Feasibility study of decontaminating steel ducts and pipes for decommissioning nuclear facilities with Forced Pulsed Water Jetting (FPWJ)

A. Tieu [1], A, Jenkins [2], B. Daniels [1], M. Vijay [1], W. Yan [1], M. Xu [1].

1 VLN Advanced Technologies Inc.

2 Sellafield Ltd.

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Aims

- Define the objectives
- Background to FPWJ and nuclear applications
- Testing of simple geometry surfaces
- Testing of enclosed systems
- Discussion
- Conclusions

What Is (De)Contamination?

Contamination is;-

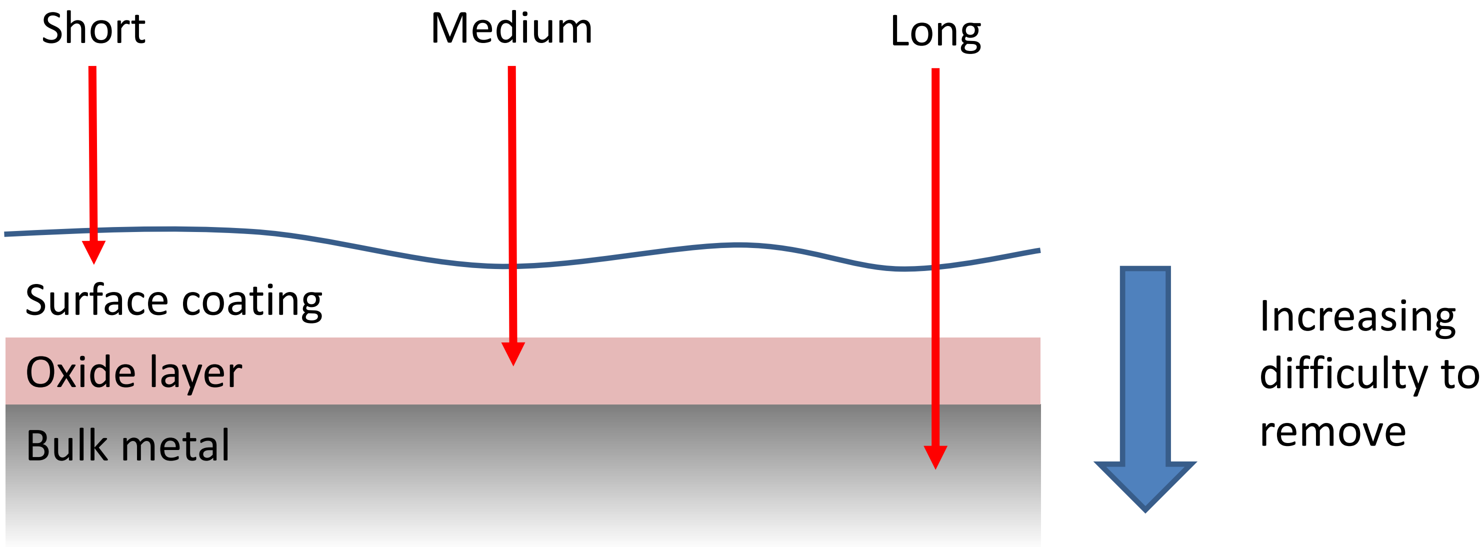
“Contamination is material where you don’t want it”

Decontamination is;-

“The mobilisation in full or in part, of contamination from a substrate for a business or safety driver”

Decontamination Of Metals

Penetration of contamination over time



Factors determining depth of penetration includes, time, concentration, temperature, solubility of species….

Typical Nuclear Facilities

- Contaminated with various ‘fission’ products
- Very low to very high contamination levels
- Complex systems
- Often inaccessible, in cells or internals of pipes
- Despite being industrial, most pipework is < 4” diameter

Potential of FPWJ

- Can control the performance factors to allow…
- More assured decontamination as its more powerful than HPWJ alone
- Waste recategorization;
  - High level wastes to Intermediate level
  - Intermediate level to low level
  - Low level to ‘clean’

FPWJ Study Scope

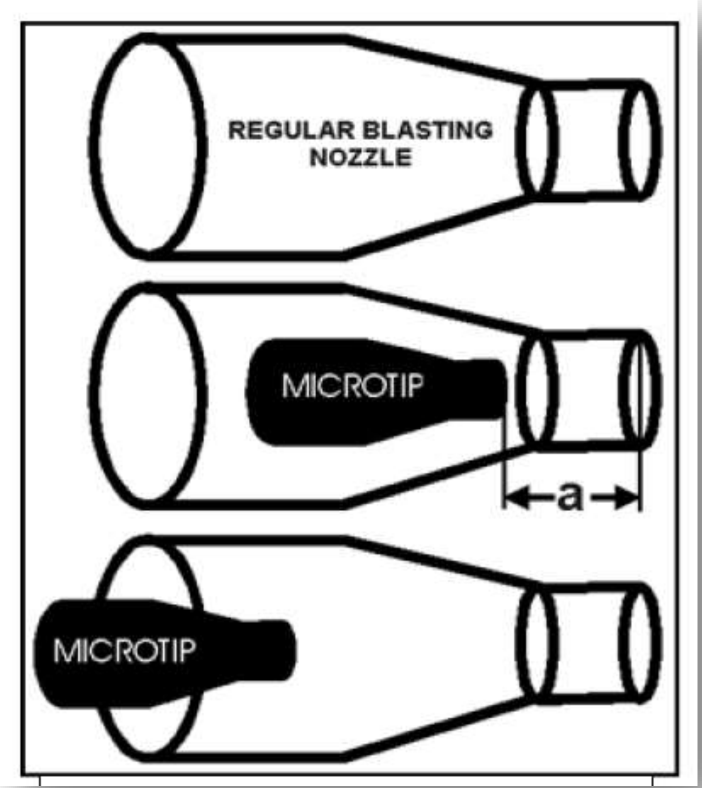
Surface Treatment

- Assessment of the process, does it work?
- Defining the material removal rates

Enclosed Systems (pipes and vessels)

- What diameters can be accommodated
- How small can it go?

Forced Pulse Fundamentals

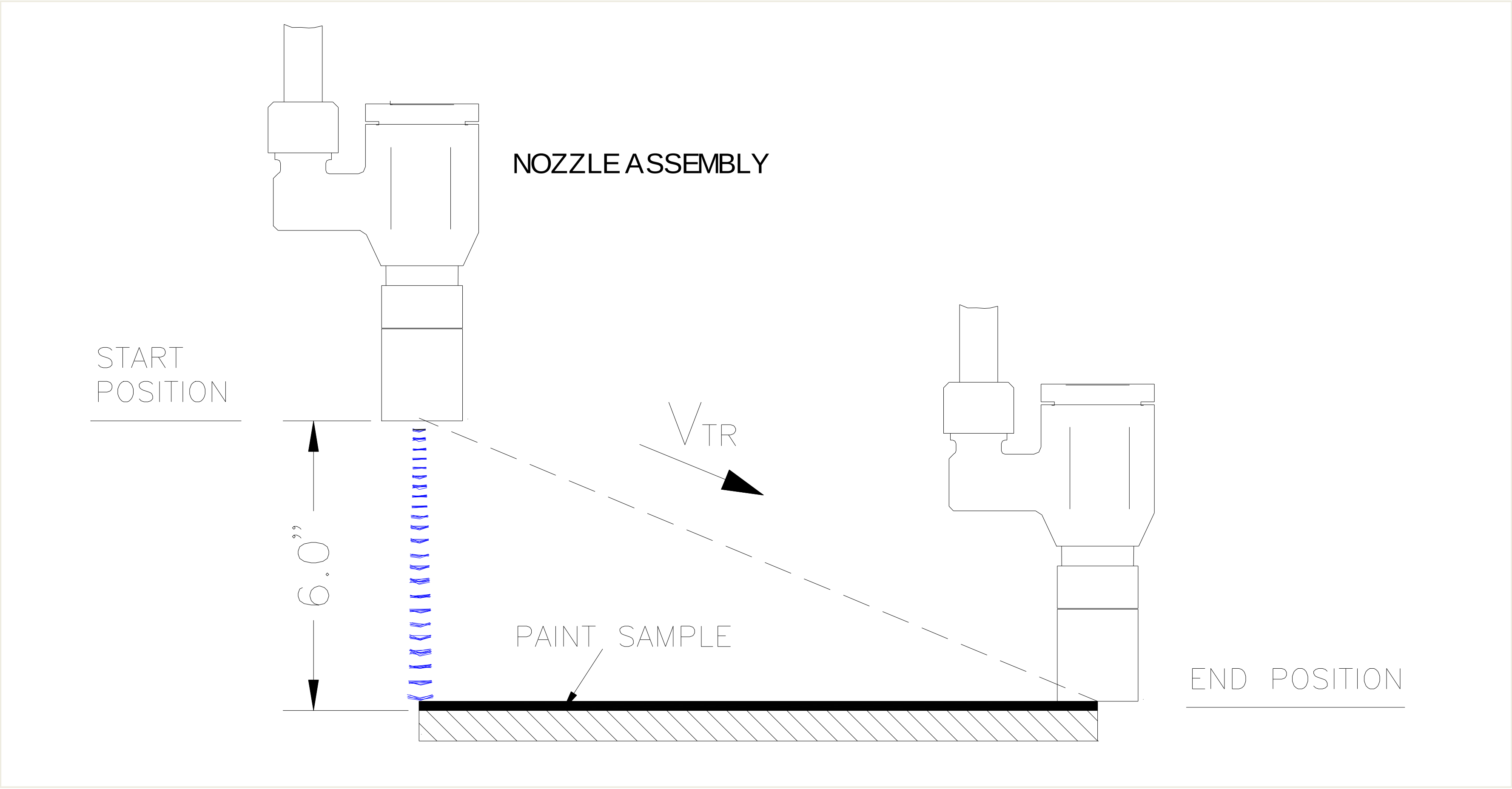


Forced Pulse Fundamentals

- Super cavitation
- Ultrasonic Frequency (~20kHz) cyclic loading to failure
- Water hammer
- High water flow rate

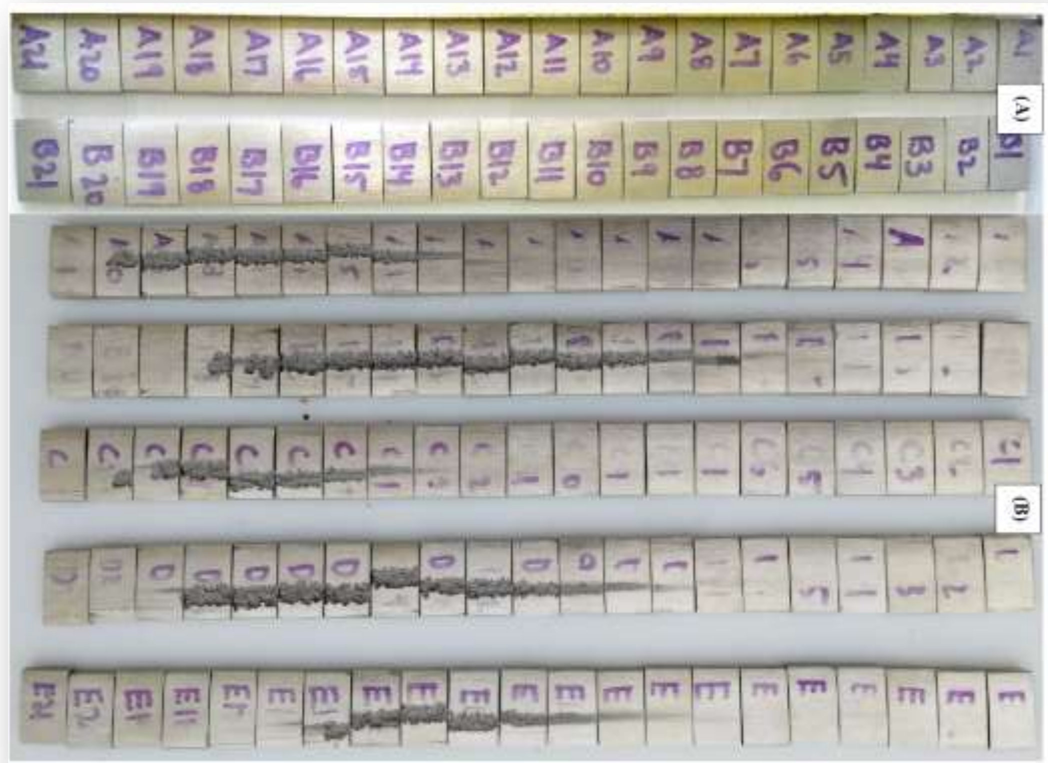
Test Environment

Drop-Testing Method



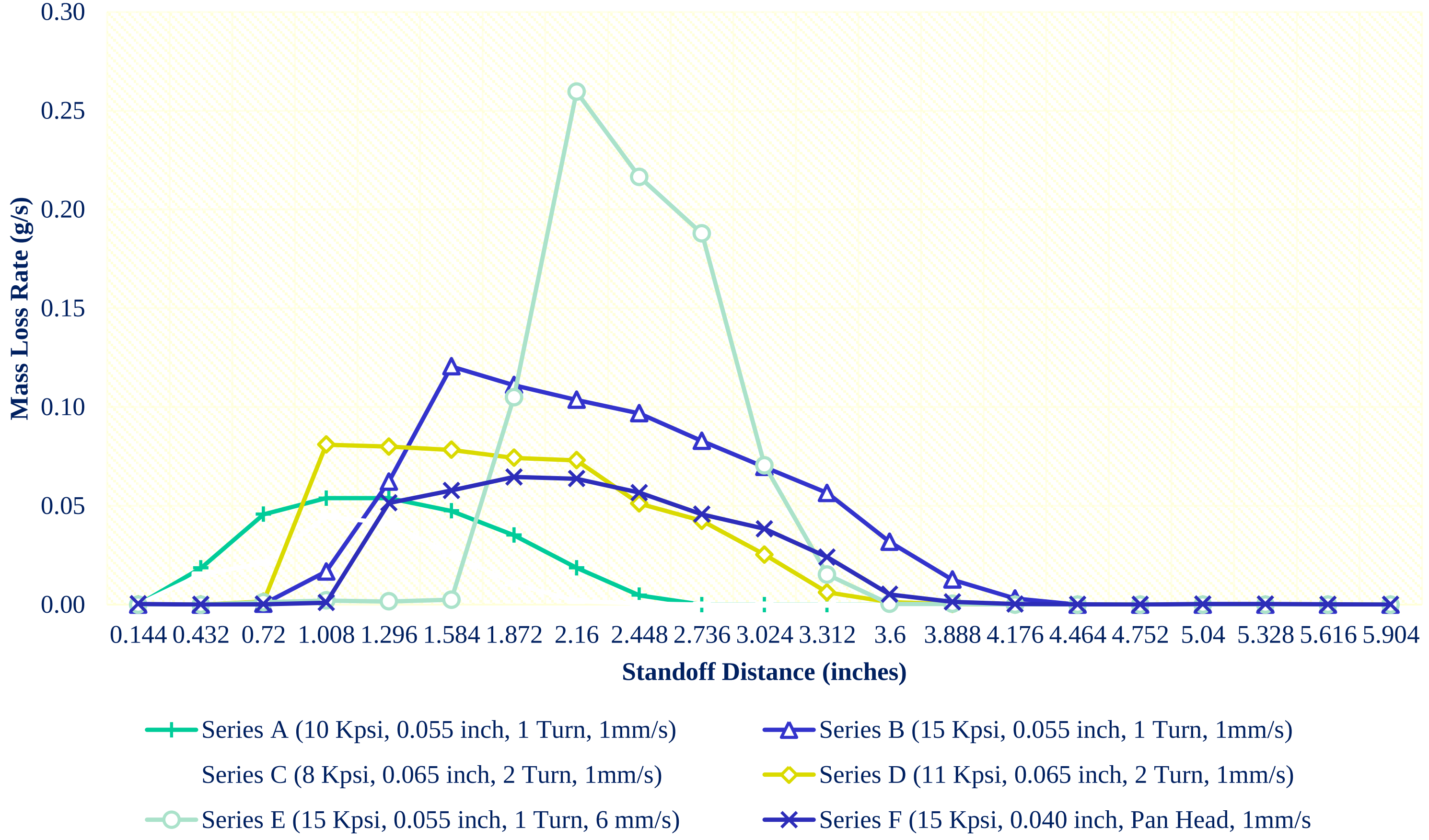
Drop Test Mass Loss Trials

- Pressure = 15kpsi
- Flow = 10 US gpm
- Power = 85 Hp
- Speed = 2.5 in/min
- Standoff = 6” to 0”
- Angle = 90 deg



Substrate: 304 Stainless Steel

Mass Loss


0.30
0.25
0.20
0.15
0.10
0.05
0.00
Mass Loss Rate (g/s)
0.144 0.432 0.72 1.008 1.296 1.584 1.872 2.16 2.448 2.736 3.024 3.312 3.6 3.888 4.176 4.464 4.752 5.04 5.328 5.616 5.904
Standoff Distance (inches)
Series A (10 Kpsi, 0.055 inch, 1 Turn, 1mm/s)
Series B (15 Kpsi, 0.055 inch, 1 Turn, 1mm/s)
Series C (8 Kpsi, 0.065 inch, 2 Turn, 1mm/s)
Series D (11 Kpsi, 0.065 inch, 2 Turn, 1mm/s)
Series E (15 Kpsi, 0.055 inch, 1 Turn, 6 mm/s)
Series F (15 Kpsi, 0.040 inch, Pan Head, 1mm/s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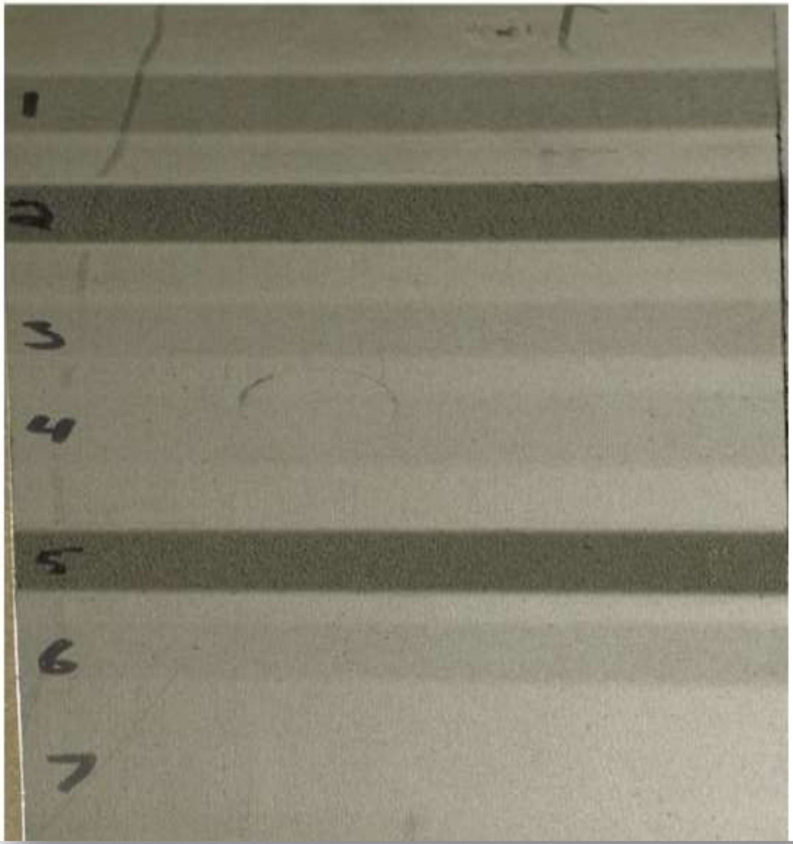
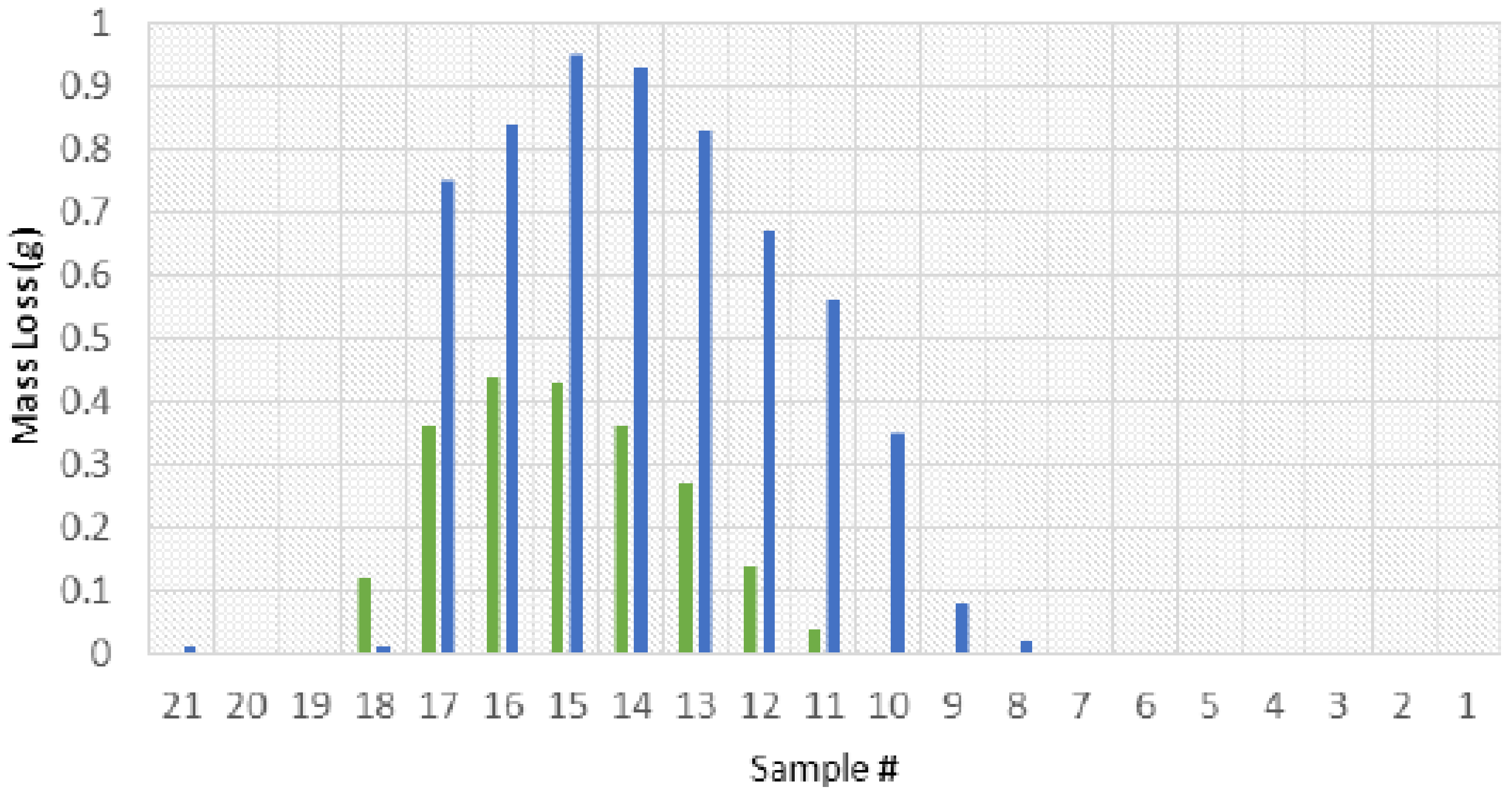
Controlled Material Removal

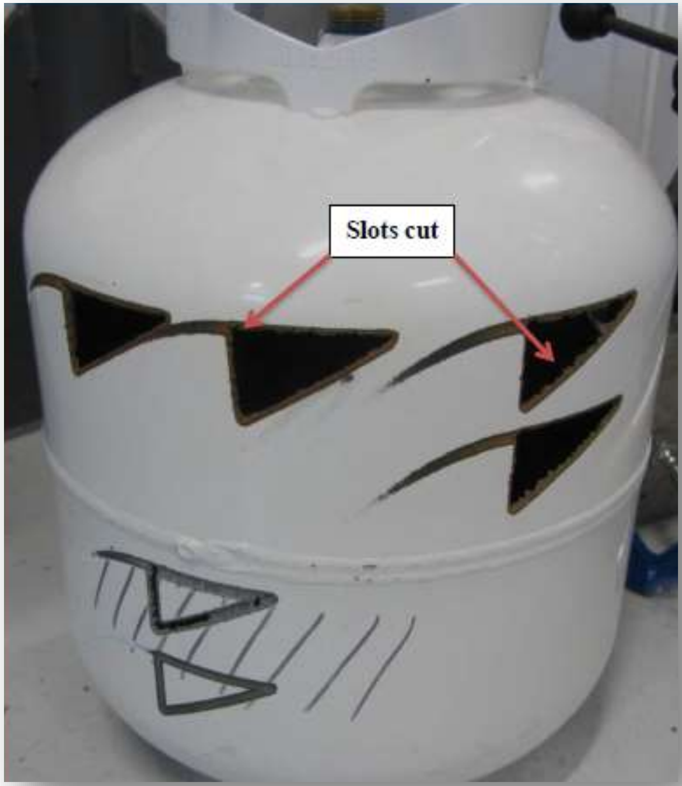


Angle of Attack Dependence



Cutting Potential

- No abrasives
- No sparks
- No heat
- No gaseous build up
- Fast rough cutting
- Cuts through thick materials



Discussion

- Demonstrated large pipe diameters can be treated aggressively
- Greater prize for smaller pipe diameters
- Large effluent volumes are accrued
- Waste recategorization possible within a plant setting with a robotic system
- Can be used to cut steel in a safe manner

Conclusions

- Effective water only tool for material removal and able to cut
- Explosion proof – no spark or heat generation
- Depth of material removal can be controlled
- Effluent is benign with trace particulate
- Automation offers safety and efficiency
- Miniaturisation offers further scope in and beyond nuclear application

THANK YOU

Alex Jenkins

alex.Jenkins@sellafieldsites.com

+44 (0)19467 74072

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