Waste Isolation Pilot Plant

Compliance Certification Application

Reference 605

Stenhouse, M.J., N.A. Chapman, and T.J. Sumerling. 1993.
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Scenario Development FEP Audit List Preparation: Methodology and Presentation

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April 1993

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SITE-94

Scenario Development
FEP Audit List Preparation: Methodology and Presentation

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April 1993

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

gotab Stockholm 1993

SKI Technical Report 93:27

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

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Contents

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.

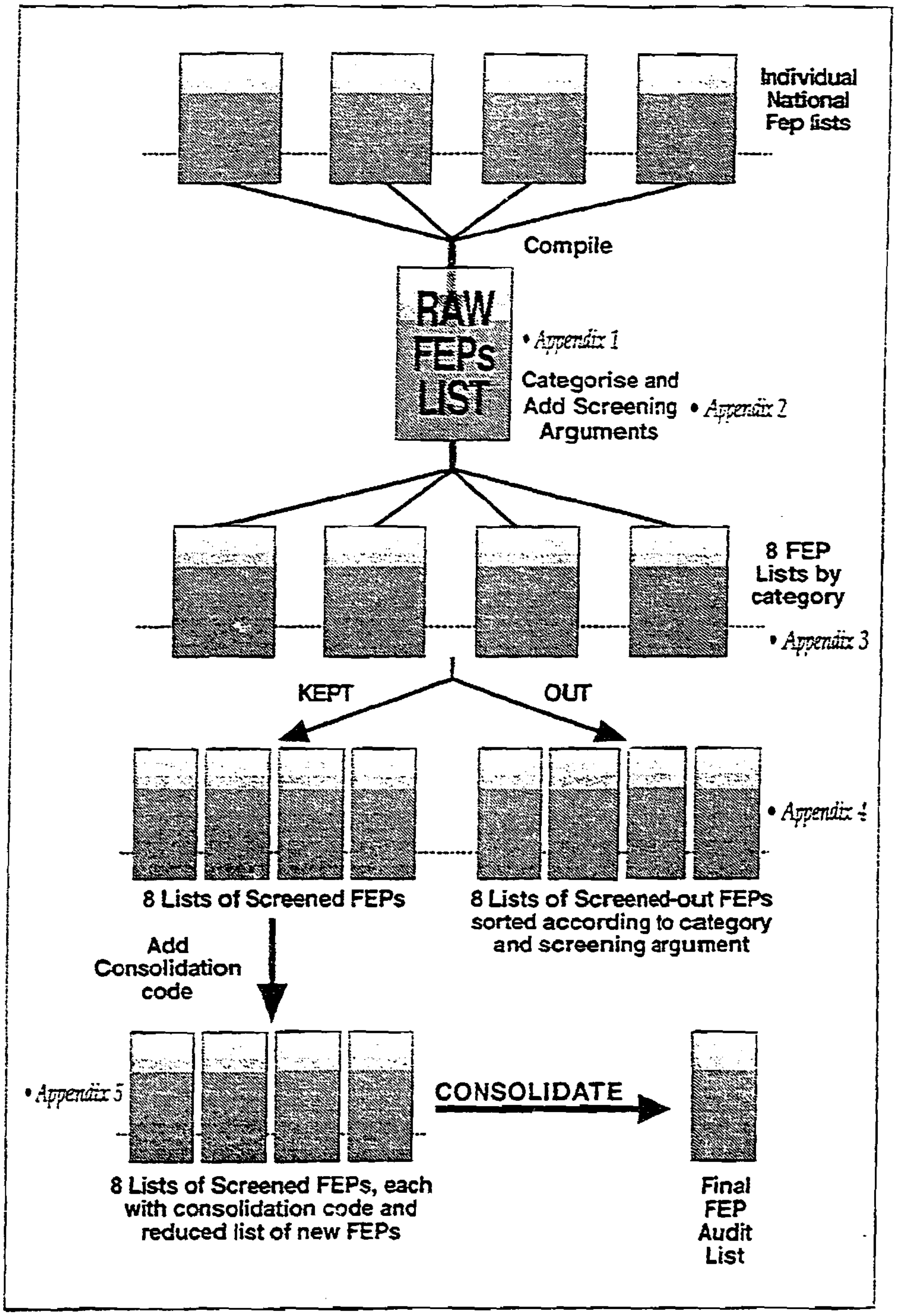
2 Description of Methodology

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 Phenomen relating to:
Site and Disposal Concept		
2.1	Waste form and packaging	L/ILW, organic wastes; vitrified wast
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
Assessment Basis		
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
Other		
4	General issues	too vague, general; incomprehensibl 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
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
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
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
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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Thorne, M.C., 1992. Dry Run . A trial assessment of underground disposal of radioactive wastes based on probabilistic risk analysis. Volume 8: Uncertainty and Bias Audit. U.K. DoE Report No. DoE/HMIP/RR/92.040.

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

<u>NOTE</u>

References for the above lists are given in the main text (page 3). In th '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

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/CO2: degradation of Cellulosics
DOE1.2.2.2	Methane/CO2: degradation of Other susceptible organic materials
DOE1.2.2.3	Methane/CO2 production: Aerobic degradation
DOE1.2.2.4	Methane/CO2 production: Anaerobic degradation
DOE1.2.2.5	Methane/CO2 production: Effects of temperature
DOE1.2.2.6	Methane/CO2 production: Effects of lithostatic pressure
DOE1.2.2.7	Methane/CO2 production: Effects of microbial growth on properties of concrete
DOE1.2.2.8	Methane/CO2 production: Effects of biofilms
DOE1.2.2.9	Methane/CO2 production: Effects of hydrogen from metal corrosion
DOE1.2.2.10	Methane/CO2 production: Inhibition due to the pressure of toxic materials
DOE1.2.2.11	Methane/CO2 production: Carbonate/bicarbonate exchange with concrete
DOE1.2.2.12	Methane/CO2 production: Energy and nutrient control of metabolism
DOE1.2.2.13	Methane/CO2 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
DOE2.3.3	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-occuring 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-occuring 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-occuring 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
DOE3.1.1	Transient greenhouse gas induced warming
DOE3.1.1.1	Greenhouse-induced Precipitation
DOE3.1.1.2	Greenhouse-induced Temperature
DOE3.1.1.3	Greenhouse-induced Sea level rise
DOE3.1.1.4	Greenhouse-induced Storm surges
DOE3.1.1.5	Greenhouse-induced Ecological effects
DOE3.1.1.6	Greenhouse-induced Potential evaporation
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: Glaciation
DOE3.1.2.9	Glacial/interglacial cycling: Deglaciation
DOE3.1.2.10	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
DOE3.2.1	Generalised denudation
DOE3.2.1.1	Generalised denudation: Fluvial
DOE3.2.1.2	Generalised denudation: Aeolian
DOE3.2.1.3	Generalised denudation: Glacial
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
DOE3.3.1	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
DOE3.4.1	Terrestrial Ecological Development
DOE3.4.1.1	Terrestrial ecological development: Agricultural systems
DOE3.4.1.2	Terrestrial ecological development: Semi-natural systems
DOE3.4.1.3	Terrestrial ecological development: Natural systems
DOE3.4.1.4	Terrestrial ecological development: Effects of succession
DOE3.4.2	Terrestrial ecological development: Estuarine

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

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.	SLOW 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
SKI1.1.1	Criticality
SKI1.1.2	Radioactive decay; heat
SKI1.1.3	Recoil of alpha-decay
SKI1.1.4	Gas generation: He production
SKI1.2.1	Radiolysis
SKI1.2.2	H2/O2 explosions
SKI1.2.3	Pb-I reactions
SKI1.2.4	Gas generation
SKI1.2.5	I, Cs-migration to glass surface
SKI1.2.6	Solubility within fuel matrix
SKI1.2.7	Recrystallization
SKI1.2.8	Redox potential
SKI1.2.9	Dissolution chemistry
SKI1.3	Damaged or deviating fuel
SKI1.4	Sudden energy release
SKI1.5	Release of radionuclides from the failured canister
SKI2.1.1	Chemical reactions (copper corrosion)
SKI2.1.2	Coupled effects (electrophoresis)
SKI2.1.3	Internal corrosion due to waste
SKI2.1.4	Role of the eventual channeling within the canister
SKI2.1.5	Role of chlorides in copper corrosion
SKI2.1.6.1	Repository induced Pb/Cu electrochemical reactions
SKI2.1.6.2	Natural telluric electrochemical reactions
SKI2.1.7	Pitting
SKI2.1.8	Corrosive agents, Sulphides, oxygen etc
SKI2.1.9	Backfill effects on Cu corrosion
SKI2.1.10	Microbes
SKI2.2	Creeping of copper
SKI2.3.1	Thermal cracking
SKI2.3.2	Electro-chemical cracking
SKI2.3.3	Stress corrosion cracking
SKI2.3.4	Loss of ductility
SKI2.3.5	Radiation effects on canister
SKI2.3.6	Cracking along welds
SKI2.3.7.1	External stress
SKI2.3.7.2	Hydrostatic pressure on canister
SKI2.3.8	Internal pressure
SKI2.4	Voids in the lead filling
SKI2.5.1	Random canister defects - quality control
SKI2.5.2	Common cause canister defects - quality control
SKI3.1.1	Degradation of the bentonite by chemical reactions
SKI3.1.2	Saturation of sorption sites
SKI3.1.3	Effects of bentonite on groundwater chemistry
SKI3.1.4	Colloid generation - source
SKI3.1.5	Coagulation of bentonite
SKI3.1.6	Sedimentation of bentonite
SKI3.1.7	Reactions with cement pore water
SKI3.1.8	Near field buffer chemistry
SKI3.1.9	Radiolysis
SKI3.1.10	Interactions with corrosion products and waste
SKI3.1.11	Redox front
SKI3.1.12	Perturbed buffer material chemistry
SKI3.1.13	Radiation effects on bentonite
SKI3.2.1	[NO ENTRY]
SKI3.2.1.1	Swelling of bentonite into tunnels and cracks
SKI3.2.1.2	Uneven swelling of bentonite
SKI3.2.2	Movement of canister in buffer/backfill
SKI3.2.3	Mechanical failure of buffer/backfill
SKI3.2.4	Erosion of buffer/backfill
SKI3.2.5	Thermal effects on the buffer material
SKI3.2.6	Diffusion - surface diffusion
SKI3.2.7	Swelling of corrosion products
SKI3.2.8	Preferential pathways in the buffer/backfill
SKI3.2.9	Flow through buffer/backfill
SKI3.2.10	Soret effect
SKI3.2.11	Backfill material deficiencies
SKI3.2.12	Gas transport in bentonite

IDENTIFIER	FEP NAME
SKI4.1.1	Oxidizing conditions
SKI4.1.2	pH-deviations
SKI4.1.3	Colloids, complexing agents
SKI4.1.4	Sorption
SKI4.1.5	Matrix diffusion
SKI4.1.6	Reconcentration
SKI4.1.7	Thermochemical changes
SKI4.1.8	Change of groundwater chemistry in nearby rock
SKI4.1.9	Complexing agents
SKI4.2.1	Mechanical failure of repository
SKI4.2.2	[NO ENTRY]
SKI4.2.2.1	Excavation/backfilling effects on nearby rock
SKI4.2.2.2	Hydraulic conductivity change - Excavation/backfilling effect
SKI4.2.2.3	Mechanical effects - Excavation/backfilling effects
SKI4.2.3	Extreme channel flow of oxidants and nuclides
SKI4.2.4	Thermal buoyancy
SKI4.2.5	Changes of groundwater flow
SKI4.2.6	Faulting
SKI4.2.7	Thermo-hydro-mechanical effects
SKI4.2.8	Enhanced rock fracturing
SKI4.2.9	Creeping of rock mass
SKI4.2.10	Chemical effects of rock reinforcement
SKI5.1	Saline (or fresh) groundwater intrusion
SKI5.2	Non-sealed repository
SKI5.3	Stray materials left
SKI5.4	Decontamination materials left
SKI5.5	Chemical sabotage
SKI5.6	Co-storage of other waste
SKI5.7	Poorly designed repository
SKI5.8	Poorly constructed repository
SKI5.9	Unsealed boreholes and/or shafts
SKI5.10	Accidents during operation
SKI5.11	Degradation of hole- and shaft seals
SKI5.12	Near storage of other waste
SKI5.13	Volcanism
SKI5.14	Resaturation
SKI5.15	Earthquakes
SKI5.16	Uplift and subsidence
SKI5.17	Permafrost
SKI5.18	Enhanced groundwater flow
SKI5.19	Effect of plate movements
SKI5.20	Changes of the magnetic field
SKI5.21	Future boreholes and undetected past boreholes
SKI5.22	Accumulation of gases under permafrost
SKI5.23	Changed hydrostatic pressure on canister
SKI5.24	Stress changes of conductivity
SKI5.25	Dissolution of fracture fillings/precipitations
SKI5.26	Erosion on surface/sediments
SKI5.27	Human induced actions on groundwater recharge
SKI5.28	Underground dwellings
SKI5.29	Meteorite
SKI5.30	Underground test of nuclear devices
SKI5.31	Change in sealevel
SKI5.32	Desert and unsaturation
SKI5.33	Waste retrieval, mining
SKI5.34	Geothermal energy production
SKI5.35	Other future uses of crystalline rock
SKI5.36	Reuse of boreholes
SKI5.37	Archaeological intrusion
SKI5.38	Explosions
SKI5.39	Postclosure monitoring
SKI5.40	Unsuccessful attempt of site improvement
SKI5.41	Water producing well
SKI5.42	Glaciation
SKI5.43	Methane intrusion
SKI5.44	Solubility and precipitation
SKI5.45	Colloid generation and transport
SKI5.46	Groundwater recharge/discharge

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	Meotorite 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 scilfluction
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 crystalisation
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/drained
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. H2)
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 ac
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 cellulosics
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 (pressurisation, 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
HMIP2.4 Geomorphology	
HMIP2.4.1	Generalised denudation
HMIP2.4.2	Localised denudation
HMIP3: CLIMATOLOGY	
HMIP3.1 Climate change	
HMIP3.1.1	Human induced climate change
HMIP3.1.2	Natural climate change
HMIP3.1.3	Exit from glacial/interglacial cycling
HMIP3.1.4	Intensification of natural climate change
HMIP4: BIOSPHERE	
HMIP4.1 Radionuclide entry points to the biosphere	
HMIP4.1.1	Groundwater discharge to soils and surface waters
HMIP4.1.2	Solid discharge via erosional processes
HMIP4.1.3	Gas discharge
HMIP4.2 Transfer (concentration/dilution) mechanisms	
HMIP4.2.1	Soil moisture and evaporation
HMIP4.2.2	Surface water mixing
HMIP4.2.3	Sediment transport including bioturbation
HMIP4.2.4	Sediment/water/gas interaction with the atmosphere
HMIP4.2.5	Bioaccumulation and translocation
HMIP4.2.6	Biogeochemical processes
HMIP4.3 Land and surface water use	
HMIP4.3.1	Terrestrial water use
HMIP4.3.2	Estuarine water use
HMIP4.3.3	Coastal waters and water use
HMIP4.3.4	Seas and water use
HMIP4.4 Human exposure	
HMIP4.4.1	External exposure
HMIP4.4.2	Ingestion
HMIP4.4.3	Inhalation
HMIP5: SHORT CIRCUIT PATHWAYS	
HMIP5.1 Related to repository construction	
HMIP5.1.1	Loss of integrity of borehole seals
HMIP5.1.2	Loss of integrity of shaft or access tunnel seals
HMIP5.1.3	Incomplete near-field chemical conditioning
HMIP5.2 Unrelated to repository construction	
HMIP5.2.1	Meteorite impact
HMIP5.2.2	Deliberate intrusion
HMIP5.2.3	Malicious intrusion
HMIP5.2.4	Accidental intrusion

RAW FEPs LIST

IDENTIFIER	FEP NAME
NEA1. NATURAL PHENOMENA	
NEA1.1 EXTRATERRESTRIAL	
NEA1.1.1	Meotorite 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 fluvian)
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/drained
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

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.H2))
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. CH4(
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 Åspö 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.

3.3 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 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 "COMMMENTS" 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?		Radiotoxic 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 pressure 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	

DOE1.6.6.2	WBRF		Microbial activity	
DOE1.6.6.3	WBRF		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	H2/O2 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	
SKI3.1.9	WB	XXXX	Radiolysis	SEE SKI1.2.1
SKI3.1.10	WB		Interactions with corrosion products and waste	
SKI5.6	W	3.1	Co-storage of other waste	
SKI5.44	WR		Solubility and precipitation	
SKI7.4	W	3.6	Chemical toxicity of wastes	
UKN1.6.14	WCBRF		Chemical gradients (electrochemical effects and osmosis)	
UKN1.7.6	WBRFL		Chemical transformations	
UKN1.7.7	WBRFL		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. H2)	
UKN3.2.2	WCBR		Interactions of host materials and groundwater with repository material (eg. concrete carbor	
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 (pressuration, 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)	

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 cellulosics	
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)	

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.3	WCBR		Biological activity	
AECL1.4	WCBR	4	Boundary conditions	
AECL1.19	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	Incomprehensi
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	
AECL1.80	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 failured 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	

SKI2.1.8	C		Corrosive agents, Sulphides, oxygen etc	
SKI2.1.9	BC		Backfill effects on Cu corrosion	
SKI2.1.10	C		Microbes	
SKI2.2	C		Creeping of copper	
SKI2.3.1	WC		Thermal cracking	
SKI2.3.2	C	XXXX	Electro-chemical cracking	SEE SKI2.1.1
SKI2.3.3	C		Stress corrosion cracking	
SKI2.3.4	C		Loss of ductility	
SKI2.3.5	C		Radiation effects on canister	
SKI2.3.6	C		Cracking along welds	
SKI2.3.7.1	C		External stress	
SKI2.3.7.2	C		Hydrostatic pressure on canister	
SKI2.3.8	C		Internal pressure	
SKI2.4	C		Voids in the lead filling	
SKI2.5.1	C		Random canister defects - quality control	
SKI2.5.2	C		Common cause canister defects - quality control	
SKI3.2.2	CB		Movement of canister in buffer/backfill	
SKI3.2.7	CB		Swelling of corrosion products	
SKI5.23	C	XXXX	Changed hydrostatic pressure on canister	SEE SKI2.3.7.2
UKN1.6.14	WCBRF		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 eg. H2)	
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	
UKN3.2.7	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 (pressuration, 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.H2))	
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)	

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL1.1	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	Correlation	Incomprehensi
AECL1.27	WCB		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	
DOE1.1.2.1	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	
DOE1.2.1.8	WB	2.1	Hydrogen: effects of microbial growth on concrete	
DOE1.2.2.8	WB	2.2	Methane/CO2 production: Effects of biofilms	
DOE1.2.2.9	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	

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	BRF		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	BRF		Chemical changes due to Complex formation	
DOE1.6.5.6	BRF		Chemical changes due to Colloid production	
DOE1.6.5.7	BRF		Chemical changes due to Solubility	
DOE1.6.5.8	BRF		Chemical changes due to Sorption	
DOE1.6.5.9	BRF		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	
DOE2.3.4.4	BRF		Groundwater flow: Fracture	
DOE2.3.4.5	BRF		Groundwater flow: Effects of solution channels	
DOE2.3.5.1	BRF		Inorganic colloid transport: Effects of pH and Eh	
DOE2.3.5.2	BRF		Inorganic colloid transport: Effects of ionic strength	
DOE2.3.6	BRF		Variations in groundwater temperature	
DOE2.4.1	BRF		Advection	
DOE2.4.2.1	BRF		Bulk diffusion	
DOE2.4.2.2	BRF		Matrix diffusion	
DOE2.4.2.3	B		Surface diffusion	
DOE2.4.3	BRF		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-occuring colloids	
DOE2.4.4.6	BR		Solubility: effects of colloids formed in 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-occuring 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-occuring colloids	
DOE2.4.5.11	BR		Sorption: effects of colloids formed in the near-field	
DOE2.4.5.13	BRFL		Sorption: effects of microbial activity	
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	BRF		Gas-induced groundwater transport	
DOE2.4.13.1	BR		Repository thermally-induced groundwater transport	
DOE2.4.13.2	BRF		Naturally thermally-induced groundwater transport	
IAEA1.13.1	BRF		Fluid interactions: Groundwater flow	
IAEA1.13.2	BRFL		Fluid interactions: Dissolution	
IAEA1.13.3	BRF		Fluid interactions: Brine pockets	
IAEA3.1.3	BRF		Thermal effects: Fluid pressure, density, viscosity changes	
IAEA3.1.4	BRF		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	

PGA3.4	CB		Canister movement in backfill	
PGA3.7.2	CB		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	CB		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 front	
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	CB		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	CB		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	BH	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 nuclides	
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	

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	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 crystalisation	
UKN1.6.9	BRFL		Colloid formation, dissolution and transport	
UKN1.6.10	BRFL		Complexing agents	
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	
UKN2.1.10	BR		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 carbor	
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corros	
HMIP1.2.3	WB	2.1	Gas generation from concrete	
HMIP1.2.6	BRF		Gas transport	
HMIP1.2.8	WBR		Thermo-chemical effects	
HMIP1.4.1	WCB		Waste-form and backfill consolidation	
HMIP1.5.3	BR		Gas production (unsaturated flow)	
HMIP1.5.4	BRF		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	
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	
NEA1.6.13	BRFL		Mass, isotopic and species dilution	
NEA1.6.14	BRFL		Chemical gradients (electrochemical effects and osmosis)	
NEA2.2.2	BR		Inadequate backfill or compaction voidage	
NEA3.1.1	BR		Differential elastic response	
NEA3.1.2	BR		Non-elastic response	
NEA3.1.4	BRF		Induced hydrological changes (fluid pressure, density convection, viscosity)	
NEA3.1.5	BR		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	BR		Convection	
AECL1.25	WCBR	4	Correlation	Incomprehensi
AECL1.29	BR		Diffusion	
AECL1.30	BR		Dispersion	
AECL1.34	R		Excessive hydrostatic pressures	
AECL1.35	R	3.1	Explosions	H
AECL1.37	BR		Formation of cracks	
AECL1.40	WBR		Geochemical pump	SEE AECL1.9
AECL1.43	BR		Hydraulic conductivity	
AECL1.44	R		Hydraulic head	
AECL1.46	BR		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	BR		Sorption	
AECL1.77	BR		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	BR		Transport in gases or of gases	
AECL1.89	R		Unmodelled design features	
AECL1.90	BR		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	HRF		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	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	
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	

DOE1.4.4.1	R		Repository-induced subsidence	
DOE1.4.5	RF	2.3?	Rock creep	
DOE1.5.1.1	RF		Changes in moisture content due to dewatering	
DOE1.5.1.2	RF		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	BRF		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	RF		Differential elastic response	
DOE1.6.2	RF		Non-elastic response	
DOE1.6.3.1	RF		Fracture changes: aperture	
DOE1.6.3.2	RF		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	BRF		Chemical changes due to Complex formation	
DOE1.6.5.6	BRF		Chemical changes due to Colloid production	
DOE1.6.5.7	BRF		Chemical changes due to Solubility	
DOE1.6.5.8	BRF		Chemical changes due to Sorption	
DOE1.6.5.9	BRF		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	RF		Repository-induced seismicity	
DOE2.2.6.2	RFG		Externally-induced seismicity	
DOE2.3.3.1	RF		Rock property changes: Porosity	
DOE2.3.3.2	RF		Rock property changes: Permeability	
DOE2.3.3.3	RF		Rock property changes: Microbial pore blocking	
DOE2.3.3.4	RF		Rock property changes: Channel formation/closure	
DOE2.3.4.1	RF		Groundwater flow: Darcy	
DOE2.3.4.2	RF		Groundwater flow: Non-Darcy	
DOE2.3.4.3	RF		Groundwater flow: Intergranular (matrix)	
DOE2.3.4.4	BRF		Groundwater flow: Fracture	
DOE2.3.4.5	BRF		Groundwater flow: Effects of solution channels	
DOE2.3.4.6	RF		Inorganic colloid transport: Porous media	
DOE2.3.5.1	BRF		Inorganic colloid transport: Effects of pH and Eh	
DOE2.3.5.2	BRF		Inorganic colloid transport: Effects of ionic strength	
DOE2.3.6	BRF		Variations in groundwater temperature	
DOE2.4.1	BRF		Advection	
DOE2.4.2.1	BRF		Bulk diffusion	
DOE2.4.2.2	BRF		Matrix diffusion	
DOE2.4.3	BRF		Hydrodynamic dispersion	
DOE2.4.4.1	BRRL		Solubility: effects of pH and Eh	
DOE2.4.4.2	BRRL		Solubility: effects of ionic strength	
DOE2.4.4.3	BRRL		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	BRRL		Solubility: effects of naturally-occuring colloids	
DOE2.4.4.6	BR		Solubility: effects of colloids formed in the near-field	
DOE2.4.4.7	RF		Solubility: effects of major ions migrating from the near-field	
DOE2.4.4.8	BRRL		Solubility: Effects of microbial activity	
DOE2.4.5.1	BRRL		Linear sorption	
DOE2.4.5.2	BRRL		Non-linear sorption	
DOE2.4.5.3	BRRL		Reversible sorption	
DOE2.4.5.4	BRRL		Irreversible sorption	
DOE2.4.5.5	BRRL		Sorption: Effects of pH and Eh	
DOE2.4.5.6	BRRL		Sorption: Effects of ionic strength	
DOE2.4.5.7	BRRL		Sorption: Effects of naturally-occurring organic complexing agents	
DOE2.4.5.8	BRRL		Sorption: Effects of naturally-occuring inorganic complexing agents	
DOE2.4.5.9	BR		Sorption: Effects of complexing agents formed in the near-field	
DOE2.4.5.10	BRRL		Sorption: effects of naturally-occuring colloids	
DOE2.4.5.11	BR		Sorption: effects of colloids formed in the near-field	
DOE2.4.5.12	RF		Sorption: effects of major ions migrating from the near-field	
DOE2.4.5.13	BRRL		Sorption: effects of microbial activity	

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	BRF		Gas-induced groundwater transport	
DOE2.4.13.1	BR		Repository thermally-induced groundwater transport	
DOE2.4.13.2	BRF		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	BRF		Fluid interactions: Groundwater flow	
IAEA1.13.2	BRFL		Fluid interactions: Dissolution	
IAEA1.13.3	BRF		Fluid interactions: Brine pockets	
IAEA2.2.1	RF		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	BRF		Thermal effects: Fluid pressure, density, viscosity changes	
IAEA3.1.4	BRF		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	
PGA3.16	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	H2/O2 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	BRF		Extreme channel flow of oxidants and nuclides	
SKI4.2.4	BR		Thermal buoyancy	
SKI4.2.5	BRF		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	

SKI5.1	BRF		Saline (or fresh) groundwater intrusion	
SKI5.11	FF		Degradation of hole- and shaft seals	
SKI5.14	BR		Resaturation	
SKI5.18	BRF	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	BRF		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 [illegible]tion	
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	BRF		Saline or freshwater intrusion	
UKN1.5.8	BRF		Effects at saline-freshwater interface	
UKN1.5.9	BRF		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 crystalisation	
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	BR		Thermal effects (eg. concrete hydration)	
UKN2.2.8	R	3.1	Repository flooding during operation	
UKN2.2.10	FH		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 carbon	
UKN3.2.3	WCBR		Interactions of waste and repository materials with host materials (eg. electrochemical, corros	
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	

HMIP1.1.2	R		Physico-chemical degradation of concrete
HMIP1.2.6	BRF		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	BRF		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	RFL		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	BRF		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	RF		Interactions of waste and repository materials with host materials (electrochemical, corrosive

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
AECL2.3	HF	2.4	Borehole - well	
AECL2.4	RF	.	Borehole seal failure/open boreholes	
AECL2.6	HRF		Boreholes - unsealed	SEE AECL2.4
AECL2.7	RF	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	FH	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 AECL1.69
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	G/W
AECL2.65	F		Unsaturated rock	
AECL2.66	HF		Vault closure (incomplete)	
AECL2.67	RF?		Vault heating effects	
DOE1.2.6.5	F		Gas transport into and through the far-field	
DOE1.4.5	RF	2.3?	Rock creep	
DOE1.5.1.1	RF		Changes in moisture content due to dewatering	
DOE1.5.1.2	RF		Changes in moisture content due to stress relief	
DOE1.5.3	BRF		Groundwater flow (saturated conditions)	
DOE1.6.1	RF		Differential elastic response	
DOE1.6.2	RF		Non-elastic response	
DOE1.6.3.1	RF		Fracture changes: aperture	
DOE1.6.3.2	RF		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	BRF		Chemical changes due to Complex formation	
DOE1.6.5.6	BRF		Chemical changes due to Colloid production	
DOE1.6.5.7	BRF		Chemical changes due to Solubility	
DOE1.6.5.8	BRF		Chemical changes due to Sorption	
DOE1.6.5.9	BRF		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	FFG		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	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
DOE2.3.5.3	F	2.3	Salinity: implications of evaporite deposits/minerals
DOE2.3.6	BFF		Variations in groundwater temperature
DOE2.4.1	BFF		Advection
DOE2.4.2.1	SRF		Bulk diffusion
DOE2.4.2.2	BRF		Matrix diffusion
DOE2.4.3	BRF		Hydrodynamic dispersion
DOE2.4.4.1	BRRL		Solubility: effects of pH and Eh
DOE2.4.4.2	BRRL		Solubility: effects of ionic strength
DOE2.4.4.3	BRRL		Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.5	BRRL		Solubility: effects of naturally-occuring colloids
DOE2.4.4.7	RF		Solubility: effects of major ions migrating from the near-field
DOE2.4.4.8	BRRL		Solubility: Effects of microbial activity
DOE2.4.5.1	BRRL		Linear sorption
DOE2.4.5.2	BRRL		Non-linear sorption
DOE2.4.5.3	BRRL		Reversible sorption
DOE2.4.5.4	BRRL		Irreversible sorption
DOE2.4.5.5	BRRL		Sorption: Effects of pH and Eh
DOE2.4.5.6	BRRL		Sorption: Effects of ionic strength
DOE2.4.5.7	BRRL		Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRRL		Sorption: Effects of naturally-occuring inorganic complexing agents
DOE2.4.5.10	BRRL		Sorption: effects of naturally-occuring colloids
DOE2.4.5.12	RF		Sorption: effects of major ions migrating from the near-field
DOE2.4.5.13	BRRL		Sorption: effects of microbial activity
DOE2.4.6	RF		Fracture mineralisation
DOE2.4.7.1	BRRL		Organic colloid transport in Porous media
DOE2.4.7.2	BRRL		Organic colloid transport in Fractured media
DOE2 7.3	BRRL		Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BRRL		Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BRRL		Inorganic colloid transport: Porous media
DOE2.4.8.2	BRRL		Inorganic colloid transport: Fractured media
DOE2.4.8.3	BRRL		Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BRRL		Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	BRRL		Transport of radionuclides bound to microbes
DOE2.4.10	BRRL		Isotopic dilution
DOE2.4.11.1	BRRL		Gas transport: solution
DOE2.4.11.2	BRRL		Gas transport: gas phase
DOE2.4.12	BRF		Gas-induced groundwater transport
DOE2.4.13.2	BRF		Naturally thermally-induced groundwater transport
DOE2.4.14	RRL		Biogeochemical changes
DOE3.3.2.4	RL		Near-surface runoff processes: Macropore flow
DOE3.3.2.5	RL		Near-surface runoff processes: Variable source area response
DOE3.3.3	F		Groundwater recharge
DOE4.1.1.1	RRL		Borehole seal failure
DOE4.1.1.2	RRL		Borehole seal degradation

IAEA1.13.1	BRF		Fluid interactions: Groundwater flow	
IAEA1.13.2	BRFL		Fluid interactions: Dissolution	
IAEA1.13.3	BRF		Fluid interactions: Brine pockets	
IAEA2.2.1	RF		Inadequate design: Shaft seal failure	
IAEA2.2.2	RFL		Inadequate design: Exploration borehole seal failure	
IAEA3.1.1	RF		Thermal effects: Differential elastic response	
IAEA3.1.2	RF		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	RF		Differing thermal expansion of host rock zones	
PGA3.8	RF		Thermal convection	
PGA3.12.2	RF		Geochemical changes in host rock	
PGA3.13	BRFL		Physico-chemical phenomena/effects (eg. colloid formation)	
PGA3.14	BRFL		Microbiological phenomena/effects	
PGA4.1	RF		Direct alterations in hydrogeology	
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	RF		Matrix diffusion	
SKI4.1.6	BRFL		Reconcentration	
SKI4.1.9	BRFL		Complexing agents	ALSO SKI4.1.3
SKI4.2.3	BRF		Extreme channel flow of oxidants and nuclides	
SKI4.2.5	BRF		Changes of groundwater flow	
SKI5.1	BRF		Saline (or fresh) groundwater intrusion	
SKI5.11	RF		Degradation of hole- and shaft seals	
SKI5.18	BRF	XXXX	Enhanced groundwater flow	SEE SKI4.2.5
SKI5.25	F		Dissolution of fracture fillings/precipitations	SEE SKI6.6
SKI5.45	RF		Colloid generation and transport	
SKI5.46	F		Groundwater recharge/discharge	
SKI6.1	F		Undetected fracture zones	
SKI6.2	BRF		Gas transport	
SKI6.3	F		Far field hydrochemistry - acids, oxidants, nitrate	
SKI6.4	BRFL		Dispersion	
SKI6.5	BRFL		Dilution	
SKI6.6	F		Weathering of flow paths	SEE SKI5.25
SKI6.12	F		Undetected discontinuities	
SKI6.13	RF		Geothermally induced flow	
SKI7.5	RFL		Isotopic dilution	
SNL6.2	RFL		Shaft and Borehole Seal Degradation	
SNL6.3	RF		Thermally Induced Stress/Fracturing in Host Rock	
SNL6.4	RF		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, intergranular fracture, channelling and preferential pathw	
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	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 crystalisation	

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 pathw
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	BFF		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)

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	GL	D	Ozone layer failure	
AECL3.77	HL	2.3?	Peat and leaf litter harvesting	
AECL3.78	L		Plant root systems	
AECL3.79	L		Precipitation (meteoric)	
AECL3.80	WL?	XXXX	Radioactive decay	SEE AECL1.68
AECL3.81	WL?		Radiotoxic contaminants	
AECL3.82	L		Radon emission	
AECL3.83	GL	2.4	Rivercourse meander	
AECL3.84	L		Runoff	
AECL3.85	L	2.3?	Saltation	
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	HL		Showers and humidifiers	
AECL3.92	HL		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	HL		Space heating	SOURCES OF E
AECL3.100	L		Surface water bodies	
AECL3.101	L		Surface water pH	
AECL3.102	L		Suspension in air	
AECL3.105	GL	4	Terrestrial surface	
AECL3.106	L	2.4?	Toxicity of mined rock	
AECL3.107	L		Tree sap	
AECL3.108	L	4	Uncertainties	
AECL3.109	HL		Urbanization on the discharge site	
AECL3.110	L	2.3	Water leak into underground living space	
AECL3.112	HL		Water source	
AECL3.113	L	2.4?	Wetlands	
AECL3.114	GL		Wind	
DOE2.4.4.1	BRL		Solubility: effects of pH and Eh	
DOE2.4.4.2	BRL		Solubility: effects of ionic strength	
DOE2.4.4.3	BRL		Solubility: effects of naturally-occurring complexing agents	
DOE2.4.4.5	BRL		Solubility: effects of naturally-occuring colloids	
DOE2.4.4.8	BRL		Solubility: Effects of microbial activity	
DOE2.4.5.1	BRL		Linear sorption	
DOE2.4.5.2	BRL		Non-linear sorption	
DOE2.4.5.3	BRL		Reversible sorption	
DOE2.4.5.4	BRL		Irreversible sorption	
DOE2.4.5.5	BRL		Sorption: Effects of pH and Eh	
DOE2.4.5.6	BRL		Sorption: Effects of ionic strength	
DOE2.4.5.7	BRL		Sorption: Effects of naturally-occurring organic complexing agents	
DOE2.4.5.8	BRL		Sorption: Effects of naturally-occuring inorganic complexing agents	
DOE2.4.5.10	BRL		Sorption: effects of naturally-occuring colloids	
DOE2.4.5.13	BRL		Sorption: effects of microbial activity	
DOE2.4.7.1	BRL		Organic colloid transport in Porous media	
DOE2.4.7.2	BRL		Organic colloid transport in Fractured media	
DOE2.4.7.3	BRL		Organic colloid transport: Effects of pH and Eh	
DOE2.4.7.4	BRL		Organic colloid transport: Effects of ionic strength	
DOE2.4.8.1	BRL		Inorganic colloid transport: Porous media	
DOE2.4.8.2	BRL		Inorganic colloid transport: Fractured media	
DOE2.4.8.3	BRL		Inorganic colloid transport: Effects of pH and Eh	
DOE2.4.8.4	BRL		Inorganic colloid transport: Effects of ionic strength	
DOE2.4.9	BRL		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
DOE2.4.14	RFL	Biogeochemical changes
DOE3.1.1.5	LG	Greenhouse-induced Ecological effects
DOE3.1.2.5	LG	Glacial/interglacial 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

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	RRL		Borehole seal failure	
DOE4.1.1.2	RRL		Borehole seal degradation	
IAEA1.13.2	BRRL		Fluid interactions: Dissolution	
IAEA2.2.2	RRL		Inadequate design: Exploration borehole seal failure	
PGA1.11	RL		Weathering, mineralisation	
PGA3.13	BRRL		Physico-chemical phenomena/effects (eg. colloid formation)	
PGA3.14	BRRL		Microbiological phenomena/effects	
SKI4.1.1	BRRL		Oxidizing conditions	
SKI4.1.2	BRRL		pH-deviations	
SKI4.1.3	BRRL	XXXX	Colloids, complexing agents	SEE SKI5.45
SKI4.1.4	BRRL		Sorption	
SKI4.1.6	BRRL		Reconcentration	
SKI4.1.9	BRRL		Complexing agents	ALSO SKI4.1.3
SKI5.41	HL		Water producing well	
SKI6.4	BRRL		Dispersion	
SKI6.5	BRRL		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	RRL		Isotopic dilution	
SNL6.2	RRL		Shaft and Borehole Seal Degradation	
UKN1.3.1	GL		Precipitation, temperature and soil water balance	
UKN1.5.4	RL		Groundwater discharge (to surface water, to springs,to soils, to wells, to marine)	
UKN1.6.1	BRRL		Advection and dispersion	
UKN1.6.2	BRRL		Diffusion	
UKN1.6.3	BRRL		Matrix diffusion	
UKN1.6.4	BRRL		Gas mediated transport	
UKN1.6.5	BRRL		Multiphase flow and gas driven flow	
UKN1.6.6	BRRL		Solubility limit	
UKN1.6.7	BRRL		Sorption (linear/non-linear, reversible/irreversible)	
UKN1.6.8	BRRL		Dissolution, precipitation and crystalisation	
UKN1.6.9	BRRL		Colloid formation, dissolution and transport	
UKN1.6.10	BRRL		Complexing agents	
UKN1.6.12	L		Accumulation in soils and organic debris	
UKN1.6.13	BRRL		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	WBRRL		Chemical transformations	
UKN1.7.7	WBRRL		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	

UKN1.7.10	L	3.7	Plant and animal evolution	
UKN2.1.2	RRL		Investigation borehole seal failure and degradation	
UKN2.4.5	L		Altered soil or surface water chemistry	
HMIP2.3.1	BRRL		Advection	
HMIP2.3.2	BRRL		Diffusion	
HMIP2.3.3	BRRL		Hydrodynamic dispersion	
HMIP2.3.4	BRRL		Solubility constraints	
HMIP2.3.5	BRRL		Sorption including ion-exchange	
HMIP2.3.6	BRRL		Changes in sorptive surfaces	
HMIP2.3.7	BRRL		Changes in groundwater chemistry and flow direction	
HMIP2.3.8	BRRL		Colloid transport	
HMIP2.3.9	BRRL		Transport of radionuclides bound to microbes	
HMIP2.3.10	BRRL		Transport of active gases	
HMIP2.3.11	BRRL		Gas induced groundwater transport	
HMIP2.3.12	BRRL		Thermal effects on hydrochemistry	
HMIP2.3.13	BRRL		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	RRL		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	BRRL		Advection and dispersion	
NEA1.6.2	BRRL		Diffusion	
NEA1.6.3	BRRL		Matrix diffusion	
NEA1.6.4	BRRL		Gas mediated transport	
NEA1.6.5	BRRL		Multiphase flow and gas-driven flow	
NEA1.6.6	BRRL		Solubility limit	
NEA1.6.7	BRRL		Sorption (linear/non-linear, reversible/irreversible)	
NEA1.6.8	BRRL		Dissolution, precipitation, and crystallisation	
NEA1.6.9	BRRL		Colloid formation, dissolution, and transport	
NEA1.6.10	BRRL		Complexing agents	
NEA1.6.12	L		Accumulation in soils and organic debris	
NEA1.6.13	BRRL		Mass, isotopic and species dilution	
NEA1.6.14	BRRL		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	HG		Externally-induced seismicity	
DOE2.2.6.3	HG		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	

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 exit, greenhouse gas induced	
DOE3.1.3.2	G		Glacial/interglacial exit 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	

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	
SKI4.2.6	G		Faulting	
SKI5.13	G	2.5	Volcanism	
SKI5.15	G		Earthquakes	
SKI5.16	G		Uplift and subsidence	
SKI5.17	G		Permafrost	
SKI5.19	G	2.5	Effect of plate movements	
SKI5.20	G		Changes of the magnetic field	
SKI5.22	GR		Accumulation of gases under permafrost	
SKI5.26	G		Erosion on surface/sediments	
SKI5.29	G	D	Meteorite	
SKI5.31	G		Change in sealevel	
SKI5.32	G	2.5	Desert and unsaturation	
SKI5.42	G		Glaciation	
SKI5.43	GR		Methane intrusion	SEE SKI5.22
SKI6.10	G		No ice age	
SKI6.11	G	2.5	Intruding dykes	
SKI6.14	G	2.5	Tectonic activity - large scale	
SKI7.10	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	

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	HG		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	HG		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 fluvian)	
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	HG		Anthropogenic climate change (greenhouse effect)	

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 PROJEC
AECL2.22	FH	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 E
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	

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	W?H	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	

IDENTIFIER	CATEGORY	ARGUMENT	FEP NAME	COMMENT
UKN2.1.1	H		Undetected past intrusions, (eg. boreholes, mining)	
UKN2.1.8	HR	3.1	Poor quality construction	
UKN2.1.9	HR	3.1	Design modification	
UKN2.2.1	H		Radioactive waste disposal error	
UKN2.2.2	HB		Inadequate backfill or compaction, voidage	
UKN2.2.3	WH	3.1	Co-disposal of reactive wastes (deliberate)	
UKN2.2.4	WH		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	RH		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	Exploitation 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, built/drained	
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	HG		Anthropogenic climate change (greenhouse effect)	
UKN2.4.10	H	2.3	Quarrying, peat extraction	
HMIP3.1.1	HG		Human induced climate change	
HMIP5.2.2	H	3.4	Deliberate intrusion	
HMIP5.2.3	H	3.4	Malicious intrusion	
HMIP5.2.4	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	Exploitation drilling	
NEA2.3.5	H		Geothermal energy production	
NEA2.3.6	H	2.4	Resource mining	
NEA2.3.7	H		Tunneling	
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/drained	
NEA2.4.3	H	2.4	Rivers rechanneled	
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	HG		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 cellulosics
UKN3.3.6	WC	2.1	Gas effects (pressuration, 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 cellulosics
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?	XXXX	Radioactive decay
SKI3.1.9	WB	XXXX	Radiolysis
SKI1.4	W?H	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 (pressuration, 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	XXXX	Electro-chemical cracking
SKI5.23	C	XXXX	Changed hydrostatic pressure on canister

BUFFER/BACKFILL CATEGORY
SCREENED OUT FEP's

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	BR	2.1	Methane/CO2 production: Effects of hydrogen from metal corrosion
HMIP1.2.3	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	BR	2.3	Groundwater flow: initial conditions
SKI3.2.11	BH	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
SKI3.1.8	B	4	Near field buffer chemistry
AECL1.33	B	XXXX	Evolution of buffer
SKI3.1.9	WB	XXXX	Radiolysis
SKI3.1.12	B	XXXX	Perturbed buffer material chemistry
SKI4.1.3	BRFL	XXXX	Colloids, complexing agents
SKI5.18	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
SKI1.2.2	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	Preclosure 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	HR	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	BRFL	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	BRFL	XXXX	Colloids, complexing agents
SKI5.18	BRF	XXXX	Enhanced groundwater flow
AECL2.22	FH	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?	Saltation
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
SKI6.9	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
SKI4.1.3	BRFL	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
SKI7.10	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 fluvian)
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	Vulcanism
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	Meotorite 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 rechanneled
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	RH	D	Explosion
AECL2.53	H	D	Sabotage
AECL3.1	HGL	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

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	BCWR	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
SKI1.1.3	W	1.4	Recoil of alpha-decay
SKI1.1.4	W	1.4	Gas generation: He production
SKI1.2.1	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
SKI1.2.4	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)
SKI1.1.2	W	1.6	Radioactive decay; heat
1.7	Thermo-mechanical effects		
AECL1.27	WCB	1.5,1.7,1.8,1.9	Coupled processes
SKI2.3.1	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	WCBR	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	WCBR	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
UKN1.6.14	WCBRF	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	WCBR	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, mineralisati
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	WCBR	XXXX	Biological activity
AECL3.81	WL?	XXXX	Radiotoxic 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	WCBR	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	BC	2.2	Backfill effects on Cu corrosion
SKI3.2.7	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 generatio
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
SKI2.2	C	2.7	Creeping of copper
SKI2.3.3	C	2.7	Stress corrosion cracking
SKI2.3.4	C	2.7	Loss of ductility
SKI2.3.6	C	2.7	Cracking along welds
SKI2.3.7.1	C	2.7	External stress
SKI2.3.7.2	C	2.7	Hydrostatic pressure on canister
SKI2.3.8	C	2.7	Internal pressure
SKI3.2.2	CB	2.7	Movement of canister in buffer/backfill
SKI3.2.7	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	WCBRF	2.8	Chemical gradients (electrochemical effects and osmosis)
UKN3.2.3	WCBR	2.8	Interactions of waste and repository materials with host materials (eg. electroc
HMIP1.4.1	WCB	2.8	Waste-form and backfill consolidation
2.9	**Radionuclide transport through containers**		
SKI1.5	C	2.9	Release of radionuclides from the failured canister
2.10	**Specific factors**		
AECL1.84	WCBR	2.10	Temperature rises (unexpected effects)
SKI2.1.4	WC	2.10	Role of the eventual channeling within the canister
SKI2.3.5	C	2.10	Radiation effects on canister
SKI2.5.1	C	2.10	Random canister defects - quality control
SKI2.5.2	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
SKI3.2.8	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
SKI5.14	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
SKI3.2.1.2	BR	3.3	Uneven swelling of bentonite
SKI3.2.2	CB	3.3	Movement of canister in buffer/backfill
SKI3.2.3	B	3.3	Mechanical failure of buffer/backfill
SKI3.2.7	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	BRF	3.4	Variations in groundwater temperature
DOE2.4.13.1	BR	3.4	Repository thermally-induced groundwater transport
DOE2.4.13.2	BRF	3.4	Naturally thermally-induced groundwater transport
IAEA3.1.3	BRF	3.4	Thermal effects: Fluid pressure, density, viscosity changes
IAEA3.1.4	BRF	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
SKI3.2.5	B	3.4	Thermal effects on the buffer material
SKI3.2.10	B	3.4,3.10	Soret effect
SKI4.2.4	BR	3.4,3.10	Thermal buoyancy
UKN1.5.9	BRF	3.4	Natural thermal effects
UKN2.1.10	BR	3.4	Thermal effects (eg. concrete hydration)
HMIP1.2.8	WBR	3.4	Thermo-chemical effects
HMIP1.6.1	BR	3.4	Thermal effects and Rock-mass changes
HMIP1.6.3	BR	3.4	Thermal effects and Chemical changes
HMIP1.6.4	BR	3.4	Thermal effects and Transport (diffusion) effects
HMIP2.3.12	BRFL	3.4	Thermal effects on hydrochemistry
3.5	**Electro-chemical effects**		
AECL1.32	WCB	3.5	Electrochemical gradients
SKI2.1.6.2	CB	3.5	Natural telluric electrochemical reactions
3.6	**Gas effects**		
AECL1.86	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	BRFL	3.6	Gas transport: solution
DOE2.4.11.2	BRFL	3.6	Gas transport: gas phase ·
DOE2.4.12	BRF	3.6	Gas-induced groundwater transport
IAEA3.2.3	WB	3.6	Chemical effects: Gas generation
SKI3.2.12	B	3.6,3.10	Gas transport in bentonite
SKI6.2	BRF	3.6	Gas transport
UKN1.6.4	BRFL	3.6,3.10	Gas mediated transport
UKN1.6.5	BRFL	3.6,3.10	Multiphase flow and gas driven flow
HMIP1.2.6	BRF	3.6,3.10	Gas transport
HMIP1.5.3	BR	3.6	Gas production (unsaturated flow)
HMIP2.3.10	BRFL	3.6,3.11	Transport of active gases
HMIP2.3.11	BRFL	3.6,3.11	Gas induced groundwater transport
NEA1.6.4	BRFL	3.6,3.11	Gas mediated transport
NEA1.6.5	BRFL	3.6,3.11	Multiphase flow and gas-driven flow

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	WBRF	3.7	Microbial activity
DOE1.6.6.3	WBRF	3.7	Microbiological effects due to Microbial product reactions
PGA3.14	BRFL	3.7	Microbiological phenomena/effects
UKN1.7.7	WBRFL	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	WBR	3.9	Chemical gradients
AECL1.13	WCBR	3.9	Chemical kinetics
AECL1.27	WCB	3.4,3.9	Coupled processes
AECL1.40	WBR	3.9	Geochemical pump
AECL1.65	WCBR	3.9,3.11	Precipitation and dissolution
DOE1.6.5.3	WBR	3.9	Chemical changes due to Waste degradation
DOE1.6.5.4	WBR	3.9	Chemical changes due to Gas production
DOE1.6.5.5	BRF	3.9	Chemical changes due to Complex formation
DOE1.6.5.6	BRF	3.9	Chemical changes due to Colloid production
DOE1.6.5.7	BRF	3.9	Chemical changes due to Solubility
DOE1.6.5.8	BRF	3.9	Chemical changes due to Sorption
DOE1.6.5.9	BRF	3.9	Chemical changes due to Species equilibrium
DOE2.4.10	BRFL	3.9	Isotopic dilution
IAEA1.13.3	BRF	3.9	Fluid interactions: Brine pockets
IAEA3.2.4	WBR	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	BRFL	3.9	Oxidizing conditions
SKI4.1.2	BRFL	3.9	pH-deviations
SKI4.1.7	BR	3.9	Thermochemical changes
SKI5.1	BRF	3.9	Saline (or fresh) groundwater intrusion
UKN1.5.7	BRF	3.9	Saline or freshwater intrusion
UKN1.5.8	BRF	3.9	Effects at saline-freshwater interface
UKN1.6.13	BRFL	3.9	Mass, isotopic and species dilution
UKN1.6.14	WCBRF	3.9	Chemical gradients (electrochemical effects and osmosis)
UKN1.7.6	WBRFL	3.9	Chemical transformations
UKN3.1.5	WB	3.9	Induced chemical changes (solubility, sorption, species equilibrium, mineralisat
UKN3.2.2	WCBR	3.9	Interactions of host materials and groundwater with repository material (eg.
HMIP1.4.1	WCB	3.9	Waste-form and backfill consolidation
HMIP2.3.7	BRFL	3.9,3.11	Changes in groundwater chemistry and flow direction
HMIP2.3.13	BRFL	3.9	Biogeochemical changes
NEA1.6.13	BRFL	3.9	Mass, isotopic and species dilution
NEA1.6.14	BRFL	3.9	Chemical gradients (electrochemical effects and osmosis)
NEA3.1.5	BR	3.9	Induced chemical changes (solubility, sorption, species equilibrium, mineralisat

BUFFER/BACKFILL CATEGORY
SCREENED FEPs
(sorted)

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
3.10	Radionuclide transport processes		
AECL1.29	BR	3.10	Diffusion
AECL1.30	BR	3.10	Dispersion
AECL1.86	BR	3.6,3.10	Transport in gases or of gases
AECL1.90	BR	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
SKI3.2.6	B	3.10	Diffusion - surface diffusion
SKI3.2.8	B	3.1,3.10	Preferential pathways in the buffer/backfill
SKI3.2.9	B	3.10	Flow through buffer/backfill
SKI3.2.10	B	3.4,3.10	Soret effect
SKI3.2.12	B	3.6,3.10	Gas transport in bentonite
SKI4.2.4	BR	3.4,3.10	Thermal buoyancy
SKI4.2.5	BFF	3.10	Changes of groundwater flow
SKI6.4	BRFL	3.10	Dispersion
SKI6.5	BRFL	3.10	Dilution
UKN1.6.1	BRFL	3.10	Advection and dispersion
UKN1.6.2	BRFL	3.10	Diffusion
UKN1.6.3	BRFL	3.10	Matrix diffusion
UKN1.6.4	BRFL	3.6,3.10	Gas mediated transport
UKN1.6.5	BRFL	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	BR	3.10	Transport of chemically active substances into the near-field
HMIP2.3.1	BRFL	3.10	Advection
HMIP2.3.2	BRFL	3.10	Diffusion
HMIP2.3.3	BRFL	3.10	Hydrodynamic dispersion
NEA1.6.1	BRFL	3.10	Advection and dispersion
NEA1.6.2	BRFL	3.10	Diffusion
NEA1.6.3	BRFL	3.10	Matrix diffusion
3.11	Radionuclide chemistry		
AECL1.65	WCBR	3.9,3.11	Precipitation and dissolution
AECL1.76	BR	3.11	Sorption
AECL1.77	BR	3.11	Sorption: non-linear
AECL1.80	WCBR	3.11	Speciation
DOE2.4.4.1	BRFL	3.11	Solubility: effects of pH and Eh
DOE2.4.4.2	BRFL	3.11	Solubility: effects of ionic strength
DOE2.4.4.3	BRFL	3.11	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.4	BR	3.11	Solubility: effects of complexing agents formed in the near-field
DOE2.4.4.5	BRFL	3.11	Solubility. effects of naturally-occuring colloids
DOE2.4.4.6	BR	3.11	Solubility: effects of colloids formed in the near-field
DOE2.4.4.8	BRFL	3.11	Solubility: Effects of microbial activity
DOE2.4.5.1	BRFL	3.11	Linear sorption
DOE2.4.5.2	BRFL	3.11	Non-linear sorption
DOE2.4.5.3	BRFL	3.11	Reversible sorption
DOE2.4.5.4	BRFL	3.11	Irreversible sorption
DOE2.4.5.5	BRFL	3.11	Sorption: Effects of pH and Eh
DOE2.4.5.6	BRFL	3.11	Sorption: Effects of ionic strength
DOE2.4.5.7	BRFL	3.11	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRFL	3.11	Sorption: Effects of naturally-occurring inorganic complexing agents
DOE2.4.5.9	BR	3.11	Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BRFL	3.11	Sorption: effects of naturally-occuring colloids
DOE2.4.5.11	BR	3.11	Sorption: effects of colloids formed in the near-field
DOE2.4.5.13	BRFL	3.11	Sorption: effects of microbial activity
IAEA1.13.2	BRFL	3.11	Fluid interactions: Dissolution
SKI3.1.2	B	3.9,3.11	Saturation of sorption sites
SKI4.1.4	BRFL	3.11	Sorption
SKI4.1.5	BRFL	3.11	Reconcentration
SKI4.1.9	BRFL	3.11	Complexing agents
UKN1.6.6	BRFL	3.11	Solubility limit
UKN1.6.7	BRFL	3.11	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BRFL	3.11	Dissolution, precipitation and crystallisation

IDENTIFIER	CATEGORY	CON. CODE	FEP NAME
3.11	Radionuclide chemistry (continued)		
UKN1.6.10	BRFL	3.11	Complexing agents
HMIP2.3.4	BRFL	3.11	Solubility constraints
HMIP2.3.5	BRFL	3.11	Sorption including ion-exchange
HMIP2.3.6	BRFL	3.11	Changes in sorptive surfaces
HMIP2.3.7	BRFL	3.9,3.11	Changes in groundwater chemistry and flow direction
HMIP2.3.9	BRFL	3.11	Transport of radionuclides bound to microbes
HMIP2.3.10	BRFL	3.6,3.11	Transport of active gases
HMIP2.3.11	BRFL	3.6,3.11	Gas induced groundwater transport
NEA1.6.4	BRFL	3.6,3.11	Gas mediated transport
NEA1.6.5	BRFL	3.6,3.11	Multiphase flow and gas-driven flow
NEA1.6.6	BRFL	3.11	Solubility limit
NEA1.6.7	BRFL	3.11	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRFL	3.11	Dissolution, precipitation, and crystallisation
3.12	Specific factors		
AECL1.36	B	3.12	Faulty buffer emplacement
DOE2.3.5.1	BF	3.12	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BF	3.12	Inorganic colloid transport: Effects of ionic strength
DOE2.4.7.1	BRFL	3.12	Organic colloid transport in Porous media
DOE2.4.7.2	BRFL	3.12	Organic colloid transport in Fractured media
DOE2.4.7.3	BRFL	3.12	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BRFL	3.12	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BRFL	3.12	Inorganic colloid transport: Porous media
DOE2.4.8.2	BRFL	3.12	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BRFL	3.12	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BRFL	3.12	Inorganic colloid transport: Effects of ionic strength
DOE2.4.9	BRFL	3.12	Transport of radionuclides bound to microbes
PGA3.13	BRFL	3.12	Physico-chemical phenomena/effects (eg. colloid formation)
SKI3.1.4	B	3.12	Colloid generation - source
SKI4.2.3	BF	3.12	Extreme channel flow of oxidants and nuclides
UKN1.6.9	BRFL	3.12	Colloid formation, dissolution and transport
UKN2.2.2	HB	3.12	Inadequate backfill or compaction, voidage
HMIP2.3.8	BRFL	3.12	Colloid transport
NEA1.6.9	BRFL	3.12	Colloid formation, dissolution, and transport
NEA1.6.10	BRFL	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
UKN3.2.3	WCBR	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	BF	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
SKI4.2.9	R	4.2	Creeping of rock mass
SKI5.11	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, settling, subsidence or caving
HMIP1.1.2	R	4.2,4.8	Physico-chemical degradation of concrete
HMIP1.4.2	R	4.2	Vault collapse
HMIP5.1.1	FRL	4.2	Loss of integrity of borehole seals
HMIP5.1.2	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, settling, 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	SR	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	BFF	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
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
DOE2.3.4.1	FF	4.3	Groundwater flow: Darcy
DOE2.3.4.2	FF	4.3	Groundwater flow: Non-Darcy
DOE2.3.4.3	FF	4.3	Groundwater flow: Intergranular (matrix)
DOE2.3.4.4	BFF	4.3	Groundwater flow: Fracture
DOE2.3.4.5	BFF	4.3	Groundwater flow: Effects of solution channels
DOE2.4.12	BFF	4.6,4.3	Gas-induced groundwater transport
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
IAEA1.13.1	SFF	4.3	Fluid interactions: Groundwater flow
IAEA3.1.4	BFF	4.5,4.3	Thermal effects: Fluid migration
PGA4.1	FF	4.3	Direct alterations in hydrogeology
SKI4.2.5	BFF	4.3	Changes of groundwater flow
SKI4.2.7	R	4.3,4.4,4.5	Thermo-hydro-mechanical flects
SKI5.14	BR	4.3	Resaturation
SKI6.13	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)
HMIP1.5.1	R	4.3	Desaturation (pumping) effects
HMIP1.5.2	R	4.3,4.4	Disturbed zone (hydromechanical) effects
HMIP1.5.4	SFF	4.3	Saturated groundwater flow
HMIP1.6.2	BR	4.5,4.3	Thermal effects and Hydrogeological changes
HMIP2.3.7	BRFL	4.8,4.3	Changes in groundwater chemistry and flow direction
NEA2.1.5	HR	4.3	Dewatering of host rock
NEA3.1.4	SFF	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	SCWR	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	RFG	4.4	Externally-induced seismicity
DOE2.3.3.4	FF	4.2,4.4	Rock property changes: Channel 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
SKI3.2.1.1	BR	4.4	Swelling of bentonite into tunnels and cracks
SKI3.2.1.2	BR	4.4	Uneven swelling of bentonite
SKI4.2.1	R	4.4	Mechanical failure of repository
SKI4.2.2.1	R	4.4	Excavation/backfilling effects on nearby rock
SKI4.2.7	R	4.3,4.4,4.5	Thermo-hydro-mechanical effects
SKI4.2.8	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
HMIP1.5.2	R	4.3,4.4	Disturbed zone (hydromechanical) effects
HMIP1.6.1	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
SKI4.2.4	BR	4.5	Thermal buoyancy
SKI4.2.7	R	4.3,4.4,4.5	Thermo-hydro-mechanical effects
SKI6.13	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)
HMIP1.6.1	BR	4.5,4.4	Thermal effects and Rock-mass changes
HMIP1.6.2	BR	4.5,4.3	Thermal effects and Hydrogeological changes
HMIP1.6.3	BR	4.5,4.8	Thermal effects and Chemical changes
HMIP1.6.4	BR	4.5,4.10	Thermal effects and Transport (diffusion) effects
HMIP2.3.12	SRFL	4.5,4.8	Thermal effects on hydrochemistry
NEA2.1.10	R	4.5	Thermal effects

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 concre
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	BFRL	4.6,4.10	Gas transport: solution
DOE2.4.11.2	BFRL	4.6	Gas transport: gas phase
DOE2.4.12	BFF	4.6,4.3	Gas-induced groundwater transport
SKI5.22	GR	4.6	Accumulation of gases under permafrost
SKI5.43	GR	4.6	Methane intrusion
SKI6.2	BFF	4.6	Gas transport
UKN1.2.13	R	4.6	Natural gas intrusion
UKN1.6.4	BFRL	4.6,4.10	Gas mediated transport
UKN1.6.5	BFRL	4.6,4.10	Multiphase flow and gas driven flow
HMIP1.26	BFF	4.6	Gas transport
HMIP1.5.3	BR	4.6	Gas production (unsaturated flow)
HMIP2.3.10	BFRL	4.6,4.10	Transport of active gases
HMIP2.3.11	BFRL	4.6,4.10	Gas induced groundwater transport
NEA1.2.13	FF	4.6	Natural gas intrusion
NEA1.6.4	BFRL	4.6,4.10	Gas mediated transport
NEA1.6.5	BFRL	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	BFRL	4.7,4.8	Transport of radionuclides bound to microbes
PGA3.14	BFRL	4.7	Microbiological phenomena/effects
UKN1.7.7	WBFRL	4.7	Microbial interactions
HMIP2.3.9	BFRL	4.7, 4.10	Transport of radionuclides bound to microbes
HMIP2.3.13	BFRL	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	BFRL	4.7,4.8	Transport of radionuclides bound to microbes
DOE2.4.14	FRL	4.8	Biogeochemical changes
IAEA1.13.2	BFRL	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	BFRL	4.8	Physico-chemical phenomena/effects (eg. colloid formation)
SKI4.1.1	BFRL	4.8	Oxidizing conditions
SKI4.1.2	BFRL	4.8	pH-deviations
SKI4.1.6	BFRL	4.8,4.9	Reconcentration
SKI4.1.7	BR	4.8	Thermochemical changes
SKI4.1.8	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)**		
SKI4.1.9	BRRL	4.8,4.9	Complexing agents
SKI4.2.10	BR	4.8	Chemical effects of rock reinforcement
SKI5.1	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	WBRFL	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. electroc
UKN3.2.4	FF	4.8	Non-radioactive solute plume in geosphere (effect on redox, effect on pH, sor
HMIP1.1.2	R	4.2,4.8	Physico-chemical degradation of concrete
HMIP1.2.8	WBR	4.8	Thermo-chemical effects
HMIP1.5.5	BR	4.8	Transport of chemically active substances into the near-field
HMIP1.6.3	BR	4.5,4.8	Thermal effects and Chemical changes
HMIP2.3.7	BRFL	4.8,4.3	Changes in groundwater chemistry and flow direction
HMIP2.3.12	BRFL	4.5,4.8	Thermal effects on hydrochemistry
NEA1.6.11	FF	4.8	Fracture mineralisation
NEA1.6.14	BRFL	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 (electrochen
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	BRFL	4.9	Solubility: effects of pH and Eh
DOE2.4.4.2	BRFL	4.9	Solubility: effects of ionic strength
DOE2.4.4.3	BRFL	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	BRFL	4.9	Solubility: effects of naturally-occuring 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	BRFL	4.9	Solubility: Effects of microbial activity
DOE2.4.5.1	BRFL	4.9	Linear sorption
DOE2.4.5.2	BRFL	4.9	Non-linear sorption
DOE2.4.5.3	BRFL	4.9	Reversible sorption
DOE2.4.5.4	BRFL	4.9	Irreversible sorption
DOE2.4.5.5	BRFL	4.9	Sorption: Effects of pH and Eh
DOE2.4.5.6	BRFL	4.9	Sorption: Effects of ionic strength
DOE2.4.5.7	BRFL	4.9	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRFL	4.9	Sorption: Effects of naturally-occuring inorganic complexing agents
DOE2.4.5.9	BR	4.9	Sorption: Effects of complexing agents formed in the near-field
DOE2.4.5.10	BRFL	4.9,4.11	Sorption: effects of naturally-occuring 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	BRFL	4.9	Sorption: effects of microbial activity
DOE2.4.10	BRFL	4.9	Isotopic dilution
SKI4.1.4	BRFL	4.9	Sorption
SKI4.1.5	FF	4.9	Matrix diffusion
SKI4.1.6	BRFL	4.8,4.9	Reconcentration
SKI4.1.9	BRFL	4.8,4.9	Complexing agents
SKI5.44	WR	4.9	Solubility and precipitation
SKI7.5	FFL	4.9	Isotopic dilution
UKN1.6.6	BRFL	4.9	Solubility limit
UKN1.6.7	BRFL	4.9	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BRFL	4.9	Dissolution, precipitation and crystalisation
UKN1.6.10	BRFL	4.9	Complexing agents
UKN1.6.13	BRFL	4.9	Mass, isotopic and species dilution
HMIP2.3.4	BRFL	4.9	Solubility constraints
HMIP2.3.5	BRFL	4.9	Sorption including ion-exchange
HMIP2.3.6	BRFL	4.9	Changes in sorptive surfaces
NEA1.6.6	BRFL	4.9	Solubility limit
NEA1.6.7	BRFL	4.9	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRFL	4.9	Dissolution, precipitation, and crystallisation
NEA1.6.10	BRFL	4.9	Complexing agents
NEA1.6.13	BRFL	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	BR	4.10	Diffusion
AECL1.30	BR	4.10	Dispersion
AECL1.46	BR	4.5,4.10	Hydrothermal alteration
AECL1.70	R	4.3,4.10	Recharge groundwater
AECL1.86	BR	4.6,4.10	Transport in gases or of gases
AECL1.90	BR	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	BRFL	4.6,4.10	Gas transport: solution
SKI6.4	BRFL	4.10	Dispersion
SKI6.5	BRFL	4.10	Dilution
UKN1.6.1	BRFL	4.10	Advection and dispersion
UKN1.6.2	BRFL	4.10	Diffusion
UKN1.6.3	BRFL	4.10	Matrix diffusion
UKN1.6.4	BRFL	4.6,4.10	Gas mediated transport
UKN1.6.5	BRFL	4.6,4.10	Multiphase flow and gas driven flow
HMIP1.6.4	BR	4.5,4.10	Thermal effects and Transport (diffusion) effects
HMIP2.3.1	BRFL	4.10	Advection
HMIP2.3.2	BRFL	4.10	Diffusion
HMIP2.3.3	BRFL	4.10	Hydrodynamic dispersion
HMIP2.3.9	BRFL	4.7, 4.10	Transport of radionuclides bound to microbes
HMIP2.3.10	BRFL	4.6,4.10	Transport of active gases
HMIP2.3.11	BRFL	4.6,4.10	Gas induced groundwater transport
NEA1.6.1	BRFL	4.10	Advection and dispersion
NEA1.6.2	BRFL	4.10	Diffusion
NEA1.6.3	BRFL	4.10	Matrix diffusion
NEA1.6.4	BRFL	4.6,4.10	Gas mediated transport
NEA1.6.5	BRFL	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	HFF	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	BRFL	4.9,4.11	Sorption: effects of naturally-occurring colloids
DOE2.4.7.1	BRFL	4.11	Organic colloid transport in Porous media
DOE2.4.7.2	BRFL	4.11	Organic colloid transport in Fractured media
DOE2.4.7.3	BRFL	4.11	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BRFL	4.11	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BRFL	4.11	Inorganic colloid transport: Porous media
DOE2.4.8.2	BRFL	4.11	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BRFL	4.11	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BRFL	4.11	Inorganic colloid transport: Effects of ionic strength
IAEA2.2.1	FF	4.11	Inadequate design: Shaft seal failure
IAEA2.2.2	FRL	4.11	Inadequate design: Exploration borehole seal failure
PGA3.16	R	4.2,4.11	Failure of shaft sealing
SKI4.2.3	BFF	4.11	Extreme channel flow of oxidants and nuclides
SKI5.45	FF	4.11	Colloid generation and transport
UKN1.6.9	BRFL	4.11	Colloid formation, dissolution and transport
UKN2.2.10	RH	4.11	Poor closure
HMIP2.3.8	BRFL	4.11	Colloid transport
HMIP5.1.3	R	4.11	Incomplete near-field chemical conditioning
NEA1.6.9	BRFL	4.11	Colloid formation, dissolution, and transport
NEA2.1.6	CR	4.11	Material defects (e.g. early canister failure)
NEA2.1.8	HR	4.11	Poor quality construction
NEA2.2.1	R	4.11	Radioactive waste disposal error
NEA2.2.2	BR	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	HF	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	HF	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	BFF	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
SKI4.2.3	BFF	5.2,5.10	Extreme channel flow of oxidants and nuclides
SKI4.2.5	BFF	5.2	Changes of groundwater flow
SKI5.1	BFF	5.2	Saline (or fresh) groundwater intrusion
SKI5.46	F	5.2	Groundwater recharge/discharge
SKI6.13	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 marin
UKN1.5.5	F	5.2	Groundwater flow (Darcy, non-Darcy, intergranular fracture, channelling and pr
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 pr
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
DOE2.2.6.1	FF	5.3	Repository-induced seismicity
DOE2.2.6.2	FFG	5.3	Externally-induced seismicity
DOE2.2.6.3	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
SKI6.13	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
SKI6.2	BFF	5.5,5.9	Gas transport
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
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
NEA1.6.5	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	5.5,5.9	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	BRF	5.7,5.8	Chemical changes due to Complex formation
DOE1.6.5.6	BRF	5.7,5.8	Chemical changes due to Colloid production
DOE1.6.5.7	BRF	5.7,5.8	Chemical changes due to Solubility
DOE1.6.5.8	BRF	5.7,5.8	Chemical changes due to Sorption
DOE1.6.5.9	BRF	5.7,5.8	Chemical changes due to Species equilibrium
DOE2.4.6	FF	5.7,5.1	Fracture mineralisation
DOE2.4.14	RFL	5.7	Biogeochemical changes
IAEA1.13.3	BRF	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)
SKI4.1.1	BRFL	5.7	Oxidizing conditions
SKI4.1.2	BRFL	5.7	pH-deviations
SKI5.25	F	5.7	Dissolution of fracture fillings/precipitations
SKI6.3	F	5.7	Far field hydrochemistry - acids, oxidants, nitrate
SKI6.6	F	5.7	Weathering of flow paths
UKN1.5.7	BRF	5.7	Saline or freshwater intrusion
UKN1.5.8	BRF	5.7	Effects at saline-freshwater interface
UKN1.6.11	FF	5.7,5.1	Fracture mineralisation and weathering
UKN1.6.14	WCBRF	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, sor
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 (electrochen
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	BRF	5.7,5.8	Chemical changes due to Complex formation
DOE1.6.5.6	BRF	5.7,5.8	Chemical changes due to Colloid production
DOE1.6.5.7	BRF	5.7,5.8	Chemical changes due to Solubility
DOE1.6.5.8	BRF	5.7,5.8	Chemical changes due to Sorption
DOE1.6.5.9	BRF	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-occuring 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-occuring inorganic complexing agents
DOE2.4.5.10	BRFL	5.8	Sorption: effects of naturally-occuring 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	BRFL	5.8	Sorption: effects of microbial activity
DOE2.4.10	BRFL	5.8	Isotopic dilution
IAEA1.13.2	BRFL	5.2,5.8	Fluid interactions: Dissolution
SKI4.1.4	BRFL	5.8	Sorption
SKI4.1.6	BRFL	5.8	Reconcentration
SKI4.1.9	BRFL	5.8	Complexing agents
SKI6.5	BRFL	5.8	Dilution
SKI7.5	RFL	5.8	Isotopic dilution
UKN1.6.6	BRFL	5.8	Solubility limit
UKN1.6.7	BRFL	5.8	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BRFL	5.8	Dissolution, precipitation and crystalisation
UKN1.6.10	BRFL	5.8	Complexing agents
UKN1.6.13	BRFL	5.8	Mass, isotopic and species dilution
HMIP2.3.4	BRFL	5.8	Solubility constraints
HMIP2.3.5	BRFL	5.8	Sorption including ion-exchange
HMIP2.3.6	BRFL	5.8	Changes in sorptive surfaces
NEA1.6.6	BRFL	5.8	Solubility limit
NEA1.6.7	BRFL	5.8	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRFL	5.8	Dissolution, precipitation, and crystallisation
NEA1.6.10	BRFL	5.8	Complexing agents
NEA1.6.13	BRFL	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	BRF	5.9	Advection
DOE2.4.2.1	BRF	5.9	Bulk diffusion
DOE2.4.2.2	BRF	5.9	Matrix diffusion
DOE2.4.3	BRF	5.9	Hydrodynamic dispersion
DOE2.4.9	BRFL	5.6,5.9	Transport of radionuclides bound to microbes
DOE2.4.11.1	BRFL	5.6,5.9	Gas transport: solution
DOE2.4.11.2	BRFL	5.6,5.9	Gas transport: gas phase
SKI4.1.5	FF	5.9	Matrix diffusion
SKI6.2	BRF	5.5,5.9	Gas transport
SKI6.4	BRFL	5.9	Dispersion
UKN1.6.1	BRFL	5.9	Advection and dispersion
UKN1.6.2	BRFL	5.9	Diffusion
UKN1.6.3	BRFL	5.9	Matrix diffusion
UKN1.6.4	BRFL	5.5,5.9	Gas mediated transport
UKN1.6.5	BRFL	5.5,5.9	Multiphase flow and gas driven flow
HMIP1.2.6	BRF	5.5,5.9	Gas transport
HMIP2.3.1	BRFL	5.9	Advection
HMIP2.3.2	BRFL	5.9	Diffusion
HMIP2.3.3	BRFL	5.9	Hydrodynamic dispersion
HMIP2.3.9	BRFL	5.6,5.9	Transport of radionuclides bound to microbes
HMIP2.3.10	BRFL	5.5,5.9	Transport of active gases
NEA1.6.1	BRFL	5.9	Advection and dispersion
NEA1.6.2	BRFL	5.9	Diffusion
NEA1.6.3	BRFL	5.9	Matrix diffusion
NEA1.6.4	BRFL	5.5,5.9	Gas mediated transport
NEA1.6.5	BRFL	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	HFF	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	RF?	5.10	Vault heating effects
DOE2.3.4.6	FF	5.10	Inorganic colloid transport: Porous media
DOE2.3.5.1	BRF	5.10	Inorganic colloid transport: Effects of pH and Eh
DOE2.3.5.2	BRF	5.10	Inorganic colloid transport: Effects of ionic strength
DOE2.4.7.1	BPRL	5.10	Organic colloid transport in Porous media
DOE2.4.7.2	BRRL	5.10	Organic colloid transport in Fractured media
DOE2.4.7.3	BRRL	5.10	Organic colloid transport: Effects of pH and Eh
DOE2.4.7.4	BRRL	5.10	Organic colloid transport: Effects of ionic strength
DOE2.4.8.1	BRRL	5.10	Inorganic colloid transport: Porous media
DOE2.4.8.2	BRRL	5.10	Inorganic colloid transport: Fractured media
DOE2.4.8.3	BRRL	5.10	Inorganic colloid transport: Effects of pH and Eh
DOE2.4.8.4	BRRL	5.10	Inorganic colloid transport: Effects of ionic strength
DOE4.1.1.1	RRL	5.10	Borehole seal failure
DOE4.1.1.2	RRL	5.10	Borehole seal degradation
IAEA2.2.1	FF	5.10	Inadequate design: Shaft seal failure
IAEA2.2.2	RRL	5.10	Inadequate design: Exploration borehole seal failure
SKI4.2.3	BRF	5.2,5.10	Extreme channel flow of oxidants and nuclides
SKI5.11	FF	5.10	Degradation of hole- and shaft seals
SKI5.45	FF	5.10	Colloid generation and transport
SKI6.1	F	5.10	Undetected fracture zones
SKI6.12	F	5.10	Undetected discontinuities
SNL6.2	RRL	5.10	Shaft and Borehole Seal Degradation
UKN1.2.12	FG	5.10	Undetected features (e.g. faults, fracture networks, shear zones, brecciation, c
UKN1.6.9	BRRL	5.10	Colloid formation, dissolution and transport
UKN2.1.2	RRL	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	BPRL	5.10	Colloid transport
HMIP5.1.1	RRL	5.10	Loss of integrity of borehole seals
NEA1.6.9	BRRL	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	CON. 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
SKI7.3	HL	6.1,6.2,6.12	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
SKI7.3	HL	6.1,6.2,6.12	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

BIOSPHERE 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
SKI7.1	L	6.3	Accumulation in sediments
SKI7.2	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
HMIP4.1.7	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
SKI5.41	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 marin
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
AECL3.112	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**		
AECL3.55	L	6.6	Gas leakage into underground living space
AECL3.82	L	6.6	Radon emission
DOE2.4.11.1	BRFL	6.6	Gas transport: solution
DOE2.4.11.2	BRFL	6.6	Gas transport: gas phase
UKN1.6.4	BRFL	6.6,6.10	Gas mediated transport
UKN1.6.5	BRFL	6.6,6.10	Multiphase flow and gas driven flow
HMIP2.3.10	BRFL	6.6,6.10	Transport of active gases
HMIP2.3.11	BRFL	6.6,6.10	Gas induced groundwater transport
HMIP4.1.3	L	6.6	Gas discharge
NEA1.6.4	BRFL	6.6,6.10	Gas mediated transport
NEA1.6.5	BRFL	6.6,6.10	Multiphase flow and gas-driven flow

BIOSPHERE CATEGORY:
SCREENED FEPs LIST
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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	BRRL	6.7	Transport of radionuclides bound to microbes
DOE2.4.14	RRL	6.7,6.8	Biogeochemical changes
PGA3.14	BRRL	6.7	Microbiological phenomena/effects
UKN1.7.7	WBRRL	6.7	Microbial interactions
HMIP2.3.9	BRRL	6.7,6.10	Transport of radionuclides bound to microbes
HMIP2.3.13	BRRL	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	RRL	6.7,6.8	Biogeochemical changes
IAEA1.13.2	BRRL	6.8	Fluid interactions: Dissolution
PGA1.11	RL	6.8	Weathering, mineralisation
PGA3.13	BRRL	6.8,6.12	Physico-chemical phenomena/effects (eg. colloid formation)
SKI4.1.1	BRRL	6.8	Oxidizing conditions
SKI4.1.2	BRRL	6.8	pH-deviations
UKN1.7.6	WBRRL	6.8	Chemical transformations
UKN2.4.5	L	6.3,6.8	Altered soil or surface water chemistry
HMIP2.3.7	BRRL	6.8	Changes in groundwater chemistry and flow direction
HMIP2.3.12	BRRL	6.8	Thermal effects on hydrochemistry
HMIP2.3.13	BRRL	6.7,6.8	Biogeochemical changes
HMIP4.2.6	L	6.7,6.8	Biogeochemical processes
NEA1.6.14	BRRL	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	BRRL	6.9	Solubility: effects of pH and Eh
DOE2.4.4.2	BRRL	6.9	Solubility: effects of ionic strength
DOE2.4.4.3	BRRL	6.9	Solubility: effects of naturally-occurring complexing agents
DOE2.4.4.5	BRRL	6.9	Solubility: effects of naturally-occuring colloids
DOE2.4.4.8	BRRL	6.9	Solubility: Effects of microbial activity
DOE2.4.5.1	BRRL	6.9	Linear sorption
DOE2.4.5.2	BRRL	6.9	Non-linear sorption
DOE2.4.5.3	BRRL	6.9	Reversible sorption
DOE2.4.5.4	BRRL	6.9	Irreversible sorption
DOE2.4.5.5	BRRL	6.9	Sorption: Effects of pH and Eh
DOE2.4.5.6	BRRL	6.9	Sorption: Effects of ionic strength
DOE2.4.5.7	BRRL	6.9	Sorption: Effects of naturally-occurring organic complexing agents
DOE2.4.5.8	BRRL	6.9	Sorption: Effects of naturally-occuring inorganic complexing agents
DOE2.4.5.10	BRRL	6.9	Sorption: effects of naturally-occuring colloids
DOE2.4.5.13	BRRL	6.9	Sorption: effects of microbial activity
DOE2.4.10	BRRL	6.9	Isotopic dilution
SKI4.1.4	BRRL	6.9	Sorption
SKI4.1.6	BRRL	6.9	Reconcentration
SKI4.1.9	BRRL	6.9	Complexing agents
SKI6.5	BRRL	6.9	Dilution
SKI7.5	RRL	6.9	Isotopic dilution
UKN1.6.6	BRRL	6.9	Solubility limit
UKN1.6.7	BRRL	6.9	Sorption (linear/non-linear, reversible/irreversible)
UKN1.6.8	BRRL	6.9	Dissolution, precipitation and crystalisation
UKN1.6.10	BRRL	6.9	Complexing agents
UKN1.6.13	BRRL	6.9	Mass, isotopic and species dilution
HMIP2.3.4	BRRL	6.9	Solubility constraints
HMIP2.3.5	BRRL	6.9	Sorption including ion-exchange
HMIP2.3.6	BRRL	6.9	Changes in sorptive surfaces
NEA1.6.6	BRRL	6.9	Solubility limit
NEA1.6.7	BRRL	6.9	Sorption (linear/non-linear, reversible/irreversible)
NEA1.6.8	BRRL	6.9	Dissolution, precipitation, and crystallisation
NEA1.6.10	BRRL	6.9	Complexing agents
NEA1.6.13	BRRL	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
SKI6.4	BRRL	6.10	Dispersion
UKN1.6.1	BRRL	6.10	Advection and dispersion
UKN1.6.2	BRRL	6.10	Diffusion
UKN1.6.3	BRRL	6.10	Matrix diffusion
UKN1.6.4	BRRL	6.6,6.10	Gas mediated transport
UKN1.6.5	BRRL	6.6,6.10	Multiphase flow and gas driven flow
HMIP2.3.1	BRRL	6.10	Advection
HMIP2.3.2	BRRL	6.10	Diffusion
HMIP2.3.3	BRRL	6.10	Hydrodynamic dispersion
HMIP2.3.9	BRRL	6.7,6.10	Transport of radionuclides bound to microbes
HMIP2.3.10	BRRL	6.6,6.10	Transport of active gases
HMIP2.3.11	BRRL	6.6,6.10	Gas induced groundwater transport
NEA1.6.1	BRRL	6.10	Advection and dispersion
NEA1.6.2	BRRL	6.10	Diffusion
NEA1.6.3	BRRL	6.10	Matrix diffusion
NEA1.6.4	BRRL	6.6,6.10	Gas mediated transport
NEA1.6.5	BRRL	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	5.11	Critical group - pets
AECL3.3[illegible]	L	6.11	Dermal sorption - nuclides other than tritium
AECL3.[illegible]	L	6.11	Household dust and fumes
AECL3.[illegible]	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
SKI5.41	HL	6.4,6.11	Water producing well
HMIP4.2.4	L	6.3,6.4,6.11	Sediment/water/gas interaction with the atmosphere
HMIP4.4.1	L	6.11	External exposure
HMIP4.4.2	L	6.11	Ingestion
HMIP4.4.3	L	6.11	Inhalation

BIOSPHERE CATEGORY:
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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)
SKI7.3	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
NEA2.4.8	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	FFG	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:
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(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, springflow)
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:
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(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
SKI5.20	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
SKI5.17	G	7.9	Permafrost
SKI5.22	GR	7.9,7.11	Accumulation of gases under permafrost
SKI5.42	G	7.9	Glaciation
SKI6.10	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
SKI6.10	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	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
UKN1.3.7	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	CON. 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
SKI5.22	GR	7.9,7.11	Accumulation of gases under permafrost
SKI5.43	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 flo
UKN1.2.12	FG	7.11	Undetected features (e.g. faults, fracture networks, shear zones, brecciation, g
UKN2.4.9	HG	7.11	Anthropogenic climate change (greenhouse effect)
HMIP3.1.1	HG	7.11	Human induced climate change
NEA1.2.11	G	7.11	Rock heterogeneity (permeability, mineralogy), affecting water and gas low
NEA1.2.12	G	7.11	Undetected features (faults, fracture networks, shear zones, brecciation, gas
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 abstaction (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	Tunnelling
DOE4.2.8	H	8.3	Construction of underground storage/disposal facilities
DOE4.2.9	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	Tunnelling
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
SKI5.27	H	8.4	Human induced actions on groundwater recharge
SKI5.41	HL	8.4	Water producing well
SKI7.8	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 wit
IAEA2.4.4	H	8.6	Transport agent introduction: Chemical liquid waste disposal
8.7	Specific factors		
AECL2.5	HRF	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
SKI5.2	H	8.7	Non-sealed repository
SKI5.3	H	8.7	Stray materials left
SKI5.4	H	8.7	Decontamination materials left
SKI5.9	H	8.7	Unsealed boreholes and/or shafts
SKI5.21	H	8.1,8.7	Future boreholes and undetected past boreholes
SKI6.8	H	8.7	Human induced climate change
SKI7.9	H	8.7	Loss of records
SKI7.11	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	RH	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	
		Radiolysis
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)
	Waste: electro-chemical effects	
F		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
		Chemical changes due to metal corrosion
L		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
		I, Cs-migration to fuel surface
		Damaged or deviating fuel
F		Role of the eventual channeling within the canister (new FEP: PREFERENTIAL PATHWAYS)

AUDIT CODE		FEP NAME
	Canister materiels/construction: SYSTEM DESCRIPTION	
		Inventory
	Canister: corrosion/degradation processes	
EFEP		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	
EFEP		Container failure (early)
		Canister movement
		Mechanical canister damage (failure)
		Creeping of copper
		Stress corrosion cracking
EFEP		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 failured canister
	Canister: specific factors	
		Role of the eventual channeling within the canister (PREFERENTIAL PATHWAYS)
		Radiation effects on canister
EFEP		Random canister defects - quality control
EFEP		Common cause canister defects - quality control
EFEP		Material defects, e.g. early canister failure

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

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)
F L L		Unsaturated transport
		Groundwater flow: fracture
L		Groundwater flow: effects of solution channels (PREFERENTIAL PATHWAYS)
		Soret effect
EFEP		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	
EFEP		Faulty buffer emplacement
		Colloid transport (inorganic and organic; porous and fractured media)
		Extreme channel flow of oxidants and nuclides (PREFERENTIAL PATHWAYS)
BFEP		Inadequate backfill or compaction, voidage
		Anion exchange

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
FLL	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
EFEP	Repository-induced seismicity
EFEP	Externally-induced seismicity
	Differing thermal expansion of host rock zones
EFEP	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
EFEP	Methane intrusion
	Transport of active gases

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
EFEP		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
EFEP		Incomplete vault or borehole closure
EFEP		Unmodelled design features
EFEP		Inadequate design: shaft seal and exploration borehole seal failure
EFEP		Open boreholes
		Extreme channel flow of oxidants and nuclides (PREFERENTIAL PATHWAYS)
EFEP		Poor quality construction
EFEP		Material defects (e.g. early canister failure)
EFEP		Abandonment of unsealed repository
EFEP		Effects of phased operations

AUDIT CODE		FEP NAME
	Rock properties: SYSTEM DESCRIPTION	
		Rock properties (porosity, permeability, discharge zones, fractures)
	Hydrogeological effects	
		Rock property changes (porosity, pemeability, 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
EFEP		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	
EFEP		Repository-induced seismicity
EFEP		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
EFEP		Saline or freshwater intrusion
EFEP		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	
EFEP		Boreholes - unsealed
		Colloids: formation & effects (including inorganic and organic colloid transport)
EFEP		Incomplete vault closure
EFEP		Rock properties - undetected features
EFEP		Inadequate design: shaft seal or exploration borehole seal failure
EFEP		Extreme channel flow of oxidants and nuclides
EFEP		Undetected features (e.g. faults, fracture networks, shear zones, discontinuities, ga
		Shaft and borehole seal degradation

AUDIT CODE		FEP NAME
	Human considerations	
		Charcoal production
		Space heating
EFEP		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)

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
EFEP		Boreholes - unsealed
		Loss of integrity of borehole seals: seal failure or degradation
EFEP		Inadequate design: Exploration borehole seal failure
		Intrusion in accumulation zone in the biosphere (animals)
		Demographic change, urban development

AUDIT CODE		FEP NAME
	Seismic events/major land movement	
		Earthquakes
		Regional uplift and subsidence (e.g. orogenic, isostatic)
EFEP		Externally-induced seismicity
EFEP		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
EFEP		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	
EFEP		Sea level change
	Magnetic effects	
EFEP		Changes in the Earth's magnetic field
	Glaciation/glacial effects	
EFEP		Glaciation
EFEP		Glacial/interglacial cycling effects (including sea level changes)
EFEP		Permafrost
		Accumulation of gases under permafrost
EFEP		No ice age
	Climate effects (natural)	
EFEP		Climate change
EFEP		Pluvial periods
EFEP		Insolation
	Specific factors	
EFEP		Anthropogenic climate change (greenhouse effect)
L		Greenhouse-induced effects (e.g. sea level change, precipitation, temp.)
EFEP		Wind
EFEP		Tsunamis

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

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