UK Irradiated Materials Archive

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MRF meeting – CCFE - 7th July 2015

UK Irradiated Materials Archive

Background

- Establishment of **N**ational **N**uclear **U**ser **F**acility for accessible study of active materials
- Initiative within Bristol-Oxford NRC to retain ex-Magnox reactor steel pressure vessel surveillance specimens
- Specimens of known pedigree with up to 40 years of service exposure
- Materials well suited for use in future university-based research programmes

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NNUF - IMAG

- A “working group” of NNUF
- Current committee:
  - (co-chair) Peter Flewitt - University of Bristol
  - (co-chair) Steve Roberts - University of Oxford
  - Chair of NNUF, currently Robin Grimes – Imperial College, FCO
  - NIRO representative, currently Andrew Brown
  - NDA representative, currently Beth Ripper
  - CCFE representative, currently Martin O’Brien
  - NNL representative, currently Dominic Rhodes
  - University representative, currently Simon Pimblott - University of Manchester.

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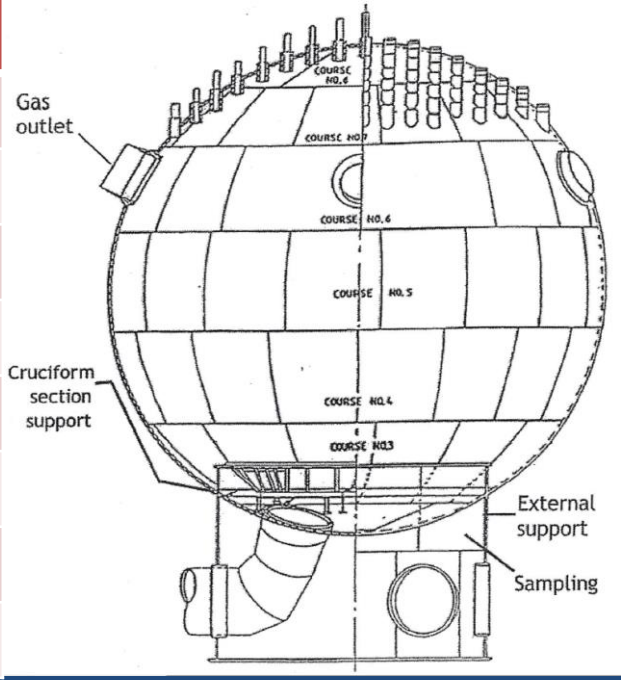
Magnox steel vessels – operating periods

Station	RPV	Start-up date	Closure date
Berkeley	Steel	1962	1989
Bradwell	Steel	1962	2002
Dungeness A	Steel	1965	2006
Hinkley Point A	Steel	1965	1999
Trawsfynydd	Steel	1965	1991
Sizewell A	Steel	1966	2006
Oldbury	Concrete	1967	2012
Wylfa	Concrete	1971	-----



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Magnox steel vessels – nominal compositions

- Design and construction standard
  - Non-nuclear BS1500 Class 1
- RPV materials
  - Plain carbon-manganese steel plates and forgings
  - Manual metal arc (MMA) or automatic submerged arc (SAW) welds

	Composition /wt%					
	C	Mn	Si	S	P	Cu
Plate	0.09-0.17	1.04-1.32	0.10-0.60	0.02-0.04	0.01-0.04	0.03-0.15
Forging	0.18	1.30	0.36	0.024	0.024	0.10
MMA	0.086	0.91	0.91	0.022	0.025	0.08
SAW	0.088	1.49	1.49	0.037	0.031	0.23

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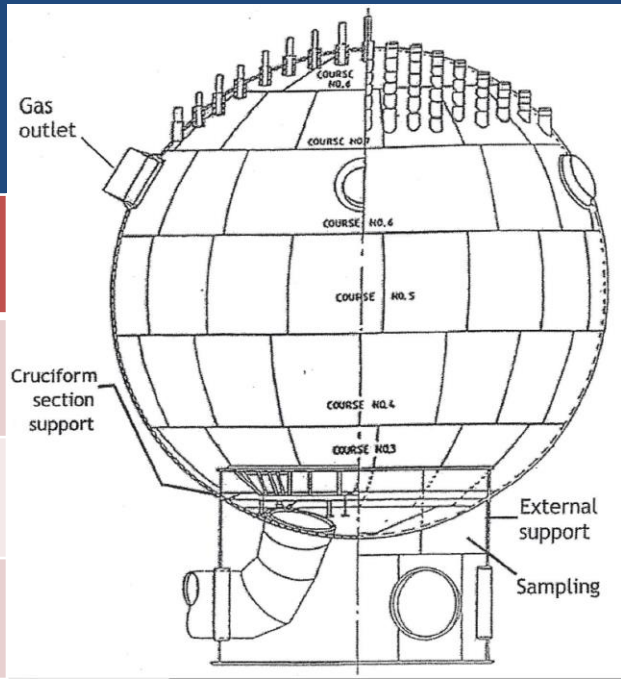
Magnox steel vessels – operating conditions

- Magnox RPVs experienced a wide range of irradiation temperatures, neutron doses and neutron energy spectra
- Surveillance schemes were designed to cover this range
  - Withdrawn periodically

Canister location	Irradiation temperature /°C	Dose rate /dpa.s^{-1} x10^{13}
Above core	330-360	3.2-4.9
Side core	198-355	7.3-26
Subcore	165-223	0.94-49



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Magnox specimens

- Specimen listing has been evaluated
  - Composition
  - Charpy and tensile specimens with linked test data
  - More than 8000 specimens
    - Plate material
    - Forged material
    - Manual metal arc welds
  - Irradiation temperatures **170 - 360°C**
  - Doses **unirradiated** plus **irradiated**, **range 10** to **400 x10^{-5}** dpa

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Magnox specimen - selection

- Specimens are distributed in cans within overpacks
- Currently stored at Sellafield
  - Well-documented but no system to what is where
- "1st division" specimens
  - kept / tested below 50°C after irradiation
  - ~500 specimens
- "2nd division" specimens
  - kept / tested below 100°C after irradiation
  - ~150 specimens

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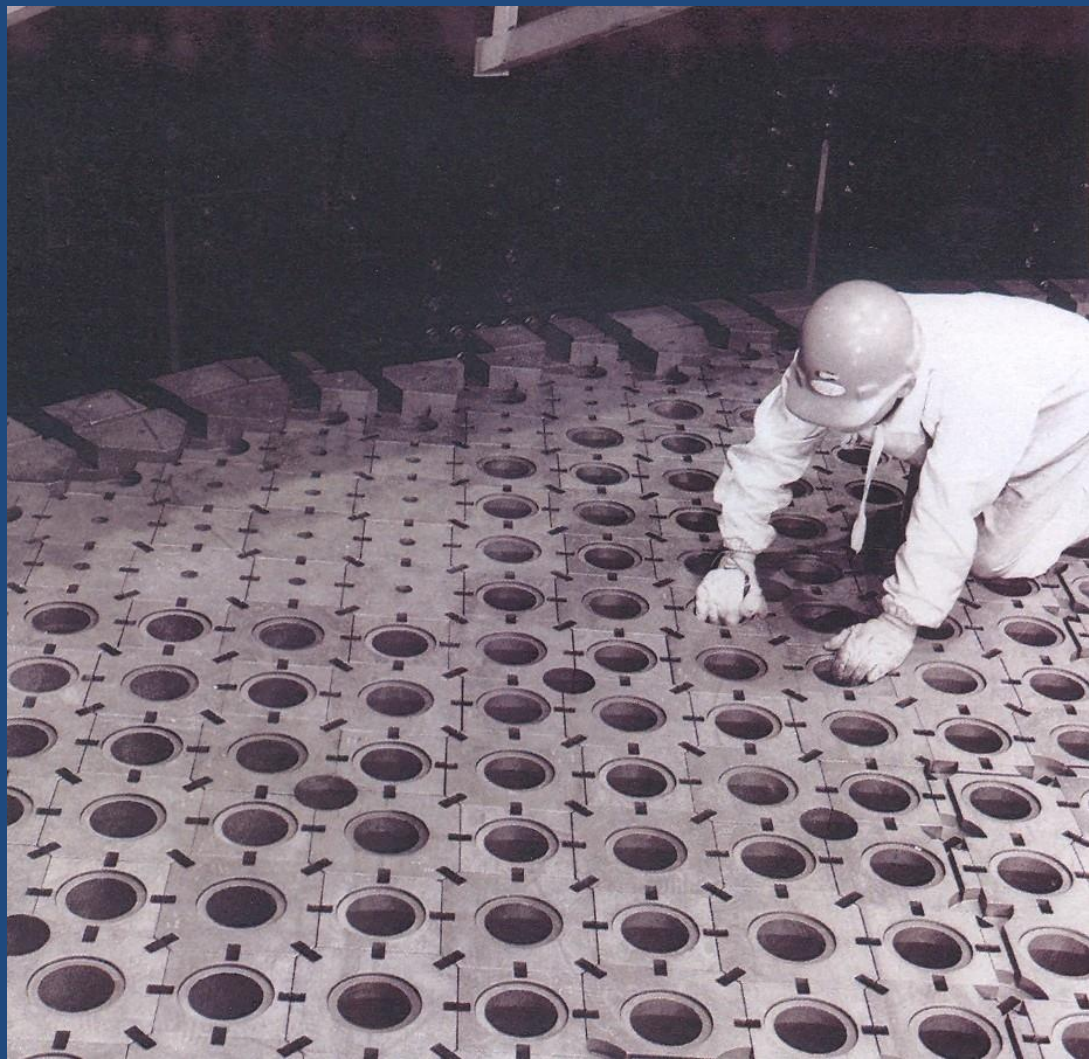
Graphite reactor core

- In addition there are graphite reactor core samples
- Pile Grade A graphite reactor core bricks



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Graphite core

- Measurement scheme made provision for property changes
  - Graphite samples inserted in special reactor core channels were withdrawn for testing at approved intervals
  - Irradiated samples trepanned from individual core bricks
  - A large number of unirradiated samples of graphite representative of the individual reactor cores
  - Measure of properties
    - Physical
    - Chemical
    - Mechanical
  - Up to 40 years of service exposure

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Other specimens for inclusion in Archive?

- Graphite
  - Database of AGR archive materials being compiled
- Dounreay fast reactor components
  - Status not yet clear
- Tungsten
  - ISIS targets being evaluated
- Anything else!
  - Suggestions sought

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Next steps

- Following NDA clearance, make Magnox specimen list available
  - Via NNUF website
- A virtual (distributed) or physical (centralised) archive?
  - Virtual – Low initial cost, continuing moderate storage costs, access to chosen specimens difficult and repeatedly expensive
  - Physical – High initial cost (~£10M), building and unpacking/sorting, continuing moderate storage costs, only pedigree specimens, access to chosen specimens much easier
- Researchers to decide value for future research projects using available specimens
  - How useful will the archive be?
  - What could be added to it?

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Further information

- Contacts
  - steve.roberts@materials.ox.ac.uk
  - peter.flewitt@bristol.ac.uk
- Website
  - NNUF website: **www.nnuf.ac.uk**

- Many thanks to Malcolm Wootton, Magnox Limited, for maintaining and making available the Magnox RPV materials database