Results of Safety Analysis

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Basic Assumptions

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- Average neutron wall loadings (based on a 3-D analysis) are 1.83 and 5.14 MW/m^2 at the inboard and outboard midplanes, respectively
- Homogeneous CP (85% GlidCop Al-15 Cu and 15% water)
- The option of varying the size of CP is examined
- The inboard first wall and shield have a lifetime of 2.86 FPY
- The outboard first wall, blanket and manifold also have a lifetime of 2.86 FPY
- The outboard low-temperature shield and vacuum vessel have a lifetime of 40 FPY

Resistivity of CP

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- Cu resistivity increases due to the production of Co, Ni and Zn as transmutation products

- Co, Ni and Zn are produced due to several reactions with Cu. The following are the dominant reactions:

  - ^{63}Cu (n,2n)^{62}Cu(β^+)^{62}Ni, ^{65}Cu (n,2n)^{64}Cu(β^+)^{64}Ni, and ^{63}Cu (n,γ)^{64}Cu(β^+)^{64}Ni
  - ^{63}Cu (n,γ)^{64}Cu(β^-)^{64}Zn, ^{65}Cu (n,2n)^{64}Cu(β^-)^{64}Zn, and ^{65}Cu (n,γ)^{66}Cu(β^-)^{66}Zn
  - ^{63}Cu (n,γ)^{64}Cu(n,α)^{60}Co, ^{65}Cu (n,2n)^{64}Cu(n,α)^{60}Co

- The change in Cu resistivity is dominated by the production of the two nickel isotopes ^{64}Ni and ^{62}Ni

- The % increase in Cu resistivity is calculated using a room temperature resistivity of Cu and specific resistivities of Ni, Co and Zn of 1.71 x 10^{-8}, 1.12 x 10^{-8}, 6.4 x 10^{-8} and 3 x 10^{-9} Ω-m, respectively

- The transmutation-induced resistivity scales somewhat linearly with fluence

Radial Distribution of the Increase in Resistivity of the Copper CP

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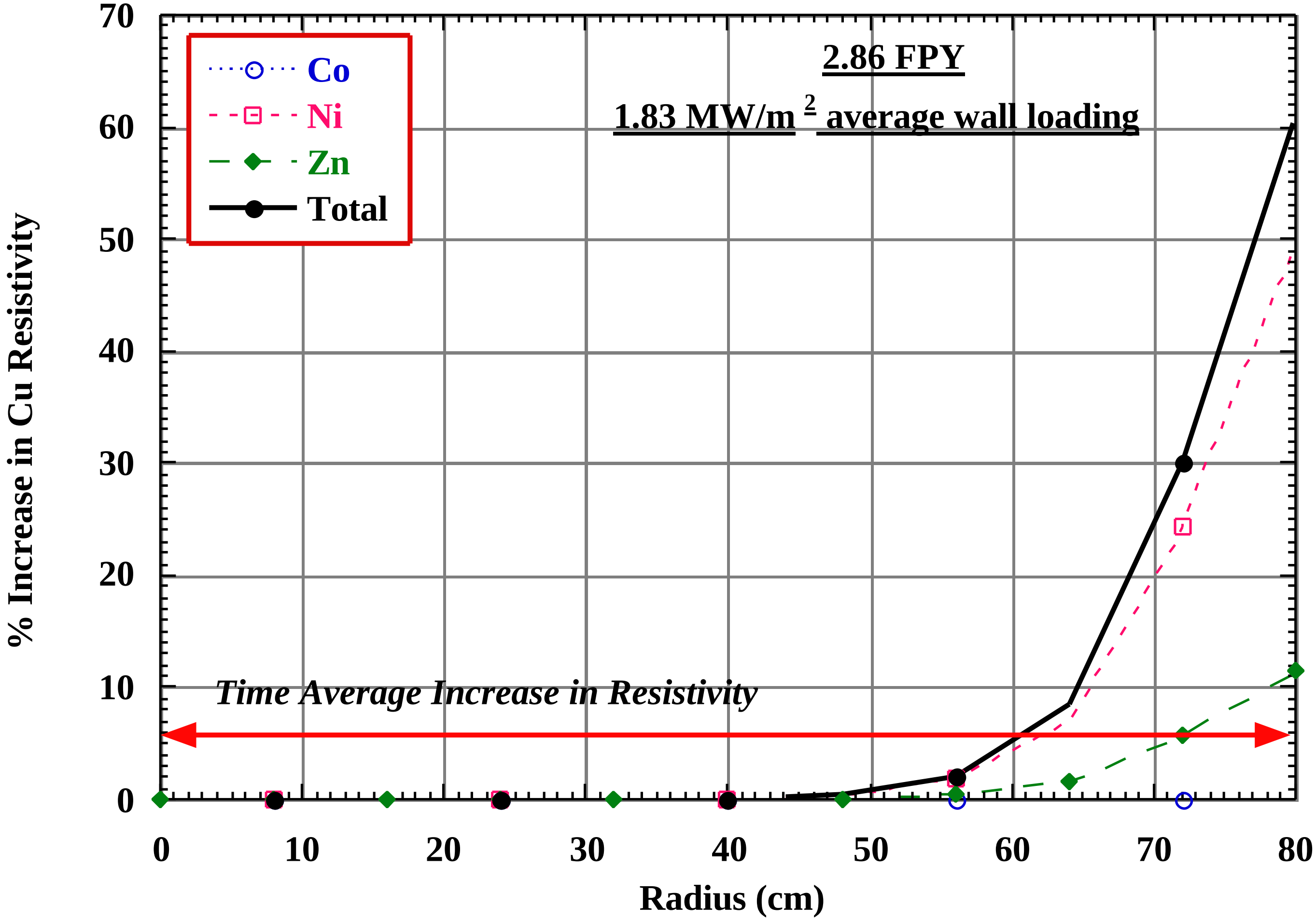

Waste Disposal Ratings

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- WDR for Class C waste are calculated using the 10CFR61 and Fetter waste disposal limits

- The ORNL steel (9Cr-2WVTa) composition used in the analysis include a 0.5 wppm of niobium as impurity

- Waste disposal ratings are given after 1 year following shutdown

- Waste disposal ratings are given for compacted wastes

Waste Disposal Ratings Using 10CFR61 Limits

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Zone	FPY	WDR	Dominant Nuclides
CP	2.86	0.83	^{63}Ni
i/b Shield	2.86	0.097	^{94}Nb
i/b FW	2.86	0.1	^{94}Nb
o/b FW	2.86	0.1	^{94}Nb
o/b Blanket	2.86	0.011	^{94}Nb
o/b Manifold	2.86	1.4e-3	^{94}Nb
o/b Shield	40	1.3e-3	^{94}Nb

Waste Disposal Ratings Using Fetter Limits

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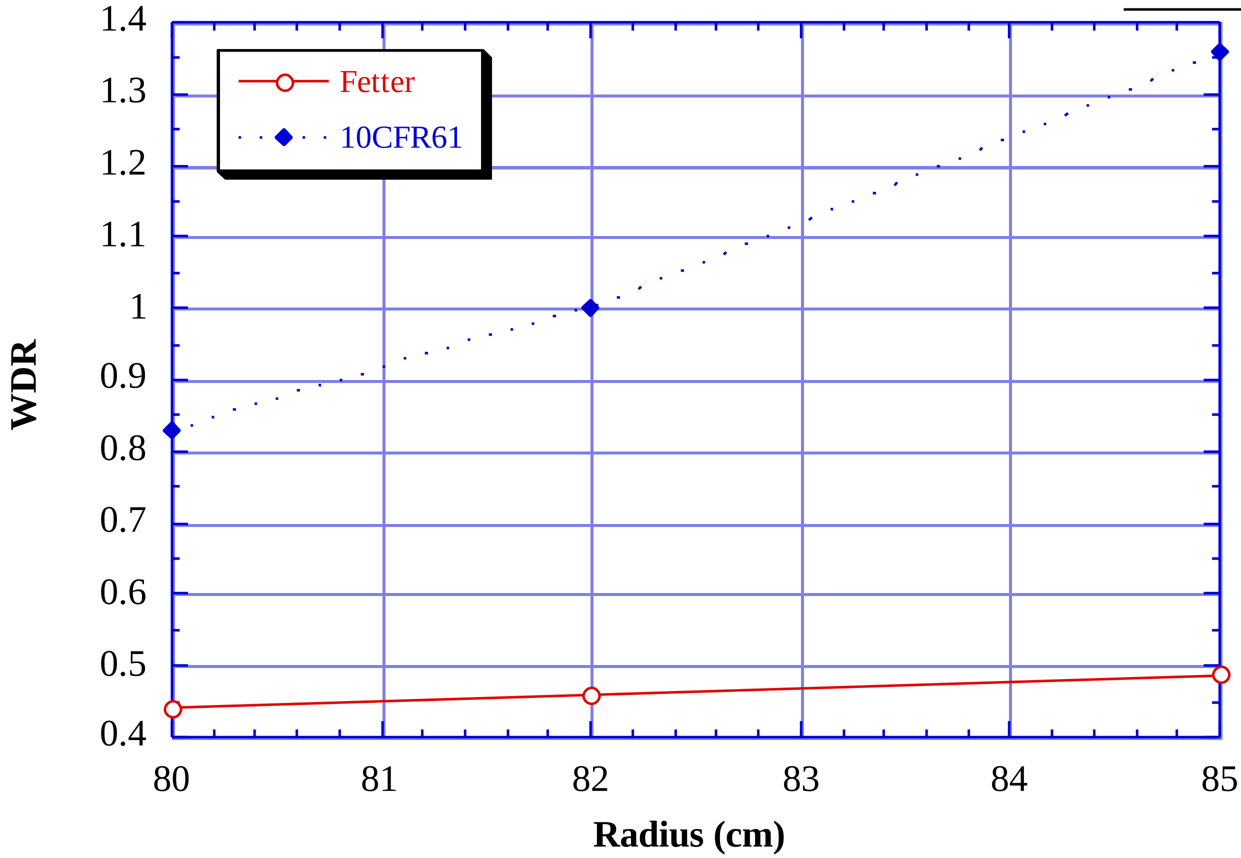
Zone	FPY	WDR	Dominant Nuclides
CP	2.86	0.44	^{108m}Ag
i/b Shield	2.86	0.44	^{192m}Ir, ^{94}Nb
i/b FW	2.86	0.29	^{192m}Ir, ^{94}Nb
o/b FW/kink shell	2.86	0.28	^{192m}Ir, ^{94}Nb
o/b Blanket	2.86	0.025	^{192m}Ir, ^{94}Nb
o/b Manifold	2.86	7.2e-3	^{192m}Ir
o/b Shield	40	0.03	^{192m}Ir

Waste Disposal Ratings as a Function of CP Radius



Assumptions Used in the Off-Site Dose Calculations

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- Off-site doses caused by the mobilization of the radioactive inventory are calculated using temperature profiles obtained from the LOCA analysis
- The release rates used are based on INEL's oxidation-driven volatility data
- The Sv/TBq values are calculated using the MACCS2 code assuming a ground release, atmospheric stability class F, 2 km site boundary and 1 m/s wind speed
- The accident is assumed to last for 24 hours at an average temperature of 700 °C
- Plate thickness of 2 mm is considered for the inboard FW and 3 mm for all other zones
- The PbLi composition used in the analysis include a 43 wppm of bismuth as impurity
- Less than 10% of the ^{210}Po produced in PbLi assumed to be mobilized during an accident
- Less than 30% of the ^{203}Hg produced in PbLi assumed to be mobilized during an accident

- A leak rate of 1% per day and a containment factor of 99% are considered

Early Dose By Zone

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Zone	Inventory (Sv)	Released (mSv)	Dominant Nuclides
CP	2,668	---	^{64}Cu
i/b Shld	4,175	0.17	^{60}Co, ^{54}Mn, ^{56}Mn
i/b FW	306	0.02	^{54}Mn, ^{56}Mn, ^{60}Co
O/b FW	5,000	0.2	^{54}Mn, ^{56}Mn, ^{60}Co
Blanket	2,257	1.38	^{210}Po, ^{203}Hg, ^{54}Mn
Manifold	167	0.004	^{60}Co
o/b Shld	53	0.0008	^{60}Co
Total	**14,626**	**1.77**	^{210}Po, ^{203}Hg, ^{54}Mn

Conclusions

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- Neutron transmutation of copper resulted in the production of several nickel, cobalt and zinc isotopes. The production of these isotopes resulted in increasing the time average resistivity of the center post by as much as 6% after 2.86 FPY

- After 2.86 FPY, the center post will qualify for disposal as Class C low level waste as long as the inboard shield thickness is 18 cm or more

- All other components of the plant would also qualify for disposal as Class C LLW

- The off-site dose calculations indicate that the current design produces an off-site dose that does not exceed the 10 mSv required to avoid evacuation in case of an accident

- Excluding ^{210}Po and ^{203}Hg, the off-site dose is dominated by ^{54}Mn, ^{56}Mn, and ^{60}Co which are produced by transmutation of steel

- ^{210}Po produces about 65% of the expected off-site dose

- The new FENDL-2 cross section data shows an order of magnitude lower production of ^{24}Na in SiC, resulting in a much lower off-site doses contribution from SiC