Delicensing and Clearance Monitoring for Tritium

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UKAEA Winfrith

Introduction

- Winfrith built in late 1950s, 9 experimental reactors, SGHWR connected to National Grid (100MW).
- Winfrith in decommissioning & de-licensing phase
  - EAST end decommissioning & de-licensing advanced.
  - extensive sampling/analysis of building structures for waste characterisation.
  - generally very low levels of contamination (minimal activation) with exception of H-3.
  - H-3 is dominant isotope in fingerprints (upto 99%!!!).
  - H-3 alone exceeds SoLA EO criteria 0.4Bq.g^{-1}.

Tritium at Winfrith

- SGHWR had D_2O moderator, activation of D_2O = H-3.
- H-3 highly mobile isotope of hydrogen.
- Hydrogen gas readily adsorbs onto metal surfaces so H-3 penetrates into material eg concrete, paint, metal.
- H-3 present in structure of many buildings @ Winfrith - authorised discharges from SGHWR <u>not</u> as a result of H-3 being historically used in the building.
- Decommissioning generate vast volumes metal/concrete which only exceeds EO criteria due to the H-3 levels.

Question 1

Is it right to send huge volumes of concrete/metal as LLW which is only contaminated with H-3 and at levels generally <1 $Bq.g^{-1}$ to Drigg?

- H-3 is low toxicity isotope.
- Is it a good use of the Drigg resource? Decommissioning could produce huge volumes of H-3 contaminated waste in UK.

Question 2

Should we as an industry be lobbying for change in the regulations to consider different Exemption Criteria for low toxicity isotopes - considering potential decommissioning waste volumes?

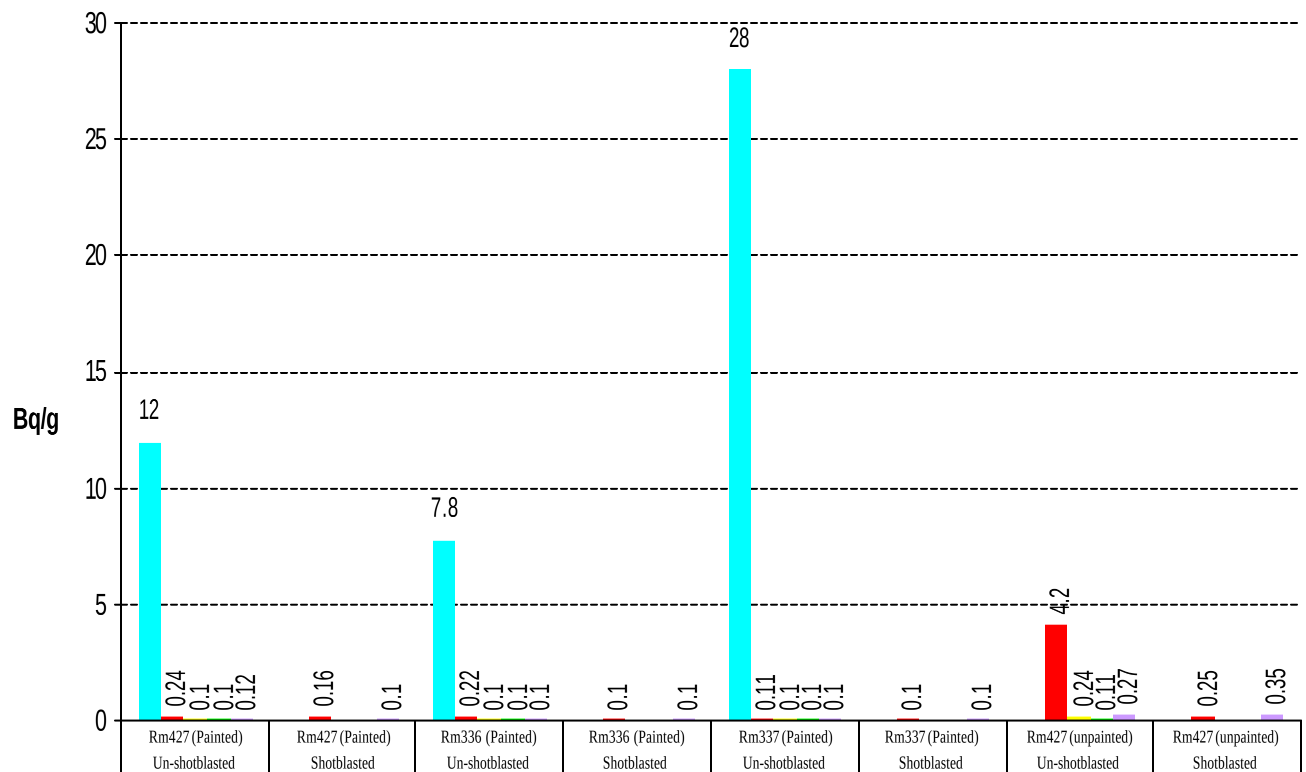
- EU directives consider wastes generated from decommissioning with criteria that's isotope specific.
- What volumes of H-3 contaminated waste will go to Drigg during the decommissioning of our industry and the associated costs?
- If H-3 limit raised to 1Bq.g^{-1} - costs, Drigg capacity?

Winfrith Approach : Tritium Contaminated Metal

- Shotblaster removes surface contamination - achieve clearance/exemption criteria BUT is H-3 >0.4Bq.g^{-1}?
- Investigate degree of penetration of H-3 in metal.
- Painted/unpainted carbon steel samples from SGHWR - areas where atmospheric H-3 high (no moderator circuitry).
- Each sample cut in half - one half shotblasted.
- Subsampled each half at discrete depths and analysed H-3.
  - Unshotblasted - Paint, 0-40µm, 40-80µm, remainder + X-section
  - Shotblasted - 0-40µm, 40-80µm, remainder + X-section
  - 0-40µm approx amount of material removed by shot blaster

- H-3 - held in paint layer or 0-40 µm layer (unpainted).
- **Initial Conclusion** - processing though shotblaster removes sufficient material and H-3 contamination to meet EO Criteria
- → Perform similar trials in low H-3 atmospheres - same profile seen.
- → Conduct post-shotblast analysis for H-3 for one year period to confirm EO being met - 0.4 $Bq.g^{-1}$ never exceeded.
- Processed metal meets shotblaster acceptance criteria will meet EO levels for H-3.
- EA kept aware of strategy

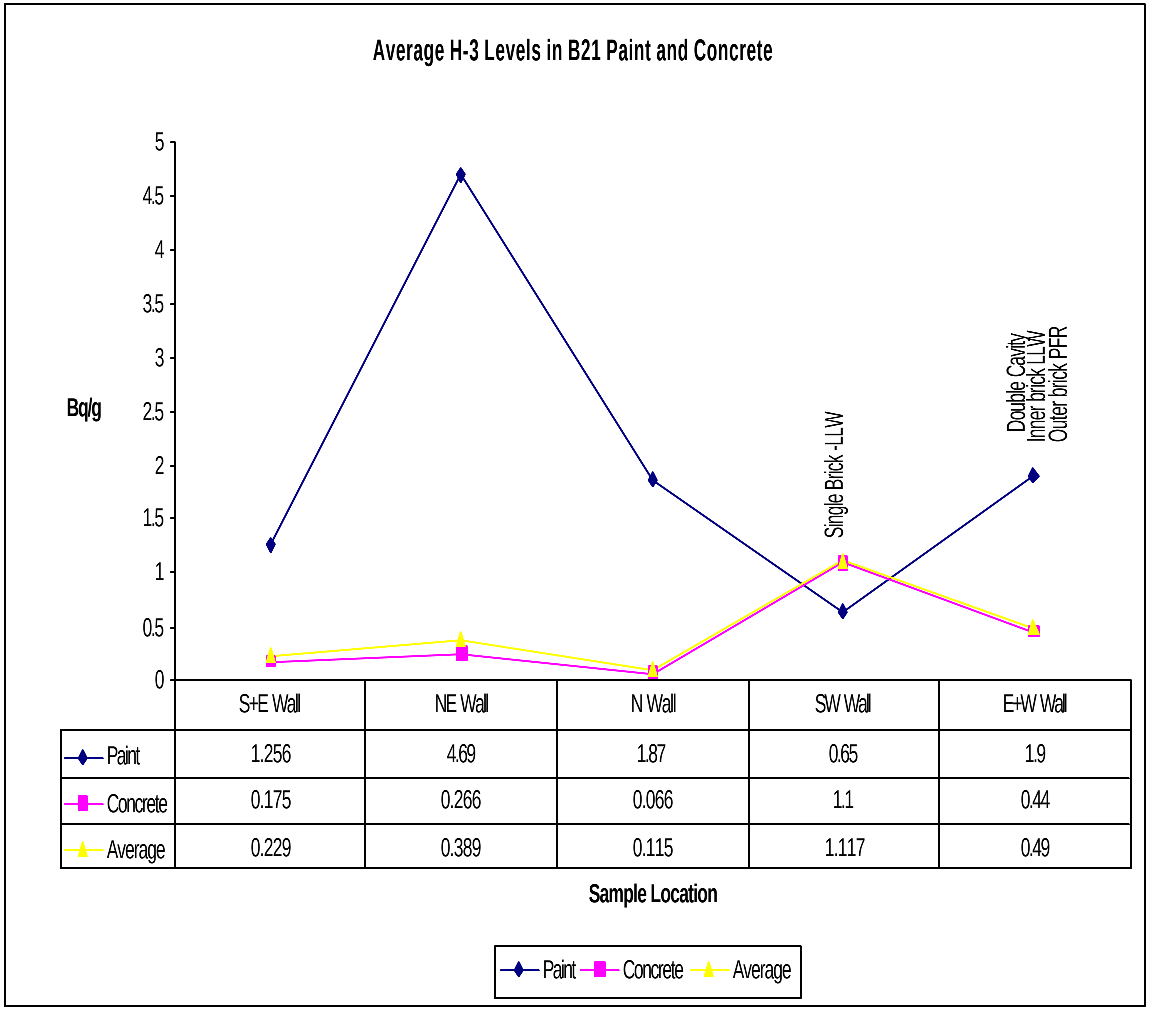
Comparison of Unshotblasted:Shotblasted Tritium Profile for Carbon Steel from High H-3 Areas of SGHWR



	Rm427 (Painted) Un-shotblasted	Rm427 (Painted) Shotblasted	Rm336 (Painted) Un-shotblasted	Rm336 (Painted) Shotblasted	Rm337 (Painted) Un-shotblasted	Rm337 (Painted) Shotblasted	Rm427 (unpainted) Un-shotblasted	Rm427 (unpainted) Shotblasted
Paint	12		7.8		28			
0-40 µm	0.24	0.16	0.22	0.1	0.11	0.1	4.2	0.25
40-80 µm	0.1		0.1		0.1		0.24	
>80 µm	0.1		0.1		0.1		0.11	
Cross-section	0.12	0.1	0.1	0.1	0.1	0.1	0.27	0.35

Winfrith Approach : Tritium Contaminated Concrete B21

- **B21 D_2O Moderator Clean-Up Facility Decommissioning**
  - No surface contamination EXCEPT $H\text{-}3_{paint} > 0.4 Bq.g^{-1}$!!!
- **Could we Average H-3 content across painted structure and achieve EO Criteria?**
  - Re- sampled each wall - paint and underlying concrete for H-3
  - $H\text{-}3_{paint} > H\text{-}3_{concrete}$ (one exception)
- EA aware - to present document proposing averaging H-3



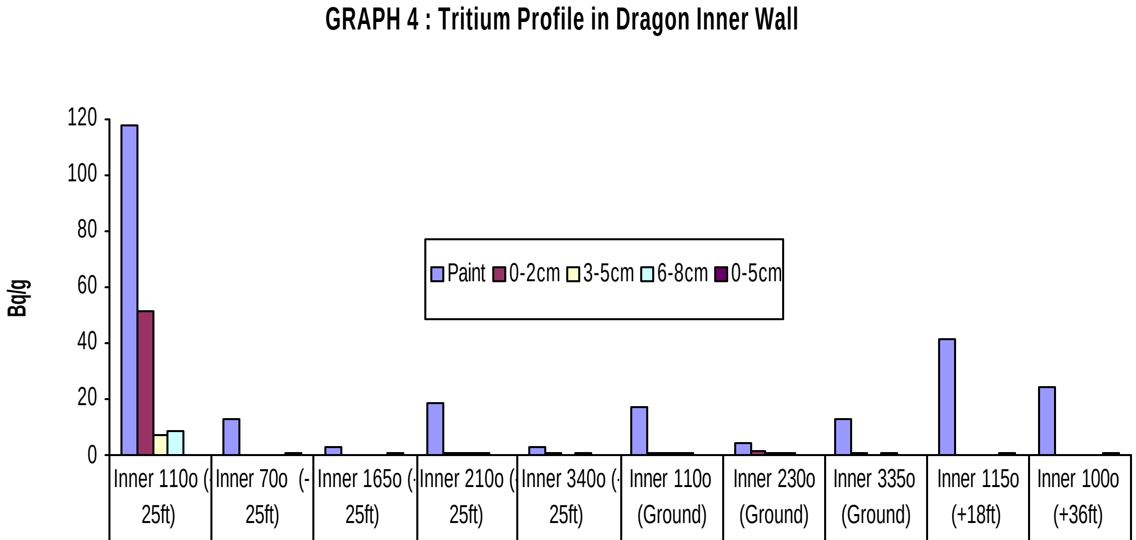
	S+E Wall	NE Wall	N Wall	SW Wall	E+W Wall
Paint	1.256	4.69	1.87	0.65	1.9
Concrete	0.175	0.266	0.066	1.1	0.44
Average	0.229	0.389	0.115	1.117	0.49

- Calculate average H-3 each wall
- Average H-3>0.4Bq.g^{-1} in 2 cases
- 1 wall is double cavity
- → propose H-3 penetrates inner only = LLW
- other single cavity
- → H-3$_{paint}$< H-3$_{concrete}$
- → fails to meet EO criteria = LLW
- EA Approval
- → ~30m^3 material suitable for disposal under EO
- → save ~£75-100k Drigg!!

Winfrith Approach : H-3 Contaminated Concrete DRAGON

- Historically, millions gaseous H-3 Light Devices (Betalites) stored in Dragon reactor.
- Has H-3 penetrated Dragon Inner/Outer Annulus Concrete?
- 20 cores - radial/vertical locations inner/outer walls
- Greater concentration cores in vicinity of store
- Sub-sample cores @ discrete depths & determine H-3 profile
  - Paint, 0-2cm, 3-5cm, 6-8cm (0-5cm - reduce analysis costs)
- Can we average H-3 across concrete structure to meet EO?

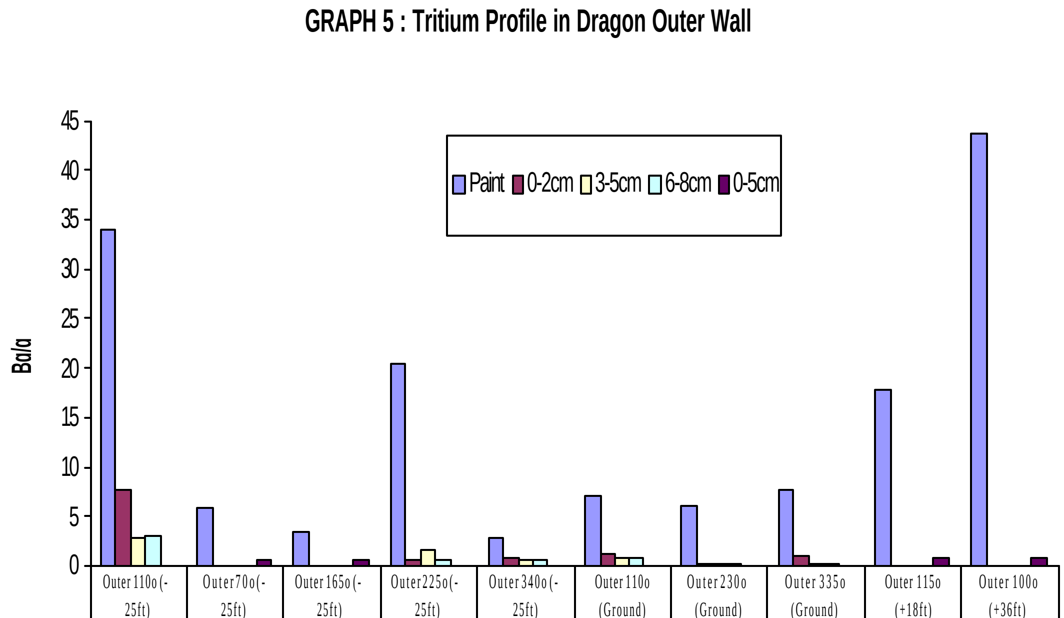
H-3 Profile Inner Dragon Wall



	Inner 110o (-25ft)	Inner 70o (-25ft)	Inner 165o (-25ft)	Inner 210o (-25ft)	Inner 340o (-25ft)	Inner 110o (Ground)	Inner 230o (Ground)	Inner 335o (Ground)	Inner 115o (+18ft)	Inner 100o (+36ft)
Paint	117.79	12.73	2.73	18.63	2.46	17.63	4.63	13.45	41.99	24.35
0-2cm	51.65			0.71	0.83	0.97	1.48	1.08		
3-5cm	7.33			0.51	0.29	0.76	0.7	0.39		
6-8cm	8.58			0.5	0.62	0.62	0.57	0.6		
0-5cm		0.5	0.83						0.87	1.16

- Betalite store -25ft level
- 110º = centre store
- H-3 mainly held in paint
- -25ft level most H-3
- Data indicates H-3 concentration reduces with depth
- Need to confirm this by coring/sampling deeper to ensure no ‘pool’ of H-3 deeper in concrete

H-3 Profile Outer Dragon Wall



	Outer 110o (-25ft)	Outer70o (-25ft)	Outer 165o (-25ft)	Outer225o (-25ft)	Outer 340o (-25ft)	Outer 110o (Ground)	Outer 230o (Ground)	Outer 335o (Ground)	Outer 115o (+18ft)	Outer 100o (+36ft)
Paint	34.1	5.7	3.48	20.51	2.83	7.1	5.89	7.67	17.81	43.83
0-2cm	7.73			0.38	0.84	1.23	0.36	0.95		
3-5cm	2.7			1.48	0.39	0.65	0.16	0.23		
6-8cm	3.05			0.53	0.53	0.77	0.23	0.35		
0-5cm		0.38	0.59						0.8	0.77

- Generally, less H-3 contamination than inner wall - were Betalites located nearer inner wall?
- Data again indicates H-3 concentration reduces with depth
- Inner/Outer wall data suggests need to scabble paint, then apply averaging argument to try to meet EO criteria.
- Potentially, huge savings in terms of Drigg costs.