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# ***Beta Absorption by 'stuff' on Air Filters***

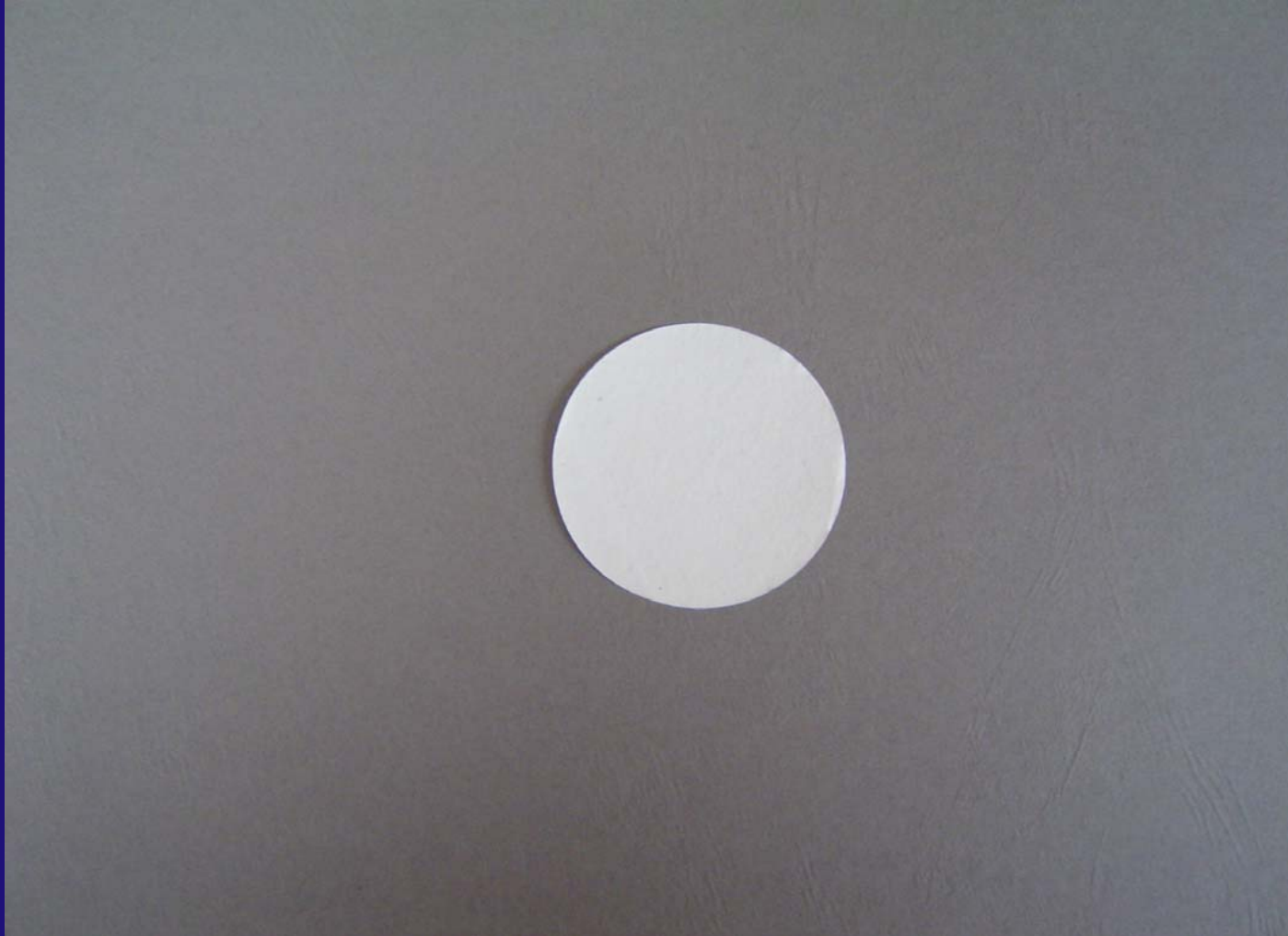
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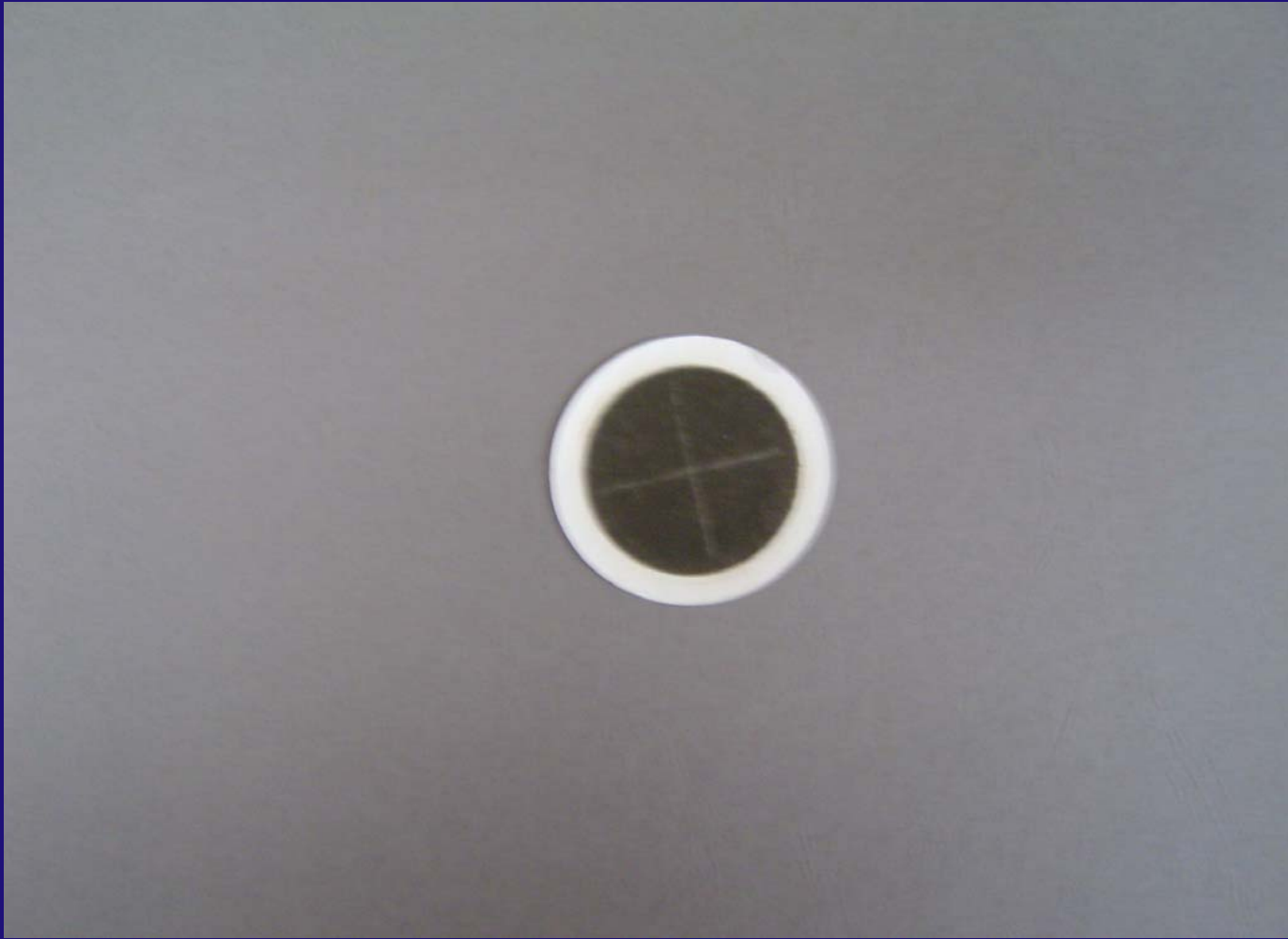
- During a routine NRC Inspection at Turkey Point, the inspector examined the condition of the new and 'used filters' and saw 'stuff' on the used filters

# *New Filter*



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# *Used Filter, Road/Tire Crud*



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# *Used Filter , Dust*



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# *NRC Asks*

Have you determined if this layer of material affects the Beta Counting Efficiency ?

# *And We Said*

( ummm, errr, ahhh, think quick)

“The ‘crud’ layer is seasonal”

“Over the years, we see about the same values,  
with & without crud”

Needless to say, this wasn't considered an  
acceptable answer

# *Basic Method*

- Assume 'stuff' is Beta Shield
- Weight of stuff: Used filter – New Filter
- Weight / Area = Area Density
- Determine Beta E Cut-off
- Compare Effluent Nuclides Beta E to Cut-off



*And The Answer Is:*

No Effect !

( I'm done ☺ )

# *New Filter Weights*

- The "Used Filters" were composed of about 70% "New" and 30% "Old"; the difference being in material ( weight).

# *New Filter Weights*

	Old	New
	0.12313	0.10875
	0.1226	0.12608
	0.125	0.11748
	0.13208	0.105
	0.12266	0.12446
	0.12445	0.11879
	0.12502	0.10574
	0.12773	
Average , gram	0.125	0.115
std dev	0.0032	0.0087
Lightest	<b>0.105</b>	

# Used Filter Weights

	T41	T51	T52	T56	T57	T58	T64	T71	T72
	0.11739	0.11809	0.11922	0.12457	0.13082	0.1258	0.1219	0.11797	0.11564
	0.11645	0.12431	0.11504	0.12218	0.12631	0.1226	0.11904	0.11693	0.12156
	0.11774	0.12431	0.11463	0.12303	0.12547	0.1127	0.11803	0.11641	0.11706
	0.12454	0.12995	0.12852	0.13102	0.15531	0.12703	0.1254	0.12968	0.12802
	0.12667	0.11824	0.1247	0.12767	0.12459	0.12573	0.12813	0.12872	0.11627
	0.11721	0.1323	0.11962	0.12049	0.12591	0.12024	0.12976	0.12627	0.12651
	0.1274	0.12464	0.12182	0.11692	<b>0.123</b>	0.12397	0.12325	0.12159	0.12206
	0.13724	0.1281	0.11696	0.12922	0.15023	0.13342	0.13053	0.12973	0.11922
	0.12021	0.11486	0.12329	0.11543	0.12193	0.11446	0.12214	0.11616	0.12254
	0.12839	0.12767	0.12846	0.12829	0.14396	0.12786	0.13032	0.11608	0.11482
	0.12693	0.12727	0.12704	0.12668	0.14353	0.12697	0.1289	0.12739	0.12701
	0.13787	0.1359	0.13285	0.13744	0.15261	0.1422	0.13835	0.13636	0.13343
	0.12853	0.1276	0.13164	0.13215	0.13285	0.12999	0.13123	0.13037	0.12932
Av	0.1251	0.1256	0.1234	0.1258	0.1351	0.1256	0.12669	0.1241	0.1226
Sd	0.0072	0.0059	0.0061	0.0062	0.0122	0.0076	0.00571	0.0069	0.0059
Avg. Added, gram									
	0.00994	0.01045	0.00818	0.01059	0.01993	0.01043	0.011505	0.00894	0.00739
Density Thick mg/cm <sup>2</sup>									
	0.6247	0.6569	0.5145	0.6659	1.2532	0.6556	<b>0.7234</b>	0.5622	0.4645



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# Used Filter Weights

	H12	H14	H30	H32	H33	H34
	0.12322	0.11869	0.11663	0.12246	0.13587	0.13638
	0.116	0.11653	0.11627	0.11357	0.13351	0.11944
	0.12456	0.12836	0.11823	0.12115	0.13107	0.12599
	0.12077	0.13047	0.11081	0.11697	0.14029	0.12734
	0.13633	0.14586	0.13027	0.13022	0.15942	0.14156
	0.13785	0.14449	0.13013	0.13318	0.15782	0.14367
	0.13357	0.14705	0.13022	0.13127	0.16321	0.14101
	0.12274	0.13593	0.12914	0.14035	0.12998	0.14027
	0.12228	0.13016	0.12734	0.1307	0.11808	0.13323
	0.13628	0.13101	0.11871	0.13339	0.13575	0.13186
	0.13517	0.13051	0.12943	0.12957	0.11984	0.13098
	0.13435	0.13434	0.13578	0.13506	0.13488	0.13836
	0.13074	0.12502	0.12213	0.12622	0.12887	0.12387
Avg , gm	0.1288	0.1322	0.1242	0.1280	0.1376	0.1334
std dev	0.0075	0.0095	0.0075	0.0076	0.0143	0.0076
Avg. Added, gram						
	0.01357	0.017	0.00905	0.01282	0.0224	0.0182
Density Thick ,						
	0.8534	1.0689	0.5692	0.806	1.4083	1.1440

# *Filter Weights Used*

- Tare : Lightest and Average of New
- Used : Site Specific Heaviest and Average
- Net Loading : Used - Tare
- Could Have Co-mingled All Data

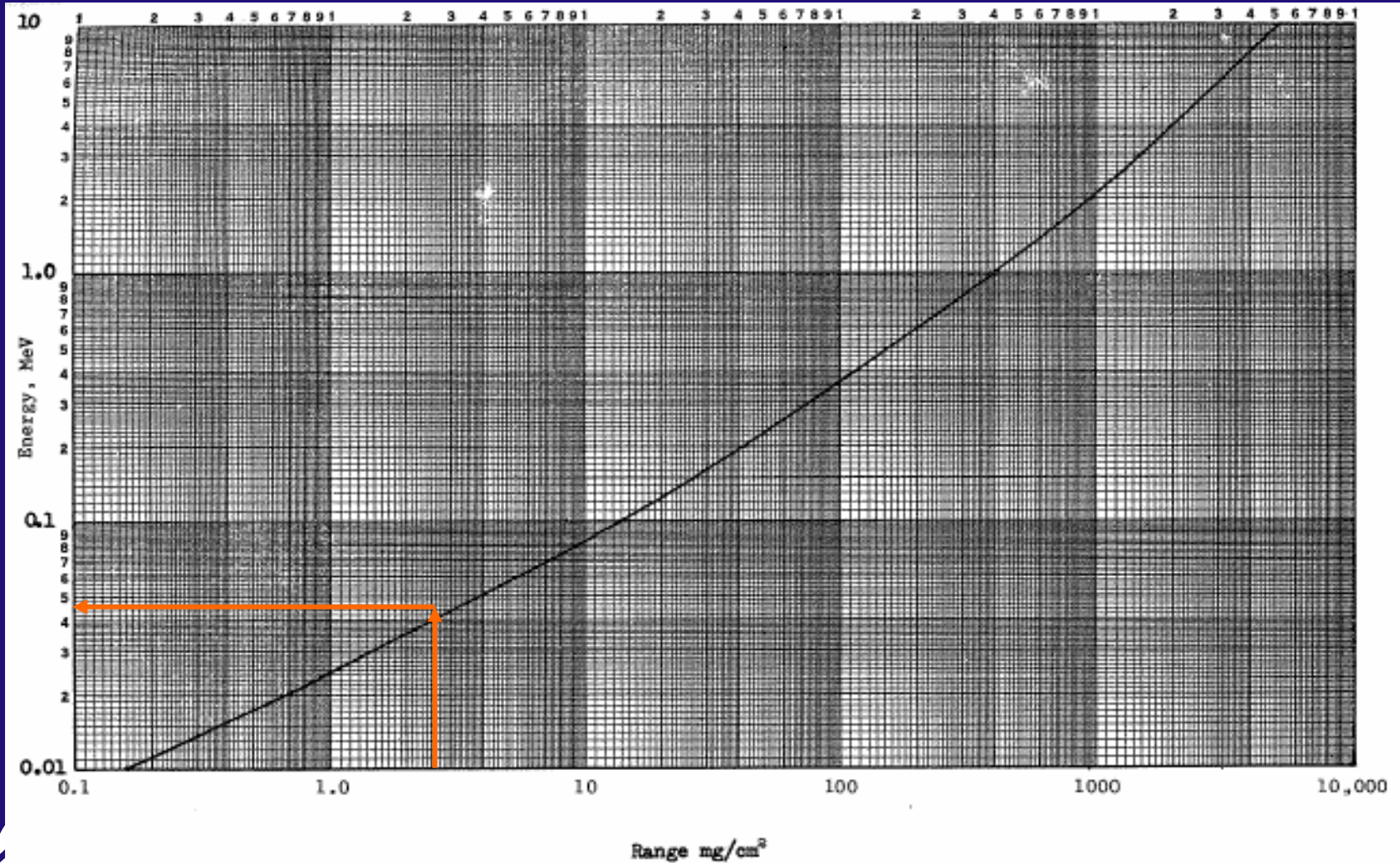
# *Net Weights , Area Density*

Area : 47mm Filter , 1 mm clean band  
45mm Effective Diameter  
15.9 cm<sup>2</sup>

- Area Density : Net Loading / Area

	Average	Worst Case	
St. Lucie	0.97	3.66	mg/cm <sup>2</sup>
Turkey Pt.	0.68	3.16	mg/cm <sup>2</sup>

# Beta E Cut-off





# List of Beta E

Table 8.2. Beta Emitters by Energy and Half-Life

Only isotopes with half-lives greater than six hours are listed; in general, a shorter half-life limits identification.

Daughters with shorter half-lives than their parents are listed in italics under the half-life of the parent. In the natural series, the short-lived daughters are listed under the half-life of the nearest antecedent having a half-life over six hours.

Half-Life	$E_{max}$ 0-0.1 (MeV)	0.1-0.3	0.3-0.5	0.5-0.7
6-12 hr.	Zn <sup>62</sup>	Ta <sup>166</sup> <i>g<sup>166</sup></i> <i>p<sup>166</sup></i>	<i>l<sup>159</sup></i> <i>g<sup>168</sup></i> <i>p<sup>212</sup></i> <i>Ac<sup>210</sup></i> <i>Pa<sup>234</sup></i>	Zn <sup>62</sup> <i>g<sup>91</sup></i> <i>g<sup>101</sup></i> <i>Ta<sup>184</sup></i> <i>p<sup>212</sup></i> <i>Ac<sup>210</sup></i> <i>Po<sup>214</sup></i>
12 hr-1 d		Nb <sup>90</sup> <i>p<sup>112</sup></i> <i>Au<sup>197</sup></i>	<i>Y<sup>87</sup></i> <i>Nb<sup>90</sup></i> <i>l<sup>122</sup></i> <i>g<sup>194</sup></i>	<i>Cu<sup>64</sup></i> <i>Ga<sup>72</sup></i> <i>Br<sup>74</sup></i> <i>l<sup>106</sup></i> <i>p<sup>142</sup></i> <i>g<sup>148</sup></i> <i>Pt<sup>187</sup></i> <i>Nb<sup>234</sup></i> <i>g<sup>242</sup></i>
1-3 d	<i>Nb<sup>164</sup></i> <i>Lu<sup>170</sup></i> <i>Ta<sup>177</sup></i> <i>Tb<sup>201</sup></i>	<i>As<sup>71</sup></i> <i>Zn<sup>72</sup></i> <i>g<sup>145</sup></i> <i>Co<sup>140</sup></i> <i>Sr<sup>152</sup></i> <i>Tb<sup>159</sup></i> <i>Ta<sup>231</sup></i> <i>Pa<sup>232</sup></i> <i>Np<sup>236</sup></i>	<i>Cu<sup>67</sup></i> <i>Br<sup>77</sup></i> <i>Br<sup>82</sup></i> <i>Na<sup>99</sup></i> <i>Zn<sup>115</sup></i> <i>g<sup>121</sup></i> <i>Ta<sup>131</sup></i> <i>g<sup>187</sup></i> <i>Ti<sup>200</sup></i> <i>Pa<sup>232</sup></i> <i>Np<sup>236</sup></i>	<i>Sc<sup>46</sup></i> <i>Cu<sup>67</sup></i> <i>g<sup>69</sup></i> <i>g<sup>72</sup></i> <i>As<sup>72</sup></i> <i>As<sup>77</sup></i> <i>g<sup>104</sup></i> <i>Gd<sup>115</sup></i> <i>g<sup>121</sup></i> <i>g<sup>148</sup></i> <i>Sn<sup>158</sup></i> <i>W<sup>187</sup></i> <i>g<sup>192</sup></i> <i>Np<sup>236</sup></i>
3-5 d	<i>Ac<sup>144</sup></i> <i>Tb<sup>170</sup></i>	<i>Ta<sup>182</sup></i> <i>Dy<sup>166</sup></i> <i>Yb<sup>170</sup></i> <i>g<sup>184</sup></i> <i>Pt<sup>192</sup></i> <i>Au<sup>199</sup></i>	<i>Sc<sup>47</sup></i> <i>Tb<sup>175</sup></i> <i>Ac<sup>123</sup></i> <i>g<sup>134</sup></i>	<i>Sc<sup>47</sup></i> <i>Ca<sup>47</sup></i> <i>g<sup>67</sup></i> <i>l<sup>124</sup></i> <i>Ta<sup>182</sup></i> <i>p<sup>214</sup></i>
5-10 d	<i>Xe<sup>122</sup></i> <i>Tb<sup>166</sup></i>	<i>Co<sup>131</sup></i> <i>Tm<sup>167</sup></i> <i>Lu<sup>174</sup></i> <i>g<sup>172</sup></i> <i>Lu<sup>177</sup></i> <i>g<sup>227</sup></i>	<i>Sm<sup>120</sup></i> <i>l<sup>131</sup></i> <i>Xe<sup>120</sup></i> <i>Tb<sup>161</sup></i> <i>Er<sup>165</sup></i> <i>Lu<sup>177</sup></i>	<i>Na<sup>52</sup></i> <i>Ac<sup>73</sup></i> <i>Ag<sup>111</sup></i> <i>l<sup>131</sup></i> <i>Co<sup>130</sup></i> <i>Tb<sup>161</sup></i> <i>Po<sup>209</sup></i>
10-13 d	<i>Sr<sup>197</sup></i> <i>g<sup>204</sup></i>	<i>g<sup>131</sup></i> <i>Ni<sup>197</sup></i>	<i>l<sup>124</sup></i> <i>g<sup>136</sup></i> <i>g<sup>194</sup></i> <i>Ni<sup>197</sup></i> <i>Po<sup>211</sup></i>	<i>Co<sup>136</sup></i>
13-15 d			<i>Ra<sup>224</sup></i>	



# *Results : Turkey Point*

- Average Loading: Beta cutoff 0.028 MeV
- Worst Case Loading: Beta cutoff 0.044 MeV
- NO 'REACTOR NUCLIDES' LISTED WITH  $E_{avg}$  LESS THAN 0.045 MeV

# *Results : St. Lucie*

Average Loading: Beta cutoff 0.029 MeV

- Worst Case Loading: Beta cutoff 0.048 MeV
- Nb-95 , Eavg 0.046
- NO OTHER 'REACTOR NUCLIDES'

( finally done)

# Questions ?

