1.4.4	G	2.4	River meander
NEA1.4.6	G	2.4?	Freshwater sediment transport and deposition
NEA1.4.7	G	2.4?	Marine sediment transport and deposition
NEA1.4.8	G	XXXX	River meander (REPEAT! - SEE 1.4.4)
NEA1.4.9	G		Chemical denudation and weathering
NEA1.4.10	G		Frost weathering
NEA1.5.1	GL		River flow and lake level changes
NEA1.5.2	G	3.1	Site flooding
NEA2.4.9	FG		Anthropogenic climate change (greenhouse effect)

FEPs LIST: HUMAN FACTORS CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.52	H		Intrusion (human)	
AECL1.73	H	D	Sabotage and improper operation	
AECL2.1	HR	3.1	Blasting and vibration	
AECL2.2	H	D	Bomb blast	
AECL2.3	HF	2.4	Borehole - well	
AECL2.5	H		Boreholes - exploration	
AECL2.6	HFF		Boreholes - unsealed	SEE AECL2.4
AECL2.13	HL	2.4	Dams	
AECL2.14	HF		Dewatering	
AECL2.19	H		Earthmoving	MAJOR PROJECT
AECL2.22	PH	D	Explosion	SEE AECL2.2
AECL2.35	H	2.3	Intrusion (mines)	
AECL2.44	H	2.3	Mines	SEE AECL2.35
AECL2.53	H	D	Sabotage	
AECL2.57	H	2.3	Solution mining	
AECL2.66	HF		Vault closure (incomplete)	
AECL2.69	H		Wells	
AECL2.70	H		Wells (high demand)	
AECL3.1	HGL	D	Acid rain	
AECL3.5	HL	2.3?	Artificial lake mixing	
AECL3.7	H	2.3?	Ashes and sewage sludge	
AECL3.10	H	2.4	Biogas production	
AECL3.19	HL		Charcoal production	
AECL3.24	HG	D	Collisions, explosions, impacts	
AECL3.35	HL	2.3?	Crop fertilization	
AECL3.36	HL	2.3?	Crop storage	
AECL3.37	H	3.7	Cure for cancer	
AECL3.43	H	2.4?	Earthmoving projects (major)	SEE 3.43
AECL3.49	HL		Fish farming	
AECL3.53	H		Food preparation	
AECL3.54	HL		Game ranching	
AECL3.60	HL		Heat storage in lakes or underground	
AECL3.61	HL	2.3?	Herbicides, pesticides, fungicides	
AECL3.66	HL	3.5	Hydroponics	
AECL3.67	H		Industrial use of water	
AECL3.68	H	2.3?	Inject/ingest/inhaling locally produced drugs	
AECL3.69	H	3.4	Intrusion (deliberate)	
AECL3.70	H		Intrusion (inadvertent)	
AECL3.73	HL	2.4?	Lake infilling	
AECL3.75	HL		Outdoor spraying of water	
AECL3.77	HL	2.3?	Peat and leaf litter harvesting	
AECL3.91	HL		Showers and humidifiers	
AECL3.92	HL		Smoking	
AECL3.99	HL		Space heating	SOURCES OF B
AECL3.103	H	3.5	Technological advances in food production	
AECL3.109	HL		Urbanization on the discharge site	
AECL3.111	H	2.4	Water management projects (major)	
AECL3.112	HL		Water source	
DOE4.2.1	H	3.4	Deliberate recovery of wastes or associated materials	
DOE4.2.2	H	3.4	Malicious intrusion	
DOE4.2.3	H		Exploratory drilling	
DOE4.2.4	H	2.3?	Exploitation drilling	
DOE4.2.5	H		Geothermal energy production	
DOE4.2.6	H	2.3?	Resource mining	
DOE4.2.7	H		Tunnelling	
DOE4.2.8	H		Construction of underground storage/disposal facilities	
DOE4.2.9	H		Construction of underground dwellings/shelters	
DOE4.2.10	H		Archaeological investigations	
DOE4.2.11	H		Injection of liquid wastes	
DOE4.2.12	H		Groundwater abstraction	
DOE4.2.13	H	D	Underground weapons testing	

FEPs LIST: HUMAN FACTORS CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
IAEA2.1.1	H		Undetected past intrusion: Boreholes	
IAEA2.1.2	H		Undetected past intrusion: Mine shafts	
IAEA2.4.1	H		Transport agent introduction: Irrigation	
IAEA2.4.2	H		Transport agent introduction: Reservoirs	
IAEA2.4.3	H		Transport agent introduction: Intentional artificial groundwater Recharge or withdrawal	
IAEA2.4.4	H		Transport agent introduction: Chemical liquid waste disposal	
IAEA2.7.1	H	D	Intentional intrusion: War	
IAEA2.7.2	H	D	Intentional intrusion: Sabotage	
IAEA2.7.3	H	D	Intentional intrusion: Waste recovery	
IAEA2.8.1	H		Inadvertent future intrusion: Exploratory drilling	
IAEA2.8.2	H		Inadvertent future intrusion: Archaeological exhumation	
IAEA2.8.3	H		Inadvertent future intrusion: Resource mining (mineral, water, hydrocarbon, geothermal, salt)	
PGA4.2	H		Injection of liquid waste	
PGA4.3.1	H	2.4	Drilling: in sediments	
PGA4.3.2	H		Drilling: in host rock	
PGA4.4	H		Geothermal energy production in crystalline rock	
SKI1.4	WH	D	Sudden energy release	
SKI3.2.11	BH	3.1	Backfill material deficiencies	
SKI5.2	H		Non-sealed repository	
SKI5.3	H		Stray materials left	
SKI5.4	H		Decontamination materials left	
SKI5.5	H	D	Chemical sabotage	
SKI5.7	H	3.1?	Poorly designed repository	
SKI5.8	H	3.1?	Poorly constructed repository	
SKI5.9	H		Unsealed boreholes and/or shafts	
SKI5.10	H	3.1	Accidents during operation	
SKI5.12	H	3.1	Near storage of other waste	
SKI5.21	H		Future boreholes and undetected past boreholes	
SKI5.27	H		Human induced actions on groundwater recharge	
SKI5.28	H		Underground dwellings	
SKI5.30	H	D	Underground test of nuclear devices	
SKI5.33	H	3.4?	Waste retrieval, mining	
SKI5.34	H		Geothermal energy production	
SKI5.35	H	3.5	Other future uses of crystalline rock	
SKI5.36	H		Reuse of boreholes	
SKI5.37	H		Archaeological intrusion	
SKI5.38	H	D	Explosions	
SKI5.39	H	3.1	Postclosure monitoring	
SKI5.40	H	3.1	Unsuccessful attempt of site improvement	
SKI5.41	HL		Water producing well	
SKI6.7	H	D	Nuclear war	
SKI6.8	H		Human induced climate change	
SKI7.3	HL		Intrusion in accumulation zone in the biosphere	
SKI7.7	H		Human induced changes in surface hydrology	
SKI7.8	H		Altered surface water chemistry by humans	
SKI7.9	H		Loss of records	
SKI7.11	H		City on the site	
SNL4.1	H		Inadvertent Intrusions: Explosions	
SNL4.2	H		Inadvertent Intrusions: Drilling	
SNL4.3	H	2.3	Inadvertent Intrusions: Mining	
SNL4.4	H		Inadvertent Intrusions: Injection Wells	
SNL4.5	H		Inadvertent Intrusions: Withdrawal Wells	
SNL5.1	H		Hydrologic Stresses: Irrigation	
SNL5.2	H		Hydrologic Stresses: Damming of Streams or Rivers	

FEPs LIST: HUMAN FACTORS CATEGORY

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
UKN2.1.1	H		Undetected past intrusions, (eg. boreholes, mining)	
UKN2.1.8	FR	3.1	Poor quality construction	
UKN2.1.9	FR	3.1	Design modification	
UKN2.2.1	H		Radioactive waste disposal error	
UKN2.2.2	FB		Inadequate backfill or compaction, voidage	
UKN2.2.3	WM	3.1	Co-disposal of reactive wastes (deliberate)	
UKN2.2.4	WM	3.1	Inadvertent inclusion of undesirable materials	
UKN2.2.6	H	3.1	Accidents during operation	
UKN2.2.7	H	D	Sabotage	
UKN2.2.9	H		Abandonment of unsealed repository	
UKN2.2.10	PH		Poor closure	
UKN2.2.11	HD	3.1	Post-closure monitoring	
UKN2.2.12	HD		Effects of phased operation	
UKN2.3.1	HD	3.4	Recovery of repository materials	
UKN2.3.2	H	D	Malicious intrusion, e.g. sabotage, act of war	
UKN2.3.3	H		Exploratory drilling	
UKN2.3.4	H	2.3	Exploration drilling	
UKN2.3.5	H		Geothermal energy production	
UKN2.3.6	H	2.3	Resource mining	
UKN2.3.7	H		Tunnelling	
UKN2.3.8	H		Underground construction	
UKN2.3.9	H		Archaeological investigation	
UKN2.3.10	H		Injection of liquid wastes	
UKN2.3.11	H		Groundwater abstraction	
UKN2.3.12	H	D	Underground nuclear testing	
UKN2.4.1	H		Loss of records	
UKN2.4.2	H	2.4	Dams and reservoirs, dewatered	
UKN2.4.3	H	2.4	River rechannelled	
UKN2.4.4	H		Irrigation	
UKN2.4.6	H		Land use changes	
UKN2.4.7	H		Agricultural and fisheries practice changes	
UKN2.4.8	H		Demographic change, urban development	
UKN2.4.9	HB		Anthropogenic climate change (greenhouse effect)	
UKN2.4.10	H	2.3	Quarrying, peat extraction	
HMP3.1.1	HB		Human induced climate change	
HMP3.2.2	H	3.4	Deliberate intrusion	
HMP3.2.3	H	3.4	Malicious intrusion	
HMP3.2.4	H		Accidental intrusion	
NEA2.1.1	H		Undetected past intrusions (boreholes, mining)	
NEA2.1.2	H		Investigation borehole seal failure and degradation	
NEA2.1.3	H		Shaft or access tunnel seal failure and degradation	
NEA2.1.4	H		Stress field changes, settling, subsidence or caving	
NEA2.1.5	H		Dewatering of host rock	
NEA2.1.6	H		Material defects (e.g. early canister failure)	
NEA2.1.7	H		Common cause failures	
NEA2.1.8	H		Poor quality construction	
NEA2.1.9	H	3.1	Design modification	
NEA2.3.1	H	3.1	Recovery of repository materials	
NEA2.3.2	H	3.4	Malicious intrusion (sabotage, act of war)	
NEA2.3.3	H		Exploratory drilling	
NEA2.3.4	H	2.4	Exploration drilling	
NEA2.3.5	H		Geothermal energy production	
NEA2.3.6	H	2.4	Resource mining	
NEA2.3.7	H		Tunnelling	
NEA2.3.8	H		Underground construction	
NEA2.3.9	H		Archaeological investigation	
NEA2.3.10	H		Injection of liquid wastes	
NEA2.3.11	H		Groundwater abstraction	
NEA2.3.12	H	D	Underground nuclear testing	
NEA2.4.1	H		Loss of records	
NEA2.4.2	H	2.4	Dams and reservoirs, built/dewatered	
NEA2.4.3	H	2.4	Rivers rechannelled	
NEA2.4.4	H		Irrigation	
NEA2.4.5	HL		Altered soil or surface water chemistry	
NEA2.4.6	HL		Land use changes	
NEA2.4.7	HL		Agricultural and fisheries practice changes	
NEA2.4.8	HL		Demographic change, urban development	
NEA2.4.9	HB		Anthropogenic climate change (greenhouse effect)	
NEA2.4.10	H	2.3	Quarrying, near surface extraction	

APPENDIX 4
Screened-out FEP Lists

**WASTE CATEGORY
SCREENED OUT FEPs**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL1.5	WB	2.1	Buffer additives
AECL1.39	WC	2.1	Galvanic coupling
AECL1.82	W	2.1	Stability of glass
DOE1.1.4.5	W	2.1	Microbial degradation of organic wastes: wastes
DOE1.2.1.3	W	2.1	Hydrogen: corrosion of waste steel
DOE1.2.1.4	W	2.1	Hydrogen: corrosion of waste Magnox
DOE1.2.1.5	W	2.1	Hydrogen: corrosion of waste aluminium
DOE1.2.1.7	W	2.1	Hydrogen: corrosion of other waste metals
DOE1.2.1.8	WB	2.1	Hydrogen: effects of microbial growth on concrete
DOE1.2.2.1	W	2.1	Methane/CO2: degradation of Cellulosics
DOE1.2.2.2	W	2.1	Methane/CO2: degradation of Other susceptible organic materials
DOE1.2.2.3	W	2.1	Methane/CO2 production: Aerobic degradation
DOE1.2.2.5	W	2.1	Methane/CO2 production: Effects of temperature
DOE1.2.2.6	WR	2.1	Methane/CO2 production: Effects of lithostatic pressure
DOE1.2.2.12	WR	2.1	Methane/CO2 production: Energy and nutrient control of metabolism
DOE1.2.2.13	WR	2.1	Methane/CO2 production: Effects of radiation on microbial populations
DOE1.2.4.1	W	2.1	Tritiated hydrogen
DOE1.2.5	W	2.1	Toxic gases
DOE1.6.6.1	W	2.1	Microbiological effects due to Cellulose degradation
PGA3.7.1	WC	2.1	Differing thermal expansion of glass matrix and canister
UKN3.2.5	W	2.1	Cellulosic degradation
UKN3.2.6	W	2.1	Introduced complexing agents and cellulotics
UKN3.3.6	WC	2.1	Gas effects (pressurization, disruption, explosion, fire)
HMIP1.2.2	W	2.1	Methane and carbon dioxide by microbial degradation
HMIP1.2.3	WB	2.1	Gas generation from concrete
HMIP1.2.7	W	2.1	Flammability
NEA3.2.5	W	2.1	Cellulosic degradation
NEA3.2.6	W	2.1	Introduced complexing agents and cellulotics
DOE1.2.2.4	W	2.1?	Methane/CO2 production: Anaerobic degradation
DOE1.2.2.10	W	2.1?	Methane/CO2 production: Inhibition due to the pressure of toxic materials
DOE1.2.2.8	WB	2.2	Methane/CO2 production: Effects of biofilms
DOE1.2.2.11	WB	2.2	Methane/CO2 production: Carbonate/bicarbonate exchange with concrete
DOE1.2.3	WB	2.2	Gas generation from concrete
SKI1.2.2	WR	2.2	H2/O2 explosions
AECL1.54	W	3.1	Other wastes (other than vitrified HLW)
SKI5.6	W	3.1	Co-storage of other waste
UKN2.2.3	WH	3.1	Co-disposal of reactive wastes (deliberate)
UKN3.4.3	W	3.1	Nuclear criticality
HMIP1.3.2	W	3.1	Nuclear criticality
NEA2.2.3	WR	3.1	Co-disposal of reactive wastes (deliberate)
NEA3.4.3	W	3.1	Nuclear criticality
AECL1.28	W	3.1?	Criticality
DOE1.3.2	W	3.1?	Nuclear criticality
IAEA3.4.4	W	3.1?	Radiological effects: Nuclear criticality
PGA3.3	W	3.1?	Nuclear criticality
SKI1.1.1	W	3.1?	Criticality
AECL3.104	W	3.6	Teratogenic contaminants
SKI7.4	W	3.6	Chemical toxicity of wastes
AECL1.4	WCBR	4	Boundary conditions
AECL1.10	WCBR	4	Chemical interactions (expected)
AECL1.11	WCBR	4	Chemical interactions (long-term)
AECL1.12	WCBR	4	Chemical interactions (other)
AECL1.25	WCBR	4	Correlation
AECL1.50	WCBR	4	Interfaces (boundary conditions)
AECL1.56	WR	4	Long-term transients
AECL1.85	WCBR	4	Time dependence
AECL3.80	WL?	XXX	Radioactive decay
SKI3.1.9	WB	XXX	Radiolysis
SKI1.4	WH?	D	Sudden energy release

**CONTAINER CATEGORY
SCREENED OUT FEPs**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL1.39	WC	2.1	Galvanic coupling
PGA3.7.1	WC	2.1	Differing thermal expansion of glass matrix and canister
UKN3.3.6	WC	2.1	Gas effects (pressurisation, disruption, explosion, fire)
NEA3.3.6	C	2.1	Gas effects (pressurisation, disruption, explosion, fire)
AECL1.45	C	2.1?	Hydride cracking
AECL1.49	C	3.1	Incomplete filling of containers
AECL1.4	WCBR	4	Boundary conditions
AECL1.10	WCBR	4	Chemical interactions (expected)
AECL1.11	WCBR	4	Chemical interactions (long-term)
AECL1.12	WCBR	4	Chemical interactions (other)
AECL1.25	WCBR	4	Correlation
AECL1.50	WCBR	4	Interfaces (boundary conditions)
AECL1.85	WCBR	4	Time dependence
SKI2.3.2	C	XXX	Electro-chemical cracking
SKI5.23	C	XXX	Changed hydrostatic pressure on canister

**BUFFER/BACKFILL CATEGORY
SCREENED OUT FEPs**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL1.5	WB	2.1	Buffer additives
DOE1.2.1.8	WB	2.1	Hydrogen: effects of microbial growth on concrete
DOE1.2.2.9	ER	2.1	Methane/CO2 production: Effects of hydrogen from metal corrosion
HMIPT.2.3	WB	2.1	Gas generation from concrete
AECL1.17	B	2.2	Concrete
DOE1.1.2.1	B	2.2	Cracking: concrete
DOE1.1.2.2	B	2.2	Sealing of cracks: concrete
DOE1.1.2.4	B	2.2	Alkali-aggregate reaction: concrete
DOE1.1.3.2	B	2.2	Exchange capacity exceeded: concrete
DOE1.1.3.3	B	2.2	Alkali-aggregate reaction: concrete
DOE1.1.3.4	B	2.2	Cement-sulphate reaction: concrete
DOE1.2.2.8	WB	2.2	Methane/CO2 production: Effects of biofilms
DOE1.2.2.11	WB	2.2	Methane/CO2 production: Carbonate/bicarbonate exchange with concrete
DOE1.2.3	WB	2.2	Gas generation from concrete
DOE1.5.2.1	ER	2.3	Groundwater flow: initial conditions
SK13.2.11	BF	3.1	Backfill material deficiencies
AECL1.4	WCBR	4	Boundary conditions
AECL1.10	WCBR	4	Chemical interactions (expected)
AECL1.11	WCBR	4	Chemical interactions (long-term)
AECL1.12	WCBR	4	Chemical interactions (other)
AECL1.25	WCBR	4	Correlation
AECL1.50	WCBR	4	Interfaces (boundary conditions)
AECL1.85	WCBR	4	Time dependence
SK13.1.9	B	4	Near field buffer chemistry
AECL1.33	B	XXXX	Evolution of buffer
SK13.1.9	WB	XXXX	Radolysis
SK13.1.12	B	XXXX	Perturbed buffer material chemistry
SK14.1.3	BRFL	XXXX	Colloids, complexing agents
SK15.18	BRF	XXXX	Enhanced groundwater flow

REPOSITORY CATEGORY:
SCREENED OUT FEPs

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL1.57	R	2.1	Methylation
DOE1.2.2.6	WR	2.1	Methane/CO2 production: Effects of lithostatic pressure
DOE1.2.2.9	BR	2.1	Methane/CO2 production: Effects of hydrogen from metal corrosion
DOE1.2.2.12	WR	2.1	Methane/CO2 production: Energy and nutrient control of metabolism
DOE1.2.2.13	WR	2.1	Methane/CO2 production: Effects of radiation on microbial populations
AECL1.16	R	2.1?	Complexation by organics
SKH1.2.2	WR	2.2	H2/O2 explosions
AECL2.7	FF	2.3	Cavitation
DOE1.5.2.1	BR	2.3	Groundwater flow: initial conditions
DOE1.4.5	FF	2.3?	Rock creep
UKN1.5.2	R	2.3?	Site flooding
AECL1.35	R	3.1	Explosions
AECL1.47	R	3.1	Improper operation
AECL1.60	R	3.1	Monitoring and remedial activities
AECL1.64	R	3.1	Pre-closure events
AECL1.72	R	3.1	Retrievability
AECL2.1	HR	3.1	Blasting and vibration
DOE1.2.7.1	R	3.1	Fires
DOE1.2.7.2	R	3.1	Explosions
IAEA2.3	R	3.1	Improper operation: improper waste emplacement
UKN2.1.8	HR	3.1	Poor quality construction
UKN2.1.9	FR	3.1	Design modification
UKN2.2.8	R	3.1	Repository flooding during operation
NEA2.2.3	WR	3.1	Co-disposal of reactive wastes (deliberate)
NEA2.2.6	R	3.1	Accidents during operation
NEA2.2.8	R	3.1	Repository flooding during operation
NEA2.2.11	R	3.1	Post-closure monitoring
AECL1.61	R	3.7	Mutation
AECL1.4	WCBR	4	Boundary conditions
AECL1.10	WCBR	4	Chemical interactions (expected)
AECL1.11	WCBR	4	Chemical interactions (long-term)
AECL1.12	WCBR	4	Chemical interactions (other)
AECL1.25	WCBR	4	Correlation
AECL1.50	WCBR	4	Interfaces (boundary conditions)
AECL1.56	WR	4	Long-term transients
AECL1.85	WCBR	4	Time dependence
SKI4.1.3	SPFL	XXXX	Colloids, complexing agents
SKI4.2.2.2	R	XXXX	Hydraulic conductivity change - Excavation/backfilling effect
SKI4.2.2.3	R	XXXX	Mechanical effects - Excavation/backfilling effects
SKI5.18	BFF	XXXX	Enhanced groundwater flow
SKI5.24	R	XXXX	Stress changes of conductivity
NEA2.2.7	R	D	Sabotage

FAR-FIELD CATEGORY:
SCREENED OUT FEPs

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL2.49	F	2.2	Radiolysis, radiation damage
NEA3.2.4	F	2.2	Non-radioactive solute plume in geosphere (effect of redox, pH, and sorption)
AECL2.7	FF	2.3	Cavitation
DOE2.3.5.3	F	2.3	Salinity: implications of evaporite deposits/minerals
DOE1.4.5	FF	2.3?	Rock creep
AECL2.3	HF	2.4	Borehole - well
AECL2.12	F	4	Correlation
AECL2.48	F	XXXX	Radioactive decay
SKI4.1.3	BFFL	XXXX	Colloids, complexing agents
SKI5.18	BF	XXXX	Enhanced groundwater flow
AECL2.22	FF	D	Explosion

**BIOSPHERE CATEGORY:
SCREENED OUT FEPs**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL3.40	L	2.1	Dermal sorption - tritium
AECL3.6	HL	2.3?	Artificial lake mixing
AECL3.35	HL	2.3?	Crop fertilization
AECL3.36	HL	2.3?	Crop storage
AECL3.47	L	2.3?	Fires (agricultural)
AECL3.48	L	2.3?	Fires (forest and grass)
AECL3.61	HL	2.3?	Herbicides, pesticides, fungicides
AECL3.77	HL	2.3?	Peat and leaf litter harvesting
AECL3.85	L	2.3?	Salination
UKN1.7.8	L	2.3?	Ecological change, eg. forest fire cycles
AECL2.13	HL	2.4	Dams
AECL3.2	GL	2.4	Alkali flats
AECL3.83	GL	2.4	Rivercourse meander
SK16.9	L	2.4	River meandering
AECL3.73	HL	2.4?	Lake infilling
AECL3.106	L	2.4?	Toxicity of mined rock
AECL3.113	L	2.4?	Wetlands
AECL3.46	GL	2.5	Erosion - wind
UKN1.7.9	L	2.5	Ecological response to climate, eg. desert formation
AECL3.66	HL	3.5	Hydroponics
AECL3.90	L	3.5	Sensitization to radiation
AECL3.21	L	3.6	Chemical toxicity
AECL3.74	L	3.6	Mutagenic contaminants
AECL3.11	L	3.7	Biological evolution
UKN1.7.10	L	3.7	Plant and animal evolution
AECL3.27	L	4	Correlation
AECL3.87	L	4	Seasons
AECL3.105	GL	4	Terrestrial surface
AECL3.108	L	4	Uncertainties
AECL3.1	HGL	D	Acid rain
AECL3.76	GL	D	Ozone layer failure
AECL3.80	WL?	XXXX	Radioactive decay
SK14.1.3	BPFL	XXXX	Colloids, complexing agents
AECL1.51	L	2.3	Intrusion (animal)
AECL3.51	GL	2.3	Flood (short-term)
AECL3.110	L	2.3	Water leak into underground living space
HMIP4.1.2	L	2.3	Solid discharge via erosional processes

**GEOLOGY/CLIMATE CATEGORY
SCREENED OUT FEPs LIST**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL3.51	GL	2.3	Flood (short-term)
DOE1.4.4.2	G	2.3	Natural subsidence
DOE2.2.5	G	2.3	Diapirism
IAEA1.10	G	2.3	Diapirism
PGA1.8	G	2.3	Diapirism
PGA2.5	G	2.3	Hurricane, storms
SNL2.5	G	2.3	Hurricanes
SNL3.1	G	2.3	Diapirism
SNL3.5	G	2.3	Formation of Dissolution Cavities
UKN1.2.7	G	2.3	Diapirism
UKN1.3.3	G	2.3	Coastal surge, storms and hurricanes
HMIP2.1.5	G	2.3	Diapirism
NEA1.2.5	G	2.3	Diagenesis
NEA1.2.7	G	2.3	Diapirism
NEA1.3.3	G	2.3	Coastal surge, storms, and hurricanes
DOE2.2.4	G	2.3?	Diagenesis
IAEA1.9	G	2.3?	Diagenesis
PGA1.9	G	2.3?	Diagenesis
SK17.10	G	2.3?	Diagenesis
SNL2.9	G	2.3?	Mass Wasting
SNL2.10	G	2.3?	Flooding
UKN1.2.5	G	2.3?	Diagenesis
HMIP2.1.4	G	2.3?	Diagenesis
AECL3.2	GL	2.4	Alkali flats
AECL3.83	GL	2.4	Rivercourse meander
DOE3.1.2.4	G	2.4	Glacial/interglacial cycling: Storm surges
DOE3.2.4.1	G	2.4	River incision/sedimentation due to sea-level change
PGA2.4	G	2.4	Flooding with extreme erosion
UKN1.4.2	G	2.4	Denudation (aeolian and fluvial)
UKN1.4.3	G	2.4	River, stream, channel erosion (downcutting)
UKN1.4.4	G	2.4	River meander
HMIP2.1.2	G	2.4	Magmatic activity
NEA1.4.2	G	2.4	Denudation (aeolian and fluvial)
NEA1.4.3	G	2.4	River, stream, channel erosion (downcutting)
NEA1.4.4	G	2.4	River meander
DOE3.1.1.4	G	2.4?	Greenhouse-induced Storm surges
NEA1.4.6	G	2.4?	Freshwater sediment transport and deposition
NEA1.4.7	G	2.4?	Marine sediment transport and deposition

**GEOLOGY/CLIMATE CATEGORY
SCREENED OUT FEPs LIST**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL2.18	G	2.5	Drought
AECL2.24	G	2.5	Flood
AECL2.34	G	2.5	Intrusion (magmatic)
AECL2.37	G	2.5	Magmatic activity
AECL2.68	G	2.5	Volcanism
AECL3.42	G	2.5	Dust storms and desertification (massive)
AECL3.46	GL	2.5	Erosion - wind
DOE2.2.2.1	G	2.5	Magmatic: Intrusive
DOE2.2.2.2	G	2.5	Magmatic: Extrusive
DOE2.2.2.3	G	2.5	Magmatic: Hydrothermal
DOE3.2.1.1	G	2.5	Generalised denudation: Fluvial
DOE3.2.1.2	G	2.5	Generalised denudation: Aeolian
DOE3.2.2.1	G	2.5	Localised denudation: Fluvial (valley incision)
DOE3.2.2.2	G	2.5	Localised denudation: Fluvial (weathering/mass movement)
DOE3.2.2.4	G	2.5	Localised denudation: Coastal
DOE3.2.3.1	G	2.5	Sediment redistribution: Fluvial
DOE3.2.3.2	G	2.5	Sediment redistribution: Aeolian
DOE3.5.1.1	G	2.5	Erosion: Fluvial
DOE3.5.1.2	G	2.5	Erosion: Aeolian
DOE3.5.1.4	G	2.5	Erosion: Coastal
IAEA1.16.1	G	2.5	Magmatic activity: Extrusive
PGA1.5	G	2.5	Tectonic crustal movements
PGA1.6	G	2.5	Magma intrusion
PGA1.7	G	2.5	Volcanism
PGA2.2	G	2.5	Volcanic eruption
SKI5.13	G	2.5	Volcanism
SKI5.19	G	2.5	Effect of plate movements
SKI5.32	G	2.5	Desert and unsaturation
SKI6.11	G	2.5	Intruding dykes
SKI6.14	G	2.5	Tectonic activity - large scale
SNL3.3	G	2.5	Volcanic Activity
SNL3.4	G	2.5	Magmatic Activity
UKN1.2.1	G	2.5	Plate movement/tectonic change
UKN1.2.3	G	2.5	Magmatic activity (intrusive, extrusive)
HMIP2.1.1	G	2.5	Regional tectonic
NEA1.2.1	G	2.5	Plate movement/tectonic change
NEA1.2.3	G	2.5	Magmatic activity (intrusive, extrusive)
NEA1.5.2	G	3.1	Site flooding
AECL1.42	G	4	Global effects
AECL3.105	GL	4	Terrestrial surface
AECL2.41	G	D	Meteorite
AECL2.45	G	D	Ozone layer
AECL3.1	HGL	D	Acid rain
AECL3.24	HG	D	Collisions, explosions, impacts
AECL3.76	GL	D	Ozone layer failure
DOE2.1.1	G	D	Meteorite impact
IAEA1.17	G	D	Meteorite impact
PGA2.3	G	D	Meteor impact
SKI5.29	G	D	Meteorite
SNL1.1	G	D	Meteorite impact
UKN1.1.1	G	D	Meteorite Impact
HMIP5.2.1	G	D	Meteorite impact
NEA1.1.1	G	D	Meteorite impact
NEA1.4.8	G	XXX	River meander (REPEAT! - SEE 1.4.4)

HUMAN FACTORS CATEGORY:
SCREENED OUT FEPs LIST

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL2.35	H	2.3	Intrusion (mines)
AECL2.44	H	2.3	Mines
AECL2.57	H	2.3	Solution mining
SNL4.3	H	2.3	Inadvertent Intrusions: Mining
UKN2.3.4	H	2.3	Exploitation drilling
UKN2.3.6	H	2.3	Resource mining
UKN2.4.10	H	2.3	Quarrying, peat extraction
NEA2.4.10	H	2.3	Quarrying, near surface extraction
AECL3.6	HL	2.3?	Artificial lake mixing
AECL3.7	H	2.3?	Ashes and sewage sludge
AECL3.35	HL	2.3?	Crop fertilization
AECL3.36	HL	2.3?	Crop storage
AECL3.61	HL	2.3?	Herbicides, pesticides, fungicides
AECL3.68	H	2.3?	Inject/ingest/inhaling locally produced drugs
AECL3.77	HL	2.3?	Peat and leaf litter harvesting
DOE4.2.4	H	2.3?	Exploitation drilling
DOE4.2.6	H	2.3?	Resource mining
AECL2.3	HF	2.4	Borehole - well
AECL2.13	HL	2.4	Dams
AECL3.10	H	2.4	Biogas production
AECL3.111	H	2.4	Water management projects (major)
PGA4.3.1	H	2.4	Drilling in sediments
UKN2.4.2	H	2.4	Dams and reservoirs, built/drained
UKN2.4.3	H	2.4	River rechannelled
NEA2.3.4	H	2.4	Exploitation drilling
NEA2.3.6	H	2.4	Resource mining
NEA2.4.2	H	2.4	Dams and reservoirs, built/drained
NEA2.4.3	H	2.4	Rivers rechannelled
AECL3.43	H	2.4?	Earthmoving projects (major)
AECL3.73	HL	2.4?	Lake infilling
AECL2.1	HR	3.1	Blasting and vibration
SKI3.2.11	BH	3.1	Backfill material deficiencies
SKI5.10	H	3.1	Accidents during operation
SKI5.12	H	3.1	Near storage of other waste
SKI5.39	H	3.1	Postclosure monitoring
SKI5.40	H	3.1	Unsuccessful attempt of site improvement
UKN2.1.8	HR	3.1	Poor quality construction
UKN2.1.9	HR	3.1	Design modification
UKN2.2.3	WH	3.1	Co-disposal of reactive wastes (deliberate)
UKN2.2.6	H	3.1	Accidents during operation
UKN2.2.11	HD	3.1	Post-closure monitoring
NEA2.1.9	H	3.1	Design modification
NEA2.3.1	H	3.1	Recovery of repository materials
SKI5.7	H	3.1?	Poorly designed repository
SKI5.8	H	3.1?	Poorly constructed repository

**HUMAN FACTORS CATEGORY:
SCREENED OUT FEPs LIST**

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME
AECL3.69	H	3.4	Intrusion (deliberate)
DOE4.2.1	H	3.4	Deliberate recovery of wastes or associated materials
DOE4.2.2	H	3.4	Malicious intrusion
UKN2.3.1	HD	3.4	Recovery of repository materials
HMIP5.2.2	H	3.4	Deliberate intrusion
HMIP5.2.3	H	3.4	Malicious intrusion
NEA2.3.2	H	3.4	Malicious intrusion: (sabotage, act of war)
SKI5.33	H	3.4?	Waste retrieval, mining
AECL3.66	HL	3.5	Hydroponics
AECL3.103	H	3.5	Technological advances in food production
SKI5.35	H	3.5	Other future uses of crystalline rock
AECL3.37	H	3.7	Cure for cancer
AECL1.73	H	D	Sabotage and improper operation
AECL2.2	H	D	Bomb blast
AECL2.22	FI	D	Explosion
AECL2.53	H	D	Sabotage
AECL3.1	HG	D	Acid rain
AECL3.24	HG	D	Collisions, explosions, impacts
DOE4.2.13	H	D	Underground weapons testing
IAEA2.7.1	H	D	Intentional intrusion: War
IAEA2.7.2	H	D	Intentional intrusion: Sabotage
IAEA2.7.3	H	D	Intentional intrusion: Waste recovery
SKI1.4	W?H	D	Sudden energy release
SKI5.5	H	D	Chemical sabotage
SKI5.30	H	D	Underground test of nuclear devices
SKI5.38	H	D	Explosions
SKI6.7	H	D	Nuclear war
UKN2.2.7	H	D	Sabotage
UKN2.3.2	H	D	Malicious intrusion, e.g. sabotage, act of war
UKN2.3.12	H	D	Underground nuclear testing
NEA2.3.12	H	D	Underground nuclear testing

APPENDIX 5

Screened FEP Lists

sorted according to consolidation code

CONSOLIDATED FEPs LIST FOR WASTE

IDENTIFIER	FEP NAME	COMMENT
1. WASTE		
1.1	Waste characteristics	fuel stability, heterogeneity
1.2	Radionuclide inventory	
1.3	Radionuclide decay and growth	
1.4	Radiological/radiation effects	radiation damage, radiolysis, embrittlement, He
1.5	Gas generation and effects	
1.6	Heat generation	chemical changes, radioactive gases, pressurisation
1.7	Thermo-mechanical effects	thermal pulse
1.8	Thermo-chemical effects	material property changes
1.9	Electro-chemical effects	gradients, galvanic coupling
1.10	Waste degradation/corrosion/dissolution	metal corrosion, leaching, zircaloy
1.11	Geochemical reactions/regime	chemical gradients & kinetics, geochemical pump, redox potential, recryst.
1.12	Radionuclide chemistry	solubility, speciation, complex formation, colloid formation
1.13	Specific factors	Pb-I reactions, Cs migration, damaged/deviating fuel, channeling

**WASTE CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
1.1 Waste characteristics			
AECL1.53	WCR	1.1	Inventory
AECL1.55	WCB	1.1	Long-term physical stability
AECL1.81	BCMR	1.1	Stability
UKN2.2.5	W	1.1	Heterogeneity of waste forms (chemical, physical)
NEA2.2.5	W	1.1	Heterogeneity of waste forms (chemical, physical)
1.3 Radionuclide decay and grow			
AECL1.68	W	1.3	Radioactive decay
DOE1.3.1	W	1.3	Radioactive decay and ingrowth
UKN3.4.4	W	1.3	Radioactive decay and ingrowth (chain decay)
HMIP1.3.1	W	1.3	Radioactive decay and ingrowth
NEA3.4.4	W	1.3	Radioactive decay and ingrowth (chain decay)
1.4 Radiological/radiation effects			
AECL1.67	WC?	1.4	Radiation damage
AECL1.69	W?	1.4	Radiolysis
DOE1.1.4.7	W	1.4	Radiolysis wastes
DOE1.4.3	WC	1.4	Embrittlement
IAEA3.4.1	W	1.4	Radiological effects: Material property changes
IAEA3.4.2	W	1.4	Radiological effects: Radiolysis
IAEA3.4.3	W	1.4	Radiological effects: Decay product gas generation
PGA3.1	W	1.4	Radiation damage of the matrix
PGA3.2	W	1.4	Radiolysis
SK11.1.3	W	1.4	Recoil of alpha-decay
SK11.1.4	W	1.4	Gas generation: He production
SK11.2.1	W	1.4	Radiolysis
UKN3.4.1	W	1.4	Radiolysis
UKN3.4.2	W	1.4.1.7.1.8	Material property changes
HMIP1.2.4	W	1.4.1.5	Radioactive gases
NEA3.4.1	W	1.4	Radiolysis
NEA3.4.2	W	1.4.1.7.1.8	Material property changes
1.5 Gas generation and effects			
AECL1.27	WCB	1.5.1.7.1.8.1.9	Coupled processes
AECL1.38	W	1.5	Formation of gases
DOE1.2.1.6	W	1.5	Hydrogen: corrosion of waste Zircaloy
DOE1.2.4.2	W	1.5	Active methane and carbon dioxide
DOE1.2.4.3	W	1.5	Other active gases
DOE1.6.5.4	WBR	1.5.1.11	Chemical changes due to Gas production
IAEA3.2.3	WB	1.5.1.11	Chemical effects: Gas generation
PGA3.15	W	1.5	Gas production
SK11.2.4	W	1.5	Gas generation
HMIP1.2.1	WC	1.5.1.10	Hydrogen by metal corrosion
1.6 Heat generation			
AECL1.84	WCBR	1.6	Temperature rises (unexpected effects)
SK11.1.2	W	1.6	Radioactive decay, heat
1.7 Thermo-mechanical effects			
AECL1.27	WCB	1.5.1.7.1.8.1.9	Coupled processes
SK12.3.1	WC	1.7	Thermal cracking
UKN3.2.3	WCBR	1.7.1.8.1.9	Interactions of waste and repository materials with host materials (eg. electroc
UKN3.4.2	W	1.4.1.7.1.8	Material property changes
NEA3.4.2	W	1.4.1.7.1.8	Material property changes
1.8 Thermo-chemical effects			
AECL1.27	WCB	1.5.1.7.1.8.1.9	Coupled processes
PGA3.9	WB	1.8	Thermally induced chemical changes
UKN3.2.3	WCBR	1.7.1.8.1.9	Interactions of waste and repository materials with host materials (eg. electroc
UKN3.4.2	W	1.4.1.7.1.8	Material property changes
HMIP1.2.8	WBR	1.8	Thermo-chemical effects
NEA3.4.2	W	1.4.1.7.1.8	Material property changes
1.9 Electro-chemical effects			
AECL1.27	WCB	1.5.1.7.1.8.1.9	Coupled processes
AECL1.32	WCB	1.9	Electrochemical gradients
UKN3.2.3	WCBR	1.7.1.8.1.9	Interactions of waste and repository materials with host materials (eg. electroc
HMIP1.1.4	WC	1.9	Electrical effects of metal corrosion

**WASTE CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
1.10	Waste degradation/corrosion/dissolution		
AECL1.65	WCSR	1.10	Precipitation and dissolution
AECL1.78	W	1.10.1.11.1.12	Source terms (expected)
AECL1.79	W	1.10.1.11.1.12	Source terms (other)
DOE1.1.4.1	W	1.10.1.11	Metal corrosion: wastes
DOE1.1.4.2	W	1.10	Leaching: wastes
DOE1.6.5.1	WCR	1.10, 1.11	Chemical changes due to Metal corrosion
DOE1.6.5.3	WBR	1.10, 1.11	Chemical changes due to Waste degradation
IAEA3.2.1	WC	1.10, 1.11	Chemical effects: Corrosion
SKI2.1.3	W	1.10	Internal corrosion due to waste
SKI3.1.10	WB	1.10.1.11	Interactions with corrosion products and waste
UKN3.2.1	WC	1.10	Metallic corrosion (pitting/uniform, internal and external agents, gas generation)
HMIP1.1.3	W	1.10	Physico-chemical degradation of wastes and transport to the far-field
HMIP1.2.1	WC	1.5.1.10	Hydrogen by metal corrosion
NEA3.3.5	WC	1.10	Fracturing
1.11	Geochemical reactions/regime		
AECL1.9	WBR	1.11	Chemical gradients
AECL1.13	WCSR	1.11	Chemical kinetics
AECL1.40	WBR	1.11	Geochemical pump
AECL1.78	W	1.10.1.11.1.12	Source terms (expected)
AECL1.79	W	1.10.1.11.1.12	Source terms (other)
DOE1.1.4.1	W	1.10.1.11	Metal corrosion: wastes
DOE1.1.4.3	W	1.11.1.12	Complex formation: wastes
DOE1.6.5.1	WCR	1.10, 1.11	Chemical changes due to Metal corrosion
DOE1.6.5.3	WBR	1.10, 1.11	Chemical changes due to Waste degradation
DOE1.6.5.4	WBR	1.5.1.11	Chemical changes due to Gas production
IAEA3.2.1	WC	1.10, 1.11	Chemical effects: Corrosion
IAEA3.2.3	WB	1.5.1.11	Chemical effects: Gas generation
IAEA3.2.4	WBR	1.11	Chemical effects: Geochemical change
PGA3.10	WCB	1.11	Chemical changes due to corrosion
SKI1.2.6	W	1.11.1.12	Solubility within fuel matrix
SKI1.2.7	W	1.11.1.12	Recrystallization
SKI1.2.8	W	1.11	Redox potential
SKI1.2.9	W	1.11	Dissolution chemistry
SKI3.1.10	WB	1.10.1.11	Interactions with corrosion products and waste
UKN1.5.14	WCBF	1.11	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBRFL	1.11	Chemical transformations
HMIP1.4.1	WCB	1.11	Waste-form and backfill consolidation
1.12	Radionuclide chemistry		
AECL1.78	W	1.10.1.11.1.12	Source terms (expected)
AECL1.79	W	1.10.1.11.1.12	Source terms (other)
AECL1.80	WCSR	1.12	Speciation
DOE1.1.4.3	W	1.11.1.12	Complex formation: wastes
SKI1.2.6	W	1.11.1.12	Solubility within fuel matrix
SKI1.2.7	W	1.11.1.12	Recrystallization
SKI5.44	WR	1.12	Solubility and precipitation
UKN3.1.5	WB	1.12	Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
1.13	Specific factors		
DOE1.1.4.4	W	1.13	Colloid formation: wastes
SKI1.2.3	WC	1.13	Pb-I reactions
SKI1.2.5	W	1.13	I, Cs-migration to glass surface
SKI1.3	W	1.13	Damaged or deviating fuel
SKI2.1.4	WC	1.13	Role of the eventual channeling within the canister
UKN2.2.4	WH	1.13	Inadvertent inclusion of undesirable materials
NEA2.2.4	WR	1.13	Inadvertent inclusion of undesirable materials
AECL1.3	WCSR	XXXX	Biological activity
AECL3.81	WL?	XXXX	Radioxic contaminants
DOE1.1.4.6	W	XXXX	Microbial corrosion: wastes
DOE1.6.6.2	WBRF	XXXX	Microbial activity
DOE1.6.6.3	WBRF	XXXX	Microbiological effects due to Microbial product reactions
IAEA3.2.2	WCR	XXXX	Chemical effects: Interactions of waste package and rock
UKN1.7.7	WBRFL	XXXX	Microbial interactions
UKN3.2.2	WCSR	XXXX	Interactions of host materials and groundwater with repository material (eg. c
UKN3.2.7	WC	XXXX	Microbiological effects (on corrosion/degradation, on solubility/complexation,
HMIP1.2.5	W	XXXX	Chemotoxic gases
NEA3.2.7	W	XXXX	Microbiological effects on corrosion/degradation, solubility/complexation, gas

CONSOLIDATED FEPs LIST FOR CANISTER

IDENTIFIER	FEP NAME	COMMENT
2. CANISTER :		
2.1	Canister materials/construction	
2.2	Corrosion/degradation processes	metal corrosion, leaching, pitting
2.3	Gas production and effects	
2.4	Microbiological effects	
2.5	Thermo-mechanical effects	thermal pulse
2.6	Electro-chemical effects	gradients, galvanic coupling
2.7	Stress/mechanical effects	material property changes
2.8	Geochemical reactions/regime	
2.9	Radionuclide transport through containers:	
2.10	Specific factors	colloids

**CONTAINER CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
2.1 Canister materials/construction			
AECL1.53	WCR	2.1	Inventory
SKI1.2.3	WC	2.1	Pb-I reactions
SKI2.4	C	2.1	Voids in the lead filling
2.2 Corrosion/degradation processes			
AECL1.19	C	2.2.2.7	Container failure (early)
AECL1.20	C	2.2.2.7	Container failure (long-term)
AECL1.22	C	2.2	Container healing
AECL1.23	C	2.2	Containers - partial corrosion
AECL1.26	C	2.2	Corrosion
AECL1.58	CBR	2.2	Microbes
AECL1.63	C	2.2	Pitting
AECL1.65	WCBR	2.2.2.6	Precipitation and dissolution
AECL1.67	WC?	2.2	Radiation damage
AECL1.88	C	2.2	Uniform corrosion
DOE1.1.1.1	C	2.2	Structural container metal corrosion: Localised
DOE1.1.1.2	C	2.2	Structural container metal corrosion: Bulk
DOE1.1.1.3	C	2.2	Structural container metal corrosion: Crevice
DOE1.1.1.4	C	2.2	Structural container metal corrosion: Stress corrosion cracking
DOE1.4.3	WC	2.2.2.7	Embrittlement
DOE1.6.5.1	WCR	2.2	Chemical changes due to Metal corrosion
IAEA3.2.1	WC	2.2.2.8	Chemical effects: Corrosion
SKI2.1.1	C	2.2	Chemical reactions (copper corrosion)
SKI2.1.5	C	2.2	Role of chlorides in copper corrosion
SKI2.1.7	C	2.2	Pitting
SKI2.1.8	C	2.2	Corrosive agents, Sulphides, oxygen etc
SKI2.1.9	CB	2.2	Backfill effects on Cu corrosion
SKIS.2.7	CB	2.2.2.7	Swelling of corrosion products
UKN3.2.1	WC	2.2	Metallic corrosion (pitting/uniform, internal and external agents, gas generation)
UKN3.3.3	C	2.2.2.7	Embrittlement and cracking
HMIP1.1.1	C	2.2	Container metal corrosion
HMIP1.2.1	WC	2.2.2.3	Hydrogen by metal corrosion
NEA3.2.1	C	2.2	Metallic corrosion (pitting/uniform, internal and external agents, gas generation)
NEA3.3.3	C	2.2.2.7	Embrittlement and cracking
2.3 Gas production and effects			
DOE1.2.1.2	C	2.3	Hydrogen: corrosion of container steel
DOE1.2.6.1	C	2.3	Gas transport in the waste container
HMIP1.2.1	WC	2.2.2.3	Hydrogen by metal corrosion
2.4 Microbiological effects			
AECL1.3	WCBR	2.4	Biological activity
AECL1.59	CBR	2.4	Microorganisms
SKI2.1.10	C	2.4	Microbes
UKN3.2.7	WC	2.4	Microbiological effects (on corrosion/degradation, on solubility/complexation)
2.5 Thermo-mechanical effects			
AECL1.27	WCB	2.5.2.6.2.7	Coupled processes
PGA3.7.2	CB	2.5	Differing thermal expansion of canister and backfill
SKI2.3.1	WC	2.5	Thermal cracking
2.6 Electro-chemical effects			
AECL1.27	WCB	2.5.2.6.2.7	Coupled processes
AECL1.32	WCB	2.6	Electrochemical gradients
SKI2.1.2	C	2.6	Coupled effects (electrophoresis)
SKI2.1.6.1	C	2.6	Repository induced Pb/Cu electrochemical reactions
SKI2.1.6.2	CB	2.6	Natural telluric electrochemical reactions
HMIP1.1.4	WC	2.6	Electrical effects of metal corrosion

**CONTAINER CATEGORY
SCREENED FEPS
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
2.7 Stress/mechanical effects			
AECL1.19	C	2.2.2.7	Container failure (early)
AECL1.20	C	2.2.2.7	Container failure (long-term)
AECL1.27	WCB	2.5.2.6,2.7	Coupled processes
AECL1.55	WCB	2.7	Long-term physical stability
DOE1.4.1	C	2.7	Canister or container movement
DOE1.4.3	WC	2.2.2.7	Embrittlement
IAEA3.3.1	CB	2.7	Mechanical effects: Canister movement
PGA3.4	CB	2.7	Canister movement in backfill
PGA3.6	C	2.7	Mechanical canister damage
SK12.2	C	2.7	Creeping of copper
SK12.3.3	C	2.7	Stress corrosion cracking
SK12.3.4	C	2.7	Loss of ductility
SK12.3.6	C	2.7	Cracking along welds
SK12.3.7.1	C	2.7	External stress
SK12.3.7.2	C	2.7	Hydrostatic pressure on canister
SK12.3.8	C	2.7	Internal pressure
SK13.2.2	CB	2.7	Movement of canister in buffer/backfill
SK13.2.7	CB	2.2.2.7	Swelling of corrosion products
UKN3.3.1	C	2.7	Canister or container movement
UKN3.3.3	C	2.2.2.7	Embrittlement and cracking
UKN3.3.4	C	2.7	Subsidence/collapse
UKN3.3.5	C	2.7	Fracturing
NEA3.3.1	C	2.7	Canister or container movement
NEA3.3.2	C	2.7	Changes in in-situ stress field
NEA3.3.3	C	2.2.2.7	Embrittlement and cracking
NEA3.3.4	C	2.7	Subsidence/collapse
NEA3.3.5	WC	2.7	Fracturing
2.8 Geochemical reactions/regime			
AECL1.13	WCBR	2.8	Chemical kinetics
AECL1.18	C	2.8	Container corrosion products
AECL1.65	WCBR	2.2.2.8	Precipitation and dissolution
AECL1.80	WCBR	2.8	Speciation
IAEA3.2.1	WC	2.2.2.8	Chemical effects: Corrosion
IAEA3.2.2	WCR	2.8	Chemical effects: Interactions of waste package and rock
PGA3.10	WCB	2.8	Chemical changes due to corrosion
UKN1.6.14	WCBF	2.8	Chemical gradients (electrochemical effects and osmosis)
UKN3.2.3	WCBR	2.8	Interactions of waste and repository materials with host materials (eg. electro)
HMIP1.4.1	WCB	2.8	Waste-form and backfill consolidation
2.9 Radionuclide transport through containers			
SK11.5	C	2.9	Release of radionuclides from the failed canister
2.10 Specific factors			
AECL1.84	WCBR	2.10	Temperature rises (unexpected effects)
SK12.1.4	WC	2.10	Role of the eventual channeling within the canister
SK12.3.5	C	2.10	Radiation effects on canister
SK12.5.1	C	2.10	Random canister defects - quality control
SK12.5.2	C	2.10	Common cause canister defects - quality control
UKN2.1.6	C	2.10	Material defects, e.g. early canister failure
NEA2.1.6	CR	2.10	Material defects (e.g. early canister failure)
AECL1.21	C	XXXX	Container failure (other long-term processes)
AECL1.81	BCWR	XXXX	Stability
UKN3.2.2	WCBR	XXXX	Interactions of host materials and groundwater with repository material (eg. e

CONSOLIDATED FEPs LIST FOR BUFFER/BACKFILL

IDENTIFIER	FEP NAME	COMMENT
3.	BUFFER/BACKFILL	
3.1	Buffer/backfill characteristics	hydraulic properties
3.2	Resaturation/desaturation	
3.3	Mechanical effects	swelling
3.4	Thermal effects	
3.5	Electro-chemical effects	
3.6	Gas effects	
3.7	Microbiological/biological effects	
3.8	Backfill degradation	chemical/physical changes
3.9	Geochemical regime	chemical gradients & kinetics, redox potential
3.10	Radionuclide transport processes	advection, dispersion, diffusion
3.11	Radionuclide chemistry	solubility, sorption, speciation, complex/colloid formation
3.12	Specific factors	

**BUFFER/BACKFILL CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON.CODE	FEP NAME
3.1 Buffer/backfill characteristics			
AECL1.1	B	3.1	Backfill characteristics
AECL1.6	B	3.1	Buffer characteristics
AECL1.81	BCWR	3.1.3.8	Stability
SK3.2.8	B	3.1.3.10	Preferential pathways in the buffer/backfill
3.2 Resaturation/desaturation			
AECL1.2	B	3.2.3.3.3.8	Backfill evolution
AECL1.7	B	3.2.3.3.3.8	Buffer evolution
AECL1.43	BR	3.2	Hydraulic conductivity
SK5.14	BR	3.2	Resaturation
3.3 Mechanical effects			
AECL1.2	B	3.2.3.3.3.8	Backfill evolution
AECL1.7	B	3.2.3.3.3.8	Buffer evolution
AECL1.83	B	3.3	Swelling pressure
IAEA3.3.1	CB	3.3	Mechanical effects: Canister movement
IAEA3.3.2	BR	3.3	Mechanical effects: Local fracturing
PGA3.4	CB	3.3	Canister movement in backfill
SK3.2.1.2	BR	3.3	Uneven swelling of bentonite
SK3.2.2	CB	3.3	Movement of canister in buffer/backfill
SK3.2.3	B	3.3	Mechanical failure of buffer/backfill
SK3.2.7	CB	3.3	Swelling of corrosion products
3.4 Thermal effects			
AECL1.24	BR	3.4	Convection
AECL1.27	WCB	3.4.3.9	Coupled processes
AECL1.46	BR	3.4	Hydrothermal alteration
AECL1.84	WCBR	3.4	Temperature rises (unexpected effects)
DOE2.3.6	EFF	3.4	Variations in groundwater temperature
DOE2.4.13.1	BR	3.4	Repository thermally-induced groundwater transport
DOE2.4.13.2	EFF	3.4	Naturally thermally-induced groundwater transport
IAEA3.1.3	EFF	3.4	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	EFF	3.4	Thermal effects: Fluid migration
PGA3.7.2	CB	3.4	Differing thermal expansion of canister and backfill
PGA3.7.3	BR	3.4	Differing thermal expansion of backfill and host rock
PGA3.9	WB	3.4	Thermally induced chemical changes
SK3.2.5	B	3.4	Thermal effects on the buffer material
SK2.2.10	B	3.4.3.10	Soret effect
SK4.2.4	BR	3.4.3.10	Thermal buoyancy
UKN1.5.9	EFF	3.4	Natural thermal effects
UKN2.1.10	BR	3.4	Thermal effects (eg. concrete hydration)
HMP1.2.8	WER	3.4	Thermo-chemical effects
HMP1.6.1	BR	3.4	Thermal effects and Rock-mass changes
HMP1.6.3	BR	3.4	Thermal effects and Chemical changes
HMP1.6.4	BR	3.4	Thermal effects and Transport (diffusion) effects
HMP2.3.12	BFRL	3.4	Thermal effects on hydrochemistry
3.5 Electro-chemical effects			
AECL1.32	WCB	3.5	Electrochemical gradients
SK12.1.6.2	CB	3.5	Natural telluric electrochemical reactions
3.6 Gas effects			
AECL1.85	BR	3.6.3.10	Transport in gases or of gases
DOE1.5.2.2	BR	3.6	Groundwater flow due to gas production
DOE2.4.11.1	BFRL	3.6	Gas transport: solution
DOE2.4.11.2	BFRL	3.6	Gas transport: gas phase
DOE2.4.12	EFF	3.6	Gas-induced groundwater transport
IAEA3.2.3	WB	3.6	Chemical effects: Gas generation
SK3.2.12	B	3.6.3.10	Gas transport in bentonite
SK16.2	EFF	3.6	Gas transport
UKN1.6.4	BFRL	3.6.3.10	Gas mediated transport
UKN1.6.5	BFRL	3.6.3.10	Multiphase flow and gas driven flow
HMP1.2.6	EFF	3.6.3.10	Gas transport
HMP1.5.3	BR	3.6	Gas production (unsaturated flow)
HMP2.3.10	BFRL	3.6.3.11	Transport of active gases
HMP2.3.11	BFRL	3.6.3.11	Gas induced groundwater transport
NEA1.6.4	BFRL	3.6.3.11	Gas mediated transport
NEA1.6.5	BFRL	3.6.3.11	Multiphase flow and gas-driven flow

**BUFFER/BACKFILL CATEGORY
SCREENED FEPS
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
3.7 Microbiological/biological effects			
AECL1.3	WCBR	3.7	Biological activity
AECL1.58	CBR	3.7	Microbes
AECL1.59	CBR	3.7	Microorganisms
DOE1.6.6.2	WBFF	3.7	Microbial activity
DOE1.6.6.3	WBFF	3.7	Microbiological effects due to Microbial product reactions
PGA3.14	BFPL	3.7	Microbiological phenomena/effects
UKN1.7.7	WBFFL	3.7	Microbial interactions
3.8 Backfill degradation			
AECL1.2	B	3.2,3.3,3.8	Backfill evolution
AECL1.7	B	3.2,3.3,3.8	Buffer evolution
AECL1.37	BR	3.8	Formation of cracks
AECL1.55	WCB	3.8	Long-term physical stability
AECL1.81	BCWR	3.1,3.8	Stability
SKI3.1.1	B	3.8	Degradation of the bentonite by chemical reactions
SKI3.1.5	B	3.8	Coagulation of bentonite
SKI3.1.13	B	3.8	Radiation effects on bentonite
SKI3.2.4	B	3.8	Erosion of buffer/backfill
3.9 Geochemical regime			
AECL1.9	WER	3.9	Chemical gradients
AECL1.13	WCBR	3.9	Chemical kinetics
AECL1.27	WCB	3.4,3.9	Coupled processes
AECL1.40	WER	3.9	Geochemical pump
AECL1.65	WCBR	3.9,3.11	Precipitation and dissolution
DOE1.6.5.3	WER	3.9	Chemical changes due to Waste degradation
DOE1.6.5.4	WER	3.9	Chemical changes due to Gas production
DOE1.6.5.5	BF	3.9	Chemical changes due to Complex formation
DOE1.6.5.6	BF	3.9	Chemical changes due to Colloid production
DOE1.6.5.7	BF	3.9	Chemical changes due to Solubility
DOE1.6.5.8	BF	3.9	Chemical changes due to Sorption
DOE1.6.5.9	BF	3.9	Chemical changes due to Species equilibrium
DOE2.4.10	BFPL	3.9	Isotopic dilution
IAEA1.13.3	BF	3.9	Fluid interactions: Brine pockets
IAEA3.2.4	WER	3.9	Chemical effects: Geochemical change
PGA3.10	WCB	3.9	Chemical changes due to corrosion
PGA3.12.1	B	3.9	Geochemical changes in backfill
SKI2.1.9	BC	3.9	Backfill effects on Cu corrosion
SKI3.1.2	B	3.9,3.11	Saturation of sorption sites
SKI3.1.3	B	3.9	Effects of bentonite on groundwater chemistry
SKI3.1.7	B	3.9	Reactions with cement pore water
SKI3.1.10	WB	3.9	Interactions with corrosion products and waste
SKI3.1.11	B	3.9	Redox front
SKI4.1.1	BFPL	3.9	Oxidizing conditions
SKI4.1.2	BFPL	3.9	pH-deviations
SKI4.1.7	BR	3.9	Thermochemical changes
SKIS.1	BF	3.9	Saline (or fresh) groundwater intrusion
UKN1.5.7	BF	3.9	Saline or freshwater intrusion
UKN1.5.8	BF	3.9	Effects at saline-freshwater interface
UKN1.6.13	BFPL	3.9	Mass, isotopic and species dilution
UKN1.6.14	WCBFF	3.9	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBFFL	3.9	Chemical transformations
UKN3.1.5	WB	3.9	Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)
UKN3.2.2	WCBR	3.9	Interactions of host materials and groundwater with repository material (eg. C)
HMP1.4.1	WCB	3.9	Waste-form and backfill consolidation
HMP2.3.7	BFPL	3.9,3.11	Changes in groundwater chemistry and flow direction
HMP2.3.13	BFPL	3.9	Biogeochemical changes
NEA1.6.13	BFPL	3.9	Mass, isotopic and species dilution
NEA1.6.14	BFPL	3.9	Chemical gradients (electrochemical effects and osmosis)
NEA3.1.5	BR	3.9	Induced chemical changes (solubility, sorption, species equilibrium, mineralisation)

**BUFFER/BACKFILL CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
3.10	Radionuclide transport processes		
AECL1.29	ER	3.10	Diffusion
AECL1.30	ER	3.10	Dispersion
AECL1.86	ER	3.6.3.10	Transport in gases or of gases
AECL1.90	ER	3.10	Unsaturated transport
DOE1.5.3	BFF	3.10	Groundwater flow (saturated conditions)
DOE2.3.4.4	BFF	3.10	Groundwater flow: Fracture
DOE2.3.4.5	BFF	3.10	Groundwater flow: Effects of solution channels
DOE2.4.1	BFF	3.10	Advection
DOE2.4.2.1	BFF	3.10	Bulk diffusion
DOE2.4.2.2	BFF	3.10	Matrix diffusion
DOE2.4.2.3	B	3.10	Surface diffusion
DOE2.4.3	BFF	3.10	Hydrodynamic dispersion
IAEA1.13.1	BFF	3.10	Fluid interactions: Groundwater flow
SK3.2.6	B	3.10	Diffusion - surface diffusion
SK3.2.8	B	3.1.3.10	Preferential pathways in the buffer/backfill
SK3.2.9	B	3.10	Flow through buffer/backfill
SK3.2.10	B	3.4.3.10	Soret effect
SK3.2.12	B	3.6.3.10	Gas transport in bentonite
SK4.2.4	ER	3.4.3.10	Thermal buoyancy
SK4.2.5	BFF	3.10	Changes of groundwater flow
SK6.4	BFFL	3.10	Dispersion
SK6.5	BFFL	3.10	Dilution
UKN1.6.1	BFFL	3.10	Advection and dispersion
UKN1.6.2	BFFL	3.10	Diffusion
UKN1.6.3	BFFL	3.10	Matrix diffusion
UKN1.6.4	BFFL	3.6.3.10	Gas mediated transport
UKN1.6.5	BFFL	3.6.3.10	Multiphase flow and gas driven flow
HMIP1.2.6	BFF	3.6.3.10	Gas transport
HMIP1.5.4	BFF	3.10	Saturated groundwater flow
HMIP1.5.5	ER	3.10	Transport of chemically active substances into the near-field
HMIP2.3.1	BFFL	3.10	Advection
HMIP2.3.2	BFFL	3.10	Diffusion
HMIP2.3.3	BFFL	3.10	Hydrodynamic dispersion
NEA1.6.1	BFFL	3.10	Advection and dispersion
NEA1.6.2	BFFL	3.10	Diffusion
NEA1.6.3	BFFL	3.10	Matrix diffusion
3.11	Radionuclide chemistry		
AECL1.65	WCBR	3.9.3.11	Precipitation and dissolution
AECL1.76	ER	3.11	Sorption
AECL1.77	ER	3.11	Sorption: non-linear
AECL1.80	WCBR	3.11	Speciation
DOE2.4.4.1	BFFL	3.11	Solubility: effects of pH and Eh
DOE2.4.4.2	BFFL	3.11	Solubility: effects of ionic strength
DOE2.4.4.3	BFFL	3.11	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	ER	3.11	Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	BFFL	3.11	Solubility: effects of naturally-occurring colloids
DOE2.4.4.6	ER	3.11	Solubility: effects of colloids formed in the near-field
DOE2.4.4.8	BFFL	3.11	Solubility: Effects of microbial activity
DOE2.4.5.1	BFFL	3.11	Linear sorption
DOE2.4.5.2	BFFL	3.11	Non-linear sorption
DOE2.4.5.3	BFFL	3.11	Reversible sorption
DOE2.4.5.4	BFFL	3.11	Irreversible sorption
DOE2.4.5.5	BFFL	3.11	Sorption: Effects of pH and Eh
DOE2.4.5.6	BFFL	3.11	Sorption: Effects of ionic strength
DOE2.4.5.7	BFFL	3.11	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BFFL	3.11	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	ER	3.11	Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BFFL	3.11	Sorption: effects of naturally-occurring colloids
DOE2.4.5.11	ER	3.11	Sorption: effects of colloids formed in the near-field
DOE2.4.5.13	BFFL	3.11	Sorption: effects of microbial activity
IAEA1.13.2	BFFL	3.11	Fluid interactions: Dissolution
SK3.1.2	B	3.9.3.11	Saturation of sorption sites
SK4.1.4	BFFL	3.11	Sorption
SK4.1.5	BFFL	3.11	Reconcentration
SK4.1.9	BFFL	3.11	Complexing agents
UKN1.6.6	BFFL	3.11	Solubility limit
UKN1.6.7	BFFL	3.11	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BFFL	3.11	Dissolution, precipitation and crystallisation

**BUFFER/BACKFILL CATEGORY
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
3.11	Radionuclide chemistry (continued)		
UKN1.6.10	BFFL	3.11	Complexing agents
HMIP2.3.4	BFFL	3.11	Solubility constraints
HMIP2.3.5	BFFL	3.11	Sorption including ion-exchange
HMIP2.3.6	BFFL	3.11	Changes in sorptive surfaces
HMIP2.3.7	BFFL	3.9.3.11	Changes in groundwater chemistry and flow direction
HMIP2.3.9	BFFL	3.11	Transport of radionuclides bound to microbes
HMIP2.3.10	BFFL	3.6.3.11	Transport of active gases
HMIP2.3.11	BFFL	3.6.3.11	Gas induced groundwater transport
NEA1.6.4	BFFL	3.6.3.11	Gas mediated transport
NEA1.6.5	BFFL	3.6.3.11	Multiphase flow and gas-driven flow
NEA1.6.6	BFFL	3.11	Solubility limit
NEA1.6.7	BFFL	3.11	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BFFL	3.11	Dissolution, precipitation, and crystallisation
3.12	Specific factors		
AECL1.36	B	3.12	Faulty buffer emplacement
DOE2.3.5.1	BFF	3.12	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BFF	3.12	Inorganic colloid transport: Effects of ionic strength
DOE2.4.7.1	BFFL	3.12	Organic colloid transport in Porous media
DOE2.4.7.2	BFFL	3.12	Organic colloid transport in Fractured media
DOE2.4.7.3	BFFL	3.12	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BFFL	3.12	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BFFL	3.12	Inorganic colloid transport: Porous media
DOE2.4.8.2	BFFL	3.12	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BFFL	3.12	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BFFL	3.12	Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	BFFL	3.12	Transport of radionuclides bound to microbes
PGA3.13	BFFL	3.12	Physico-chemical phenomena/effects (eg. colloid formation)
SKI3.1.4	B	3.12	Colloid generation - source
SKI4.2.3	BFF	3.12	Extreme channel flow of oxidants and nucleides
UKN1.6.9	BFFL	3.12	Colloid formation, dissolution and transport
UKN2.2.2	HB	3.12	Inadequate backfill or compaction, voidage
HMIP2.3.8	BFFL	3.12	Colloid transport
NEA1.6.9	BFFL	3.12	Colloid formation, dissolution, and transport
NEA1.6.10	BFFL	3.12	Complexing agents
NEA2.2.2	BR	3.12	Inadequate backfill or compaction voidage
SKI3.1.6	B	XXXX	Sedimentation of bentonite
SKI3.2.1.1	BR	XXXX	Swelling of bentonite into tunnels and cracks
SKI4.2.10	BR	XXXX	Chemical effects of rock reinforcement
SNL6.1	BR	XXXX	Subsidence and Caving
UKNS.2.3	WCBP	XXXX	Interactions of waste and repository materials with host materials (eg. electroc
HMIP1.6.2	BR	XXXX	Thermal effects and Hydrogeological changes
NEA3.1.1	BR	XXXX	Differential elastic response
NEA3.1.2	BR	XXXX	Non-elastic response
NEA3.1.4	BFF	XXXX	Induced hydrological changes (fluid pressure, density convection, viscosity)

CONSOLIDATED FEPs LIST FOR REPOSITORY

IDENTIFIER	FEP NAME	COMMENT
4. REPOSITORY		
4.1	Repository elements/materials	Inventory
4.2	Repository degradation	including shafts, seals, normal evolution
4.3	Hydraulic effects/groundwater flow	resaturation, dewatering
4.4	Mechanical effects	swelling
4.5	Thermal effects	
4.6	Gas effects and transport	
4.7	Microbiological/biological activity	
4.8	Geochemical regime	chemical gradients & kinetics, redox potential, thermochemical
4.9	Radionuclide chemistry	solubility, speciation, sorption, complex formation
4.10	Radionuclide transport processes	advection, dispersion, diffusion
4.11	Specific factors	colloids, poor QA, material defects, undetected features

**REPOSITORY CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
4.1	Repository elements/materials		
AECL1.53	WCR	4.1	Inventory
AECL1.91	R	4.1	Vault geometry
4.2	Repository degradation		
AECL1.8	R	4.2	Cave ins
AECL1.74	R	4.2	Seal evolution
AECL1.75	R	4.2	Seal failure
DOE2.3.3.1	FF	4.2	Rock property changes: Porosity
DOE2.3.3.2	FF	4.2,4.3	Rock property changes: Permeability
DOE2.3.3.3	FF	4.2,4.3,4.7	Rock property changes: Microbial pore blocking
DOE2.3.3.4	FF	4.2,4.4	Rock property changes: Channel formation/closure
DOE4.1.1.1	FRL	4.2	Borehole seal failure
DOE4.1.1.2	FRL	4.2	Borehole seal degradation
DOE4.1.2.1	R	4.2	Shaft/tunnel seal failure
DOE4.1.2.2	R	4.2	Shaft/tunnel seal degradation
PGA3.16	R	4.2,4.11	Failure of shaft sealing
SK4.2.9	R	4.2	Creeping of rock mass
SK5.11	FF	4.2	Degradation of hole- and shaft seals
SNL6.1	BR	4.2	Subsidence and Caving
SNL6.2	FRL	4.2	Shaft and Borehole Seal Degradation
UKN2.1.2	FRL	4.2	Investigation borehole seal failure and degradation
UKN2.1.3	FF	4.2	Shaft or access tunnel seal failure and degradation
UKN2.1.4	R	4.2,4.4	Stress field changes, setting, subsidence or caving
HMP1.1.2	R	4.2,4.8	Physico-chemical degradation of concrete
HMP1.4.2	R	4.2	Vault collapse
HMP5.1.1	FRL	4.2	Loss of integrity of borehole seals
HMP5.1.2	R	4.2	Loss of integrity of shaft or access tunnel seals
NEA2.1.2	HR	4.2	Investigation borehole seal failure and degradation
NEA2.1.3	HR	4.2	Shaft or access tunnel seal failure and degradation
NEA2.1.4	HR	4.2,4.4	Stress field changes, setting, subsidence or caving
NEA2.1.7	HR	4.2	Common cause failures
4.3	Hydraulic effects/groundwater flow		
AECL1.34	R	4.3	Excessive hydrostatic pressures
AECL1.43	BR	4.3	Hydraulic conductivity
AECL1.44	R	4.3	Hydraulic head
AECL1.70	R	4.3,4.10	Recharge groundwater
AECL1.71	R	4.3	Reflooding
AECL1.90	BR	4.3,4.10	Unsaturated transport
DOE1.5.1.1	FF	4.3	Changes in moisture content due to dewatering
DOE1.5.1.2	FF	4.3,4.4	Changes in moisture content due to stress relief
DOE1.5.2.2	BR	4.3	Groundwater flow due to gas production
DOE1.5.3	EFF	4.3	Groundwater flow (saturated conditions)
DOE1.6.3.1	FF	4.3	Fracture changes: aperture
DOE1.6.3.2	FF	4.3	Fracture changes: length
DCE2.3.3.2	FF	4.2,4.3	Rock property changes: Permeability
DCE2.3.3.3	FF	4.2,4.3,4.7	Rock property changes: Microbial pore blocking
DOE2.3.4.1	FF	4.3	Groundwater flow: Darcy
DOE2.3.4.2	FF	4.3	Groundwater flow: Non-Darcy
DCE2.3.4.3	FF	4.3	Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	EFF	4.3	Groundwater flow: Fracture
DOE2.3.4.5	EFF	4.3	Groundwater flow: Effects of solution channels
DOE2.4.12	EFF	4.5,4.3	Gas-induced groundwater transport
DOE2.4.13.1	BR	4.5,4.3	Repository thermally-induced groundwater transport
DCE2.4.13.2	EFF	4.5,4.3	Naturally thermally-induced groundwater transport
IAEA1.13.1	EFF	4.3	Fluid interactions: Groundwater flow
IAEA3.1.4	EFF	4.5,4.3	Thermal effects: Fluid migration
PGA4.1	FF	4.3	Direct alterations in hydrogeology
SK4.2.5	EFF	4.3	Changes of groundwater flow
SK4.2.7	R	4.3,4.4,4.5	Thermo-hydro-mechanical effects
SK5.14	BR	4.3	Resaturation
SK6.13	FF	4.3,4.5	Geothermally induced flow
UKN2.1.5	FF	4.3	Dewatering of host rock
UKN3.1.4	FF	4.3	Induced hydrological changes (fluid pressure, density convection, viscosity)
HMP1.5.1	R	4.3	Desaturation (pumping) effects
HMP1.5.2	R	4.3,4.4	Disturbed zone (hydromechanical) effects
HMP1.5.4	EFF	4.3	Saturated groundwater flow
HMP1.6.2	BR	4.5,4.3	Thermal effects and Hydrogeological changes
HMP2.3.7	EFF	4.8,4.3	Changes in groundwater chemistry and flow direction
NEA2.1.5	HR	4.3	Dewatering of host rock
NEA3.1.4	EFF	4.3	Induced hydrological changes (fluid pressure, density convection, viscosity)

REPOSITORY CATEGORY:
SCREENED FEPS
(sorted)

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
4.4 Mechanical effects			
AECL1.37	BR	4.4	Formation of cracks
AECL1.81	BCWR	4.4	Stability
DOE1.4.2	R	4.4	Changes in in-situ stress field
DOE1.4.4.1	R	4.4	Repository-induced subsidence
DOE1.5.1.2	FF	4.3.4.4	Changes in moisture content due to stress relief
DOE1.6.1	FF	4.4	Differential elastic response
DOE1.6.2	FF	4.4	Non-elastic response
DOE2.2.6.1	FF	4.4	Repository-induced seismicity
DOE2.2.6.2	FFG	4.4	Externally-induced seismicity
DOE2.3.3.4	FF	4.2.4.4	Rock property changes: Gravel formation/closure
IAEA3.1.1	FF	4.4.4.5	Thermal effects: Differential elastic response
IAEA3.1.2	FF	4.4.4.5	Thermal effects: Non-elastic response
IAEA3.1.3	BFF	4.4.4.5	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.3.2	BR	4.4	Mechanical effects: Local fracturing
PGA3.5	R	4.4	Decompressed zones from mining
PGA3.7.3	BR	4.4.4.5	Differing thermal expansion of backfill and host rock
PGA3.7.4	FF	4.4.4.5	Differing thermal expansion of host rock zones
SKB3.2.1.1	BR	4.4	Swelling of bentonite into tunnels and cracks
SKB3.2.1.2	BR	4.4	Uneven swelling of bentonite
SKG4.2.1	R	4.4	Mechanical failure of repository
SKH4.2.2.1	R	4.4	Excavation/backfilling effects on nearby rock
SKH4.2.7	R	4.3.4.4.4.5	Thermo-hydro-mechanical effects
SKH4.2.8	R	4.4	Enhanced rock fracturing
SNL6.3	FF	4.4.4.5	Thermally Induced Stress/Fracturing in Host Rock
SNL6.4	FF	4.4	Excavation-Induced Stress/Fracturing in Host Rock
UKN2.1.4	R	4.2.4.4	Stress field changes, settling, subsidence or caving
UKN3.1.1	FF	4.4	Differential elastic response
UKN3.1.2	FF	4.4	Non-elastic response
UKN3.1.3	FF	4.4	Host rock fracture aperture changes
UKN3.3.2	R	4.4	Changes in in-situ stress field
HMP1.5.2	R	4.3.4.4	Disturbed zone (hydromechanical) effects
HMP1.6.1	BR	4.5.4.4	Thermal effects and Rock-mass changes
NEA2.1.4	HR	4.2.4.4	Stress field changes, settling, subsidence or caving
NEA3.1.1	BR	4.4	Differential elastic response
NEA3.1.2	BR	4.4	Non-elastic response
NEA3.1.3	R	4.4	Host rock fracture aperture changes
4.5 Thermal effects			
AECL1.24	BR	4.5	Convection
AECL1.46	BR	4.5.4.10	Hydrothermal alteration
AECL1.84	WCBR	4.5	Temperature rises (unexpected effects)
AECL2.67	FF?	4.5	Vault heating effects
DOE2.3.6	BFF	4.5	Variations in groundwater temperature
DOE2.4.13.1	BR	4.5.4.3	Repository thermally-induced groundwater transport
DOE2.4.13.2	BFF	4.5.4.3	Naturally thermally-induced groundwater transport
IAEA3.1.1	FF	4.4.4.5	Thermal effects: Differential elastic response
IAEA3.1.2	FF	4.4.4.5	Thermal effects: Non-elastic response
IAEA3.1.3	BFF	4.4.4.5	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BFF	4.5.4.3	Thermal effects: Fluid migration
PGA3.7.3	BR	4.4.4.5	Differing thermal expansion of backfill and host rock
PGA3.7.4	FF	4.4.4.5	Differing thermal expansion of host rock zones
PGA3.8	FF	4.5	Thermal convection
SKH4.2.4	BR	4.5	Thermal buoyancy
SKH4.2.7	R	4.3.4.4.4.5	Thermo-hydro-mechanical effects
SKB.13	FF	4.3.4.5	Geothermally induced flow
SNL6.3	FF	4.4.4.5	Thermally Induced Stress/Fracturing in Host Rock
UKN1.5.9	BFF	4.5	Natural thermal effects
UKN2.1.10	BR	4.5	Thermal effects (eg. concrete hydration)
HMP1.6.1	BR	4.5.4.4	Thermal effects and Rock-mass changes
HMP1.6.2	BR	4.5.4.3	Thermal effects and hydrogeological changes
HMP1.6.3	BR	4.5.4.8	Thermal effects and Chemical changes
HMP1.6.4	BR	4.5.4.10	Thermal effects and Transport (diffusion) effects
HMP2.3.12	SPFL	4.5.4.9	Thermal effects on hydrochemistry
NEA2.1.10	R	4.5	Thermal effects

**REPOSITORY CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON.CODE	FEP NAME
4.6	Gas effects and transport		
AECL1.86	BR	4.6.4.10	Transport in gases or of gases
DOE1.2.1.1	R	4.6	Hydrogen: corrosion of structural steel
DOE1.2.2.7	R	4.6	Methane/CO2 production: Effects of microbial growth on properties of concrete
DOE1.2.6.2	R	4.6	Gas transport in the vaults between containers
DOE1.2.6.3	R	4.6	Gas transport: Between vaults
DOE1.2.6.4	R	4.6	Gas transport in the near-field, including up and around access shafts and adits
DOE2.4.11.1	BFFL	4.6.4.10	Gas transport: solution
DOE2.4.11.2	BFFL	4.6	Gas transport: gas phase
DOE2.4.12	BFF	4.6.4.3	Gas-induced groundwater transport
SK15.22	GR	4.6	Accumulation of gases under permafrost
SK15.43	GR	4.6	Methane intrusion
SK16.2	BFF	4.6	Gas transport
UKN1.2.13	R	4.6	Natural gas intrusion
UKN1.6.4	BFFL	4.6.4.10	Gas mediated transport
UKN1.6.5	BFFL	4.6.4.10	Multiphase flow and gas driven flow
HMIP1.2.6	BFF	4.6	Gas transport
HMIP1.5.3	BR	4.6	Gas production (unsaturated flow)
HMIP2.3.10	BFFL	4.6.4.10	Transport of active gases
HMIP2.3.11	BFFL	4.6.4.10	Gas induced groundwater transport
NEA1.2.13	FF	4.6	Natural gas intrusion
NEA1.6.4	BFFL	4.6.4.10	Gas mediated transport
NEA1.6.5	BFFL	4.6.4.10	Multiphase flow and gas-driven flow
4.7	Microbiological/biological activity		
AECL1.3	WCBR	4.7	Biological activity
AECL1.58	CBR	4.7	Microbes
AECL1.59	CBR	4.7	Microorganisms
DOE1.5.4.3	R	4.7.4.8	Transport of Microbes into the near-field
DOE1.6.6.2	WBFF	4.7	Microbial activity
DOE1.6.6.3	WBFF	4.7	Microbiological effects due to Microbial product reactions
DOE2.3.3.3	FF	4.2.4.3.4.7	Rock property changes: Microbial pore blocking
DOE2.4.9	BFFL	4.7.4.8	Transport of radionuclides bound to microbes
PGA3.14	BFFL	4.7	Microbiological phenomena/effects
UKN1.7.7	WBFFL	4.7	Microbial interactions
HMIP2.3.9	BFFL	4.7.4.10	Transport of radionuclides bound to microbes
HMIP2.3.13	BFFL	4.7	Biogeochemical changes
4.8	Geochemical regime		
AECL1.9	WBR	4.8	Chemical gradients
AECL1.13	WCBR	4.8	Chemical kinetics
AECL1.40	WBR	4.8	Geochemical pump
DOE1.1.2.3	R	4.8	Pore blockage: concrete
DOE1.1.2.5	R	4.8	Cement-sulphate reaction: concrete
DOE1.1.3.1	R	4.8	Changes in pore water composition, pH, Eh: concrete
DOE1.5.4.1	R	4.8.4.10	Transport of Inorganic ions into the near-field
DOE1.5.4.2	R	4.8.4.10	Transport of Humic and fulvic acids into the near-field
DOE1.5.4.3	R	4.7.4.8	Transport of Microbes into the near-field
DOE1.5.4.4	R	4.8.4.10	Transport of Organic complexes into the near-field
DOE1.6.5.1	WCR	4.8	Chemical changes due to Metal corrosion
DOE1.6.5.2	R	4.8	Chemical changes due to Concrete degradation
DOE1.6.5.3	WBR	4.8	Chemical changes due to Waste degradation
DOE1.6.5.4	WBR	4.8	Chemical changes due to Gas production
DOE1.6.5.5	BFF	4.8	Chemical changes due to Complex formation
DOE1.6.5.6	BFF	4.8	Chemical changes due to Colloid production
DOE1.6.5.7	BFF	4.8	Chemical changes due to Solubility
DOE1.6.5.8	BFF	4.8	Chemical changes due to Sorption
DOE1.6.5.9	BFF	4.8	Chemical changes due to Species equilibrium
DOE2.4.6	FF	4.8	Fracture mineralisation
DOE2.4.9	BFFL	4.7.4.8	Transport of radionuclides bound to microbes
DOE2.4.14	BFFL	4.8	Biogeochemical changes
IAEA1.13.2	BFFL	4.8	Fluid interactions: Dissolution
IAEA1.13.3	BFF	4.8	Fluid interactions: Brine pockets
IAEA3.2.2	WCR	4.8	Chemical effects: Interactions of waste package and rock
IAEA3.2.4	WBR	4.8	Chemical effects: Geochemical change
PGA3.12.2	FF	4.8	Geochemical changes in host rock
PGA3.13	BFFL	4.8	Physico-chemical phenomena/effects (eg. colloid formation)
SK14.1.1	BFFL	4.8	Oxidizing conditions
SK14.1.2	BFFL	4.8	pH-deviations
SK14.1.6	BFFL	4.8.4.9	Reconcentration
SK14.1.7	BR	4.8	Thermochemical changes
SK14.1.8	R	4.8	Change of groundwater chemistry in nearby rock

REPOSITORY CATEGORY:
SCREENED FEPs
(sorted)

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
4.8	Geochemical regime (continued)		
SK14.1.9	BFFL	4.8,4.9	Complexing agents
SK14.2.10	BR	4.8	Chemical effects of rock reinforcement
SK15.1	BFF	4.8	Saline (or fresh) groundwater intrusion
UKN1.5.7	BFF	4.8	Saline or freshwater intrusion
UKN1.5.8	BFF	4.8	Effects at saline-freshwater interface
UKN1.6.11	FF	4.8	Fracture mineralisation and weathering
UKN1.6.14	WCBFF	4.8	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBFFL	4.8	Chemical transformations
UKN3.2.2	WCBR	4.8	Interactions of host materials and groundwater with repository material (eg. c
UKN3.2.3	WCBR	4.8	Interactions of waste and repository materials with host materials (eg. electro
UKN3.2.4	FF	4.8	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sor
HMP1.1.2	R	4.2,4.8	Physico-chemical degradation of concrete
HMP1.2.8	WER	4.8	Thermo-chemical effects
HMP1.5.5	BR	4.8	Transport of chemically active substances into the near-field
HMP1.6.3	BR	4.5,4.8	Thermal effects and Chemical changes
HMP2.3.7	BFFL	4.8,4.3	Changes in groundwater chemistry and flow direction
HMP2.3.12	BFFL	4.5,4.8	Thermal effects on hydrochemistry
NEA1.6.11	FF	4.8	Fracture mineralisation
NEA1.6.14	BFFL	4.8	Chemical gradients (electrochemical effects and osmosis)
NEA3.1.5	BR	4.8	Induced chemical changes (solubility, sorption, species equilibrium, mineralisat
NEA3.2.2	R	4.8	Interactions of host materials and groundwater with repository material (e.g. c
NEA3.2.3	FF	4.8	Interactions of waste and repository materials with host materials (electrochem
4.9	Radionuclide chemistry		
AECL1.65	WCBR	4.9	Precipitation and dissolution
AECL1.76	BR	4.9	Sorption
AECL1.77	BR	4.9	Sorption: non-linear
AECL1.80	WCBR	4.9	Speciation
DOE2.4.4.1	BFFL	4.9	Solubility: effects of pH and Eh
DOE2.4.4.2	BFFL	4.9	Solubility: effects of ionic strength
DOE2.4.4.3	BFFL	4.9	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	BR	4.9	Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	BFFL	4.9	Solubility: effects of naturally-occurring colloids
DOE2.4.4.6	BR	4.9	Solubility: effects of colloids formed in the near-field
DOE2.4.4.7	FF	4.9	Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	BFFL	4.9	Solubility: Effects of microbial activity
DOE2.4.5.1	BFFL	4.9	Linear sorption
DOE2.4.5.2	BFFL	4.9	Non-linear sorption
DOE2.4.5.3	BFFL	4.9	Reversible sorption
DOE2.4.5.4	BFFL	4.9	Irreversible sorption
DOE2.4.5.5	BFFL	4.9	Sorption: Effects of pH and Eh
DOE2.4.5.6	BFFL	4.9	Sorption: Effects of ionic strength
DOE2.4.5.7	BFFL	4.9	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BFFL	4.9	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	BR	4.9	Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BFFL	4.9,4.11	Sorption: effects of naturally-occurring colloids
DOE2.4.5.11	BR	4.9	Sorption: effects of colloids formed in the near-field
DOE2.4.5.12	FF	4.9	Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	BFFL	4.9	Sorption: effects of microbial activity
DOE2.4.10	BFFL	4.9	Isotopic dilution
SK14.1.4	BFFL	4.9	Sorption
SK14.1.5	FF	4.9	Matrix diffusion
SK14.1.6	BFFL	4.8,4.9	Reconcentration
SK14.1.9	BFFL	4.8,4.9	Complexing agents
SK15.44	WR	4.9	Solubility and precipitation
SK17.5	BFFL	4.9	Isotopic dilution
UKN1.6.6	BFFL	4.9	Solubility limit
UKN1.6.7	BFFL	4.9	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BFFL	4.9	Dissolution, precipitation and crystallisation
UKN1.6.10	BFFL	4.9	Complexing agents
UKN1.6.13	BFFL	4.9	Mass, isotopic and species dilution
HMP2.3.4	BFFL	4.9	Solubility constraints
HMP2.3.5	BFFL	4.9	Sorption including ion-exchange
HMP2.3.6	BFFL	4.9	Changes in sorptive surfaces
NEA1.6.6	BFFL	4.9	Solubility limit
NEA1.6.7	BFFL	4.9	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BFFL	4.9	Dissolution, precipitation, and crystallisation
NEA1.6.10	BFFL	4.9	Complexing agents
NEA1.6.13	BFFL	4.9	Mass, isotopic and species dilution

REPOSITORY CATEGORY:
SCREENED FEPs
(sorted)

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
4.10	Radionuclide transport processes		
AECL1.29	ER	4.10	Diffusion
AECL1.30	ER	4.10	Dispersion
AECL1.46	ER	4.5.4.10	Hydrothermal alteration
AECL1.70	R	4.3.4.10	Recharge groundwater
AECL1.86	ER	4.6.4.10	Transport in gases or of gases
AECL1.90	ER	4.3.4.10	Unsaturated transport
DOE1.5.4.1	R	4.8.4.10	Transport of Inorganic ions into the near-field
DOE1.5.4.2	R	4.8.4.10	Transport of Humic and fulvic acids into the near-field
DOE1.5.4.4	R	4.8.4.10	Transport of Organic complexes into the near-field
DOE2.4.1	BFF	4.10	Advection
DOE2.4.2.1	BFF	4.10	Bulk diffusion
DOE2.4.2.2	BFF	4.10	Matrix diffusion
DOE2.4.3	BFF	4.10	Hydrodynamic dispersion
DOE2.4.11.1	BAFL	4.6.4.10	Gas transport: solution
SK16.4	BAFL	4.10	Dispersion
SK16.5	BAFL	4.10	Dilution
UKN1.6.1	BAFL	4.10	Advection and dispersion
UKN1.6.2	BAFL	4.10	Diffusion
UKN1.6.3	BAFL	4.10	Matrix diffusion
UKN1.6.4	BAFL	4.6.4.10	Gas mediated transport
UKN1.6.5	BAFL	4.6.4.10	Multiphase flow and gas driven flow
HMIP1.6.4	ER	4.5.4.10	Thermal effects and Transport (diffusion) effects
HMIP2.3.1	BAFL	4.10	Advection
HMIP2.3.2	BAFL	4.10	Diffusion
HMIP2.3.3	BAFL	4.10	Hydrodynamic dispersion
HMIP2.3.9	BAFL	4.7, 4.10	Transport of radionuclides bound to microbes
HMIP2.3.10	BAFL	4.6.4.10	Transport of active gases
HMIP2.3.11	BAFL	4.6.4.10	Gas induced groundwater transport
NEA1.6.1	BAFL	4.10	Advection and dispersion
NEA1.6.2	BAFL	4.10	Diffusion
NEA1.6.3	BAFL	4.10	Matrix diffusion
NEA1.6.4	BAFL	4.6.4.10	Gas mediated transport
NEA1.6.5	BAFL	4.6.4.10	Multiphase flow and gas-driven flow
4.11	Specific factors		
AECL1.15	R	4.11	Colloids
AECL1.48	R	4.11	Incomplete closure
AECL1.62	R	4.11	Percolation in shafts
AECL1.66	R	4.11	Pseudo-colloids
AECL1.89	R	4.11	Unmodelled design features
AECL2.4	FF	4.11	Borehole seal failure/open boreholes
AECL2.6	FFF	4.11	Boreholes - unsealed
DOE1.5.4.5	R	4.11	Transport of Colloids into the near-field
DOE2.3.4.6	FF	4.11	Inorganic colloid transport: Porous media
DOE2.3.5.1	BFF	4.11	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BFF	4.11	Inorganic colloid transport: Effects of ionic strength
DOE2.4.5.10	BAFL	4.9.4.11	Sorption: effects of naturally-occurring colloids
DOE2.4.7.1	BAFL	4.11	Organic colloid transport in Porous media
DOE2.4.7.2	BAFL	4.11	Organic colloid transport in Fractured media
DOE2.4.7.3	BAFL	4.11	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BAFL	4.11	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BAFL	4.11	Inorganic colloid transport: Porous media
DOE2.4.8.2	BAFL	4.11	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BAFL	4.11	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BAFL	4.11	Inorganic colloid transport: Effects of ionic strength
IAEA2.2.1	FF	4.11	Inadequate design: Shaft seal failure
IAEA2.2.2	FFL	4.11	Inadequate design: Exploration borehole seal failure
PGA3.16	R	4.2.4.11	Failure of shaft sealing
SK14.2.3	BFF	4.11	Extreme channel flow of oxidants and nucleides
SK15.45	FF	4.11	Colloid generation and transport
UKN1.6.9	BAFL	4.11	Colloid formation, dissolution and transport
UKN2.2.10	FF	4.11	Poor closure
HMIP2.3.8	BAFL	4.11	Colloid transport
HMIP5.1.3	R	4.11	Incomplete near-field chemical conditioning
NEA1.6.9	BAFL	4.11	Colloid formation, dissolution, and transport
NEA2.1.6	FR	4.11	Material defects (e.g. early canister failure)
NEA2.1.8	FR	4.11	Poor quality construction
NEA2.2.1	R	4.11	Radioactive waste disposal error
NEA2.2.2	ER	4.11	Inadequate backfill or compaction voidage
NEA2.2.4	WR	4.11	Inadvertent inclusion of undesirable materials
NEA2.2.9	R	4.11	Abandonment of unsealed repository
NEA2.2.10	R	4.11	Poor closure
NEA2.2.12	R	4.11	Effects of phased operation
PGA4.2	R	XXXX	Injection of liquid waste

CONSOLIDATED FEPs LIST FOR FAR FIELD

IDENTIFIER	FEP NAME	COMMENT
5. FAR FIELD		
5.1	Rock property effects	porosity, permeability, fracture changes
5.2	Hydrogeological effects	hydraulic effects, groundwater flow
5.3	Physical/mechanical effects	seismicity, fault activation
5.4	Thermal effects	elastic, non-elastic response
5.5	Gas effects and transport	
5.6	Microbiological/biological activity	
5.7	Geochemical regime	chemical gradients & kinetics, redox potential, thermochemical
5.8	Radionuclide chemistry	solubility, speciation, sorption, complex formation
5.9	Radionuclide transport processes	advection, dispersion, diffusion
5.10	Specific factors	colloids, poor QA & design, borehole seal failure, undetected features

**FAR-FIELD CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
5.1 Rock property effects			
AECL2.14	FF	5.1.5.2	Dewatering
AECL2.51	F	5.1	Rock properties
DOE1.6.3.1	FF	5.1	Fracture changes: aperture
DOE1.6.3.2	FF	5.1	Fracture changes: length
DOE2.3.3.1	FF	5.1	Rock property changes: Porosity
DOE2.3.3.2	FF	5.1	Rock property changes: Permeability
DOE2.3.3.3	FF	5.1	Rock property changes: Microbial pore blocking
DOE2.3.3.4	FF	5.1	Rock property changes: Channel formation/closure
DOE2.4.6	FF	5.7.5.1	Fracture mineralisation
UKN1.6.11	FF	5.7.5.1	Fracture mineralisation and weathering
UKN2.1.5	FF	5.1.5.2	Dewatering of host rock
HMIP2.2.2	F	5.1	Rock property changes
5.2 Hydrogeological effects			
AECL2.11	F	5.2	Conceptual model - hydrology
AECL2.14	FF	5.1.5.2	Dewatering
AECL2.16	FL	5.2	Discharge zones
AECL2.27	F	5.4.5.2	Geothermal gradient effects
AECL2.30	F	5.2	Groundwater - evolution
AECL2.33	F	5.2	Hydraulic properties - evolution
AECL2.50	F	5.2	Recharge groundwater
AECL2.54	F	5.2	Salinity effects on flow
AECL2.55	F	5.2	Saturation
AECL2.63	F	5.2	Turbulence
AECL2.65	F	5.2	Unsaturated rock
DOE1.5.1.1	FF	5.2	Changes in moisture content due to dewatering
DOE1.5.1.2	FF	5.2.5.3	Changes in moisture content due to stress relief
DOE1.5.3	BFF	5.2	Groundwater flow (saturated conditions)
DOE1.6.4.1	F	5.2	Hydrological changes: Fluid pressure
DOE1.6.4.2	F	5.2	Hydrological changes: Density
DOE1.6.4.3	F	5.2	Hydrological changes: Viscosity
DOE2.3.4.1	FF	5.2	Groundwater flow: Darcy
DOE2.3.4.2	FF	5.2	Groundwater flow: Non-Darcy
DOE2.3.4.3	FF	5.2	Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	BFF	5.2	Groundwater flow: Fracture
DOE2.3.4.5	BFF	5.2	Groundwater flow: Effects of solution channels
DOE2.3.6	BFF	5.4.5.2	Variations in groundwater temperature
DOE2.4.12	BFF	5.6.5.2	Gas-induced groundwater transport
DOE2.4.13.2	BFF	5.4.5.2	Naturally thermally-induced groundwater transport
DOE3.3.2.4	FL	5.2	Near-surface runoff processes: Macropore flow
DOE3.3.2.5	FL	5.2	Near-surface runoff processes: Variable source area response
DOE3.3.3	F	5.2	Groundwater recharge
IAEA1.13.1	FFF	5.2	Fluid interactions: Groundwater flow
IAEA1.13.2	BFFL	5.2.5.8	Fluid interactions: Dissolution
IAEA1.13.3	BFF	5.2.5.7	Fluid interactions: Brine pockets
IAEA3.1.3	BFF	5.4.5.2	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BFF	5.4.5.2	Thermal effects: Fluid migration
PGA4.1	FF	5.2	Direct alterations in hydrogeology
SK4.2.3	BFF	5.2.5.10	Extreme channel flow of oxidants and radionuclides
SK4.2.5	BFF	5.2	Changes of groundwater flow
SK5.1	BFF	5.2	Saline (or fresh) groundwater intrusion
SK5.46	F	5.2	Groundwater recharge/discharge
SK6.13	FF	5.4.5.2	Geothermally induced flow
UKN1.5.3	F	5.2	Recharge to groundwater
UKN1.5.4	FL	5.2	Groundwater discharge (to surface water, to springs, to soils, to wells, to marine)
UKN1.5.5	F	5.2	Groundwater flow (Darcy, non-Darcy, intergranular fracture, channeling and perched)
UKN1.5.6	F	5.2	Groundwater conditions (saturated/unsaturated)
UKN2.1.5	FF	5.1.5.2	Dewatering of host rock
UKN3.1.4	FF	5.2	Induced hydrological changes (fluid pressure, density convection, viscosity)
HMIP1.5.4	BFF	5.2	Saturated groundwater flow
HMIP2.2.1	F	5.2	Changes in geometry and driving forces of the flow system
HMIP2.2.3	F	5.2	Groundwater flow
HMIP2.3.7	BFFL	5.7.5.2	Changes in groundwater chemistry and flow direction
HMIP2.3.11	BFFL	5.5.5.2	Gas induced groundwater transport
NEA1.5.3	F	5.2	Recharge to groundwater
NEA1.5.5	F	5.2	Groundwater flow (Darcy, non-Darcy, intergranular fracture, channeling and perched)
NEA1.5.6	F	5.2	Groundwater conditions (saturated/unsaturated)
NEA3.1.4	BFF	5.2	Induced hydrological changes (fluid pressure, density convection, viscosity)

**FAR-FIELD CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
5.3 Physical/mechanical effects			
DOE1.5.1.2	FF	5.2.5.3	Changes in moisture content due to stress relief
DOE2.26.1	FF	5.3	Repository-induced seismicity
DOE2.26.2	FFG	5.3	Externally-induced seismicity
DOE2.26.3	FG	5.3	Natural seismicity
SNL6.3	FF	5.4.5.3	Thermally Induced Stress/Fracturing in Host Rock
SNL6.4	FF	5.3	Excavation-induced Stress/Fracturing in Host Rock
UKN1.2.9	GF	5.3	Fault activation
UKN3.1.1	FF	5.3	Differential elastic response
UKN3.1.2	FF	5.3	Non-elastic response
UKN3.1.3	FF	5.3	Host rock fracture aperture changes
5.4 Thermal effects			
AECL2.27	F	5.4.5.2	Geothermal gradient effects
DOE1.6.1	FF	5.4	Differential elastic response
DOE1.6.2	FF	5.4	Non-elastic response
DOE2.3.6	BFF	5.4.5.2	Variations in groundwater temperature
DOE2.4.13.2	BFF	5.4.5.2	Naturally thermally-induced groundwater transport
IAEA3.1.1	FF	5.4	Thermal effects: Differential elastic response
IAEA3.1.2	FF	5.4	Thermal effects: Non-elastic response
IAEA3.1.3	BFF	5.4.5.2	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BFF	5.4.5.2	Thermal effects: Fluid migration
PGA3.7.4	FF	5.4	Differing thermal expansion of host rock zones
PGA3.8	FF	5.4	Thermal convection
SK16.13	FF	5.4.5.2	Geothermally induced flow
SNL6.3	FF	5.4.5.3	Thermally Induced Stress/Fracturing in Host Rock
UKN1.5.9	BFF	5.4	Natural thermal effects
HMIP2.3.12	BFFL	5.4	Thermal effects on hydrochemistry
NEA1.5.9	F	5.4	Natural thermal effects
5.5 Gas effects and transport			
AECL2.26	F	5.5	Gases and gas transport
AECL2.42	F	5.5	Methane
DOE1.2.6.5	F	5.5	Gas transport into and through the far-field
SK16.2	BFF	5.5.5.9	Gas transport
UKN1.6.4	BFFL	5.5.5.9	Gas mediated transport
UKN1.8.5	BFFL	5.5.5.9	Multiphase flow and gas driven flow
HMIP1.2.6	BFF	5.5.5.9	Gas transport
HMIP2.1.9	F	5.5	Effects of natural gases
HMIP2.3.10	BFFL	5.5.5.9	Transport of active gases
HMIP2.3.11	BFFL	5.5.5.2	Gas induced groundwater transport
NEA1.2.13	FF	5.5	Natural gas intrusion
NEA1.6.4	BFFL	5.5.5.9	Gas mediated transport
NEA1.8.5	BFFL	5.5.5.9	Multiphase flow and gas-driven flow
5.6 Microbiological/biological activity			
AECL2.43	F	5.6	Microbes
DOE1.6.6.2	WBFF	5.6	Microbial activity
DOE1.6.6.3	WBFF	5.6	Microbiological effects due to Microbial product reactions
DOE2.4.9	BFFL	5.6.5.9	Transport of radionuclides bound to microbes
DOE2.4.11.1	BFFL	5.6.5.9	Gas transport: solution
DOE2.4.11.2	BFFL	5.6.5.9	Gas transport: gas phase
DOE2.4.12	BFF	5.6.5.2	Gas-induced groundwater transport
PGA3.14	BFFL	5.6	Microbiological phenomena/effects
UKN1.7.7	WBFFL	5.6	Microbial interactions
HMIP2.3.9	BFFL	5.6.5.9	Transport of radionuclides bound to microbes
HMIP2.3.13	BFFL	5.6.5.7	Biogeochemical changes

**FAR-FIELD CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
5.7	Geochemical regime		
AECL2.31	F	5.7	Groundwater composition change
DOE1.6.5.5	BFF	5.7.5.8	Chemical changes due to Complex formation
DOE1.6.5.6	BFF	5.7.5.8	Chemical changes due to Colloid production
DOE1.6.5.7	BFF	5.7.5.8	Chemical changes due to Solubility
DOE1.6.5.8	BFF	5.7.5.8	Chemical changes due to Sorption
DOE1.6.5.9	BFF	5.7.5.8	Chemical changes due to Species equilibrium
DOE2.4.6	FF	5.7.5.1	Fracture mineralisation
DOE2.4.14	FR	5.7	Biogeochemical changes
IAEA1.13.3	BFF	5.2.5.7	Fluid interactions: Brine pockets
PGA1.11	FL	5.7	Weathering, mineralisation
PGA1.12	F	5.7	Groundwater changes
PGA3.12.2	FF	5.7	Geochemical changes in host rock
PGA3.13	BRFL	5.7	Physico-chemical phenomena/effects (eg. colloid formation)
SK4.1.1	BRFL	5.7	Oxidizing conditions
SK4.1.2	BRFL	5.7	pH-deviations
SK5.25	F	5.7	Dissolution of fracture fillings/precipitations
SK6.3	F	5.7	Far field hydrochemistry - acids, oxidants, nitrate
SK6.6	F	5.7	Weathering of flow paths
UKN1.5.7	BFF	5.7	Saline or freshwater intrusion
UKN1.5.8	BFF	5.7	Effects at saline-freshwater interface
UKN1.6.11	FF	5.7.5.1	Fracture mineralisation and weathering
UKN1.6.14	WCBFF	5.7	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBRFL	5.7	Chemical transformations
UKN3.2.4	FF	5.7	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)
HMIP2.3.7	BRFL	5.7.5.2	Changes in groundwater chemistry and flow direction
HMIP2.3.13	BRFL	5.6.5.7	Biogeochemical changes
NEA1.5.7	F	5.7	Saline or freshwater intrusion
NEA1.5.8	F	5.7	Effects at saline-freshwater interface
NEA1.6.11	FF	5.7	Fracture mineralisation
NEA1.6.14	BRFL	5.7	Chemical gradients (electrochemical effects and osmosis)
NEA3.2.3	FF	5.7	Interactions of waste and repository materials with host materials (electrochemical)
5.8	Radionuclide chemistry		
AECL2.10	F	5.8	Complexation by organics
AECL2.25	F	5.8	Fulvic acid
AECL2.32	F	5.8	Humic acid
AECL2.46	F	5.8	Precipitation - dissolution
AECL2.58	F	5.8	Sorption
AECL2.59	F	5.8	Sorption - non-linear
AECL2.60	F	5.8	Speciation
DOE1.6.5.5	BFF	5.7.5.8	Chemical changes due to Complex formation
DOE1.6.5.6	BFF	5.7.5.8	Chemical changes due to Colloid production
DOE1.6.5.7	BFF	5.7.5.8	Chemical changes due to Solubility
DOE1.6.5.8	BFF	5.7.5.8	Chemical changes due to Sorption
DOE1.6.5.9	BFF	5.7.5.8	Chemical changes due to Species equilibrium
DOE2.4.4.1	BRFL	5.8	Solubility: effects of pH and Eh
DOE2.4.4.2	BRFL	5.8	Solubility: effects of ionic strength
DOE2.4.4.3	BRFL	5.8	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.5	BRFL	5.8	Solubility: effects of naturally-occurring colloids
DOE2.4.4.7	FF	5.8	Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	BRFL	5.8	Solubility: Effects of microbial activity
DOE2.4.5.1	BRFL	5.8	Linear sorption
DOE2.4.5.2	BRFL	5.8	Non-linear sorption
DOE2.4.5.3	BRFL	5.8	Reversible sorption
DOE2.4.5.4	BRFL	5.8	Irreversible sorption
DOE2.4.5.5	BRFL	5.8	Sorption: Effects of pH and Eh
DOE2.4.5.6	BRFL	5.8	Sorption: Effects of ionic strength
DOE2.4.5.7	BRFL	5.8	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRFL	5.8	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.10	BRFL	5.8	Sorption: effects of naturally-occurring colloids

**FAR-FIELD CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
5.8	Radionuclide chemistry (continued)		
DOE2.4.5.12	FF	5.8	Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	BFFL	5.8	Sorption: effects of microbial activity
DOE2.4.10	BFFL	5.8	Isotopic dilution
IAEA1.13.2	BFFL	5.2,5.8	Fluid interactions: Dissolution
SK4.1.4	BFFL	5.8	Sorption
SK4.1.6	BFFL	5.8	Reconcentration
SK4.1.9	BFFL	5.8	Complexing agents
SK6.5	BFFL	5.8	Dilution
SK7.5	FF	5.8	Isotopic dilution
UKN1.6.6	BFFL	5.8	Solubility limit
UKN1.6.7	BFFL	5.8	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BFFL	5.8	Dissolution, precipitation and crystallisation
UKN1.6.10	BFFL	5.8	Complexing agents
UKN1.6.13	BFFL	5.8	Mass, isotopic and species dilution
HMP2.3.4	BFFL	5.8	Solubility constraints
HMP2.3.5	BFFL	5.8	Sorption including ion-exchange
HMP2.3.6	BFFL	5.8	Changes in sorptive surfaces
NEA1.6.6	BFFL	5.8	Solubility limit
NEA1.6.7	BFFL	5.8	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BFFL	5.8	Dissolution, precipitation, and crystallisation
NEA1.6.10	BFFL	5.8	Complexing agents
NEA1.6.13	BFFL	5.8	Mass, isotopic and species dilution
5.9	Radionuclide transport processes		
AECL2.15	F	5.9	Diffusion
AECL2.17	F	5.9	Dispersion
AECL2.39	F	5.9	Matrix diffusion
DOE2.4.1	BFF	5.9	Advection
DOE2.4.2.1	BFF	5.9	Bulk diffusion
DOE2.4.2.2	BFF	5.9	Matrix diffusion
DOE2.4.3	BFF	5.9	Hydrodynamic dispersion
DOE2.4.9	BFFL	5.6,5.9	Transport of radionuclides bound to microbes
DOE2.4.11.1	BFFL	5.6,5.9	Gas transport: solution
DOE2.4.11.2	BFFL	5.6,5.9	Gas transport: gas phase
SK4.1.5	FF	5.9	Matrix diffusion
SK6.2	BFF	5.5,5.9	Gas transport
SK6.4	BFFL	5.9	Dispersion
UKN1.6.1	BFFL	5.9	Advection and dispersion
UKN1.6.2	BFFL	5.9	Diffusion
UKN1.6.3	BFFL	5.9	Matrix diffusion
UKN1.6.4	BFFL	5.5,5.9	Gas mediated transport
UKN1.6.5	BFFL	5.5,5.9	Multiphase flow and gas driven flow
HMP1.2.6	BFF	5.5,5.9	Gas transport
HMP2.3.1	BFFL	5.9	Advection
HMP2.3.2	BFFL	5.9	Diffusion
HMP2.3.3	BFFL	5.9	Hydrodynamic dispersion
HMP2.3.9	BFFL	5.6,5.9	Transport of radionuclides bound to microbes
HMP2.3.10	BFFL	5.3,5.9	Transport of active gases
NEA1.6.1	BFFL	5.9	Advection and dispersion
NEA1.6.2	BFFL	5.9	Diffusion
NEA1.6.3	BFFL	5.9	Matrix diffusion
NEA1.6.4	BFFL	5.5,5.9	Gas mediated transport
NEA1.6.5	BFFL	5.5,5.9	Multiphase flow and gas-driven flow

**FAR-FIELD CATEGORY:
SCREENED FEPs
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
5.10	Specific factors		
AECL2.4	FF	5.10	Borehole seal failure/open boreholes
AECL2.6	HF	5.10	Boreholes - unsealed
AECL2.9	F	5.10	Colloid formation
AECL2.47	F	5.10	Pseudo-colloids
AECL2.52	F	5.10	Rock properties - undetected features
AECL2.56	F	5.10	Shaft seal failure
AECL2.66	HF	5.10	Vault closure (incomplete)
AECL2.67	FF?	5.10	Vault heating effects
DOE2.3.4.6	FF	5.10	Inorganic colloid transport: Porous media
DOE2.3.5.1	BFF	5.10	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BFF	5.10	Inorganic colloid transport: Effects of ionic strength
DOE2.4.7.1	BFRL	5.10	Organic colloid transport in Porous media
DOE2.4.7.2	BFRL	5.10	Organic colloid transport in Fractured media
DOE2.4.7.3	BFRL	5.10	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BFRL	5.10	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BFRL	5.10	Inorganic colloid transport: Porous media
DOE2.4.8.2	BFRL	5.10	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BFRL	5.10	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BFRL	5.10	Inorganic colloid transport: Effects of ionic strength
DOE4.1.1.1	RFL	5.10	Borehole seal failure
DOE4.1.1.2	RFL	5.10	Borehole seal degradation
IAEA2.2.1	FF	5.10	Inadequate design: Shaft seal failure
IAEA2.2.2	RFL	5.10	Inadequate design: Exploration borehole seal failure
SK4.2.3	BFF	5.2.5.10	Extreme channel flow of oxidants and radides
SK15.11	FF	5.10	Degradation of hole- and shaft seals
SK15.45	FF	5.10	Colloid generation and transport
SK16.1	F	5.10	Undetected fracture zones
SK16.12	F	5.10	Undetected discontinuities
SNL6.2	RFL	5.10	Shaft and Borehole Seal Degradation
UKN1.2.12	FG	5.10	Undetected features (e.g. faults, fracture networks, shear zones, brecciation,
UKN1.6.9	BFRL	5.10	Colloid formation, dissolution and transport
UKN2.1.2	RFL	5.10	Investigation borehole seal failure and degradation
UKN2.1.3	FF	5.10	Shaft or access tunnel seal failure and degradation
HMIP2.3.8	BFRL	5.10	Colloid transport
HMIP5.1.1	RFL	5.10	Loss of integrity of borehole seals
NEA1.6.9	BFRL	5.10	Colloid formation, dissolution, and transport

CONSOLIDATED FEPs LIST FOR BIOSPHERE

IDENTIFIER	FEP NAME	COMMENT
6: BIOSPHERE		
6.1	Human considerations	living conditions (space heating), land use
6.2	Ecological factors	plants, animals
6.3	Soil/sediment effects	terrestrial sediment, including organic component, peat
6.4	Surface/near-surface water processes	groundwater discharge
6.5	Coastal water/ocean processes	including deep ocean sediment
6.6	Gas effects	
6.7	Microbiological/biological activity	bioturbation,
6.8	Geochemical regime (general)	chemical gradients & kinetics, redox potential, thermochemical
6.9	Radionuclide chemistry	solubility, speciation, sorption, complex formation
6.10	Radionuclide transport processes	advection, dispersion, diffusion
6.11	Radiological factors	critical group, wind, air suspension, irrigation
6.12	Specific factors	smoking, shaft/borehole seal failure, undetected features

**BIOSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CONL CODE	FEP NAME
6.1	Human considerations		
AECL3.19	HL	6.1	Charcoal production
AECL3.49	HL	6.1	Fish farming
AECL3.54	HL	6.1.6.2	Game ranching
AECL3.60	HL	6.1	Heat storage in lakes or underground
AECL3.99	HL	6.1.6.11	Space heating
AECL3.109	HL	6.1	Urbanization on the discharge site
DOE3.1.1.5	LG	6.1.6.2	Greenhouse-induced Ecological effects
SK17.3	HL	6.1.6.2.5.12	Intrusion in accumulation zone in the biosphere
NEA2.4.6	HL	6.1	Land use changes
NEA2.4.7	HL	6.1	Agricultural and fisheries practice changes
NEA2.4.8	HL	6.1.6.12	Demographic change, urban development
6.2	Ecological factors		
AECL3.3	L	6.2	Animal grooming and fighting
AECL3.4	L	6.2	Animal soil ingestion
AECL3.5	L	6.2	Animals' diets
AECL3.54	HL	6.1.6.2	Game ranching
AECL3.63	L	6.2	Houseplants
AECL3.78	L	6.2	Plant root systems
AECL3.86	L	6.2	Scavengers and predators
AECL3.107	L	6.2.6.11	Tree sap
DOE3.1.1.5	LG	6.1.6.2	Greenhouse-induced Ecological effects
DOE3.1.2.5	LG	6.2	Glacial/interglacial cycling: Ecological effects
DOE3.4.1.1	L	6.2	Terrestrial ecological development: Agricultural systems
DOE3.4.1.2	L	6.2	Terrestrial ecological development: Semi-natural systems
DOE3.4.1.3	L	6.2	Terrestrial ecological development: Natural systems
DOE3.4.1.4	L	6.2	Terrestrial ecological development: Effects of succession
DOE3.4.2	L	6.2	Terrestrial ecological development: Estuarine
DOE3.5.10.1	L	6.2	Plants: Root uptake
DOE3.5.10.2	L	6.2	Plants: Deposition on surfaces
DOE3.5.10.3	L	6.2	Plants: Vapour uptake
DOE3.5.10.4	L	6.2	Plants: Internal translocation and retention
DOE3.5.10.5	L	6.2	Plants: Washoff and leaching by rainfall
DOE3.5.10.6	L	6.2	Plants: Leaf-fall and senescence
DOE3.5.10.7	L	6.2	Plants: Cycling processes
DOE3.5.11.1	L	6.2	Animals: Uptake by ingestion
DOE3.5.11.2	L	6.2	Animals: Uptake by inhalation
DOE3.5.11.3	L	6.2	Animals: Internal translocation and retention
DOE3.5.11.4	L	6.2	Animals: Cycling processes
DOE3.5.11.5	L	6.2	Animals: Effects of relocation and migration
SK17.3	HL	6.1.6.2.5.12	Intrusion in accumulation zone in the biosphere
UKN1.3.1	GL	6.2.6.4	Precipitation, temperature and soil water balance
UKN1.7.1	L	6.2	Plant uptake
UKN1.7.2	L	6.2	Animal uptake
UKN1.7.3	L	6.2	Uptake by deep rooting species
NEA1.7.1	L	6.2	Plant uptake
NEA1.7.2	L	6.2	Animal uptake
NEA1.7.3	L	6.2	Uptake by deep rooting species
NEA1.7.8	L	6.2	Ecological change (e.g. forest fire cycles)
NEA1.7.9	L	6.2	Ecological response to climate (e.g. desert formation)
NEA1.7.10	L	6.2	Plant and animal evolution

**BROSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
6.3	Soil/sediment effects		
AECL3.16	L	6.3	Capillary rise in soil
AECL3.65	L	6.3.6.11	Human soil ingestion
AECL3.71	L	6.3	Ionic exchange in soil
AECL3.72	L	6.3	Irrigation
AECL3.75	HL	6.3.6.4	Outdoor spraying of water
AECL3.88	L	6.3.6.4	Sediment resuspension in water bodies
AECL3.89	L	6.3	Sedimentation in water bodies
AECL3.93	L	6.3	Soil
AECL3.94	L	6.3	Soil depth
AECL3.95	L	6.3	Soil leaching
AECL3.96	L	6.3.6.8	Soil porewater pH
AECL3.97	L	6.3.6.9	Soil sorption
AECL3.98	L	6.3	Soil type
DOE3.5.2.1	L	6.3.6.4	Groundwater discharge to soils: Advective
DOE3.5.2.2	L	6.3.6.4	Groundwater discharge to soils: Diffusive
DOE3.5.2.3	L	6.3.6.4	Groundwater discharge to soils: Biotic
DOE3.5.2.4	L	6.3.6.4	Groundwater discharge to soils: Volatilisation
DOE3.5.3	L	6.3.6.4	Groundwater discharge to wells or springs
DOE3.5.4	L	6.3.6.4	Groundwater discharge to freshwaters
SK7.1	L	6.3	Accumulation in sediments
SK7.2	L	6.3	Accumulation in peat
UKN1.6.12	L	6.3	Accumulation in soils and organic debris
UKN1.7.4	L	6.3	Soil and sediment bioturbation
UKN1.7.5	L	6.3	Pedogenesis
UKN2.4.5	L	6.3.6.8	Altered soil or surface water chemistry
HMIP4.1.1	L	6.3.6.4	Groundwater discharge to soils and surface waters
HMIP4.2.1	L	6.3	Soil moisture and evaporation
HMIP4.2.3	L	6.3.6.7	Sediment transport including bioturbation
HMIP4.2.4	L	6.3.6.4,6.11	Sediment/water/gas interaction with the atmosphere
NEA1.6.12	L	6.3	Accumulation in soils and organic debris
NEA1.7.4	L	6.3	Soil and sediment bioturbation
NEA1.7.5	L	6.3	Pedogenesis
NEA2.4.5	HL	6.3	Altered soil or surface water chemistry
6.4	Surface/near-surface water processes		
AECL2.16	FL	6.4.6.5	Discharge zones
AECL3.52	L	6.4	Flushing of water bodies
AECL3.75	HL	6.3.6.4	Outdoor spraying of water
AECL3.84	L	6.4	Runoff
AECL3.88	L	6.3.6.4	Sediment resuspension in water bodies
AECL3.100	L	6.4	Surface water bodies
AECL3.101	L	6.4	Surface water pH
AECL3.112	HL	6.4.6.5	Water source
DOE3.3.2.1	L	6.4	Near-surface runoff processes: Overland flow
DOE3.3.2.2	L	6.4	Near-surface runoff processes: Interflow
DOE3.3.2.3	L	6.4	Near-surface runoff processes: Return flow
DOE3.3.2.4	FL	6.4	Near-surface runoff processes: Macropore flow
DOE3.3.2.5	FL	6.4	Near-surface runoff processes: Variable source area response
DOE3.3.4.1	L	6.4	Surface flow characteristics (freshwater): Stream/river flow
DOE3.3.4.2	L	6.4	Surface flow characteristics (freshwater): Sediment transport
DOE3.3.4.3	L	6.4	Surface flow characteristics (freshwater): Meander migration or other fluvial res
DOE3.3.4.4	L	6.4	Surface flow characteristics (freshwater): Lake formation/sedimentation
DOE3.3.4.5	L	6.4	Surface flow characteristics (freshwater): Effects of sea level change
DOE3.3.5.1	L	6.4	Surface flow characteristics (estuarine): Tidal cycling
DOE3.3.5.2	L	6.4	Surface flow characteristics (estuarine): Sediment transport
DOE3.3.5.3	L	6.4	Surface flow characteristics (estuarine): Successional development
DOE3.3.5.4	L	6.4	Surface flow characteristics (estuarine): Effects of sea level change
DOE3.5.2.1	L	6.3.6.4	Groundwater discharge to soils: Advective
DOE3.5.2.2	L	6.3.6.4	Groundwater discharge to soils: Diffusive
DOE3.5.2.3	L	6.3.6.4	Groundwater discharge to soils: Biotic

**BIOSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
6.4 Surface/near-surface water processes (continued)			
DOE3.5.2.4	L	6.3.6.4	Groundwater discharge to soils: Volatilisation
DOE3.5.3	L	6.3.6.4	Groundwater discharge to wells or springs
DOE3.5.4	L	6.3.6.4	Groundwater discharge to freshwaters
DOE3.5.7.1	L	6.4	Surface water bodies: Water flow
DOE3.5.7.2	L	6.4	Surface water bodies: Suspended sediments
DOE3.5.7.3	L	6.4	Surface water bodies: Bottom sediments
DOE3.5.7.4	L	6.4	Surface water bodies: Effects on vegetation
DOE3.5.7.5	L	6.4	Surface water bodies: Effects of fluvial system development
SKIS.4.1	HL	6.4.6.11	Water producing well
UKN1.3.1	GL	6.2.6.4	Precipitation, temperature and soil water balance
UKN1.5.4	FL	6.4	Groundwater discharge (to surface water, to springs, to soils, to wells, to marine)
HMIP4.1.1	L	6.3.6.4	Groundwater discharge to soils and surface waters
HMIP4.2.2	L	6.4	Surface water mixing
HMIP4.2.4	L	6.3.6.4.6.11	Sediment/water/gas interaction with the atmosphere
HMIP4.3.1	L	6.4	Terrestrial water use
NEA1.5.1	GL	6.4	River flow and lake level changes
NEA1.5.4	L	6.4	Groundwater discharge (to surface water, springs, soils, wells, and marine)
6.5 Coastal water/ocean processes			
AECL2.16	FL	6.4.6.5	Discharge zones
AECL3.11.2	HL	6.4.6.5	Water source
DOE3.3.6.1	L	6.5	Coastal waters: Tidal mixing
DOE3.3.6.2	L	6.5	Coastal waters: Residual current mixing
DOE3.3.6.3	L	6.5	Coastal waters: Effects of sea level change
DOE3.3.7.1	L	6.5	Ocean waters: Water exchange
DOE3.3.7.2	L	6.5	Ocean waters: Effects of sea level change
DOE3.4.3	L	6.5	Coastal waters
DOE3.4.4	L	6.5	Oceans
DOE3.5.5	L	6.5	Groundwater discharge to estuaries
DOE3.5.6	L	6.5	Groundwater discharge to coastal waters
DOE3.5.8.1	L	6.5	Estuaries: Water flow
DOE3.5.8.2	L	6.5	Estuaries: Suspended sediments
DOE3.5.8.3	L	6.5	Estuaries: Bottom sediments
DOE3.5.8.4	L	6.5	Estuaries: Effects of salinity variation
DOE3.5.8.5	L	6.5	Estuaries: Effects on vegetation
DOE3.5.8.6	L	6.5	Estuaries: Effects of estuarine development
DOE3.5.8.7	L	6.5	Estuaries: Effects of sea-level change
DOE3.5.9.1	L	6.5	Coastal waters: Water transport
DOE3.5.9.2	L	6.5	Coastal waters: Suspended sediment transport
DOE3.5.9.3	L	6.5	Coastal waters: Bottom sediment transport
DOE3.5.9.4	L	6.5	Coastal waters: Effects of sea level change
DOE3.5.9.5	L	6.5	Coastal waters: Effects of estuarine development
DOE3.5.9.6	L	6.5	Coastal waters: Effects of coastal erosion
DOE3.5.9.7	L	6.5	Coastal waters: Effects of sea-level change
HMIP4.3.2	L	6.5	Estuarine water use
HMIP4.3.3	L	6.5	Coastal waters and water use
HMIP4.3.4	L	6.5	Seas and water use
6.6 Gas effects			
AECL3.5.5	L	6.6	Gas leakage into underground living space
AECL3.8.2	L	6.6	Radon emission
DOE2.4.11.1	BAFL	6.6	Gas transport: solution
DOE2.4.11.2	BAFL	6.6	Gas transport: gas phase
UKN1.6.4	BAFL	6.6.6.10	Gas mediated transport
UKN1.6.5	BAFL	6.6.6.10	Multiphase flow and gas driven flow
HMIP2.3.10	BAFL	6.6.6.10	Transport of active gases
HMIP2.3.11	BAFL	6.6.6.10	Gas induced groundwater transport
HMIP4.1.3	L	6.6	Gas discharge
NEA1.6.4	BAFL	6.6.6.10	Gas mediated transport
NEA1.6.5	BAFL	6.6.6.10	Multiphase flow and gas-driven flow

**BIOSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
6.7	Microbiological/biological		activity
AECL3.8	L	6.7	Bacteria and microbes (soil)
AECL3.9	L	6.7	Bioconcentration
AECL3.12	L	6.7	Biotoxicity
AECL3.13	L	6.7	Bioturbation of soils and sediments
AECL3.15	L	6.7	Burrowing animals
DOE2.4.9	BFFL	6.7	Transport of radionuclides bound to microbes
DOE2.4.14	FFL	6.7,6.8	Biogeochemical changes
PGA3.14	BFFL	6.7	Microbiological phenomena/effects
UKN1.7.7	WBFFL	6.7	Microbial interactions
HMIP2.3.9	BFFL	6.7,6.10	Transport of radionuclides bound to microbes
HMIP2.3.13	BFFL	6.7,6.8	Biogeochemical changes
HMIP4.2.3	L	6.3,6.7	Sediment transport including bioturbation
HMIP4.2.5	L	6.7	Bioaccumulation and translocation
HMIP4.2.6	L	6.7,6.8	Biogeochemical processes
NEA1.7.7	L	6.7	Microbial interactions
6.8	Geochemical regime (general)		
AECL3.20	L	6.8	Chemical precipitation
AECL3.96	L	6.3,6.8	Soil porewater pH
DOE2.4.14	FFL	6.7,6.8	Biogeochemical changes
IAEA1.13.2	BFFL	6.8	Fluid interactions: Dissolution
PGA1.11	FL	6.8	Weathering, mineralisation
PGA3.13	BFFL	6.8,6.12	Physico-chemical phenomena/effects (eg. colloid formation)
SK4.1.1	BFFL	6.8	Oxidizing conditions
SK4.1.2	BFFL	6.8	pH-deviations
UKN1.7.6	WBFFL	6.8	Chemical transformations
UKN2.4.5	L	6.3,6.8	Altered soil or surface water chemistry
HMIP2.3.7	BFFL	6.8	Changes in groundwater chemistry and flow direction
HMIP2.3.12	BFFL	6.8	Thermal effects on hydrochemistry
HMIP2.3.13	BFFL	6.7,6.8	Biogeochemical changes
HMIP4.2.6	L	6.7,6.8	Biogeochemical processes
NEA1.6.14	BFFL	6.8	Chemical gradients (electrochemical effects and osmosis)
NEA1.7.6	L	6.8	Chemical transformations
6.9	Radionuclide chemistry		
AECL3.97	L	6.3,6.9	Soil sorption
DOE2.4.4.1	BFFL	6.9	Solubility: effects of pH and Eh
DOE2.4.4.2	BFFL	6.9	Solubility: effects of ionic strength
DOE2.4.4.3	BFFL	6.9	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.5	BFFL	6.9	Solubility: effects of naturally-occurring colloids
DOE2.4.4.8	BFFL	6.9	Solubility: Effects of microbial activity
DOE2.4.5.1	BFFL	6.9	Linear sorption
DOE2.4.5.2	BFFL	6.9	Non-linear sorption
DOE2.4.5.3	BFFL	6.9	Reversible sorption
DOE2.4.5.4	BFFL	6.9	Irreversible sorption
DOE2.4.5.5	BFFL	6.9	Sorption: Effects of pH and Eh
DOE2.4.5.6	BFFL	6.9	Sorption: Effects of ionic strength
DOE2.4.5.7	BFFL	6.9	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BFFL	6.9	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.10	BFFL	6.9	Sorption: effects of naturally-occurring colloids
DOE2.4.5.13	BFFL	6.9	Sorption: effects of microbial activity
DOE2.4.10	BFFL	6.9	Isotopic dilution
SK4.1.4	BFFL	6.9	Sorption
SK4.1.6	BFFL	6.9	Reconcentration
SK4.1.9	BFFL	6.9	Complexing agents
SK4.5	BFFL	6.9	Dilution
SK7.5	FFL	6.9	Isotopic dilution
UKN1.6.6	BFFL	6.9	Solubility limit
UKN1.6.7	BFFL	6.9	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BFFL	6.9	Dissolution, precipitation and crystallisation
UKN1.6.10	BFFL	6.9	Complexing agents
UKN1.6.13	BFFL	6.9	Mass, isotopic and species dilution
HMIP2.3.4	BFFL	6.9	Solubility constraints
HMIP2.3.5	BFFL	6.9	Sorption including ion-exchange
HMIP2.3.6	BFFL	6.9	Changes in sorptive surfaces
NEA1.6.6	BFFL	6.9	Solubility limit
NEA1.6.7	BFFL	6.9	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BFFL	6.9	Dissolution, precipitation, and crystallisation
NEA1.6.10	BFFL	6.9	Complexing agents
NEA1.6.13	BFFL	6.9	Mass, isotopic and species dilution

**BIOSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
6.10 Radionuclide transport processes			
AECL3.38	L	6.10	Deposition (wet and dry)
AECL3.41	L	6.10	Dispersion
SK16.4	BFFL	6.10	Dispersion
UKN1.6.1	BFFL	6.10	Advection and dispersion
UKN1.6.2	BFFL	6.10	Diffusion
UKN1.6.3	BFFL	6.10	Matrix diffusion
UKN1.6.4	BFFL	6.6.6.10	Gas mediated transport
UKN1.6.5	BFFL	6.6.6.10	Multiphase flow and gas driven flow
HMP2.3.1	BFFL	6.10	Advection
HMP2.3.2	BFFL	6.10	Diffusion
HMP2.3.3	BFFL	6.10	Hydrodynamic dispersion
HMP2.3.9	BFFL	6.7.6.10	Transport of radionuclides bound to microbes
HMP2.3.10	BFFL	6.6.6.10	Transport of active gases
HMP2.3.11	BFFL	6.6.6.10	Gas induced groundwater transport
NEA1.6.1	BFFL	6.10	Advection and dispersion
NEA1.6.2	BFFL	6.10	Diffusion
NEA1.6.3	BFFL	6.10	Matrix diffusion
NEA1.6.4	BFFL	6.6.6.10	Gas mediated transport
NEA1.6.5	BFFL	6.6.6.10	Multiphase flow and gas-driven flow
6.11 Radiological factors			
AECL3.14	L	6.11	Building materials
AECL3.17	L	6.11	Carcasses
AECL3.18	L	6.11	Carcinogenic contaminants
AECL3.26	L	6.11	Convection, turbulence and diffusion (atmospheric)
AECL3.28	L	6.11	Critical group - agricultural labour
AECL3.29	L	6.11	Critical group - clothing and home furnishings
AECL3.30	L	6.11	Critical group - evolution
AECL3.31	L	6.11	Critical group - house location
AECL3.32	L	6.11	Critical group - individuality
AECL3.33	L	6.11	Critical group - leisure pursuits
AECL3.34	L	6.11	Critical group - pets
AECL3.35	L	6.11	Dermal sorption - nuclides other than tritium
AECL3.36	L	6.11	Household dust and fumes
AECL3.37	L	6.11	Human diet
AECL3.65	L	6.3.6.11	Human soil ingestion
AECL3.79	L	6.11	Precipitation (meteoric)
AECL3.81	WL?	6.11	Radiotoxic contaminants
AECL3.91	HL	6.11	Showers and humidifiers
AECL3.99	HL	6.1.6.11	Space heating
AECL3.102	L	6.11	Suspension in air
AECL3.107	L	6.2.6.11	Tree sap
AECL3.114	GL	6.11	Wind
DOE3.6.1.1	L	6.11	External exposure: Land
DOE3.6.1.2	L	6.11	External exposure: Sediments
DOE3.6.1.3	L	6.11	External exposure: Water bodies
DOE3.6.2.1	L	6.11	Ingestion and Drinking water
DOE3.6.2.2	L	6.11	Ingestion and Agricultural crops
DOE3.6.2.3	L	6.11	Ingestion and Domestic animal products
DOE3.6.2.4	L	6.11	Ingestion and Wild plants
DOE3.6.2.5	L	6.11	Ingestion and Wild animals
DOE3.6.2.6	L	6.11	Ingestion and Soils and sediments
DOE3.6.3.1	L	6.11	Inhalation and Soils and sediments
DOE3.6.3.2	L	6.11	Inhalation and Gases and vapours (indoor)
DOE3.6.3.3	L	6.11	Inhalation and Gases and vapours (outdoor)
DOE3.6.3.4	L	6.11	Inhalation and Biotic material
DOE3.6.3.5	L	6.11	Inhalation and Salt particles
SK15.41	HL	6.4.6.11	Water producing well
HMP4.2.4	L	6.3.6.4.6.11	Sediment/water/gas interaction with the atmosphere
HMP4.4.1	L	6.11	External exposure
HMP4.4.2	L	6.11	Ingestion
HMP4.4.3	L	6.11	Inhalation

**BIOSPHERE CATEGORY:
SCREENED FEPs LIST
(screened)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
6.12	Specific factors		
AECL3.25	L	6.12	Colloids
AECL3.57	GL	6.12	Greenhouse (food production)
AECL3.92	HL	6.12	Smoking
DOE2.4.7.1	BFFL	6.12	Organic colloid transport in Porous media
DOE2.4.7.2	BFFL	6.12	Organic colloid transport in Fractured media
DOE2.4.7.3	BFFL	6.12	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BFFL	6.12	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BFFL	6.12	Inorganic colloid transport: Porous media
DOE2.4.8.2	BFFL	6.12	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BFFL	6.12	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BFFL	6.12	Inorganic colloid transport: Effects of ionic strength
DOE4.1.1.1	FFL	6.12	Borehole seal failure
DOE4.1.1.2	FFL	6.12	Borehole seal degradation
IAEA2.2.2	FFL	6.12	Inadequate design: Exploration borehole seal failure
PGA3.13	BFFL	6.8.6.12	Physico-chemical phenomena/effects (eg. colloid formation)
SK17.3	HL	6.1.6.2,6.12	Intrusion in accumulation zone in the biosphere
SNL6.2	FFL	6.12	Shaft and Borehole Seal Degradation
UKN1.6.9	BFFL	6.12	Colloid formation, dissolution and transport
UKN2.1.2	FFL	6.12	Investigation borehole seal failure and degradation
HMIP2.3.8	BFFL	6.12	Colloid transport
HMIP5.1.1	FFL	6.12	Loss of integrity of borehole seals
NEA1.6.9	BFFL	6.12	Colloid formation, dissolution, and transport
NEA2.4.6	HL	6.1.6.12	Demographic change, urban development

CONSOLIDATED FEPs LIST FOR GEOLOGY/CLIMATE

IDENTIFIER	FEP NAME	COMMENT
7. GEOLOGY/CLIMATE CHANGES		
7.1	Seismic events/major land movement	including uplift, subsidence
7.2	Rock deformation	faults, fractures
7.3	Metamorphic processes	
7.4	Erosion/weathering (surface)	including denudation and topography effects, land slide
7.5	Groundwater flow and effects	including denudation and topography effects, land slide
7.6	Surface water flow and effects	
7.7	Sea-level effects	
7.8	Magnetic effects	
7.9	Glaciation/glacial effects	including permafrost
7.10	Climate effects (natural)	general effects, including extremes
7.11	Specific factors	greenhouse-induced climate effect, undetected features, gas effects, ge

**GEOLOGY/CLIMATE CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
7.1	Seismic events/major land movement		
AECL1.31	G	7.1	Earthquakes
AECL2.20	G	7.1	Earthquakes
AECL2.36	G	7.1	Isostatic rebound
AECL3.44	G	7.1	Earthquakes
DOE2.2.1.1	G	7.1	Uplift
DOE2.2.1.2	G	7.1	Subsidence
DOE2.2.6.2	FRG	7.1	Externally-induced seismicity
DOE2.2.6.3	FG	7.1	Natural seismicity
DOE4.1.3.1	G	7.1	Subsidence and fault/fracture induction
IAEA1.1	G	7.10	Climatic change
IAEA1.14.3	G	7.1	Uplift/Subsidence: isostatic
PGA2.1	G	7.1	Earthquakes
SKI5.15	G	7.1	Earthquakes
SNL2.7	G	7.1,7.11	Tsunamis
SNL2.8	G	7.1	Regional Subsidence or Uplift (also applies to subsurface)
SNL3.2	G	7.1	Seismic Activity
UKN1.2.6	G	7.1	Uplift and subsidence (e.g. orogenic, isostatic)
UKN1.2.8	G	7.1	Seismicity
HMIP2.1.6	G	7.1	Seismicity
HMIP3.1.2	G	7.10	Natural climate change
NEA1.2.6	G	7.1	Uplift and subsidence (orogenic, isostatic)
NEA1.2.8	G	7.1	Seismicity
7.2	Rock deformation		
AECL2.23	G	7.2	Faulting
DOE1.4.6	G	7.2	Fracturing
DOE2.2.1.3	G	7.2	Lateral and/or vertical flexure
DOE2.2.7.1	G	7.2	Faulting/fracturing: Activation
DOE2.2.7.2	G	7.2	Faulting/fracturing: Generation
DOE2.2.7.3	G	7.2	Faulting/fracturing: Change of properties
DOE2.2.8	G	7.2	Major incision
IAEA1.11	G	7.2	Faulting/seismicity
PGA2.6	G	7.2	Movements at faults
PGA2.7	G	7.2	Formation of new faults
SKI4.2.6	G	7.2	Faulting
SKI5.16	G	7.2	Uplift and subsidence
SNL3.6	G	7.2	Formation of Interconnected Fracture Systems
SNL3.7	G	7.2	Faulting
UKN1.2.9	GF	7.2	Fault activation
UKN1.2.10	G	7.2	Fault generation
HMIP2.1.7	G	7.2	Faulting/fracturing
HMIP2.1.8	G	7.2	Major incision
NEA1.2.9	G	7.2	Fault activation
NEA1.2.10	G	7.2	Fault generation
7.3	Metamorphic processes		
AECL2.40	G	7.3	Metamorphic activity
DOE2.2.3.1	G	7.3	Contact metamorphism
DOE2.2.3.2	G	7.3	Regional metamorphism
DOE2.2.3.3	G	7.3	Dislocation metamorphism
PGA1.10	G	7.3	Metamorphosis
UKN1.2.4	G	7.3	Metamorphic activity
HMIP2.1.3	G	7.3	Metamorphism
NEA1.2.4	G	7.3	Metamorphic activity

**GEOLOGY/CLIMATE CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
7.4 Erosion/weathering (surface)			
AECL2.21	G	7.4	Erosion
AECL2.61	G	7.4	Topography - current
AECL2.62	G	7.4	Topography - future
AECL3.45	G	7.4	Erosion - lateral transport
DOE2.2.9	G	7.4	Weathering
DOE3.2.1.3	G	7.4	Generalised denudation: Glacial
DOE3.2.2.3	G	7.4.7.9	Localised denudation: Glacial
DOE3.2.4.2	G	7.4.7.7	Coastal erosion due to sea-level change
DOE3.5.1.3	G	7.4.7.9	Erosion: Glacial
IAEA1.4	G	7.4	Denudation
IAEA1.5	G	7.4.7.6	Stream erosion
IAEA1.6	G	7.4.7.9	Glacial erosion
IAEA1.8	G	7.4	Sedimentation
PGA1.3	G	7.4	Erosion (fluvial and glacial)
PGA1.4	G	7.4	Sedimentation
SKI5.26	G	7.4	Erosion on surface/sediments
SNL2.1	G	7.4	Erosion/Sedimentation
UKN1.4.1	G	7.4	Land slide
UKN1.4.5	G	7.4	Freshwater sediment transport and deposition
UKN1.4.6	G	7.4	Coastal erosion and estuarine development
UKN1.4.7	G	7.4	Marine sediment transport and deposition
UKN1.4.8	G	7.4	Frost weathering and solifluction
UKN1.4.9	G	7.4	Chemical denudation and weathering
UKN1.4.10	G	7.4	Frost weathering
HMIP2.4.1	G	7.4	Generalised denudation
HMIP2.4.2	G	7.4	Localised denudation
NEA1.4.1	G	7.4	Land slide
NEA1.4.9	G	7.4	Chemical denudation and weathering
NEA1.4.10	G	7.4	Frost weathering
7.5 Groundwater flow and effects			
DOE2.3.1	G	7.5	Variation in groundwater recharge
DOE2.3.2	G	7.5	Groundwater losses (direct evaporation, spring flow)
IAEA1.2	G	7.5.7.6	Hydrological change
IAEA2.6	G	7.5.7.6	Large-scale hydrological change
7.6 Surface water flow and effects			
IAEA1.2	G	7.5.7.6	Hydrological change
IAEA1.5	G	7.4.7.6	Stream erosion
IAEA1.7	G	7.6.7.10	Flooding
IAEA2.6	G	7.5.7.6	Large-scale hydrological change
UKN1.3.1	GL	7.6.7.10	Precipitation, temperature and soil water balance
UKN1.3.2	G	7.6.7.10	Extremes of precipitation, snow melt and associated flooding
UKN1.5.1	G	7.6	River flow and lake level changes
NEA1.3.1	G	7.6.7.10	Precipitation, temperature, and soil water balance
NEA1.5.1	GL	7.6	River flow and lake level changes
7.7 Sea-level effects			
DOE3.1.1.3	G	7.7.7.11	Greenhouse-induced Sea level rise
DOE3.1.2.3	G	7.7.7.9	Glacial/interglacial cycling: Sea level changes (rise/fall)
DOE3.2.4.2	G	7.4.7.7	Coastal erosion due to sea-level change
DOE3.3.1	G	7.7	Soil moisture and evaporation due to sea-level change
IAEA1.3	G	7.7	Sea level change
PGA1.2	G	7.7	Sea-level changes
SKI5.31	G	7.7	Change in sealevel
SNL2.4	G	7.7	Sea-Level Variations
UKN1.3.4	G	7.7	Sea-level rise/fall
NEA1.3.4	G	7.7	Sea-level rise/fall

**GEOLOGY/CLIMATE CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
7.8 Magnetic effects			
AECL2.38	G	7.8	Magnetic poles
AECL3.50	G	7.8	Flipping of earth's magnetic poles
SK15.20	G	7.8	Changes of the magnetic field
UKN1.2.2	G	7.8	Changes in the Earth's magnetic field
NEA1.2.2	G	7.8	Changes in the Earth's magnetic field
7.9 Glaciation/glacial effects			
AECL1.41	G	7.9	Glaciation
AECL2.28	G	7.9	Glaciation
AECL3.56	G	7.9	Glaciation
DOE3.1.2.1	G	7.9	Glacial/interglacial cycling: Precipitation
DOE3.1.2.2	G	7.9	Glacial/interglacial cycling: Temperature
DOE3.1.2.3	G	7.7,7.9	Glacial/interglacial cycling: Sea level changes (rise/fall)
DOE3.1.2.5	LG	7.9	Glacial/interglacial cycling: Ecological effects
DOE3.1.2.6	G	7.9	Glacial/interglacial cycling: Seasonally frozen ground
DOE3.1.2.7	G	7.9	Glacial/interglacial cycling: Permanently frozen ground
DOE3.1.2.8	G	7.9	Glacial/interglacial cycling: Glaciation
DOE3.1.2.9	G	7.9	Glacial/interglacial cycling: Deglaciation
DOE3.1.2.10	G	7.9	Glacial/interglacial cycling: Potential evaporation
DOE3.1.3.1	G	7.9,7.11	Glacial/interglacial exit: greenhouse gas induced
DOE3.1.3.2	G	7.9	Glacial/interglacial exit due to other causes
DOE3.2.2.3	G	7.4,7.9	Localised denudation: Glacial
DOE3.2.3.3	G	7.9	Sediment redistribution: Glacial
DOE3.5.1.3	G	7.4,7.9	Erosion: Glacial
IAEA1.6	G	7.4,7.9	Glacial erosion
SK15.17	G	7.9	Permafrost
SK15.22	GR	7.9,7.11	Accumulation of gases under permafrost
SK15.42	G	7.9	Glaciation
SK16.10	G	7.9,7.10	No ice age
SNL2.2	G	7.9	Glaciation
UKN1.3.5	G	7.9	Periglacial effects (eg. permafrost, high seasonality)
UKN1.3.6	G	7.9	Glaciation (erosion/deposition, glacial loading, hydrogeological change)
HMIP3.1.3	G	7.9,7.10	Exit from glacial/interglacial cycling
NEA1.3.5	G	7.9	Periglacial effects (permafrost, high seasonality)
NEA1.3.6	G	7.9	Glaciation (erosion/deposition, glacial loading, hydrogeological change)
NEA1.3.7	G	7.9,7.10	No ice age
7.10 Climate effects (natural)			
AECL1.14	G	7.10	Climate change
AECL2.8	G	7.10	Climate change
AECL3.22	G	7.10	Climate
AECL3.23	G	7.10	Climate - evolution
IAEA1.1	G	7.10	Climatic change
IAEA1.7	G	7.6,7.10	Flooding
IAEA2.5	G	7.10	Climatic change (including climate control)
PGA1.1	G	7.10	Climate changes
SK16.10	G	7.9,7.10	No ice age
SNL2.3	G	7.10	Pluvial Periods
UKN1.1.2	G	7.10	Solar insolation
UKN1.3.1	CL	7.6,7.10	Precipitation, temperature and soil water balance
UKN1.3.2	G	7.6,7.10	Extremes of precipitation, snow melt and associated flooding
UKN1.3.7	G	7.10	No ice age
HMIP3.1.2	G	7.10	Natural climate change
HMIP3.1.3	G	7.9,7.10	Exit from glacial/interglacial cycling
HMIP3.1.4	G	7.10	Intensification of natural climate change
NEA1.1.2	G	7.10	Solar insolation
NEA1.3.1	G	7.6,7.10	Precipitation, temperature, and soil water balance
NEA1.3.2	G	7.10	Extremes of precipitation, snow melt and associated flooding
NEA1.3.7	G	7.9,7.10	No ice age

**GEOLOGY/CLIMATE CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CONL CODE	FEP NAME
7.11	Specific factors		
AECL2.29	G	7.11	Greenhouse effect
AECL3.57	GL	7.11	Greenhouse (food production)
AECL3.58	G	7.11	Greenhouse effect
AECL3.59	G	7.11	Groundshine, treeshine
AECL3.114	GL	7.11	Wind
DOE2.2.10	G	7.11	Effects of natural gases
DOE2.2.11	G	7.11	Geothermal effects
DOE3.1.1.1	G	7.11	Greenhouse-induced Precipitation
DOE3.1.1.2	G	7.11	Greenhouse-induced Temperature
DOE3.1.1.3	G	7.7.7.11	Greenhouse-induced Sea level rise
DOE3.1.1.5	LG	7.11	Greenhouse-induced Ecological effects
DOE3.1.1.6	G	7.11	Greenhouse-induced Potential evaporation
DOE3.1.3.1	G	7.9.7.11	Glacial/interglacial exit: greenhouse gas induced
IAEA1.12	G	7.11	Geochemical change
IAEA1.15.1	G	7.11	Undetected features: Faults, shear zones
IAEA1.15.2	G	7.11	Undetected features: Breccia pipes
IAEA1.15.3	G	7.11	Undetected features: Lava tubes
IAEA1.15.4	G	7.11	Undetected features: Intrusive dykes
IAEA1.15.5	G	7.11	Undetected features: Gas or brine pockets
SK15.22	GR	7.9.7.11	Accumulation of gases under permafrost
SK15.43	GR	7.11	Methane intrusion
SNL2.7	G	7.1.7.11	Tsunamis
UKN1.2.11	G	7.11	Rock heterogeneity (e.g. permeability, mineralogy) affecting water and gas flow
UKN1.2.12	FG	7.11	Undetected features (e.g. faults, fracture networks, shear zones, brecciation, gas flow)
UKN2.4.9	HG	7.11	Anthropogenic climate change (greenhouse effect)
HMIPS.1.1	HG	7.11	Human induced climate change
NEA1.2.11	G	7.11	Rock heterogeneity (permeability, mineralogy), affecting water and gas flow
NEA1.2.12	G	7.11	Undetected features (faults, fracture networks, shear zones, brecciation, gas flow)
NEA2.4.9	HG	7.11	Anthropogenic climate change (greenhouse effect)
IAEA1.14.1	G	XXXX	Uplift/Subsidence: Orogenic
IAEA1.14.2	G	XXXX	Uplift/Subsidence: Epeirogenic

CONSOLIDATED FEPs LIST FOR HUMAN INFLUENCES

IDENTIFIER	FEP NAME	COMMENT
8. HUMAN INFLUENCES		
8.1	Inadvertent intrusion	drilling (boreholes), archaeological investigations
8.2	Surface activities	land/earth moving, land use practices (non-agricultural)
8.3	Subsurface activities	tunneling, underground construction, injection of liquid wastes
8.4	Water use	groundwater abstraction (wells), industrial, geothermal
8.5	Agricultural and fisheries practices	charcoal production, farming
8.6	Radiological factors	smoking, transport agents
8.7	Specific factors	shaft/borehole seal failure, undetected features, urbanisation, loss of records

**HUMAN FACTORS CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
8.1	Inadvertent intrusion		
AECL1.52	H	8.1	Intrusion (human)
AECL2.5	H	8.1	Boreholes - exploration
AECL3.70	H	8.1	Intrusion (inadvertent)
DOE4.2.3	H	8.1	Exploratory drilling
DOE4.2.10	H	8.1	Archaeological investigations
IAEA2.8.1	H	8.1	Inadvertent future intrusion: Exploratory drilling
IAEA2.8.2	H	8.1	Inadvertent future intrusion: Archaeological exhumation
IAEA2.8.3	H	8.1	Inadvertent future intrusion: Resource mining (mineral, water, hydrocarbon, ge)
PGA4.3.2	H	8.1	Drilling in host rock
SKI5.21	H	8.1.8.7	Future boreholes and undetected past boreholes
SKI5.36	H	8.1	Reuse of boreholes
SKI5.37	H	8.1	Archaeological intrusion
SKI7.3	HL	8.1	Intrusion in accumulation zone in the biosphere
SNL4.1	H	8.1	Inadvertent Intrusions: Explosions
SNL4.2	H	8.1	Inadvertent Intrusions: Drilling
SNL4.4	H	8.1	Inadvertent Intrusions: Injection Wells
SNL4.5	H	8.1	Inadvertent Intrusions: Withdrawal Wells
UKN2.3.3	H	8.1	Exploratory drilling
UKN2.3.9	H	8.1	Archaeological investigation
HMIP5.2.4	H	8.1	Accidental intrusion
NEA2.3.3	H	8.1	Exploratory drilling
NEA2.3.9	H	8.1	Archaeological investigation
8.2	Surface activities		
AECL2.19	H	8.2	Earthmoving
SKI7.7	H	8.2	Human induced changes in surface hydrology
SKI7.8	H	8.2.8.4	Altered surface water chemistry by humans
SNL5.1	H	8.2.8.4	Hydrologic Stresses: Irrigation
SNL5.2	H	8.2	Hydrologic Stresses: Damming of Streams or Rivers
UKN2.4.6	H	8.2	Land use changes
NEA2.4.5	HL	8.2.8.4	Altered soil or surface water chemistry
NEA2.4.6	HL	8.2	Land use changes
8.3	Subsurface activities		
AECL2.14	HF	8.3	Dewatering
AECL2.69	H	8.3	Wells
AECL2.70	H	8.3	Wells (high demand)
AECL3.60	HL	8.3.8.4	Heat storage in lakes or underground
DOE4.2.5	H	8.3	Geothermal energy production
DOE4.2.7	H	8.3	Tunneling
DOE4.2.8	H	8.3	Construction of underground storage/disposal facilities
DCE4.2.9	H	8.3	Construction of underground dwellings/shelters
DOE4.2.11	H	8.3	Injection of liquid wastes
PGA4.2	H	8.3	Injection of liquid waste
PGA4.4	H	8.3	Geothermal energy production in crystalline rock
SKI5.28	H	8.3	Underground dwellings
SKI5.34	H	8.3	Geothermal energy production
UKN2.3.5	H	8.3	Geothermal energy production
UKN2.3.7	H	8.3	Tunneling
UKN2.3.8	H	8.3	Underground construction
UKN2.3.10	H	8.3	Injection of liquid wastes
NEA2.3.5	H	8.3	Geothermal energy production
NEA2.3.7	H	8.3	Tunneling
NEA2.3.8	H	8.3	Underground construction
NEA2.3.10	H	8.3	Injection of liquid wastes

**HUMAN FACTORS CATEGORY:
SCREENED FEPs LIST
(sorted)**

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
8.4 Water use			
AECL3.60	HL	8.3.8.4	Heat storage in lakes or underground
AECL3.67	H	8.4	Industrial use of water
AECL3.75	HL	8.4.8.6	Outdoor spraying of water
AECL3.112	HL	8.4	Water source
DOE4.2.12	H	8.4	Groundwater abstraction
SK15.27	H	8.4	Human induced actions on groundwater recharge
SK15.41	HL	8.4	Water producing well
SK17.8	H	8.2.8.4	Altered surface water chemistry by humans
SNL5.1	H	8.2.8.4	Hydrologic Stresses: Irrigation
UKN2.3.11	H	8.4	Groundwater abstraction
UKN2.4.4	H	8.4.8.5	Irrigation
NEA2.3.11	H	8.4	Groundwater abstraction
NEA2.4.4	H	8.4.8.5	Irrigation
NEA2.4.5	HL	8.2.8.4	Altered soil or surface water chemistry
8.5 Agricultural and fisheries practices			
AECL3.19	HL	8.5	Charcoal production
AECL3.49	HL	8.5	Fish farming
AECL3.54	HL	8.5	Game ranching
UKN2.4.4	H	8.4.8.5	Irrigation
UKN2.4.7	H	8.5	Agricultural and fisheries practice changes
NEA2.4.4	H	8.4.8.5	Irrigation
NEA2.4.7	HL	8.5	Agricultural and fisheries practice changes
8.6 Radiological factors			
AECL3.53	H	8.6	Food preparation
AECL3.75	HL	8.4.8.6	Outdoor spraying of water
AECL3.91	HL	8.6	Showers and humidifiers
AECL3.92	HL	8.6	Smoking
AECL3.99	HL	8.6	Space heating
IAEA2.4.1	H	8.6	Transport agent introduction: Irrigation
IAEA2.4.2	H	8.6	Transport agent introduction: Reservoirs
IAEA2.4.3	H	8.6	Transport agent introduction: Intentional artificial groundwater Recharge or withdrawal
IAEA2.4.4	H	8.6	Transport agent introduction: Chemical liquid waste disposal
8.7 Specific factors			
AECL2.6	HFF	8.7	Boreholes - unsealed
AECL2.66	HF	8.7	Vault closure (incomplete)
AECL3.109	HL	8.7	Urbanization on the discharge site
IAEA2.1.1	H	8.7	Undetected past intrusion: Boreholes
IAEA2.1.2	H	8.7	Undetected past intrusion: Mine shafts
SK15.2	H	8.7	Non-sealed repository
SK15.3	H	8.7	Stray materials left
SK15.4	H	8.7	Decontamination materials left
SK15.9	H	8.7	Unsealed boreholes and/or shafts
SK15.21	H	8.1.8.7	Future boreholes and undetected past boreholes
SK16.8	H	8.7	Human induced climate change
SK17.9	H	8.7	Loss of records
SK17.11	H	8.7	City on the site
UKN2.1.1	H	8.7	Undetected past intrusions, (eg. boreholes, mining)
UKN2.2.1	H	8.7	Radioactive waste disposal error
UKN2.2.2	HB	8.7	Inadequate backfill or compaction, voidage
UKN2.2.4	WH	8.7	Inadvertent inclusion of undesirable materials
UKN2.2.9	H	8.7	Abandonment of unsealed repository
UKN2.2.10	PH	8.7	Poor closure
UKN2.2.12	HD	8.7	Effects of phased operation
UKN2.4.1	H	8.7	Loss of records
UKN2.4.8	H	8.7	Demographic change, urban development
UKN2.4.9	HG	8.7	Anthropogenic climate change (greenhouse effect)
HMIP3.1.1	HG	8.7	Human induced climate change
NEA2.1.1	H	8.7	Undetected past intrusions (boreholes, mining)
NEA2.1.7	HR	8.7	Common cause failures
NEA2.1.8	HR	8.7	Poor quality construction
NEA2.4.1	H	8.7	Loss of records
NEA2.4.8	HL	8.7	Demographic change, urban development
NEA2.4.9	HG	8.7	Anthropogenic climate change (greenhouse effect)

HUMAN FACTORS CATEGORY:
SCREENED FEPs LIST
(sorted)

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
OTHER (not relevant)			
NEA2.1.2	HR	XXXX	Investigation borehole seal failure and degradation
NEA2.1.3	HR	XXXX	Shaft or access tunnel seal failure and degradation
NEA2.1.4	HR	XXXX	Stress field changes, settling, subsidence or caving
NEA2.1.5	HR	XXXX	Dewatering of host rock

APPENDIX 6
Final List of FEPs

Appendix 6. Final List of FEPs

The following pages (13) contain the final list of FEPs generated as a result of the audit held at Kemakta on April 21st, 1993. Additions to FEP descriptions, based on discussions during the audit, have been added in parentheses, mainly in UPPER CASE.

The key to the coding (letters) added to the left-hand column of the tables (AUDIT CODE) is given below.

- EFEP A feature, event or process (FEP) which is external to the Process System.
- F new FEP
- L new link in the influence diagram
- L* new link to other parts of the Process System
(*e.g.* far-field, biosphere)

The eight categories have been retained for FEP descriptions. For the biosphere, several FEP descriptions may be combined. Rather than reduce these FEPs to one entry, however, the original descriptions have been retained and 'group' has been added to one of the first two columns. Shading has also been added, where appropriate, to help identify individual groups.

AUDIT	CODE	FEP NAME	Waste characteristics (initial): SYSTEM DESCRIPTION
			Inventory
			Long-term physical stability
			Heterogeneity of waste forms (chemical, physical)
			Waste: radionuclide decay and growth
			Waste: radiological/radiation effects
			Radionuclides
	L		Radiation damage of the matrix including embrittlement
			Recoil of alpha-decay
			Gas generation: He production
			Waste: gas generation and effects
			Formation of gases
	L		Active methane, carbon dioxide and other active gases
			Chemical changes due to gas production
			Hydrogen by metal corrosion
			Waste: heat generation
			Radioactive decay: heat
			Waste: thermo-mechanical effects
			Thermal cracking
			Material property changes
			Waste: thermo-chemical effects
			Thermally induced chemical changes (water chemistry)
	F		Waste: electro-chemical effects
			Electrochemical gradients
	L		Electrical effects of metal corrosion
			Waste: degradation/corrosion/dissolution
			Precipitation and dissolution
			Source terms (expected)
			Source terms (other)
			Metal corrosion: wastes
			Leaching: wastes
			Chemical changes due to metal corrosion
			Internal corrosion due to waste
			Metallic corrosion (pitting/uniform, internal and external agents, gas generation eg. H2)
			Fracturing
			Waste: geochemical reactions/regime
			Chemical gradients, osmosis (INCLUDE in FEP description)
			Chemical kinetics (INCLUDE in FEP description)
			Complex formation: wastes
	L		Chemical changes due to metal corrosion
			Chemical changes due to gas production
			Chemical effects: geochemical change
			Solubility within fuel matrix
			Recrystallization
			Redox potential
			Dissolution chemistry
			Interactions with corrosion products and waste
			Waste: radionuclide chemistry
			Speciation
			Complex formation: wastes
			Solubility within fuel matrix
			Recrystallization
			Solubility and precipitation
			Waste: specific factors
			Colloid formation: wastes
			Cs-migration to fuel surface
			Damaged or deviating fuel
	F		Role of the eventual channeling within the canister (new FEP: PREFERENTIAL PATHWAYS)

FINAL FEPs: CANISTER

AUDIT CODE	FEP NAME
	Canister materials/construction: SYSTEM DESCRIPTION
	Inventory
	Canister: corrosion/degradation processes
EFEF	Container failure (early)
	Container failure (long-term)
	Container healing (include in FEP description: corrosion)
	Corrosion (including partial corrosion)
	Pitting
	Precipitation and dissolution
F	Radiation damage to container (embrittlement)
	Uniform corrosion
	Structural container metal corrosion: localised
	Structural container metal corrosion: bulk
	Structural container metal corrosion: crevice
	Structural container metal corrosion: stress corrosion cracking
	Chemical changes due to metal corrosion
	Chemical reactions (copper corrosion)
	Role of chlorides in copper corrosion
	Corrosive agents, Sulphides, oxygen etc
	Backfill effects on Cu corrosion
	Swelling of corrosion products
	Canister: gas production and effects
	Hydrogen: corrosion of container steel
	Gas transport in the waste container
	Canister: microbiological effects/microbial activity
	Canister: thermo-mechanical effects
F	Differing thermal expansion of canister and backfill
L	Thermal cracking
	Canister: electro-chemical effects
F	Electrochemical gradients
L	Coupled effects (electrophoresis)
	Natural telluric electrochemical reactions (INCLUDE in FEP description)
	Canister: stress/mechanical effects
EFEF	Container failure (early)
	Canister movement
	Mechanical canister damage (failure)
	Creeping of copper
	Stress corrosion cracking
EFEF	Loss of ductility
	Cracking along welds
	External stress
	Hydrostatic pressure on canister
	Internal pressure
	Swelling of corrosion products
	Canister: geochemical reactions/regime
	Chemical kinetics
	Container corrosion products
	Precipitation and dissolution
	Speciation of corrosion products (INCLUDE in water chemistry)
	Chemical effects: Interactions of waste package and rock
	Chemical gradients (electrochemical effects and osmosis)
	Canister: radionuclide transport through containers
	Release of radionuclides from the failed canister
	Canister: specific factors
	Role of the eventual channeling within the canister (PREFERENTIAL PATHWAYS)
	Radiation effects on canister
EFEF	Random canister defects - quality control
EFEF	Common cause canister defects - quality control
EFEF	Material defects, e.g. early canister failure

FINAL FEPs: BUFFER/BACKFILL

AUDIT	
CODE	FEP NAME
	Buffer/backfill characteristics: SYSTEM DESCRIPTION
	Backfill characteristics
	Hydraulic conductivity
	Long-term physical stability
	Buffer/backfill: resaturation/desaturation
	Buffer/backfill: mechanical effects
F	Preferential pathways in the buffer/backfill
	Mechanical effects: local fractures/cracks (PREFERENTIAL PATHWAYS)
	Mechanical failure of buffer/backfill (PREFERENTIAL PATHWAYS)
	Swelling pressure
	Movement of canister in buffer/backfill
	Uneven swelling of bentonite
	Swelling of corrosion products
	Buffer/backfill: thermal effects
	Convection (contaminant transport)
	Hydrothermal alteration
	Variations in groundwater temperature
	Differing thermal expansion (canister-backfill; buffer-host rock)
	Thermal effects on the buffer material
	Soret effect
L*	Natural thermal effects (temperature LINK to FAR FIELD)
L*	Thermal effects (eg. concrete hydration: LINK to FAR FIELD)
	Thermo-chemical effects
	Thermal effects and transport (diffusion) effects
	Buffer/backfill: electro-chemical effects
	Natural telluric electrochemical reactions
	Buffer/backfill: gas effects
	Groundwater flow due to gas production
	Gas transport: gas phase and in solution
	Chemical effects: gas generation
L	Transport of active gases
	Buffer/backfill: microbiological effects/microbial activity
	Buffer/backfill: degradation
	Degradation of the bentonite by chemical reactions
	Coagulation of bentonite
	Radiation effects on bentonite
	Erosion of buffer/backfill

FINAL FEPs: BUFFER/BACKFILL

AUDIT	
CODE	FEP NAME
	Buffer/backfill: geochemical regime
	Chemical gradients (INCLUDE in FEP description: water chemistry)
	Chemical kinetics (INCLUDE in FEP description: water chemistry)
	Precipitation and dissolution
	Chemical changes due to waste degradation (CHEMICAL CHANGES)
L	Chemical changes due to gas production (CHEMICAL CHANGES)
	Chemical changes due to complex formation (CHEMICAL CHANGES)
	Chemical changes due to colloid production (CHEMICAL CHANGES)
	Chemical changes due to sorption (CHEMICAL CHANGES)
	Chemical changes due to speciation (CHEMICAL CHANGES)
F	Isotopic dilution
	Chemical changes due to corrosion
	Saturation of sorption sites
	Effects of bentonite on groundwater chemistry
	Reactions with cement pore water (INCLUDE in chemical degradation)
	Redox front
	Thermochemical changes
	Saline (or fresh) groundwater intrusion
	Effects at saline-freshwater interface
	Changes in groundwater flow direction (INCLUDE in FEP description)
L	Biogeochemical changes
	Buffer/backfill: radionuclide transport processes
	Groundwater flow; advection/dispersion (saturated conditions)
L	Diffusion (bulk, matrix, surface)
FLL	Unsaturated transport:
	Groundwater flow: fracture
L	Groundwater flow: effects of solution channels (PREFERENTIAL PATHWAYS)
	Soret effect
FEP	Transport of chemically active substances into the near-field
	Buffer/backfill: radionuclide chemistry
	Precipitation, dissolution, recrystallisation, reconcentration
	Sorption (linear, non-linear, irreversible)
	Speciation
	Solubility effects (pH and Eh; ionic strength, complexing agents, colloids)
	Sorption effects (pH and Eh; ionic strength, complexing agents, colloids)
	Changes in sorptive surfaces
	Transport of radionuclides bound to microbes
	Buffer/backfill: specific factors
FEP	Faulty buffer emplacement
	Colloid transport (inorganic and organic; porous and fractured media)
	Extreme channel flow of oxidants and nuclides (PREFERENTIAL PATHWAYS)
FEP	Inadequate backfill or compaction, voidage
	Anion exchange

FINAL FEPs: REPOSITORY/NEAR-FIELD ROCK

AUDIT CODE	FEP NAME
	Near-field rock: elements/materials: SYSTEM DESCRIPTION
	Inventory
	Vault geometry
	Rock properties (porosity, permeability, hydraulic head, conductivity)
	Near-field rock: degradation
	Rock property changes (fractures, pore blocking, channel formation/closure)
	Borehole seal failure (including investigation boreholes and shaft/tunnel)
	Borehole seal degradation (including investigation boreholes and shaft/tunnel)
	Creeping of rock mass
	Subsidence and caving
	Physico-chemical degradation of concrete
	Near-field rock: hydraulic effects/groundwater flow
F L L	Unsaturated transport
	Groundwater flow due to gas production
	Groundwater flow (saturated conditions; including fracture flow)
L	Groundwater flow: effects of solution channels (PREFERENTIAL PATHWAYS)
L	Repository thermally-induced groundwater transport
L	Naturally thermally-induced groundwater transport
	Thermo-hydro-mechanical effects
	Resaturation
	Disturbed zone (hydromechanical) effects
	Saturated groundwater flow
	Changes in groundwater chemistry and flow direction
	Near-field rock: mechanical effects
	Formation of cracks
L	Changes in in-situ stress field
	Changes in moisture content due to stress relief
F	Differential elastic response
F	Non-elastic response
FEP	Repository-induced seismicity
FEP	Externally-induced seismicity
	Differing thermal expansion of host rock zones
FEP	Uneven swelling of bentonite
	Thermally-induced stress/fracturing in host rock
	Excavation-induced stress/fracturing in host rock
4.5	Near-field rock: thermal effects
	Convection
	Hydrothermal alteration
	Variations in groundwater temperature
	Thermal effects (e.g. concrete hydration)
	Thermal effects and transport (diffusion) properties
	Thermal effects on hydrochemistry
L	Thermal differential elastic response
L	Thermal non-elastic response
	Near-field rock: gas effects and transport
	Transport in gases or of gases
	Hydrogen: corrosion of structural steel
	Methane/CO2 production: effects of microbial growth on properties of concrete
	Gas transport in the near field, as gas phase and in solution
	Accumulation of gases under permafrost
FEP	Methane intrusion
	Transport of active gases

FINAL FEPs: REPOSITORY/NEAR-FIELD ROCK

AUDIT	
CODE	FEP NAME
	Near-field rock: microbiological/biological activity
	Microbial activity
	Transport of microbes into the near-field
	Rock property changes: microbial pore blocking
	Biogeochemical changes
	Near-field rock: geochemical regime
	Chemical gradients (INCLUDE in FEP description: water chemistry)
	Chemical kinetics (INCLUDE in FEP description: water chemistry)
	Pore blockage: concrete
	Cement-sulphate reaction: concrete
	Changes in pore water composition, pH, Eh: concrete
	Chemical changes due to waste degradation (CHEMICAL CHANGES)
L	Chemical changes due to gas production (CHEMICAL CHANGES)
	Chemical changes due to complex formation (CHEMICAL CHANGES)
	Chemical changes due to colloid production (CHEMICAL CHANGES)
	Chemical changes due to sorption (CHEMICAL CHANGES)
	Chemical changes due to speciation (CHEMICAL CHANGES)
	Fracture mineralisation
	Fluid interactions: dissolution
	Chemical effects: interactions of waste package and rock
	Physico-chemical phenomena/effects (eg. colloid formation)
	Reconcentration
	Thermochemical changes
	Chemical effects of rock reinforcement
EFP	Saline (or fresh) groundwater intrusion
	Effects at saline-freshwater interface
	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)
	Physico-chemical degradation of concrete
	Changes in groundwater flow direction
	Near-field rock: radionuclide chemistry
	Precipitation, dissolution, recrystallisation, reconcentration
	Sorption (linear, non-linear, irreversible)
	Speciation
	Solubility effects (pH and Eh; ionic strength, complexing agents, colloids)
	Sorption effects (pH and Eh; ionic strength, complexing agents, colloids)
	Changes in sorptive surfaces
	Dilution (mass, isotopic, species)
	Near-field rock: radionuclide transport processes
	Groundwater flow; advection/dispersion (saturated conditions)
L	Diffusion (bulk, matrix, surface)
	Soret effect
	Transport of radionuclides bound to microbes
	Near-field rock: specific factors
	Colloids
EFP	Incomplete vault or borehole closure
EFP	Unmodelled design features
EFP	Inadequate design: shaft seal and exploration borehole seal failure
EFP	Open boreholes
	Extreme channel flow of oxidants and nuclides (PREFERENTIAL PATHWAYS)
EFP	Poor quality construction
EFP	Material defects (e.g. early canister failure)
EFP	Abandonment of unsealed repository
EFP	Effects of phased operations

FINAL FEPs: FAR-FIELD

AUDIT CODE	FEP NAME
	Rock properties: SYSTEM DESCRIPTION
	Rock properties (porosity, permeability, discharge zones, fractures)
	Hydrogeological effects
	Rock property changes (porosity, permeability, fractures, pore blocking)
	Dewatering
	Geothermal gradient effects
	Salinity effects on flow
	Saturated groundwater flow
	Variations in groundwater temperature
	Gas-induced groundwater transport
	Naturally thermally-induced groundwater transport
	Groundwater recharge
	Thermal effects: fluid pressure, density, viscosity changes
	Thermal effects: fluid migration
BFP	Saline (or fresh) groundwater intrusion
	Groundwater conditions (saturated/unsaturated)
	Changes in geometry and driving forces of the flow system
	Changes in groundwater flow direction
	Physical/mechanical effects
BFP	Repository-induced seismicity
BFP	Externally-induced seismicity
	Fault activation
F	Differential elastic response
F	Non-elastic response
	Thermal effects
	Geothermal gradient effects
L	Thermal differential elastic response
L	Thermal non-elastic response
	Gas effects and transport
	Gas transport into and through the far-field (gas phase and in solution)
	Multiphase flow and gas driven flow
	Effects of natural gases
	Transport of active gases
	Microbiological/biological activity
	Microbial activity
	Transport of radionuclides bound to microbes
L	Biogeochemical changes

AUDIT CODE	FEP NAME
	Geochemical regime
	Groundwater composition changes (pH, Eh, chemical composition)
	Fracture mineralisation
	Weathering, mineralisation
	Dissolution of fracture fillings/precipitations
L	Far field hydrochemistry - acids, oxidants, nitrate
EFE	Saline or freshwater intrusion
EFE	Effects at saline-freshwater interface
	Chemical gradients (electrochemical effects and osmosis)
L*	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sorption)
	(LINK to NEAR FIELD)
	Radionuclide chemistry
	Complexation by organics (including humic and fulvic acids)
	Precipitation, dissolution, recrystallisation, reconcentration
	Sorption (linear, non-linear, irreversible)
	Speciation
	Chemical changes due to sorption, complex formation, speciation, gas, solubility
	Solubility effects (pH and Eh; ionic strength, complexing agents, colloids)
	Sorption effects (pH and Eh; ionic strength, complexing agents, colloids)
	Changes in sorptive surfaces
	Transport of radionuclides bound to microbes
	Dilution (mass, isotopic, species)
5.9	Radionuclide transport processes
	Groundwater flow; advection/dispersion (saturated conditions)
	Diffusion (bulk, matrix, surface)
FLL	Unsaturated transport
	Groundwater flow: fracture
L	Groundwater flow: effects of solution channels (PREFERENTIAL PATHWAYS)
	Soret effect
	Transport of radionuclides bound to microbes
	Gas-mediated transport
	Specific factors
EFE	Boreholes - unsealed
	Colloids: formation & effects (including inorganic and organic colloid transport)
EFE	Incomplete vault closure
EFE	Rock properties - undetected features
EFE	Inadequate design: shaft seal or exploration borehole seal failure
EFE	Extreme channel flow of oxidants and nuclides
EFE	Undetected features (e.g. faults, fracture networks, shear zones, discontinuities, gas)
	Shaft and borehole seal degradation

FINAL FEPs: BIOSPHERE

AUDIT	
CODE	FEP NAME
	Human considerations
	Charcoal production
	Space heating
EFP	Land use changes
	Ecological factors
	Animal habits (grooming and fighting, soil ingestion, diets, scavengers/predators)
	Houseplants
	Tree sap
	Terrestrial ecological development: natural and agricultural systems
	Terrestrial ecological development: Effects of succession
	Terrestrial ecological development: Estuarine
	Plants: Root uptake, including deep-rooting species (PLANTS)
	Plants: Deposition on surfaces (PLANTS)
	Plants: Vapour uptake (PLANTS)
	Plants: Internal translocation and retention (PLANTS)
	Plants: Washoff and leaching by rainfall (PLANTS)
	Plants: Leaf-fall and senescence (PLANTS)
	Plants: Cycling processes (PLANTS)
	Animals: Uptake by ingestion (ANIMALS)
	Animals: Uptake by inhalation (ANIMALS)
	Animals: Internal translocation and retention (ANIMALS)
	Animals: Cycling processes (ANIMALS)
	Animals: Effects of relocation and migration (ANIMALS)
	Precipitation, temperature and soil water balance
	Ecological change (e.g. forest fire cycles)
L*	Ecological response to climate, including glacial/interglacial cycling (e.g. desert formation)
	(LINK to CLIMATE)
	Soil/sediment effects
	Capillary rise in soil
	Soil properties (type, depth, porewater pH, moisture, sorption)
	Soil leaching
	Ionic exchange in soil
	Sediment resuspension in water bodies
	Sedimentation in water bodies
	Groundwater discharge to soils: advective, diffusive, biotic, volatilisation
	Accumulation in sediments
	Accumulation in soils and organic debris, including peat
	Pedogenesis
	Evaporation of soil moisture
	Surface/near-surface water processes
	Groundwater discharge (to surface water, springs, and wells)
	Flushing of water bodies
	Surface water bodies: properties (e.g. pH)
	Near-surface runoff processes: overland flow, interflow, return flow, macropore flow
	Near-surface runoff processes: Variable source area response
group	Surface flow characteristics (freshwater): Stream/river flow
group	Surface flow characteristics (freshwater): Sediment transport
group	Surface flow characteristics (freshwater): Meander migration or other fluvial response
group	Surface flow characteristics (freshwater): Lake formation/sedimentation
group	Surface flow characteristics (freshwater): Effects of sea level change
group	Surface flow characteristics (estuarine): Tidal cycling
group	Surface flow characteristics (estuarine): Sediment transport
group	Surface flow characteristics (estuarine): Successional development
group	Surface flow characteristics (estuarine): Effects of sea level change
group	Surface water bodies: Water flow
group	Surface water bodies: Suspended sediments
group	Surface water bodies: Bottom sediments
group	Surface water bodies: Effects on vegetation
group	Surface water bodies: Effects of fluvial system development
	Surface water mixing
	Sediment/water/gas interaction with the atmosphere
	Terrestrial water use (including well)
	River flow and lake level changes

AUDIT CODE	FEP NAME
	Coastal water/ocean processes
group	Coastal waters: Tidal mixing
group	Coastal waters: Residual current mixing
group	Coastal waters: Effects of sea level change
group	Ocean waters: Water exchange
group	Ocean waters: Effects of sea level change
	Groundwater discharge to estuaries
	Groundwater discharge to marine waters including coastal
group	Estuaries: Water flow
group	Estuaries: Suspended sediments
group	Estuaries: Bottom sediments
group	Estuaries: Effects of salinity variation
group	Estuaries: Effects on vegetation
group	Estuaries: Effects of estuarine development
group	Estuaries: Effects of sea-level change
group	Coastal waters: Water transport
group	Coastal waters: Suspended sediment transport
group	Coastal waters: Bottom sediment transport
group	Coastal waters: Effects of sea level change
group	Coastal waters: Effects of estuarine development
group	Coastal waters: Effects of coastal erosion
group	Coastal waters: Effects of sea-level change
	Estuarine water use
	Coastal water use
	Sea water use
	Gas effects
	Gas leakage into underground living space
	Radon emission
	Gas transport: gas phase and in solution
	Gas discharge
	Microbiological/biological activity
	Microbial activity
	Bioaccumulation and translocation
	Biotoxicity
	Soil and sediment transport including bioturbation
	Burrowing animals
	Transport of radionuclides bound to microbes
L	Biogeochemical changes
	Geochemical regime (general)
	Soil and surface water chemistry (pH, Eh)
	Fluid interactions: dissolution, precipitation
	Weathering, mineralisation
	Physico-chemical phenomena/effects (eg. colloid formation)
	Altered soil or surface water chemistry (pH, Eh)
	Thermal effects on hydrochemistry
	Chemical gradients (electrochemical effects and osmosis)
	Radionuclide chemistry
	Complexation by organics (including humic and fulvic acids)
	Precipitation, dissolution, recrystallisation, reconcentration
	Sorption (linear, non-linear, irreversible)
	Speciation
	Chemical changes due to sorption, complex formation, speciation, gas, solubility
	Solubility effects (pH and Eh; ionic strength, complexing agents, colloids)
	Sorption effects (pH and Eh; ionic strength, complexing agents, colloids)
	Changes in sorptive surfaces
	Dilution (mass, isotopic, species)

FINAL FEPs: BIOSPHERE

AUDIT CODE	FEP NAME
	Radionuclide transport processes
	Water flow: advection and dispersion
	Diffusion (bulk, matrix, surface)
	Gas mediated transport
	Transport of active gases: gas phase and in solution
	Transport of radionuclides bound to microbes
	Radiological factors
	Building materials
	Carcasses
	Carcinogenic contaminants
	Convection, turbulence and diffusion (atmospheric)
group	Critical group - agricultural labour
group	Critical group - clothing and home furnishings
group	Critical group - evolution
group	Critical group - house location
group	Critical group - individuality
group	Critical group - leisure pursuits
group	Critical group - pets
	Dermal sorption - nuclides other than tritium
	Household dust and fumes
	Human diet
	Food preparation
	Human soil ingestion
	Precipitation (meteoric)
	Deposition (wet and dry)
	Radiotoxic contaminants
	Showers and humidifiers
	Suspension in air
	Wind
group	External exposure: Land
group	External exposure: Sediments
group	External exposure: Water bodies
group	Ingestion and Drinking water
group	Ingestion and Agricultural crops
group	Ingestion and Domestic animal products
group	Ingestion and Wild plants
group	Ingestion and Wild animals
group	Ingestion and Soils and sediments
group	Inhalation and Soils and sediments
group	Inhalation and Gases and vapours (indoor)
group	Inhalation and Gases and vapours (outdoor)
group	Inhalation and Biotic material
group	Inhalation and Salt particles
	Sediment/water/gas interaction with the atmosphere
	Specific factors
	Colloids: formation and effects (including inorganic and organic colloid transport)
	Greenhouse-induced ecological effects (including food production)
	Smoking
EFEF	Boreholes - unsealed
	Loss of integrity of borehole seals: seal failure or degradation
EFEF	Inadequate design: Exploration borehole seal failure
	Intrusion in accumulation zone in the biosphere (animals)
	Demographic change, urban development

FINAL FEPs: GEOLOGY/CLIMATE CATEGORY

AUDIT CODE	FEP NAME
	Seismic events/major land movement
	Earthquakes
	Regional uplift and subsidence (e.g. orogenic, isostatic)
EFP	Externally-induced seismicity
EFP	Natural seismicity
	Rock deformation
	Faulting/fracturing: activation
	Faulting/fracturing: generation
	Faulting/fracturing: change of properties
	Major incision
	Movements at faults
	Formation of new faults
	Formation of interconnected fracture systems
	Metamorphic processes
	Erosion/weathering (surface)
	Erosion
	Changes in topography
	Weathering
	Extreme erosion and denudation: glacial-induced (e.g. coastal/stream erosion)
	Coastal erosion due to sea-level change
	Erosion: Glacial
	Stream erosion
	Sedimentation
EFP	Land slide
L*	Freshwater sediment transport and deposition (LINK to BIOSPHERE)
L*	Marine sediment transport and deposition (LINK to BIOSPHERE)
	Solifluction
	Groundwater flow and effects
L*	Variation in groundwater recharge (LINK to BIOSPHERE)
	Surface water flow and effects
	Hydrological change
	Flooding
	Precipitation, temperature and soil water balance
	Snow melt
	River flow and lake level changes
	Sea-level effects
EFP	Sea level change
	Magnetic effects
EFP	Changes in the Earth's magnetic field
	Glaciation/glacial effects
EFP	Glaciation
EFP	Glacial/interglacial cycling effects (including sea level changes)
EFP	Permafrost
	Accumulation of gases under permafrost
EFP	No ice age
	Climate effects (natural)
EFP	Climate change
EFP	Pluvial periods
EFP	Insolation
	Specific factors
EFP	Anthropogenic climate change (greenhouse effect)
L	Greenhouse-induced effects (e.g. sea level change, precipitation, temp.)
EFP	Wind
EFP	Tsunamis

FINAL FEPs: HUMAN CATEGORY

AUDIT CODE	FEP NAME
	Inadvertent intrusion into repository
EFP	Archaeological investigations
EFP	Future intrusion: exploratory boreholes
EFP	Future intrusion: resource mining (e.g. water, hydrocarbon, geothermal).
EFP	Reuse of boreholes
EFP	Intrusion in accumulation zone in the biosphere
EFP	Explosions
EFP	Injection wells
EFP	Withdrawal wells
	Surface activities
EFP	Earthmoving
L*	Altered soil or surface water chemistry by human activities (LINK to BIOSPHERE)
EFP	Human induced changes in surface hydrology
EFP	Heat storage in lakes
EFP	Hydrologic Stresses: irrigation
EFP	Hydrologic Stresses: damming of streams or rivers
	Subsurface activities
	Dewatering
	Wells
	Wells (high demand)
EFP	Heat storage underground
EFP	Geothermal energy production
EFP	Tunnelling
EFP	Construction of underground storage/disposal facilities
EFP	Construction of underground dwellings/shelters
EFP	Injection of liquid wastes
	Water use
	Industrial use of water
	Outdoor spraying of water
	Groundwater abstraction
EFP	Human induced actions on groundwater recharge
	Irrigation
EFP	Reservoirs
EFP	Intentional artificial groundwater recharge or withdrawal
	Agricultural and fisheries practices
	Fish farming
	Game ranching
EFP	Agricultural and fisheries practice changes
	Specific factors
EFP	Demographic change, urban development
EFP	Undetected past intrusions (boreholes, mining)
EFP	Stray materials left
EFP	Decontamination materials left
EFP	Loss of records
EFP	Radioactive waste disposal error
EFP	Inadvertent inclusion of undesirable materials

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