Waste Disposal of Flibe and the Stabilizing Shell

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Flibe Disposal Requirements

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- According to 10CFR61, Flibe waste need to be solidified before qualifying for disposal as near surface LLW
- The solidified waste would have an order of magnitude lower specific activity limits than an activated metal (corroded) waste
- The solidification process must insure the structural integrity of the waste for 300 y
- In 10CFR61, the following solidification scenarios were considered:
  - Solidification Scenario A: the waste stream is solidified using cement system
  - Solidification Scenario B: the waste stream is solidified using synthetic polymer system
  - Solidification Scenario C: the waste stream is solidified using improved synthetic polymer system
- The waste volume increases by a factor of 1.4 for scenario A and 2.0 for scenarios B and C

- The selection of the solidification technique would have an impact on the waste performance characteristics as well as the cost of disposal

Assumptions Used in the Flibe Analysis

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- The thick liquid wall concept uses a 42-cm thick layer of Flibe as a first wall and blanket
- The thin liquid wall concept uses a 2-cm thick layer of Flibe as a first wall
- The elemental composition of Flibe is taken from the BCSS
- 30 FPY
- Flibe is assumed to spend only half the time inside the reactor
- WDR for Class C waste are calculated using the 10CFR61 and Fetter waste disposal limits

- Waste disposal ratings are given after 10 year following shutdown

WDR of Flibe Used in Thin Liquid Wall Concepts

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Solidification Technique	WDR	Dominant Nuclides
Scenario A		
10CFR61	**50.1**	**^{14}C (50.1)**
Fetter	**7.77**	**^{14}C (6.68), ^{26}Al (1.1)**
Scenarios B & C		
10CFR61	**35.1**	**^{14}C (35.1)**
Fetter	**5.44**	**^{14}C (4.67), ^{26}Al (0.76)**

WDR Flibe Used in Thick Liquid Wall Concepts

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Solidification Technique	WDR	Dominant Nuclides
Scenario A		
10CFR61	**5.23**	**^{14}C (5.23)**
Fetter	**0.87**	**^{14}C (0.7), ^{26}Al (0.17)**
Scenarios B & C		
10CFR61	**3.66**	**^{14}C (3.66)**
Fetter	**0.61**	**^{14}C (0.49), ^{26}Al (0.12)**

Assumptions Used in the Stabilizing Shell Analysis

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- The 2 cm stabilizing shell is placed at the following locations:
  - immediately behind the liquid FW
  - deep inside the blanket at 30 cm from the liquid FW

- The following materials are analyzed:
  - ORNL (9Cr-2WVTa) FS with (0.5 wppm Nb)
  - V-4Cr-4Ti
  - W-5Re
  - Al-6061
  - Glidcop-Al15-DS-Cu

- 3 FPY

WDR of the Stabilizing Shell

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Alloy	Behind the FW		30 cm inside the blanket	
	Fetter	**10CFR61**	**Fetter**	**10CFR61**
ORNL FS	0.97	0.42	0.46	0.24
V-4Cr-4Ti	0.4	0.47	0.18	0.26
W-5Re	29.9	11.6	17.7	9.7
Al-6061	412	0.34	33.4	0.08
Glidcop Cu	23.3	329	4.71	78.1

Conclusions

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- Large amount of ^{14}C is generated in Flibe
- The ^{14}C is generated by the high energy $^{19}F(n,np)$ and (n,d) $^{18}O(n,n\alpha)$ reactions
- Most of the ^{14}C is produced by neutrons with $E > 10$ MeV
- Generation of ^{14}C is more of a problem for the thin liquid wall concepts
- Reducing the Flibe life time may allow for the disposal of Flibe form liquid wall concepts as LLW
- Only stabilizing shells made of FS or V alloys would qualify for disposal as LLW

Elemental Composition of Flibe

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Nuclide	wt% or wppm
Li	14.038 wt%
Be	8.975 wt%
C	91 wppm
O	987 wppm
F	76.848 wt%
Mg	5.5 wppm
Al	77 wppm
Si	27 wppm
Ti	19 wppm
Cr	9 wppm
Mn	11 wppm
Fe	139 wppm

Ni	13 wppm
Cu	7 wppm