

Innovation, Sustainability and the Future of Healthcare Linen Decontamination



Sustainable Healthcare Linen Decontamination

Exploring low-temperature washing, energy reduction and innovative decontamination technologies to support safe, sustainable healthcare textile processing.



Royal Devon University Healthcare NHS Foundation Trust

Linen Decontamination Unit

With over 40 years' experience in healthcare textiles, I have seen significant changes in healthcare linen processing technology, infection prevention and sustainability.

Today, the Royal Devon University Healthcare NHS Foundation Trust (RDUH) Linen Services Department operates one of the UK's most modern in-house Linen Decontamination Units, capable of processing over 16 million textile items annually through advanced and sustainable laundry operations.

I don't have a lot of time but whenever I get an opportunity to tell others what we've been up to in the laundry healthcare sector, then I am always happy to do so.

Innovation, Sustainability and the Future of Healthcare Linen Decontamination



— EXPLORING — **LOW-TEMPERATURE WASHING** for Healthcare Textiles

CLEAN. SAFE. SUSTAINABLE. | LOWER TEMPERATURES, HIGHER STANDARDS.



40–50°C
EFFECTIVE CLEANING
LOWER IMPACT



**INFECTION
PREVENTION**
Proven hygiene
performance



SUSTAINABILITY
Lower energy use,
reduced carbon
footprint



TEXTILE CARE
Protects fabric
quality and
extends lifespan



SUPPORTING HEALTHIER OUTCOMES THROUGH SMARTER LAUNDRY



Innovation, Sustainability and the Future of Healthcare Linen Decontamination

Sustainable Linen Decontamination

Exploring low-temperature washing, energy reduction and innovative decontamination technologies.



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Legislation for Healthcare Textiles

Health Services Guidelines - HSG (95)18 (April 1995)

'Hospital Laundry Arrangements for Used and Infected Linen'.

Superseded by:

Choice Framework for Local Policy and Procedures (CFPP) 01-04 (July 2012)

Pilot initiative by the Department of Health based on (Risk) Essential Quality Requirements and Best Practice.

Superseded by:

Health Technical Memorandum (HTM) 01-04 (June 2016)

'Target' driven to 'Outcome' focused on clinical safety and patient experience being top of the agenda.

Who Makes the Rules?



(HTM) Decontamination Series

(HTM) Decontamination Series

(HTM) 01-04:

Laundry guidance manuals for the safe decontamination of linen for health and social care.

Decontamination of linen for health and social care itself is divided into four manuals.

1. Management and provision.
2. Engineering, equipment and validation.
3. Social care.
4. Guidance for linen processors implementing BS EN 14065.

<https://www.england.nhs.uk/publication/decontamination-of-linen-for-health-and-social-care-htm-01-04/>

How do we kill germs on used healthcare linen ?

We heat the textiles in our washing machines to a temperature and hold this for a length of time. This can be either:

- 71°C for at least 3 minutes
- 65°C for at least 10 minutes

This is called
THERMAL DISINFECTION

Scientists have worked out that this kills 99.999% of all germs!



We also add detergent

Detergent helps to disinfect the textiles and also removes dirt.

Once we have disinfected and cleaned our textiles, we say they have been....

Decontaminated

Testing, Validation and Verification

Testing and Validation: Testing is currently carried out using systems such as Clean-Trace Hygiene Management, alongside swabbing of key Process Control Points using Microslide dipslides to support bacterial detection. This includes testing various processing surfaces, selected textile items, and rinse water taken from different stages of the washing process. External testing and calibration of washing systems is also undertaken, with additional support from our chemical and detergent partner, Christeyns UK, to help validate both system performance and healthcare textile processing standards.

Realtime monitoring and Validation: is carried out at each stage of the washing and decontamination process ensuring that all key factors for safe decontamination are achieved and recorded in real-time.

Verification: Bio-Indicators: Verification is achieved by sending off a sample of textiles that have been processed and decontaminated through our washing systems, along with pre-loaded test membranes with increasing levels of microbial content.

Precision Analysis



Royal Devon
University Healthcare
NHS Foundation Trust



Christeyns UK Ltd
Rutland Street
Bradford
West Yorkshire
BD4 7EA

TEST CERTIFICATE Microbiological Examination of Garments

Our Ref: PAF 44865-2

Synergy: Royal D+E Powertrans: 14 Program 3 Washed with: Large Sheets
Pillowcase:2 PO No: P90386

Date Received: 15.05.26

Date Started: 15.05.26

Date Completed: 23.03.26

Sample Ref	Lab Ref	TACC@30°C cfu/25cm ²	Presumptive Coliforms cfu/25cm ²	<u>S.aureus</u> cfu/25cm ²	Pseudomonas spp cfu/25cm ²	<u>B.cereus</u> cfu/25cm ²	Yeast & Moulds cfu/25cm ²	Listeria spp /25cm ²	Salmonella spp /25cm ²
Corner	10440	<20	Absent	<10	<10	<10	<10	Absent	Absent
Corner	10441	<20	Absent	<10	<10	<10	<10	Absent	Absent
Corner	10442	<20	Absent	<10	<10	<10	<10	Absent	Absent
Corner	10443	<20	Absent	<10	<10	<10	<10	Absent	Absent
Centre	10444	<20	Absent	<10	<10	<10	<10	Absent	Absent
Centre	10445	<20	Absent	<10	<10	<10	<10	Absent	Absent
Method based on		A2/15	A2/06	A2/07	A2/11	A2/01	A2/13	A2/09	A2/10
Theoretical Limits of Detection		20cfu/25cm²	10cfu/25cm²	10cfu/25cm²	10cfu/25cm²	10cfu/25cm²	10cfu/25cm²	1cfu/25cm²	1cfu/25cm²

ND = not detected
cfu = colony forming unit

For and on behalf of
PRECISION ANALYSIS (NW) LTD

Justin Miscampbell
Microbiology Laboratory Manager

Results relate only to the items tested.
This certificate shall not be reproduced, except in full, without prior written approval by Precision Analysis NW Ltd.

Page 1 of 4

The first is a destructive test called Precision Analysis. This requires a sample of linen, that has been through the LDU's decontamination process, to be sent to an independent laboratory for testing, where they identify the level of contamination, (including but not limited to S.aureus, Pseudomonas spp, B.cereus, Listeria spp and Salmonella spp). The LDU's test results have so far shown that we are below the recommended bacterial coliform forming units (cfu) 'Theoretical Limits of Detection' for all sample references.

Results DES-infection CONTROLLER



Cleaning Consultancy Delft bv.
Industrieweg 12-5
NL-5262 GJ Vught The Netherlands
Phone : +31 15 2156676
IBAN : NL07ABNA0550105379
BIC : ABNANL2A
VAT : NL009329329.B01
www.ccd.eu / info@ccd.eu

Our ref. : 259379.DES
Your ref. : Royal Devon & Exeter
Date : 26-05-2026

Christeys UK
Mrs. A. Hunter
Barnard Road, Gate 3
Off Rutland street
GB-BD4 7EA BRADFORD, WEST YORKSHIRE
UNITED KINGDOM

RESULTS DES-infection CONTROLLER		KT3-7
Testorganism :	<i>Enterococcus faecium</i>	Serialnumber : 259379
Process information		
Testdate :	20-04-2026	
Machine :	16 STAGE	
Formula :	03	
RESULTS FOR EACH STARTVALUE [cfu/cm ²]		
10 ⁵	10 ⁶	10 ⁷
☒	☒	☒
DEGREE OF REDUCTION: 10 ⁷		
Remarks:		

DES-controller: this product is intended for testing the degree of microbiological reduction of a process.

The results are only reliable if the user has acted according to the instructions, especially in regard to the limited usability. The DES-controller consists of test organisms which have been placed on standardised swatches. These swatches have been packed in a semi-permeable membrane, as a result of which the micro-organisms can be reached by water and chemicals, but cannot be rinsed off. The analysis determines which level of bacteria have been killed.

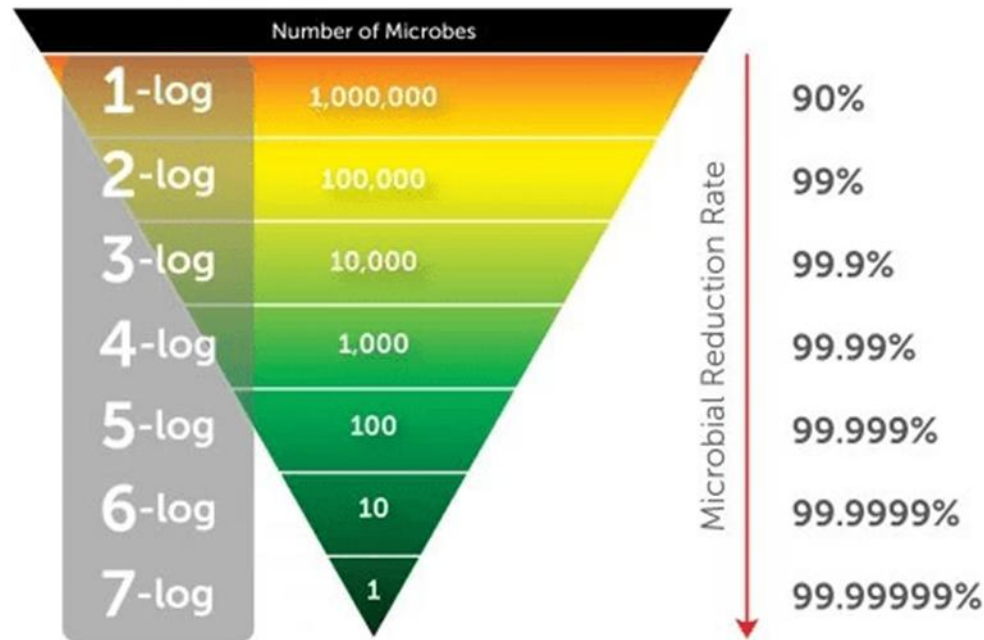
Objective: for a process where germ reduction is needed, like e.g. industrial laundry processes for hospitals or the food-industry a required degree of reduction of 10⁶ is necessary.



Registered at Chamber of Commerce, no. 272.31.287
Terms of delivery deposited at Chamber of Commerce Haaglanden, no. 804

The second is a DES-infection Controller, and is intended for testing the degree of microbiological reduction of a process. This test involves passing swatches of fabric, containing a test-organism, through the decontamination process. Each of the swatches have been pre-packed in a semi-permeable membrane which allows the test-organism to be reached by water and chemicals, but not to be rinsed off. The start values for the level of microbial content on each swatch are increasing at 10⁵, 10⁶ and 10⁷ cfu/cm². After the process, the swatches are sent back to the independent laboratory to determine which level of bacteria have been killed. The objective for germ reduction in industrial laundry processes for hospitals, or the food-industry is 10⁶. The LDU's test results have so far shown that we have a minimum kill log of 10⁷ or over.

Eliminating Bacteria on Different Surface Types



CHANGE IS INEVITABLE AT SOME POINT, RIGHT?

71°C+
HIGH TEMPERATURE PROCESSING

- HIGHER ENERGY CONSUMPTION
- MORE WATER USAGE
- HIGHER CARBON EMISSIONS

40-60°C
LOW TEMPERATURE INNOVATION

- LOWER ENERGY CONSUMPTION
- WATER SAVINGS
- LOWER CARBON FOOTPRINT

LOWER TEMPERATURES. SAME STANDARDS. GREATER SUSTAINABILITY.

MAINTAINING STANDARDS.	PROTECTING PATIENTS.	REDUCING ENVIRONMENTAL IMPACT.
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SAFE, CLEAN HEALTHCARE TEXTILES	SUPPORTING PATIENT SAFETY	EXTENDING TEXTILE LIFE	SUPPORTING NHS NET ZERO GOALS	OPERATIONAL EFFICIENCY	A SUSTAINABLE FUTURE FOR HEALTHCARE
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INNOVATION | EVIDENCE | SAFETY | SUSTAINABILITY

NHS

Low-Temperature Processing Trials: In partnership with Christeyns UK, we are exploring lower-temperature laundering processes to reduce energy consumption and carbon emissions while maintaining compliance with HTM 01-04 standards and proven decontamination performance.

We will have to consider consulting with Infection Control and Prevention Teams, Microbiologists, The Textile Association (TSA) and most importantly NHS England the Governing Body of the current Healthcare Technical Memorandum HTM 01-04 Standards and Guidance.

NEXT STEPS.....

What are the benefits of Low Temperature Washing of Healthcare Textiles

Transitioning away from traditional high-temperature thermal disinfection (e.g., 65°C to 75+°C) using advanced detergents and potential alternative sanitisation methods which will hopefully provide the following benefits:

Extended Textile Lifespan: High-temperature processing can weaken and shrink both cotton and synthetic-blend textiles, accelerating fabric degradation, increasing fibre shedding, and reducing the service life of bed linen textiles typically used in hospitals. Lower-temperature laundering helps preserve textile integrity, extends product lifespan, reduces replacement costs, and minimises microfibre release into the environment.

Carbon and Cost Savings: Water heating is one of the largest energy demands in healthcare laundry operations. By adopting low-temperature washing and decontamination processes, healthcare laundries can significantly reduce energy consumption, lower carbon emissions, and decrease utility costs. For organisations such as the NHS, this supports both sustainability goals and financial savings. However, the full laundering process must be considered. While lower wash temperatures reduce energy use, some textiles, such as thermal blankets and bath towels, still require effective drying. If wash temperatures are reduced too far, longer drying times may offset some of the savings. The key is to identify an optimum low-temperature “sweet spot” that maintains decontamination standards and textile quality while delivering the greatest overall reduction in energy consumption, carbon emissions, and operational costs.

What are the benefits of Low Temperature Washing of Healthcare Textiles Cont.....

Minimises Shrinkage and Colour Fading: Lower-temperature laundering helps preserve dimensional stability and colour-coded textile systems, reducing shrinkage and colour loss over time. Gentler wash conditions protect bed linen, staff uniforms, patient gowns, and nightwear from thermal shock, helping to maintain fabric quality and appearance. This can also improve processing efficiency during the finishing stages, resulting in better presentation, extended textile life, and reduced replacement costs.

Limits Wastewater Contamination: Lower-temperature washing reduces the physical stress placed on synthetic textiles, helping to minimise fibre damage and the release of microscopic plastic particles during laundering. This can reduce the amount of microplastics entering wastewater systems, supporting environmental sustainability and helping to protect aquatic ecosystems and food chains. Combined with extended textile life, lower-temperature processing can contribute to a more responsible and sustainable healthcare laundry operation.

THE PLAN

We propose to establish a controlled testing zone using a single dedicated washing system for research and evaluation purposes only. The testing environment will mirror our existing operation, incorporating the same real-time monitoring factors, controls, and validation procedures used in day-to-day healthcare linen decontamination.

Christeyns UK will work closely with us to design an appropriate wash and decontamination programme, utilising the correct balance of water, advanced detergents, and chemical sanitisation to ensure effective and safe textile decontamination. The objective will be to test a range of time and temperature combinations to determine whether the required decontamination standards can be achieved at lower temperatures.

Following each testing phase, textiles will undergo both in-house and independent external laboratory analysis, using the same verification methods currently employed within our service. Importantly, no healthcare linen processed during the testing programme will be used or distributed. All test textiles will be reprocessed through our existing validated decontamination systems before being released back into use.

THE PLAN CONT.....

Should a successful lower-temperature formula be identified, we would then begin engaging with the relevant healthcare textile governing bodies and professional organisations to share our findings and seek their consideration and guidance.

This is by no means a quick exercise. Even if a lower-temperature process can be shown to safely decontaminate healthcare textiles, extensive validation will still be required. Any proposed programme must consistently achieve the same level of decontamination across every wash load, regardless of the varying levels of bio-burden present within returned healthcare linen. This is exactly the challenge managed today through the approved time and temperature relationships specified within current HTM guidance and standards.

We must also recognise the impact of seasonal pathogen prevalence when evaluating any alternative decontamination process.

THE PLAN CONT.....

Autumn and Winter: *Klebsiella pneumoniae*, a Gram-negative bacterium associated with severe respiratory and bloodstream infections, demonstrates higher environmental contamination rates during colder months. *Clostridioides difficile* (C. diff) also reaches peak clinical incidence during late autumn and winter, with its spores known for their resilience.

Spring: Norovirus remains highly prevalent in healthcare environments and can persist on textile surfaces, including bedding, creating additional decontamination challenges.

Summer: Certain *Bacillus* species, particularly *Bacillus cereus*, are associated with increased seasonal risk during warmer periods. Elevated temperatures and humidity can promote bacterial growth where storage or handling conditions are less than optimal. Many of you may be aware of the recent UKHSA Health Protection Briefing Note concerning a major healthcare laundry provider, where routine microbiological testing identified *Bacillus cereus* counts above accepted thresholds.

Year-Round Threats: Organisms such as Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa* remain persistent concerns throughout the year, with *P. aeruginosa* occasionally showing increased prevalence during warmer conditions.



FUTURE UPDATES

However, if I am fortunate enough to be invited back in the future, I hope to be able to share with you the progress we have made and the lessons we have learned along the way.

BETTER FOR PATIENTS • BETTER FOR PLANET • BETTER FOR BUDGET



**Royal Devon
University Healthcare**
NHS Foundation Trust

REUSABLE CURTAINS

CLEAN.
DURABLE.
SUSTAINABLE.



DISPOSABLE CURTAINS

SINGLE USE.
COSTLY.
WASTEFUL.



£ 
**SMART CHOICE.
LASTING IMPACT.**

**Reusable vs Single-
Use Curtains:
Comparing Cost
and Sustainability
Impacts**

**SAVE MONEY
IN THE LONG-TERM**



REDUCE WASTE



**SUPPORT A
HEALTHIER PLANET**



REUSABLE CURTAINS

HEALTHIER CARE

GREENER FUTURE

Some Quick Background Before We Look at the Facts and Figures

The Royal Devon University Healthcare NHS Foundation Trust was established in April 2022 following the integration of the Royal Devon & Exeter NHS Foundation Trust (RD&E) and Northern Devon Healthcare NHS Trust (NDHT).

As part of the integration process, both clinical and non-clinical services reviewed and challenged existing practices to identify opportunities for improvement and standardisation.

One area that impacted both Linen Services and Domestic Services was the use and management of hospital curtains.

Historically, the larger acute RD&E site had successfully used reusable curtains for many years, whereas the Northern Devon site had adopted single-use disposable curtains.

To support an evidence-based decision, the Deputy Service Manager for Domestic Services was tasked with gathering the facts, figures, and associated costs of both options.

Some Quick Background Before We Look at the Facts and Figures. Cont.....

The review considered financial costs, operational requirements, environmental impacts, and overall value for money.

A key objective was to determine which curtain solution would best support the Trust's commitment to achieving its Net Zero ambitions.

The evaluation aimed to establish whether reusable or single-use curtains offered the most sustainable, cost-effective, and practical solution for future use across the Trust.

Assumes that each re-usable curtain has a minimum lifespan of 100 washing cycles.

Lets move on to the Facts and Figures...

The figures below are based on 1,000 Cleans

Disosable
Curtain Costs

Disposable Curtains		Waste Costs per 1,000 curtains (2 ton @ £475 per ton)										£950.00	£70,300		
Ongoing Replacement Cost per clean. Assumes 1 x privacy curtain (375cm x 200cm) and 1 Window curtain (200cm x 200cm)	Cleans 11 to 100	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	1,229.40	12,294.00			
	Clean 10	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 9	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 8	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 7	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 6	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 5	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 4	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 3	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
	Clean 2	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
Initial Purchase cost		Clean 1	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	13.66	136.60			
			SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8	SR9	SR10		Total	£14,610
Fabric Curtains															
Ongoing Laundry Cost per clean. 2 items @ £1.62 per item	Cleans 11 to 100	£291.60	£291.60	£291.60	£291.60	£291.60	£291.60	£291.60	£291.60	£291.60	£291.60	£2,916.00			
	Clean 10	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 9	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 8	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 7	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 6	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 5	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 4	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 3	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
	Clean 2	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£3.24	£32.40			
Initial Purchase cost		Clean 1	£164.57	£164.57	£164.57	£164.57	£164.57	£164.57	£164.57	£164.57	£164.57	£1,645.68			
			SR1	SR2	SR3	SR4	SR5	SR6	SR7	SR8	SR9	SR10		Total	£4,853
															£179,571.36
Disposable														Cost per 1,000 cleans	£9,757
Bay Privacy Curtain (375cm x 200cm) Hospital Blue	£5.93													Cost based on 37,000 cleans carried out in the last 12 months	£360,998.64
Window curtain (200cm x 200cm) Hospital Blue	£5.45														
VAT	£2.28														
Total	£13.66														
		Negative difference between current costs and costs associated with potentially moving to single use													£181,427.28
Fabric															
Fabric Curtain (300cm x 200cm)	£95.00														
Fabric Window Curtain	42.14														
VAT	£27.43														
Total	£164.57														

As a result of these findings, the Trust has asked us to develop a business case to support the transition of the Northern Devon sites to reusable curtains. While there will always be a requirement for a limited number of single-use curtains in specific clinical areas and for emergency situations, their use would be minimised wherever practical. This approach aims to deliver long-term cost savings, reduce waste, extend textile life, and support the Trust's sustainability objectives.

One final benefit is that many larger curtain suppliers provide both reusable and single-use curtains, and in most cases both products are fully compatible with the same curtain tracking system. This means that no additional expenditure would be required for replacing or modifying existing tracks, resulting in no further installation or set-up costs as part of any transition to reusable curtains. This provides the Trust with greater flexibility to use the most appropriate curtain type in different clinical environments while minimising the financial impact of the change.

I will leave you with these thoughts... Figures vary, but both Google and AI sources suggest there are just over 200 NHS Trusts in England, of which approximately 135 are acute trusts. Based solely on activity at the Royal Devon and Exeter Hospital site within RDUH, we carry out around 37,000 curtain cleans each year. Assuming two curtains are used per clean, that equates to approximately 74,000 curtains annually for just one acute hospital site.

If this figure were replicated across England's acute trusts, it would result in an estimated 9.99 million, almost 10 million, curtains being disposed of every year. The vast majority of these would either be incinerated or treated as offensive waste and sent to landfill, depending on each Trust's own waste stream guidelines, highlighting the significant environmental impact and the scale of the opportunity for more sustainable reusable alternatives.

If even a proportion of these curtains could be replaced with reusable alternatives, the potential reduction in waste, carbon emissions and long-term costs across the NHS would be substantial. From our own experience, making the switch may not be as difficult or complex as many organisations might initially think.



Thank you for listening. Any questions?

John Herbert – RDUH, Linen Services General Manager (GM)

For any further information or assistance, I can be contacted by email:

johnherbert@nhs.net