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Used Fuel Disposition Campaign: Features, Events, and Processes (FEPs) (Work Package FTLL11UF0329) Level 4 Milestone (M4): M41UF032901 (LLNL Input to SNL L3 Milestone) FEP Status Tool and LLNL FEPs

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Disclaimer

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Used Fuel Disposition Campaign

Features, Events, and Processes (FEPs)
(Work Package FTLL11UF0329)

Level 4 Milestone (M4): M41UF032901
(LLNL INPUT TO SNL L3 MILESTONE)

FEP STATUS TOOL AND LLNL FEPS

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ACRONYMS

ANL	Argonne National Laboratory
DOE	U.S. Department of Energy
EBS	Engineered Barrier System
FEPs	Features, Events and Processes
GEN III+	Generation III or later versions of nuclear reactors
HLW	High-Level nuclear Waste
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LTHLW	Lower Than High-Level nuclear Waste
LWR	Light Water Reactor
RI	Responsible Individual
RO	Responsible Organization
SNF	Spent Nuclear Fuel
SNL	Sandia National Laboratories
SZ	Saturated Zone
UFD	Used Fuel Disposition
UNF	Used Nuclear Fuel
UZ	Unsaturated Zone
WP	Waste Package

1. STATUS TOOL FOR ASSESSING PROGRESS OF FEATURES, EVENTS, AND PROCESSES

The combination of 208 FEPs with the 5 waste forms and 7 geologic settings leads to a truly large parameter space for evaluation. Fortunately, many evaluations can handle multiple waste form and/or geologic setting situations for a given FEP. Also, some evaluations of a given waste form and/or geologic setting can apply to multiple FEPs. The FEP *Status Tool* (an Excel workbook) was developed to track progress in these evaluations. The current version (12.0) of the Status Tool is being released on the SharePoint website (Ref. 1) concurrent with this deliverable.

The SharePoint *Status Tool* workbook can be downloaded for use by the FEP Team and other UFD staff members. However, LLNL staff will be the only people uploading changed *Status Tool* workbooks to SharePoint, to ensure version control. FEP Team members with updates to the *Status Tool* should provide the information to LLNL (J. Blink and V. Chipman). The information may be in e-mail form, or in an e-mail attachment. The attachment would typically be an Excel workbook with one sheet for each FEP with changed or new information. LLNL staff will copy the modified sheets into the master workbook, update the version number, and upload the new *Status Tool* workbook onto SharePoint.

Section 1.1 of the report discusses the heart of the *Status Tool*, the individual *FEP Sheets*. Section 1.2 discusses the *Summary Sheets* of the *Status Tool*. Finally, Section 1.3 discusses some of the overall status results that can be obtained from the *Summary Sheets*.

1.1 STATUS TOOL FEP SHEETS

The heart of the *Status Tool* is a *Status Block* for each of the 208 FEPs x 35 waste form / geologic setting combinations (Fig. 1.1).

FEP Status Block for each Waste Form/Repository Environment	
Score 0 or 1	Applicability
Score 0 to 1	Completion Status
Score 0 to 1	Importance
FEP Argument Summary	
Remarks	
Reference (or hyperlink)	
Responsible Org/Ind	Number of Org(s)

Figure 1.1 FEP Status Block *for each combination of* Waste Form *and* Repository Environment.

The *Applicability*, *Completion Status*, and *Importance* numbers at the upper left of the *Status Block* are quantitative metrics of progress. They vary between 0.0 and 1.0, with 1.0 being applicable, complete, and of key importance for this FEP and combination of *Waste Form* and *Geologic Setting*. It should be noted that the entries for *Importance* are neither complete nor consistent. It was decided midway through the evaluations that *Importance* should not be evaluated until the Performance Assessment model was more mature and the

ensemble of FEP Evaluations was available. In some cases, a default of 1.0 was assumed for *Importance*, and in other cases a default of blank or 0.0 was assumed. Therefore, *Importance* entries and summaries of those entries should be treated as place-holders at this time.

The *Status Block* also includes space to discuss these three metrics (word wrap allows longer discussions than the block size implies, and the user can expand the row height as needed). The space initially contains the titles of the metrics, which are replaced with the discussion when the FEP evaluation is developed.

Below the three metrics is space to briefly summarize the *FEP Inclusion or Exclusion Argument*, record any pertinent R*emarks*, and point to the *Reference(s)* in which the more detailed evaluation is documented. Finally, the *Status Block* includes two cells at the bottom to identify the *Responsible Organization* and *Responsible Individual* (RO/RI, slash delimited, with multiple RO/RI situations semicolon delimited), and to indicate the number of organizations that have proposed to take responsibility for the evaluation.

The *Status Block* is used repeatedly in a large Microsoft Excel workbook file (about 6 MB). The workbook is organized into one sheet per FEP. Each *FEP Sheet* is named by the numeric FEP designator (e.g., 1.1.02.03) and is organized with column pairs for the 5 *Waste Form* categories, and sets of seven rows for each of the 7 *Geologic Setting* categories. Thus, each *FEP Sheet* has 35 status blocks for the defined categories. (Actually, there are 6x8 = 48 status blocks because there are the *Other* categories for both the *Waste Form* and *Geologic Setting*.)

Figure 1.2 shows an example *FEP Sheet*. Figure 1.2 in this report is not intended to be readable; rather, it is intended to show the organization of a *FEP Sheet*. The text that follows describes each part of the *FEP Sheet* and provides readable information for its various parts.

At the top left is the FEP number and FEP name. Immediately below those cells is a *Legend* that looks very much like Figure 1.1 above. This *Legend* is intended to remind the reader of the titles of the cells in the *Status Block*, which become overwritten as the FEP evaluation is documented in the *Status Block.*

At the top center are four hyperlinks, to *Summary Sheets* in the workbook. These sheets (*RevHistory, Statistics, Statistics-binary,* and *Organizations*) are discussed in Section 1.2. Each FEP row on the four summary sheets has, at its left side, a hyperlink to the associated *FEP Sheet.*

FEP Number	FEP Name
x.x.xx.xx	

RevHistory Statistics Statistics-binary Organizations

FEP Status Block for each Waste Form/Repository Environment	
Score 0 or 1	Applicability
Score 0 to 1	Completion Status
Score 0 to 1	Importance
FEP Argument Summary	
Remarks	
Reference (or hyperlink)	
Responsible Org/Ind	Number of Org(s)

		Waste Form											
Repository Environment		Used Nuclear Fuel (UNF)		High-Level Waste (HLW) Glass		High-Level Waste (HLW) Glass Ceramic		High-Level Waste (HLW) Metal Alloy		Lower Than HLW (LTHLW)		Other	
		Commerical used fuel including uranium oxide fuels from LWRs and GEN III+, and DOE-owned used fuel including Naval inventories		Borosilicate waste forms, alternative glass waste forms, phosphate glass forms, and alternative glass waste forms such as iron phosphate glass		Waste form materials with ceramic phases embedded in the glass matrtix which includes glass-bonded ceramics, glass-bonded zeolite, and Synroc-type formulations		Waste forms which include metal alloys such as compacted assembly hardware, claddin, and undissolved solids that are placed in HLW canisters during reprocessing activities, and alternative metal waste forms such as cermets		LLW as defined by 10CFR Part 61 and low activity wastye or waste incidental to reprocessing of HLW		Waste forms not included in the other listed categories and/or future waste forms such as off-gas waste forms and volatile fission products resulting from reprocessing activities, and grouted waste forms	
Surface Storage	Interim storage at reacors or at centralized sites		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Shallow Disposal	Disposal sites with a depth of 100m or less		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Mined Geologic Disposal (UZ)	Deep geologic repositories located in unsaturated hard rock such as granite or tuff		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Mined Geologic Disposal (SZ)	Deep geologic repositories located in saturated hard rock such as granite or tuff		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Mined Geologic Disposal (Salt,SZ)	Deep geologic repositories in saturated bedded or domal salt formations		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Mined Clay or Shale	Deep geologic repositories located in saturated media such as clay, shale, or argillaceous formations		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Deep Borehole Disposal	Deep geologic disposal in boreholes in basement rock at depths greater than 1000m		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0
Other	Disposal concepts and/or geologic settings not included in the other listed categories (disposal in sub-seabed, carbonate, or sedimentary disposal).		Applicability		Applicability		Applicability		Applicability		Applicability		Applicability
			Completion Status		Completion Status		Completion Status		Completion Status		Completion Status		Completion Status
			Importance		Importance		Importance		Importance		Importance		Importance
		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary		FEP Argument Summary	
		Remarks		Remarks		Remarks		Remarks		Remarks		Remarks	
		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)		Reference (or hyperlink)	
		RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0	RO/RI	0

Figure 1.2 FEP Sheet *showing each of the 48* Status Blocks.

The two columns on the left side describe the *Geologic Settings* (*Repository Environments*) for which the FEPs are being evaluated. These are generic geologic settings; the FEP evaluations will require updating when site-specific information is available from candidate sites. The two columns show the setting title and clarifying information, which are repeated as bullets and sub-bullets, respectively, below.

- Surface Storage
  - Interim storage at reactors or at centralized sites
- Shallow Disposal
  - Disposal sites with a depth of 100 m or less
- Mined Geologic Disposal (Unsaturated Zone, UZ)
  - Deep geologic repositories located in unsaturated hard rock such as granite or tuff

- Mined Geologic Disposal (Saturated Zone, SZ)
    - Deep geologic repositories located in saturated hard rock such as granite or tuff
- Mined Geologic Disposal (Salt, SZ)
    - Deep geologic repositories located in saturated bedded or domal salt formations
- Mined Clay or Shale
    - Deep geologic repositories located in saturated media such as clay, shale, or argillaceous formations
- Deep Borehole Disposal
    - Deep geologic disposal in boreholes in basement rock at depths greater than 1000 m
- Other
    - Disposal concepts and/or geologic settings not included in the other listed categories (disposal in sub-seabed, carbonate, or sedimentary formations)

The FEP evaluations conducted the past two years focus on the four mined geologic disposal categories and also deep boreholes. The *Surface Storage* and *Shallow Disposal* categories are included to allow integration of the Storage and Transportation FEP results into the *FEP Sheet* at a later date, although some common sense entries already have been made to some of the *FEP Sheets* for these two categories. The *Other* category permits addition of another geologic medium at a later date, if appropriate. Additional background information on *Geologic Settings* is shown in sheet *Geologic Settings*.

The two rows near the top (rows 14 and 15) on the left side describe the *Waste Forms* for which the FEPs are being evaluated. These are generic waste forms; the FEP evaluations will require updating when fuel-cycle-specific information is available. The two rows show the waste form title and clarifying information, which are repeated as bullets and sub-bullets, respectively, below.

- Used Nuclear Fuel (UNF)
    - Commercial used fuel including uranium oxide fuels from LWRs and GEN III+, and DOE-owned used fuel including Naval inventories
- High-Level Waste (HLW) Glass
    - Borosilicate waste forms, alternative glass waste forms, phosphate glass forms, and alternative glass waste forms such as iron phosphate glass
- HLW Glass Ceramic
    - Waste form materials with ceramic phases embedded in the glass matrix which includes glass-bonded ceramics, glass-bonded zeolite, and Synroc-type formulations
- HLW Metal Alloy
    - Waste forms which include metal alloys such as compacted assembly hardware, cladding, and undissolved solids that are placed in HLW canisters during reprocessing activities, and alternative metal waste forms such as cermets
- Lower Than HLW (LTHLW)
    - LLW as defined by 10CFR Part 61 and low activity waste or waste incidental to reprocessing of HLW

- Other
    - Waste forms not included in the other listed categories and/or future waste forms such as off-gas waste forms and volatile fission products resulting from reprocessing activities, and grouted waste forms

The FEP evaluations conducted the past two years focus on *UNF*, the three *HLW* categories, and *LTHLW*. The *Other* category permits addition of another waste form at a later date, if appropriate. Additional background information on waste forms is shown in sheet *WF Descriptions*.

Some programming notes are appropriate at this point. First, the descriptions of *Geologic Settings* and *Waste Forms* are contained in the *Template* sheet, and each of the 208 *FEP Sheets* displays header row and column information from that sheet, so that changes can be made quickly if appropriate. Second, the content in rows 12 through 16, rightward from column P is a compilation of the *Status Block* values for the three metrics, and the compilation is pulled into the *Statistics* and *Statistics-binary* sheets discussed in the next section. Finally, the *FEP Number* and FEP Name blocks in the *Statistics* sheet and the *FEP Sheets*, and the *FEP Sheet* names themselves are independently entered; therefore, if FEP sequencing, numbering, or naming change in the future, the workbook will need to be modified in each of these places.

1.2 STATUS TOOL SUMMARY SHEETS

The *Status Tool* includes ten *Summary Sheets*, which are described below.

The *Read-me* sheet contains two sets of information. The top of the sheet is information from Sections 1.1 and 1.2 of this report, which can guide users through the construction and usage of the workbook. The lower part of the sheet is labeled "*Legend*", and contains information recorded by the FEP Team and the *Status Tool* developers during development of the *Status Tool*. The "*Legend*" part of the *Read-me* sheet is included only for historical purposes.

The *File Location* sheet sets up the hyperlink protocol for the workbook. Cell B2 contains the path to the *Status Tool* workbook on the host machine. **It is important that the user edits this cell to include the correct path and filename.** Differences between Mac and Windows operating systems can cause issues if the path is not entered correctly. Hints for successful use are included, and Cell B17 is a copy of the contents of cell B2, in case the user is unsuccessful and does not remember the starting point. The rest of the sheet sets up the *Summary Sheet* hyperlink locations (including row number) that are used in the top row of each of the 208 *FEP Sheets* to jump back to the *Summary Sheets*.

The *RevHistory* sheet (Figure 1.3) documents changes to the *Status Tool* workbook. The top section documents Rev numbers of the file itself. The middle section documents changes to each *FEP Sheet*, with one row per FEP and as many column pairs as necessary to show the sequential changes. The bottom section (not shown in the figure) is intended to document changes to the *Gaps* sheet; that sheet and Revision History section of this sheet have not yet been populated with data.

Sheet *RevHistory:*

The top section is for the master file rev history (J. Blink entries).
The middle section is for the FEP rev history.
The bottom section is for the Gap rev history.
Make entries to the right of each existing entry for a given FEP or Gap. Add a Gap line if you create a GAP entry on sheet *GAP*

Date	File Name	Author	Remarks
3/18/10	FEPs-Stats-Rev4.xlsx or .xls	J. Blink	First full version distributed (prior distribution was for template development and had only a few sheet)
3/22/10	FEPs-Stats-Rev5.xlsx or .xls	J. Blink	Incorporated Paul Mariner's 3/19/10 input from file FEPs-Stats-Rev5pem.xlsx (see below in Date/Info columns 2)
5/26/10	FEPs-Stats-Rev6.xlsx or .xls	J. Blink	Incorporated Florie Caporuscio's 4/26/10 input from file FEPs-Stats-LANL.xlsx (see below for Date/Info in Columns 2); Added "WF Descriptions" sheet with Jim Cunnane's WORD file information
9/17/10	FEPs-Stats-Rev7.xlsx or .xls	V. Chipman	Created new Template sheet, copied new Template sheet into FEPs sheets, re-entered info for FEPs, created Organizations sheet, reformatted
1/19/11	FEPs-Stats-Rev8.xlsx or .xls	J. Blink	Created REFERENCE section on sheet "Legend". Posted info from Aug2010 deliverable (Ref 1) to FEP sheets
6/29/11	FEPs-Stats-Rev9.xlsx or .xls	V. Chipman	Created recursive hyperlinks from RevHistory, Statistics, Statistic-binary, and Organization sheets to individual FEP sheets, Entered info for FEPs, and created the File Location sheet (cell B1 should contain the location of this file on your computer in order for the hyperlinks to work).
7/11/11	FEPs-Stats-Rev10.xlsx or .xls	V. Chipman	Added "roll-ups" to Statistics, Statistics-binary, and Organizations. Added a legend to the FEPs sheets. Set all FEP completion values to 0 if the applicability is 0.

	FEP Number	FEP Name	1. Date	1. Info	2. Date	2. Info	3. Date	3. Info	4. Date	4. Info
0.1.02.01	**0.1.02.01**	**Timescales of Concern**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
0.1.03.01	**0.1.03.01**	**Spatial Domain of Concern**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
0.1.09.01	**0.1.09.01**	**Regulatory Requirements and Exclusions**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
0.1.10.01	**0.1.10.01**	**Model Issues**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Ref *Freeze et al, 2010*	1/19/11	J. Blink, modified Chipman's entries	6/13/11	V. Chipman - Created hyperlinks
0.1.10.02	**0.1.10.02**	**Data Issues**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Ref *Freeze et al, 2010*	1/19/11	J. Blink, modified Chipman's entries	6/13/11	V. Chipman - Created hyperlinks
1.1.01.01	**1.1.01.01**	**Open Boreholes**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
1.1.02.01	**1.1.02.01**	**Chemical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
1.1.02.02	**1.1.02.02**	**Mechanical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)			6/13/11	V. Chipman - Created hyperlinks
1.1.02.03	**1.1.02.03**	**Thermal-Hydrologic Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)			6/13/11	V. Chipman - Created hyperlinks
1.1.08.01	**1.1.08.01**	**Deviations from Design and Inadequate Quality Control**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
1.1.10.01	**1.1.10.01**	**Control of Repository Site**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
1.1.13.01	**1.1.13.01**	**Retrievability**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8					6/13/11	V. Chipman - Created hyperlinks
1.2.01.01	**1.2.01.01**	**Tectonic Activity – Large Scale**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks
1.2.02.01	**1.2.02.01**	**Subsidence**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks
1.2.03.01	**1.2.03.01**	**Seismic activity impacts EBS and/or EBS components**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)			6/13/11	V. Chipman - Created hyperlinks
1.2.03.02	**1.2.03.02**	**Seismic activity impacts Geosphere**	8/20/10	J. Blink added FEP based on 6/7 email					6/13/11	V. Chipman - Created hyperlinks
1.2.03.03	**1.2.03.03**	**Seismic activity impacts Biosphere**	8/20/10	J. Blink added FEP based on 6/7 email					6/13/11	V. Chipman - Created hyperlinks
1.2.04.01	**1.2.04.01**	**Igneous activity impacts EBS and/or EBS components**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)			6/13/11	V. Chipman - Created hyperlinks
1.2.04.02	**1.2.04.02**	**Igneous activity impacts Geosphere**	8/20/10	J. Blink added FEP based on 6/7 email					6/13/11	V. Chipman - Created hyperlinks
1.2.04.03	**1.2.04.03**	**Igneous activity impacts Biosphere**	8/20/10	J. Blink added FEP based on 6/7 email					6/13/11	V. Chipman - Created hyperlinks
1.2.05.01	**1.2.05.01**	**Metamorphism**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks
1.2.08.01	**1.2.08.01**	**Diagenesis**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks
1.2.09.01	**1.2.09.01**	**Diapirism**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks
1.2.09.02	**1.2.09.02**	**Large-Scale Dissolution**	3/16/10	J. Blink, creation of WFs 1-7, Enviro's 1-8	8/20/10	J. Blink, put LANL as RO on all combos	9/30/10	V. Chipman - Populated FEP fields per Appendix B (August 19, 2010 copy)	6/13/11	V. Chipman - Created hyperlinks

Figure 1.3 Revision History sheet.

The *Statistics-Summary* sheet (Figure 1.4) documents, for each combination of *Geologic Setting* and *Waste Form*, the number of the 208 FEPs that are *Applicable* (have *Applicability* >0), and the level of *Completion* of the FEP evaluations. Because *Completion* is entered in a range of zero to one, two values are provided: The first is the number of FEPs that have any completion above zero, and the second is the number that have more than 50% completion. A more global measure of *Applicability* and *Completion* is also available on the *Statistics* sheet, as described in the next paragraph.

		Waste Form											
Repository Environment		Used Nuclear Fuel (UNF)		High-Level Waste (HLW) Glass		High-Level Waste (HLW) Glass Ceramic		High-Level Waste (HLW) Metal Alloy		Lower Than HLW (LTHLW)		Other	
		Commerical used fuel including uranium oxide fuels from LWRs and GEN III+, and DOE-owned used fuel including Naval inventories		Borosilicate waste forms, alternative glass waste forms, phosphate glass forms, and alternative glass waste forms such as iron phosphate glass		Waste form materials with ceramic phases embedded in the glass matrix which includes glass-bonded ceramics, glass-bonded zeolite, and Synroc-type formulations		Waste forms which include metal alloys such as compacted assembly hardware, claddin, and undissolved solids that are placed in HLW canisters during reprocessing activities, and alternative metal waste forms such as cermets		LLW as defined by 10CFR Part 61 and low activity wastye or waste incidental to reprocessing of HLW		Waste forms not included in the other listed categories and/or future waste forms such as off-gas waste forms and volatile fission products resulting from reprocessing activities, and grouted waste forms	
Surface Storage	Interim storage at reactors or at centralized sites	88	Applicable FEPs	88	Applicable FEPs	88	Applicable FEPs	89	Applicable FEPs	87	Applicable FEPs	69	Applicable FEPs
		90	Completion Status >0	90	Completion Status >0	90	Completion Status >0	91	Completion Status >0	89	Completion Status >0	71	Completion Status >0
		52	Completion Status >0.5	52	Completion Status >0.5	52	Completion Status >0.5	53	Completion Status >0.5	51	Completion Status >0.5	33	Completion Status >0.5
Shallow Disposal	Disposal sites with a depth of 100m or less	123	Applicable FEPs	123	Applicable FEPs	123	Applicable FEPs	124	Applicable FEPs	121	Applicable FEPs	90	Applicable FEPs
		98	Completion Status >0	98	Completion Status >0	98	Completion Status >0	99	Completion Status >0	96	Completion Status >0	85	Completion Status >0
		56	Completion Status >0.5	56	Completion Status >0.5	56	Completion Status >0.5	57	Completion Status >0.5	54	Completion Status >0.5	44	Completion Status >0.5
Mined Geologic Disposal (UZ)	Deep geologic repositories located in unsaturated hard rock such as granite or tuff	129	Applicable FEPs	129	Applicable FEPs	129	Applicable FEPs	130	Applicable FEPs	127	Applicable FEPs	91	Applicable FEPs
		122	Completion Status >0	122	Completion Status >0	122	Completion Status >0	123	Completion Status >0	120	Completion Status >0	84	Completion Status >0
		64	Completion Status >0.5	64	Completion Status >0.5	64	Completion Status >0.5	65	Completion Status >0.5	62	Completion Status >0.5	42	Completion Status >0.5
Mined Geologic Disposal (SZ)	Deep geologic repositories located in saturated hard rock such as granite or tuff	127	Applicable FEPs	127	Applicable FEPs	127	Applicable FEPs	128	Applicable FEPs	125	Applicable FEPs	89	Applicable FEPs
		121	Completion Status >0	121	Completion Status >0	121	Completion Status >0	122	Completion Status >0	119	Completion Status >0	83	Completion Status >0
		63	Completion Status >0.5	63	Completion Status >0.5	63	Completion Status >0.5	64	Completion Status >0.5	61	Completion Status >0.5	41	Completion Status >0.5
Mined Geologic Disposal (Salt,SZ)	Deep geologic repositories in saturated bedded or domal salt formations	129	Applicable FEPs	129	Applicable FEPs	129	Applicable FEPs	130	Applicable FEPs	127	Applicable FEPs	89	Applicable FEPs
		123	Completion Status >0	123	Completion Status >0	123	Completion Status >0	124	Completion Status >0	121	Completion Status >0	83	Completion Status >0
		65	Completion Status >0.5	65	Completion Status >0.5	65	Completion Status >0.5	66	Completion Status >0.5	63	Completion Status >0.5	41	Completion Status >0.5
Mined Clay or Shale	Deep geologic repositories located in saturated media such as clay, shale, or argillaceous formations	128	Applicable FEPs	128	Applicable FEPs	128	Applicable FEPs	129	Applicable FEPs	126	Applicable FEPs	89	Applicable FEPs
		128	Completion Status >0	128	Completion Status >0	128	Completion Status >0	129	Completion Status >0	126	Completion Status >0	88	Completion Status >0
		71	Completion Status >0.5	71	Completion Status >0.5	71	Completion Status >0.5	72	Completion Status >0.5	69	Completion Status >0.5	47	Completion Status >0.5
Deep Borehole Disposal	Deep geologic disposal in boreholes in basement rock at depths greater than 1000m	126	Applicable FEPs	126	Applicable FEPs	126	Applicable FEPs	127	Applicable FEPs	124	Applicable FEPs	87	Applicable FEPs
		120	Completion Status >0	120	Completion Status >0	120	Completion Status >0	121	Completion Status >0	118	Completion Status >0	81	Completion Status >0
		63	Completion Status >0.5	63	Completion Status >0.5	63	Completion Status >0.5	64	Completion Status >0.5	61	Completion Status >0.5	40	Completion Status >0.5
Other	Disposal concepts and/or geologic settings not included in the other listed categories (disposal in sub-seabed, carbonate, or sedimentary disposal).	53	Applicable FEPs	53	Applicable FEPs	53	Applicable FEPs	54	Applicable FEPs	51	Applicable FEPs	50	Applicable FEPs
		54	Completion Status >0	54	Completion Status >0	54	Completion Status >0	55	Completion Status >0	52	Completion Status >0	51	Completion Status >0
		30	Completion Status >0.5	30	Completion Status >0.5	30	Completion Status >0.5	31	Completion Status >0.5	28	Completion Status >0.5	27	Completion Status >0.5

Figure 1.4 Statistics-Summary Sheet.

Figure 1.5 shows a small part of the *Statistics* sheet. The figure is intended to show the organization of the sheet, rather than specific data, as described below.

- The figure shows the left three columns (i.e., the hyperlink to the associated *FEP Sheet*, FEP number, and FEP name), and the columns associated with one *Geologic Setting* (Surface Storage). These columns are six sets of three columns, for the six *Waste Forms* and the three metrics of *Applicability*, *Completion Status*, and *Importance.* The figure shows the top of the list of FEPs, along with summary rows.

- The metrics in the FEP rows are color coded, with light green being $\geq$ 0.99, light yellow being between 0.01 and 0.99, and pink being $\leq$ 0.01.

- The summary row titles are shaded in three shades of blue, with the brightest shade being a high level summary row (e.g. 1.0.00.00), the medium shade being second level (e.g., 1.1.00.00 just below the second bright summary row), and the lightest shade being third level (e.g., 1.2.01.00, just below the third bright summary row).

- The summary row data are the averages of the rows one "level" below. That is, the first summary row above one or more FEP rows is the average of the values of those FEPs. (The summary row could be any of the three shades, because some FEPs do not need three levels of summary hierarchy.) The summary row above a set of first summary rows (and subordinate FEP rows) is the summary of the first summary rows (i.e., if the number of FEPs summarized at the first summary level is different among those first summary levels, the average of the second level summary row will give greater weight to first summary rows with few subordinate FEPs; however, see below for an alternative summarization methodology). Finally, in cases where there are all three levels of summary hierarchy, the bright summary row is the average of the medium blue summary rows, again giving equal weighting independent of the number of FEPs being summarized in each component of the average.

- The data columns for the summary rows are shaded similar to the data columns of the FEP rows; however, bright green, bright yellow, and bright red are used, to distinguish the summary data from the FEP raw data.

- The two rows between the *Geologic Setting* and *Waste Form* titles and the FEP data are the grand summary rows for each combination of *Geologic Setting* and *Waste Form*. Two averages are provided. The top average is the average of the individual FEPs, and the second average is the average of the highest-level (bright blue) summary lines. The difference between these numbers is due to equal vs. unequal weighting of individual FEPs in the two averaging processes.

- The second row shown in the figure is a total of the FEPs in that combination of *Geologic Setting* and *Waste Form*, that have *Applicability* >0 and also the total that have *Completion* >0. These sums are of the 208 FEPs only, and do not include any of the summary row discussed above. These sums are the source of two of the three values on the *Statistics-Summary* sheet, for each combination of *Geologic Setting* and *Waste Form*. It should be noted that this figure was created before the file update was completed, and the values shown in this summary are lower than discussed in Section 1.3.

			Total Applicable	Total w/ Completion > 0		Total Applicable	Total w/ Completion > 0		Total Applicable	Total w/ Completion > 0		Total Applicable	Total w/ Completion > 0		Total Applicable	Total w/ Completion > 0		Total Applicable	Total w/ Completion > 0	
			72	72		72	72		72	72		73	73		71	71		69	69	
			Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance
			Repository Environment / Waste Form Combination																	
			Surface Storage / Used Nuclear Fuel (UNF)			Surface Storage / High-Level Waste (HLW) Glass			Surface Storage / High-Level Waste (HLW) Glass Ceramic			Surface Storage / High-Level Waste (HLW) Metal Alloy			Surface Storage / Lower Than HLW (LTHLW)			Surface Storage / Other		
		Average of individual FEPs	0.35	0.15	0.21	0.35	0.15	0.20	0.35	0.15	0.20	0.36	0.16	0.21	0.35	0.15	0.19	0.34	0.14	0.18
		Average of top level categories	0.16	0.08	0.13	0.15	0.08	0.13	0.15	0.08	0.13	0.16	0.08	0.13	0.15	0.08	0.12	0.15	0.08	0.12
	0.0.00.00	0. ASSESSMENT BASIS	0.40	0.20	0.40	0.40	0.20	0.40	0.40	0.20	0.40	0.40	0.20	0.40	0.40	0.20	0.40	0.40	0.20	0.40
0.1.02.01	0.1.02.01	Timescales of Concern	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1.03.01	0.1.03.01	Spatial Domain of Concern	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1.09.01	0.1.09.01	Regulatory Requirements and Exclusions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1.10.01	0.1.10.01	Model Issues	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00
0.1.10.02	0.1.10.02	Data Issues	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00	1.00	0.50	1.00
	1.0.00.00	1. EXTERNAL FACTORS	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.06	0.06	0.02
	1.1.00.00	1. REPOSITORY ISSUES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.01.01	1.1.01.01	Open Boreholes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.02.01	1.1.02.01	Chemical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.02.02	1.1.02.02	Mechanical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.02.03	1.1.02.03	Thermal-Hydrologic Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.08.01	1.1.08.01	Deviations from Design and Inadequate Quality Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.10.01	1.1.10.01	Control of Repository Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.13.01	1.1.13.01	Retrievability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.2.00.00	2. GEOLOGICAL PROCESSES AND EFFECTS	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.28	0.28	0.11
	1.2.01.00	2.01. LONG-TERM PROCESSES	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.17	0.17	0.00
1.2.01.01	1.2.01.01	Tectonic Activity – Large Scale	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
1.2.02.01	1.2.02.01	Subsidence	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.05.01	1.2.05.01	Metamorphism	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.08.01	1.2.08.01	Diagenesis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.09.01	1.2.09.01	Diapirism	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.09.02	1.2.09.02	Large-Scale Dissolution	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00
	1.2.03.00	2.03.SEISMIC ACTIVITY	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
1.2.03.01	1.2.03.01	Seismic activity impacts EBS and/or EBS components	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.2.03.02	1.2.03.02	Seismic activity impacts Geosphere (Host Rock, and Other Geologic Units)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.03.03	1.2.03.03	Seismic activity impacts Biosphere (Surface Environment, and Human Behavior)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.2.04.00	2.04. IGNEOUS ACTIVITY	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
1.2.04.01	1.2.04.01	Igneous activity impacts EBS and/or EBS components	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
1.2.04.02	1.2.04.02	Igneous activity impacts Geosphere (Host Rock, and Other Geologic Units)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2.04.03	1.2.04.03	Igneous activity impacts Biosphere (Surface Environment, and Human Behavior)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.3.00.00	3. CLIMATIC PROCESSES AND EFFECTS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3.01.01	1.3.01.01	Climate Change (Natural, and Anthropogenic)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3.04.01	1.3.04.01	Periglacial Effects	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3.05.01	1.3.05.01	Glacial and Ice Sheet Effects	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.4.00.00	4. FUTURE HUMAN ACTIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4.01.01	1.4.01.01	Human Influences on Climate (Intentional, and Accidental)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4.02.01	1.4.02.01	Human Intrusion (Deliberate, and Inadvertent)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4.11.01	1.4.11.01	Explosions and Crashes from Human Activities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.5.00.00	5. OTHER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5.01.01	1.5.01.01	Meteorite Impact	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5.01.02	1.5.01.02	Extraterrestrial Events	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5.03.01	1.5.03.01	Earth Planetary Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.0.00.00	2. DISPOSAL SYSTEM FACTORS	0.16	0.07	0.09	0.15	0.07	0.07	0.15	0.07	0.09	0.16	0.07	0.09	0.15	0.07	0.05	0.15	0.06	0.05
	2.1.00.00	1. WASTES AND ENGINEERED FEATURES	0.29	0.09	0.27	0.26	0.09	0.23	0.28	0.09	0.27	0.29	0.10	0.27	0.28	0.09	0.19	0.27	0.07	0.19
	2.1.01.00	1.01. INVENTORY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.01.01	2.1.01.01	Waste Inventory (Radionuclides, and Non-Radionuclides)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.01.02	2.1.01.02	Radioactive Decay and Ingrowth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.01.03	2.1.01.03	Heterogeneity of Waste Inventory (Waste Package Scale, and Repository Scale)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.01.04	2.1.01.04	Interactions Between Co-Located Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.1.02.00	1.02. WASTE FORM	0.50	0.37	0.23	0.50	0.37	0.20	0.50	0.37	0.20	0.67	0.45	0.32	0.33	0.28	0.12	0.17	0.12	0.12
2.1.02.01	2.1.02.01	SNF (Commercial, and DOE) Degradation (Alteration/Phase Separation, Dissolution/Leaching, and Radionuclide Release)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.02.02	2.1.02.02	HLW (Glass, Ceramic, and Metal) Degradation (Alteration/Phase Separation, Dissolution/Leaching, Cracking, and Radionuclide Release)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1.02.03	2.1.02.03	Degradation of Organic/Cellulosic Materials in Waste	1.00	0.70	0.70	1.00	0.70	0.70	1.00	0.70	0.70	1.00	0.70	0.70	1.00	0.70	0.70	1.00	0.70	0.70
2.1.02.04	2.1.02.04	HLW (Glass, Ceramic, and Metal) Recrystallization	0.00	0.00	0.00	1.00	0.50	0.50	1.00	0.50	0.50	1.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
2.1.02.05	2.1.02.05	Pyrophoricity or Flammable Gas from SNF or HLW	1.00	0.50	0.70	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.50	0.70	0.00	0.00	0.00	0.00	0.00	0.00
2.1.02.06	2.1.02.06	SNF Cladding Degradation and Failure	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00

Figure 1.5 FEP Statistics Sheet. The figure shows a single repository environment/waste form combination, cropping the right side. It shows a fraction of the FEPs, cropping the bottom. It does not show five summary columns between the FEP names and the numerical metrics.

Not shown on Figure 1.5 are five columns between the FEP name and the columns of *Applicability*, *Completion Status*, and *Importance* metrics for the combinations of *Geologic Setting* and *Waste Form*. These five columns are shown in Figure 1.6, which was taken from the latest *Status Tool* workbook (Rev 12).

- The two wide columns (some with light green shading) show the *Completion* status of the FEP. The right-column of this column pair is the sum of the *Completion* metrics for the 48 combinations of *Geologic Setting* and *Waste Form*. The left-column of this column pair is set to 1 if the right column is not zero. The left column is color coded for the July 2011 reconciliation with the SharePoint web-site. The four colors are explained in the second row of the figure. The third, sixth and seventh rows of the figure show the overall *Completion* of FEP evaluations, and are discussed in Section 1.3 below.

- The three right columns are the averages over the 25 combinations of *Geologic Setting* and *Waste Form* that have been the focus of the ongoing FEP evaluations. These are five *Waste Forms* (all but *Other*) and five *Geologic Settings* (deep borehole and the four mined geologic media: hard-rock-UZ, hard-rock-SZ, Salt, and Clay/Shale). The summary line averages and overall averages are also computed for these columns.

- The top line is a check line that uses a formula that excludes summary lines (copied from the *Applicability* summary formula), and correctly returns the number of FEPs.

			208.00	<-- Column E formula check, should return total num			
	Col C: Light yellow background indicates out of numeric sequence in this file and on the FEPS_List.DOCX (FEP list) file on the SharePoint site on 22Jul2011	Col E: Purple background indicates a file is in the FEP Eval folder on SharePoint, with no link in the FEP Navigator	Col E: Light or dark green background indicates a link to the FEP evaluation existed on the SharePoint site FEP Navigator on 22Jul2011 (and is "touched" here, or not touched, respectively); Dark changed to light when the FEP sheet in this file was updated.	Col E: Light pink background indicates the FEP is not on the list (w/ or w/o a link to the FEP evaluation) on the SharePoint site FEP Navigator on 22Jul2011			
		Average Touched (across the 48 WF/Geo combinations)		102			
			Completion, # Touched in any of the 48 cases	Completion, sum over the 48 cases	Applicability	Completion	Importance
		Total Touched (max = 208 & 9984)	133	2284			
		% Touched (of 208 & 9984)	64%	23%	Average over the 5 WFs (i.e., w/o "Other") and 5 mined environments (i.e., w/o "Surface Storage", "Shallow Burial", or "Other" categories)		
		Average of individual FEPs			0.61	0.27	0.26
		Average of top level categories			0.40	0.25	0.27
	0.0.00.00	0. ASSESSMENT BASIS			0.40	0.22	0.40
0.1.02.01	0.1.02.01	Timescales of Concern	0	0	0.00	0.00	0.00
0.1.03.01	0.1.03.01	Spatial Domain of Concern	0	0	0.00	0.00	0.00
0.1.09.01	0.1.09.01	Regulatory Requirements and Exclusions	0	0	0.00	0.00	0.00
0.1.10.01	0.1.10.01	Model Issues	1	25	1.00	0.54	1.00
0.1.10.02	0.1.10.02	Data Issues	1	25	1.00	0.54	1.00
	1.0.00.00	1. EXTERNAL FACTORS			0.74	0.60	0.48
	1.1.00.00	1. REPOSITORY ISSUES			0.29	0.04	0.24
1.1.01.01	1.1.01.01	Open Boreholes	0	0	0.00	0.00	0.00
1.1.02.01	1.1.02.01	Chemical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0	0	0.00	0.00	0.00
1.1.02.02	1.1.02.02	Mechanical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	1	1	1.00	0.02	1.00
1.1.02.03	1.1.02.03	Thermal-Hydrologic Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	1	16	1.00	0.26	0.70
1.1.08.01	1.1.08.01	Deviations from Design and Inadequate Quality Control	0	0	0.00	0.00	0.00
1.1.10.01	1.1.10.01	Control of Repository Site	0	0	0.00	0.00	0.00
1.1.13.01	1.1.13.01	Retrievability	0	0	0.00	0.00	0.00
	1.2.00.00	2. GEOLOGICAL PROCESSES AND EFFECTS			0.69	0.53	0.25
	1.2.01.00	2.01. LONG-TERM PROCESSES			0.80	0.80	0.48
1.2.01.01	1.2.01.01	Tectonic Activity – Large Scale	1	48	1.00	1.00	0.00
1.2.02.01	1.2.02.01	Subsidence	1	25	1.00	1.00	1.00
1.2.05.01	1.2.05.01	Metamorphism	1	25	1.00	1.00	0.18
1.2.08.01	1.2.08.01	Diagenesis	1	25	1.00	1.00	1.00
1.2.09.01	1.2.09.01	Diapirism	1	15	0.60	0.60	0.50
1.2.09.02	1.2.09.02	Large-Scale Dissolution	1	15	0.20	0.20	0.20

Figure 1.6 FEP Statistics Sheet. This is similar to Figure 1.5, but shows the five summary columns between the FEP names and the numerical metrics.

The Statistics-*binary* sheet (Figure 1.7) is identical to the *statistics sheet*, with two differences. First, the five columns discussed in the description of Figure 1.6 are omitted in this sheet. Second, the *Applicability*, *Completion Status*, and *Importance* values are rounded (and thus are either 0 or 1).

The roll-up averages and table averages are not rounded, but are the averages of the rounded metrics. The totals shown on the second line of the figure are the count of the FEPs with *Applicability*, *Completion Status* that rounds to 1 (i.e., those with raw values greater than 0.5); these totals are used to populate the "Completion Status >0.5" blocks in the *Statistics-Summary* sheet.

			Total Applicable	Total w/ Completion > 0.5		Total Applicable	Total w/ Completion > 0.5		Total Applicable	Total w/ Completion > 0.5		Total Applicable	Total w/ Completion > 0.5		Total Applicable	Total w/ Completion > 0.5		Total Applicable	Total w/ Completion > 0.5	
			72	33		71	33		72	33		73	34		71	32		69	30	
			Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance	Applicability	Completion	Importance
			Repository Environment / Waste Form Combination																	
			Surface Storage / Used Nuclear Fuel (UNF)			Surface Storage / High-Level Waste (HLW) Glass			Surface Storage / High-Level Waste (HLW) Glass Ceramic			Surface Storage / High-Level Waste (HLW) Metal Alloy			Surface Storage / Lower Than HLW (LTHLW)			Surface Storage / Other		
		Average of individual FEPs	0.35	0.16	0.21	0.35	0.16	0.21	0.35	0.16	0.21	0.36	0.17	0.22	0.35	0.16	0.19	0.34	0.15	0.19
		Average of top level categories	0.16	0.13	0.13	0.15	0.13	0.13	0.16	0.13	0.13	0.16	0.13	0.13	0.15	0.13	0.12	0.15	0.13	0.12
	0.0.00.00	0. ASSESSMENT BASIS	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
0.1.02.01	0.1.02.01	Timescales of Concern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1.03.01	0.1.03.01	Spatial Domain of Concern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1.09.01	0.1.09.01	Regulatory Requirements and Exclusions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.1.10.01	0.1.10.01	Model Issues	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.1.10.02	0.1.10.02	Data Issues	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1.0.00.00	1. EXTERNAL FACTORS	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.07	0.07	0.03	0.06	0.06	0.02
	1.1.00.00	1. REPOSITORY ISSUES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1.01.01	1.1.01.01	Open Boreholes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.02.01	1.1.02.01	Chemical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.02.02	1.1.02.02	Mechanical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.02.03	1.1.02.03	Thermal-Hydrologic Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.08.01	1.1.08.01	Deviations from Design and Inadequate Quality Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.10.01	1.1.10.01	Control of Repository Site	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.1.13.01	1.1.13.01	Retrievability	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.2.00.00	2. GEOLOGICAL PROCESSES AND EFFECTS	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.28	0.28	0.11
	1.2.01.00	2.01. LONG-TERM PROCESSES	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.33	0.33	0.17	0.17	0.17	0.00
1.2.01.01	1.2.01.01	Tectonic Activity – Large Scale	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
1.2.02.01	1.2.02.01	Subsidence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.05.01	1.2.05.01	Metamorphism	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.08.01	1.2.08.01	Diagenesis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.09.01	1.2.09.01	Diapirism	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.09.02	1.2.09.02	Large-Scale Dissolution	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
	1.2.03.00	2.03.SEISMIC ACTIVITY	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
1.2.03.01	1.2.03.01	Seismic activity impacts EBS and/or EBS components	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1.2.03.02	1.2.03.02	Seismic activity impacts Geosphere (Host Rock, and Other Geologic Units)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.03.03	1.2.03.03	Seismic activity impacts Biosphere (Surface Environment, and Human Behavior)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.2.04.00	2.04. IGNEOUS ACTIVITY	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.33	0.00
1.2.04.01	1.2.04.01	Igneous activity impacts EBS and/or EBS components	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0
1.2.04.02	1.2.04.02	Igneous activity impacts Geosphere (Host Rock, and Other Geologic Units)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.2.04.03	1.2.04.03	Igneous activity impacts Biosphere (Surface Environment, and Human Behavior)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 1.7 FEP Statistics-binary Sheet (cropped at the right and bottom).

The *Organizations* sheet (Figure 1.8) shows the responsible organization(s) and responsible individual(s) (RO and RI) for each FEP and combination of *Geologic Setting* and *Waste Form*.

- The format is to use a slash between RO and RI, commas between RIs, and semicolons between sets of RO/RIs.
- To the right of each list of ROs and RIs is a count of the number of organizations. The count cells are pink for zero, green for 1, and yellow for >1, based on input from the organizations participating in FEP evaluations.
- The three rows at the top of the figure are the number of FEPs with 0, 1, and >1 responsible organizations for each combination of *Geologic Setting* and *Waste Form*. The three wide cells at the top are the averages of those totals (averaged over all 48 combinations of *Geologic Setting* and *Waste Form*).

	Average	56.5	Total with 0 assigned Orgs	54	Total with 0 assigned Orgs	54	Total with 0 assigned Orgs	54	Total with 0 assigned Orgs	54	Total with 0 assigned Orgs	54	Total with 0 assigned Orgs	55
	Average	101.7	Total with 1 assigned Org	104	Total with 1 assigned Org	104	Total with 1 assigned Org	104	Total with 1 assigned Org	104	Total with 1 assigned Org	104	Total with 1 assigned Org	104
	Average	49.7	Total with >1 assigned Orgs	50	Total with >1 assigned Orgs	50	Total with >1 assigned Orgs	50	Total with >1 assigned Orgs	50	Total with >1 assigned Orgs	50	Total with >1 assigned Orgs	49
			RO/RI	# of Organizations	RO/RI	# of Organizations	RO/RI	# of Organizations	RO/RI	# of Organizations	RO/RI	# of Organizations	RO/RI	# of Organizations
			Repository Environment / Waste Form Combination											
			Surface Storage / Used Nuclear Fuel (UNF)		Surface Storage / High-Level Waste (HLW) Glass		Surface Storage / High-Level Waste (HLW) Glass Ceramic		Surface Storage / High-Level Waste (HLW) Metal Alloy		Surface Storage / Lower Than HLW (LTHLW)		Surface Storage / Other	
0.1.02.01	0.1.02.01	Timescales of Concern		0		0		0		0		0		0
0.1.03.01	0.1.03.01	Spatial Domain of Concern		0		0		0		0		0		0
0.1.09.01	0.1.09.01	Regulatory Requirements and Exclusions		0		0		0		0		0		0
0.1.10.01	0.1.10.01	Model Issues	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1
0.1.10.02	0.1.10.02	Data Issues	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1
1.1.01.01	1.1.01.01	Open Boreholes		0		0		0		0		0		0
1.1.02.01	1.1.02.01	Chemical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)		0		0		0		0		0		0
1.1.02.02	1.1.02.02	Mechanical Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1	LBNL/JH	1
1.1.02.03	1.1.02.03	Thermal-Hydrologic Effects from Preclosure Operations (in EBS, EDZ, and Host Rock)	LBNL/JH;LLNL/TB,HG	2	LBNL/JH;LLNL/TB,HG	2	LBNL/JH;LLNL/TB,HG	2	LBNL/JH;LLNL/TB,HG	2	LBNL/JH;LLNL/TB,HG	2	LBNL/JH;LLNL/TB,HG	2
1.1.08.01	1.1.08.01	Deviations from Design and Inadequate Quality Control		0		0		0		0		0		0
1.1.10.01	1.1.10.01	Control of Repository Site		0		0		0		0		0		0
1.1.13.01	1.1.13.01	Retrievability		0		0		0		0		0		0
1.2.01.01	1.2.01.01	Tectonic Activity – Large Scale	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.02.01	1.2.02.01	Subsidence	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.03.01	1.2.03.01	Seismic activity impacts EBS and/or EBS components	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1
1.2.03.02	1.2.03.02	Seismic activity impacts Geosphere	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1
1.2.03.03	1.2.03.03	Seismic activity impacts Biosphere	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1
1.2.04.01	1.2.04.01	Igneous activity impacts EBS and/or EBS components	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.04.02	1.2.04.02	Igneous activity impacts Geosphere	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.04.03	1.2.04.03	Igneous activity impacts Biosphere	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.05.01	1.2.05.01	Metamorphism	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.08.01	1.2.08.01	Diagenesis	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.09.01	1.2.09.01	Diapirism	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.09.02	1.2.09.02	Large-Scale Dissolution	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.3.01.01	1.3.01.01	Climate Change (Natural, and Anthropogenic)	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.3.04.01	1.3.04.01	Periglacial Effects	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.3.05.01	1.3.05.01	Glacial and Ice Sheet Effects	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.4.01.01	1.4.01.01	Human Influences on Climate (Intentional, and Accidental)	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.4.02.01	1.4.02.01	Human Intrusion (Deliberate, and Inadvertent)	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.4.11.01	1.4.11.01	Explosions and Crashes from Human Activities	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.5.01.01	1.5.01.01	Meteorite Impact	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/RP	1
1.5.01.02	1.5.01.02	Extraterrestrial Events	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
1.5.03.01	1.5.03.01	Earth Planetary Changes	SNL/PM,RP	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1	SNL/PM	1
2.1.01.01	2.1.01.01	Waste Inventory (Radionuclides, and Non-Radionuclides)		0		0		0		0		0		0
2.1.01.02	2.1.01.02	Radioactive Decay and Ingrowth		0		0		0		0		0		0
1.2.03.02	1.2.03.02	Seismic activity impacts Geosphere	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1
1.2.03.03	1.2.03.03	Seismic activity impacts Biosphere	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1	LANL/FC,FP	1
1.2.04.01	1.2.04.01	Igneous activity impacts EBS and/or EBS components	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.04.02	1.2.04.02	Igneous activity impacts Geosphere	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.04.03	1.2.04.03	Igneous activity impacts Biosphere	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.05.01	1.2.05.01	Metamorphism	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.08.01	1.2.08.01	Diagenesis	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.09.01	1.2.09.01	Diapirism	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1
1.2.09.02	1.2.09.02	Large-Scale Dissolution	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1	LANL/FC	1

Figure 1.8 Organization sheet (cropped at the right and bottom).

The *Gaps* sheet is intended to capture information gaps identified in FEP evaluations, as a tool for planning future work. It has not yet been populated.

The *WF Descriptions* and *Geologic Setting Descriptions* sheets provide background information in support of the short-hand used in the *FEP Sheets* and various *Summary Sheets.*

1.3 SUMMARY INFORMATION FROM THE STATUS TOOL

The *Status Tool*, in file "FEPs-Stats-Rev12.xlsx", is frozen for the purposes of reporting in this milestone report. Some of the figures above were printed from preliminary drafts of this file revision. Hence, the results in this Section (1.3) of the milestone report or the frozen file itself (available in SharePoint) are more recent than the figures in Sections 1.1 and 1.2; those figures are intended to describe the structure of the tool, rather than the most current content.

The *Statistics-Summary* sheet has 48 triplets of summary counts. These numbers are the number of FEPs (of the 208 total FEPs) that are *Applicable*, have a non-zero *Completion Status*, or have a $\geq$0.5 *Completion Status*, for each of combination of *Geologic Setting* and *Waste Form*. For example, *UNF* in *Salt* has 129 *Applicable* FEPs, with 123 having some evaluation (*Completion Status* >0), and 65 having *Completion Status* $\geq$ 0.5.

The *Statistics* sheet has several summary categories:

- Cells E6:E7. **Of the 208 FEPs, 133 (64%) have non-zero *Completion Status* for at least one combination of *Geologic Setting* and *Waste Form*.**

- Cells F6:F7. **Totaled over the 9984 combinations of FEP, *Geologic Setting,* and *Waste Form*, the completion metric is 2284 (23%)** This is the fraction of the planned FEP evaluation work that has been completed. However, it should be noted that the fraction would be higher if *Surface Storage, Shallow Burial, Other Geologic Setting,* and *Other Waste Form* categories are eliminated. Revision 13 of the *Status Tool* will compute that metric in an added column just to the right of the current column F.

- Row 3. This row totals the number of FEPs with non-zero *Applicability* and with non-zero *Completion Status,* for each combination of *Geologic Setting* and *Waste Form*. These values are shown in *Status Block* format in the *Statistics-Summary* sheet, and an example is given for *UNF* in *Salt* in the preceding paragraph. Cell F3 shows the average of the 48 values of the count of non-zero *Completion Status* FEPs; it is 102 currently, somewhat lower than the 133 FEPs that have non-zero *Completion Status* in at least one combination of *Geologic Setting* and *Waste Form.*

- Rows 8 and 9. These rows are the average scores for the *Applicability*, *Completion Status*, and *Importance* metrics, computed two ways. Row 8 is the *direct average* of the 208 FEPs. Row 9 is the *sequential average* of the top-level summary categories (n.0.00.00), which in turn are the averages of the items one level below them (which could be n.n.00.00, n.n.nn.00, or FEPs themselves – n.n.nn.nn). The averaging proceeds from the lowest level upward, but some FEPs are summarized directly into higher-level summaries, making it complicated to describe. As an example, *UNF* in *Salt* has 0.62 *direct-average* and 0.40 *sequential-average Applicability* across the 208 FEPs; and 0.27 and 0.25 *Completion Status.* As noted in Section 1.1, the *Importance* values shown should not be used at this time, based on their inconsistent and preliminary basis.

The *Statistics-binary* sheet is very similar to the *Statistics* sheet, with the raw values of *Applicability*, *Completion Status*, and *Importance* rounded to integers (0 or 1). This affects Row 3, where the *Applicability* and *Completion Status* counts are incremented for each FEP, *Geologic Setting,* and *Waste Form* combination when the value is 1 (raw value is $\geq$0.5).

Similarly, the averages in Rows 8 and 9 are based on the rounded values of the metrics (but note that summary lines are not rounded). As an example, *UNF* in *Salt* has 0.62 *direct-average* and 0.40 *sequential-average Applicability* across the 208 FEPs; and 0.31 and 0.33 *Completion Status.*

The *Organizations* sheet rows 2, 3, and 4 are the total number of FEPs, for each combination of *Geologic Setting* and *Waste Form*, that have 0, 1, and >1 responsible organizations. For example, *UNF* in *Salt* as 54 FEPs with no currently assigned RO, 103 FEPs with 1 RO, and 51 FEPs with more than 1 RO. Averaged across the 48 combinations of *Geologic Setting* and *Waste Form*, 57 FEPs have no currently assigned RO, 102 FEPs have 1 RO, and 50 FEPs have more than 1 RO (these total to 209, rather than 208, due to rounding).

2. FEP ASSIGNMENTS

Table 2.1 shows the FEPs that LLNL has claimed or has responsibility for, and whether that responsibility is as the sole organization, the lead of other organizations, or a support role to another organization.

2.1 FEP ASSIGNMENTS – ORGANIZED BY FEP NUMBER

The *Organizations* sheet shows the RO/RI assignments for all combinations of FEP, *Geologic Setting,* and *Waste Form*. These assignments can be viewed in SharePoint.

2.2 FEP ASSIGNMENTS TO LLNL

Table 2.1 shows the FEPs currently assigned to LLNL. For simplicity, this table does not show the combinations of *Geologic Setting,* and *Waste Form*. This is reasonable because the RI/RO assignments are similar across these combinations, with the notable exception that LBNL may support a number of the Clay *Geologic Setting* FEPs assigned to other laboratories.

The top section of the table is the list of FEPs for which LLNL is the sole responsible organization. The middle section is the list of FEPs for which LLNL is the lead RO, with other labs in a supporting role. The bottom section is the list of FEPs for which LLNL supports another lab.

With the completion of this release of the *Status Tool*, LLNL will shift its efforts in FY12 to FEP evaluations, while continuing to maintain the *Status Tool*. Priority will be given to FEPs with no existing evaluation. To maximize productivity, LLNL staff will meet via telecon with Paul Mariner, who has developed an efficient system for generating FEP evaluations, prior to beginning FY12 work on the FEP evaluations

Table 2.1 FEPs for which LLNL has Responsibility or Shared Responsibility

LLNL is the Sole Responsible Organization	2.1.01.04 Interactions between co-located waste 2.1.03.01 Early failure of WPs 2.1.03.02 General corrosion of WPs 2.1.03.03 Stress corrosion cracking of WPs 2.1.03.04 Localized corrosion of WPs 2.1.03.07 Internal corrosion of WPs prior to breach 2.1.11.01 Heat generation in EBS 2.1.11.02 Exothermic reactions in EBS 2.1.11.13 Thermal effects on chemistry and microbial activity in EBS 2.1.11.14 Thermal effects on transport in EBS 2.2.11.01 Thermal effects on flow in geosphere (repository-induced and natural geothermal) 2.2.11.02 Themally-drive flow (convection) in geosphere 2.2.11.03 Thermally-driven buoyant flow / heat pipes in geosphere 2.2.11.04 Thermal effects on chemistry & microbial activity in geosphere 2.2.11.05 Thermal effects on transport in geosphere 2.2.11.06 Thermal-mechanical effects on geosphere 2.2.11.07 Thermal-chemical alteration of geosphere
LLNL is the Lead Organization, with Other Organization(s) Supporting	2.1.02.06 SNF cladding degradation and failure 2.1.11.03 Effects of backfill on EBS thermal environment 2.1.11.04 Effects of drift collapse on EBS thermal environment 2.1.11.05 Effects of influx (seepage) on thermal environment 2.1.11.10 Thermal effects on flow in EBS 2.1.11.11Thermally-driven flow (convection) in EBS 2.1.11.12 Thermally-driven buoyant flow / heat pipes in EBS 2.2.09.01 Chemical characteristics of groundwater in host rock 2.2.09.02 Chemical characteristics of groundwater in other geologic units 2.2.09.03 Chemical interactions & evolution of groundwater in host rock 2.2.09.04 Chemical interactions and evolution of groundwater in other geologic units
LLNL is Supporting the Lead Organization	1.1.02.03 Thermal-hydrologic effects from preclosure operations 2.1.09.01 Chemistry of water flowing into the repository 2.1.09.02 Chemical characteristics of water in WPs 2.1.09.03 Chemical characteristics of water in backfill 2.1.09.04 Chemical characteristics of water in tunnels 2.1.09.53 Sorption of dissolved radionuclides in EBS 2.1.09.54 Complexation in EBS 2.1.09.55 Formation of colloids in EBS 2.1.09.56 Stability of colloids in EBS 2.1.09.57 Advection of colloids in EBS 2.1.09.58 Diffusion of colloids in EBS 2.1.09.59 Sorption of colloids in EBS 2.1.09.60 Sorption of colloids at air-water interface in EBS 2.1.09.61 Filtration of colloids in EBS 2.2.09.05 Radionuclide speciation and solubility in host rock 2.2.09.06 Radionuclide speciation and solubility in other geologic units 2.2.09.55 Sorption of dissolved radionuclides in host rock 2.2.09.56 Sorption of dissolved radionuclides in other geologic units 2.2.09.59 Colloidal transport in host rock 2.2.09.60 Colloidal transport in other geologic units 2.2.10.01 Microbial activity in host rock 2.2.10.02 Microbial activity in other geologic units

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4. REFERENCES

1. Individual files for FEP evaluations on the UFD-FEPs SharePoint site, https://collaborate.sandia.gov/sites/anep/SitePages/Home.aspx (Choose FEPs on the left side menu bar).