



Sellafield Ltd

**A Nuclear Management Partners company
operated under contract to the NDA**

Characterisation of metal in support of decommissioning a Reactor Site

Radiological Characterisation Working Group

Chris Hope – Technical Manager, Facility Characterisation

Date: April 2012

A Nuclear Management Partners company operated under contract to the NDA



Sellafield Ltd

Scope

Characterisation programme executed by Sellafield Ltd to support Calder Hall decommissioning programme.

- Background.
- Scope of decommissioning.
- Characterisation strategies (3 populations).
 - Expectations.
 - Objectives.
 - Execution.
 - Sentencing decision.
- Conclusions.

A Nuclear Management Partners company operated under contract to the NDA

Background – Calder Hall



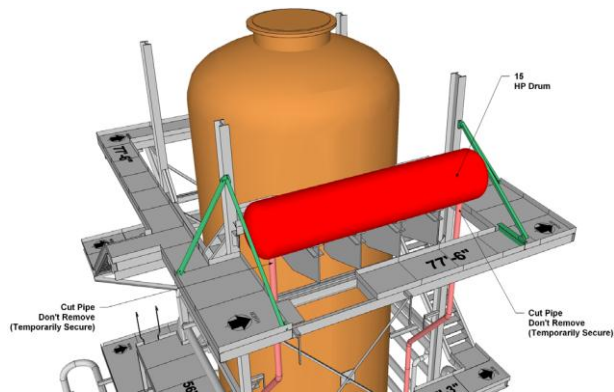
A Nuclear Management Partners company operated under contract to the NDA

Scope of Decommissioning

1. Top duct elbow, bellows & mid section removal



2. Steam pipework removal



3. Structural steelwork removal



A Nuclear Management Partners company operated under contract to the NDA

Characterisation Strategy - Populations

Population	Potential Contamination Mechanism / Activation			
	Direct contact with reactor gas	Direct contact with steam	Atmospheric deposition	Activation
1. Top Duct Components	✓	✗	✓ (minor due to recent removal of insulation lagging pipework)	✓
2. Steam system pipework	✗	✓	✓ (minor due to recent removal of insulation lagging pipework)	✗
3. Painted structural steelwork	✗	✗	✓	✓ (closest point to reactor)

A Nuclear Management Partners company operated under contract to the NDA

1. Top Duct Components - Background



- Gas pipework connecting reactor to top of heat exchanger
- Carried reactor gas (CO₂)
- 3 key components
 - Elbow
 - Bellows x 2
 - Mid Section
- Approximately 30 te per heat exchanger

A Nuclear Management Partners company operated under contract to the NDA

1. Top Duct Components – Expectations & Objectives

Expectations

- Significant contamination on internals (LLW levels)
- Tritiation likely.
- Activation a possibility.

Characterisation Objectives

- Radionuclide fingerprint.
- Activation levels (if present).
- Bulk tritium activity concentrations.
- Most effective decontamination methods.
- Total activity pre and post decontamination.

A Nuclear Management Partners company operated under contract to the NDA

1. Top Duct Components – Characterisation Execution



- Top duct man hole covers selected for investigation.
- Metal plates - 60cm diameter, 4cm thick.
- Characterisation included:
 - Decontamination trials on test areas.
 - Comprehensive destructive analysis of surface scrapings.
 - Depth profiling of metal (activation and tritiation assessment).

A Nuclear Management Partners company operated under contract to the NDA

1. Top Duct Components – Characterisation Execution

Decontamination trials

- Chemical agent, wire brushing and grit blasting trialled.
- Grit blasting removed all surface contamination.

Surface Contamination assessment

- Average of approximately 150Bq/cm² of activity detected.
- Fingerprint consisted of activation products (dominated by Fe-55 (59%), Co-60 (29%), Ni-63 (7%) and H-3 (4%)).

Depth Profiling

- Metal cored from outer (non contaminated) side.
- One partial core and one full core.
- No evidence of activation.
- Tritium found in bulk metal up to 5 Bq/g.

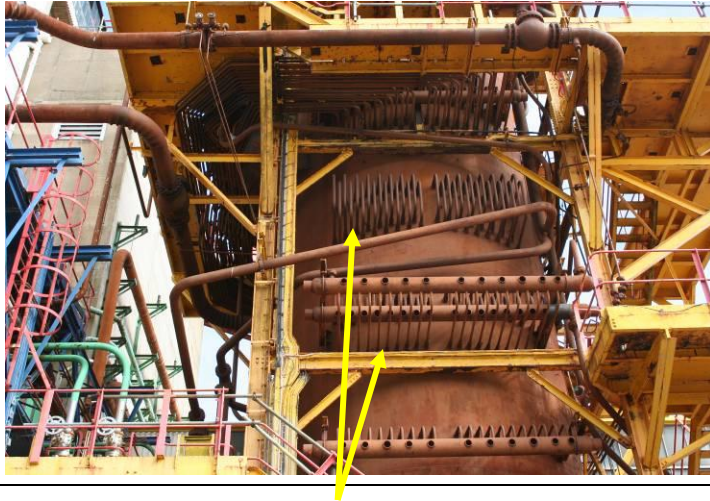
A Nuclear Management Partners company operated under contract to the NDA

1. Top Duct Components – Sentencing Decision

- All metal classified as Low Level Waste.
- Material treated by supply chain through Low Level Waste Repository (LLWR) Segregated Services contract.
- Characterisation data used to model components and infer total activity from radiation readings.

A Nuclear Management Partners company operated under contract to the NDA

2. Steam System Pipework - Background



Banks of small bore pipework



Steam drum

- Pipework exiting heat exchangers and linking to turbine halls.
- High and Low pressure systems.
- Approximately 60 te per heat exchanger.

A Nuclear Management Partners company operated under contract to the NDA

2. Steam System Pipework – Expectations & Objectives

Expectations

- Closed system with clean steam under normal operations.
- Historic tube leaks (reactor gas contact with steam).
- Contamination of steam unlikely due to pressure differential – but potential for H-3 due to mobility.
- Material expected to be exempt.

Objective

- Determine the average total activity concentration at the 95% upper confidence level.

A Nuclear Management Partners company operated under contract to the NDA

2. Steam System Pipework – Characterisation Execution

- If contamination present – unlikely to be significant differences throughout system.
- Header banks and steam drums targeted for sampling.
- Core samples obtained using Mag drill with coolant (over 120 cores taken to date).
- Samples analysed for gamma scan, Fe-55, Ni-63, C-14, H-3.
- Only trace levels of activity detected (C-14 and H-3).



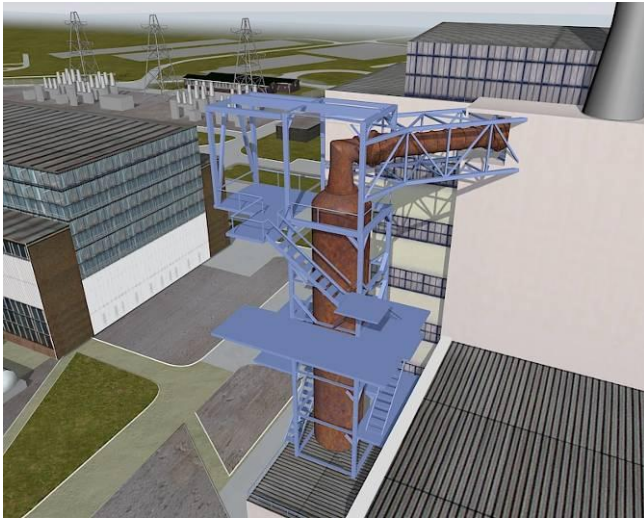
A Nuclear Management Partners company operated under contract to the NDA

2. Steam System Pipework –Sentencing Decision

- All steam system pipework associated with the heat exchangers sampled to date has been sentenced as exempt material.
- Reassurance monitoring required (no detectable activity above background).

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork - Background



- Each heat exchanger is surrounded by stairways, walkways and access platforms.
- All metal is painted with numerous layers (accumulated over 50 years).
- Approximately 60 te per heat exchanger.

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork – Expectations & Objectives

Expectations

- Paint contaminated due to atmospheric deposition (> exemption limit).
- Bare metal essentially clean (unlikely to be activated).

Objectives

- Paint total activity concentration.
- Demonstrate that the 'bare' metal is not activated.
- Paint + metal total activity concentration.
- Calculate the dose impact for reuse and smelting of the painted metal without decontamination.

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork – Characterisation Execution

Metal

- Sections closest to reactor sampled after decontamination
- No evidence of activation.

Paint

- Scrapings taken across structures (22 multi incremental samples).
- Total activity levels up to 3.4 Bq/g (exceeds exemption limit).
- H-3 variability.
- Lognormal distribution.

Paint & Metal

- Total activity at 95% confidence level below exemption threshold.

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork – Characterisation Execution

NICoP guidance:

‘Presumption of Separation and Segregation unless justification that removal is not reasonably practicable and the expenditure is grossly disproportionate to the safety and environmental benefits gained, and the overall impact of disposal is less than 10 $\mu\text{Sv}/\text{yr}$ ’

Site Wheelabrator facility required 7 passes to fully decontaminate metal during trials.

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork – Characterisation Execution

Full decontamination of 1000te of metal using the wheelabrater would have the following issues:

- Safety
 - Significant additional handling and cutting.
- Environmental
 - Secondary waste generation (approx 6 ISO containers to LLWR)
- Cost
 - Several million pounds in processing costs.

The dose impact of not decontaminating was calculated using RP89 models. Both reuse and recycling scenarios $< 10 \mu\text{Sv/yr}$

A Nuclear Management Partners company operated under contract to the NDA

3. Painted Structural Steelwork – Sentencing Decision

- Painted structural steelwork from heat exchangers sampled, sentenced as exempt material.
- Reassurance monitoring required.
- Justification for no decontamination.
- Sellafield Ltd applying cautious approach – single pass through wheelabrator to remove flaky material.

A Nuclear Management Partners company operated under contract to the NDA

Conclusion (1)

- None of the metal characterised to date is activated.
- Metal exposed to reactor gas is surface contaminated to LLW levels (removable using a grit blasting technique).
- Metal exposed to reactor gas is tritiated to levels which exceed the SoLA exemption order limit.
- Steam system pipework contains trace levels of H-3 & C-14 (exempt levels)
- Painted structural steelwork is considered to be exempt despite activity levels in the paint exceeding the SoLA exemption order limit.

A Nuclear Management Partners company operated under contract to the NDA

Conclusion (2)

To date, comprehensive characterisation has enabled in excess of 90% of the metal to be sentenced as exempt material with no or limited treatment, enabling huge safety, environmental and cost savings to be realised.

A Nuclear Management Partners company operated under contract to the NDA