Centre for Sustainable Delivery

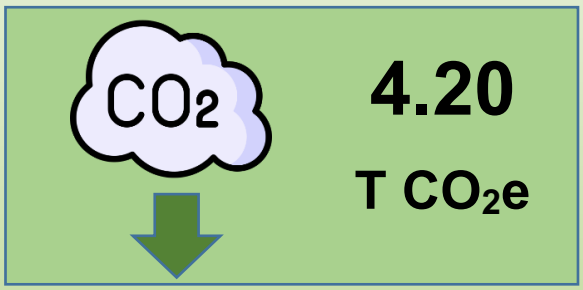
NHS SCOTLAND

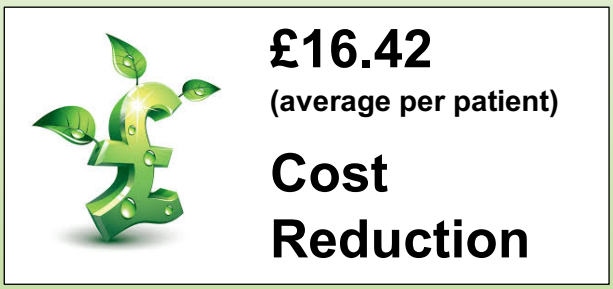
National Green Theatres Programme

Pròg̀ram Nàiseanta Lannsaireachd Uaine

Reducing the environmental footprint of fluorinated gases in vitreoretinal surgery: transitioning from single-dose to multi-dose canisters

March 2026





1. Description of action

1.1 It is the intention of this opportunity for change to highlight a single action that will lessen the environmental impact of delivering vitreoretinal services in NHS Scotland. Clinical teams should consider switching from single-dose to multi-dose canisters for fluorinated gases used in vitreoretinal surgery.

2. Background

2.1 In the previous 12 months (June 2024 – June 2025) clinical teams across NHS Scotland performed 1,625 vitrectomies[1]. Vitreoretinal surgery is an intervention used to treat problems of the retina and vitreous within the eye[2]. Some conditions include, but are not limited to:

- Diabetic retinopathy
- Some forms of retinal detachment
- Macular hole
- Macular pucker
- An infection of the eye called endophthalmitis

2.2 A patient undergoing a vitrectomy will usually have local anaesthesia to numb the eye. The surgeon will then make a small incision into the whites of the eye to insert the instruments - at this stage there are a number of approaches that a surgeon may use to treat the eye depending on the condition or disease.

2.3 At the end of the case clinicians may elect to inject a fluorinated gas bubble into the eye to help the retina remain in the correct position, known as a tamponade.

2.4 There are 3 commonly used fluorinated gases for this purpose:

- Sulphur Hexafluoride (SF_6[3])
- Hexafluoroethane (C_2F_6)
- Perfluoropropane (C_3F_8)

2.5 Although only small volumes of these gases are used in clinical practice, they remain some of the most potent greenhouse gases. Sulphur Hexaflouride (SF_6) is a Long-lived Climate Pollutant (LLCP) with an atmospheric lifetime of 1,909 to 2,646 years, and a Global Warming Potential (GWP100) of 24,300[4]. If clinically indicated, other fluorinated gases with lower GWP100 could be considered, such as Hexafluoroethane C_2F_6 (GWP100 12,400) or Perfluoroethane C_3F_8.

(GWP100 9,290), but addressing unnecessary waste should remain a priority.

2.6 All gases serve a comparable clinical role within vitreoretinal surgery, with choice typically guided by clinical judgement and patient need.

2.7 This opportunity for change focuses on addressing the current practice of routinely using single-dose canisters where multi-dose canisters are available through local procurement routes.

2.8 Switching to multi-dose canisters would:

- Reduce unnecessary wastage of fluorinated gases, thereby lowering associated greenhouse gas emissions
- Reduce the volume of aluminium canisters entering Scottish waste streams
- Deliver financial savings to vitreoretinal departments

2.9 From data submitted by health boards across Scotland, a total of 1,772 single-dose canisters were ordered over a 12-month period, with canister sizes ranging from 15ml to 50ml. For a health board breakdown, please see Table 1 and 1.1 within the Appendix.

2.10 On average, clinicians use approximately 10ml of gas per case. This results in:

- Around 30% wastage in a 15ml canister
- Around 66% wastage in a 30 ml canister
- Around 80% wastage in a 50 ml canister

2.11 Overall, this equates to 41,035ml of fluorinated gas being unnecessarily expelled into the atmosphere each year. This avoidable waste contributes approximately 4.07 tonnes of CO_2e emissions annually (see Table 2).

2.12 To mitigate against this practice, multi-dose canisters are available from suppliers. These canisters incorporate an in-line filter and shut-off mechanism that allows gas delivery to be stopped precisely once the required dose has been administered, preventing unnecessary release of residual gas.

2.13 The use of multi-dose canisters has been embedded within NHS Highland for several years, demonstrating that this approach is feasible and safe in routine clinical practice.

2.14 In addition to reducing fluorinated gas emissions, there is a clear co-benefit in reducing the quantity of aluminium waste generated. Moving from single-dose to multi-dose canisters would avoid just under 14.65kg of aluminium waste annually, equating to a further ~ 0.13 tonnes of CO_2e savings (Table 3).

2.15 By switching from single-dose to multi-dose canisters, there is the potential to reduce the carbon footprint of vitreoretinal services in NHS Scotland by approximately 4.2 tonnes of CO_2e annually. This includes:

- ~ 4.07 tonnes from reduced fluorinated gas wastage
- ~ 0.13 tonnes from reduced aluminium canister procurement and disposal

2.16 Climate change is widely recognised as one of the most significant challenges facing humanity. While systemic action is essential, targeted changes to local clinical practice can make a meaningful contribution to reducing the environmental impact of healthcare delivery.

3. Who needs to be involved in this change locally?

- Vitreoretinal surgeons – to support and lead the change in practice.
- Theatre nurses – to implement the use of multi-dose canisters in day-to-day practice.
- Prevention and Control of Infection teams – to review and approve the use of multi-dose canisters and ensure any infection risks are mitigated.
- Procurement teams – to support changes to ordering patterns and ensure appropriate products are available locally.
- Waste Mangers - to review current practice of canister disposal.

4. Boundaries

4.1 The table below identifies the boundaries for this action:

In scope	Out of scope
• All vitreoretinal services within NHS Scotland.	• Changes to clinical indications for gas selection.

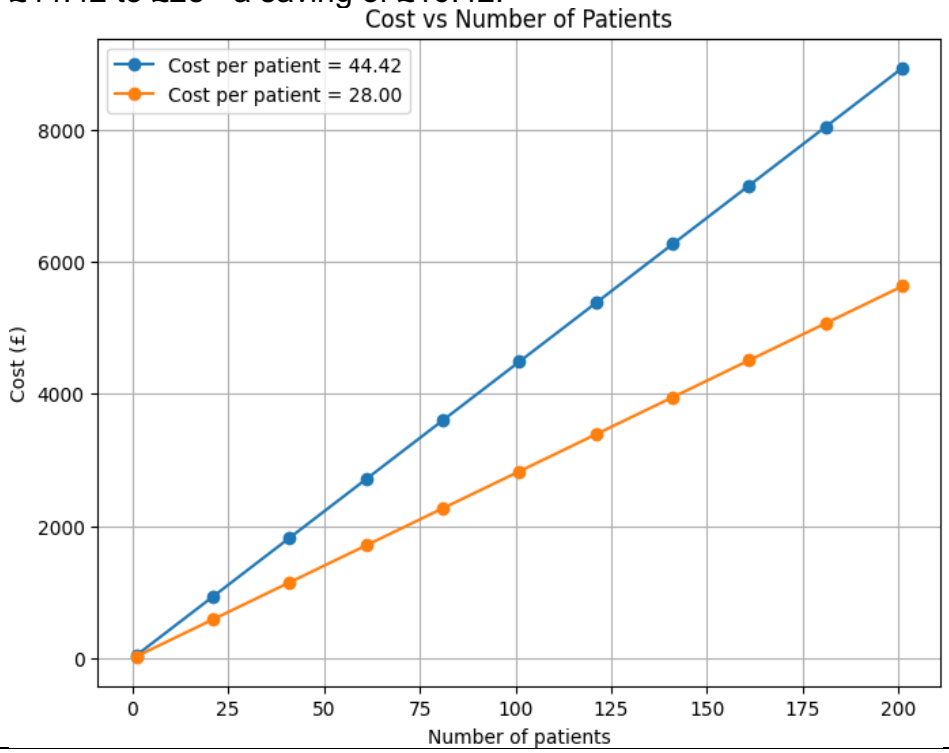
5. What is the change and how will it be implemented?

5.1 This action focuses on a single change in practice: switching from single-dose to multi-dose canisters for fluorinated gases used in vitreoretinal surgery.

5.2 Implementation will be:

- Clinician-led, with support from theatre nursing staff
- Coordinated with local procurement teams to update ordering arrangements
- Reviewed by Prevention and Control of Infection teams to ensure any risks are appropriately managed

6. What are the potential co-benefits of this change?

Outcome	Potential Benefits
Carbon reductions	**4.21 tonnes of Co2e annually**
Financial savings	Taking NHS Greater Glasgow and Clyde as an example, the following graph shows their current use of SF6 (30ml) single use canisters. The opportunity for change to multi-dose is shown alongside, and change would reduce the cost per patient from £44.42 to £28 - a saving of £16.42. 
Staff experience	Clinical staff would be required to follow manufactures instructions for multiple dose use.

7. Risks and Issues

Description of risk or issue	Mitigation / Action Plan
A risk that there is no uptake of the recommendations.	This paper will be shared with vitreoretinal clinicians and distributed via National Green Theatres Programme (NGTP) governance channels.
A risk that local Prevention and Control of Infection colleagues do not approve for local implementation.	Engage with local IPC colleagues prior to implementing to identify and manage any risks. Ensure that users are following manufacturers instructions for use.

8. Implementation Guidance

8.1 The opportunity for change highlights the importance of implementing this action. This change will help your site and NHS Scotland achieve net zero emissions by 2040 as stated in NHS Scotland's Climate Emergency and Sustainability Strategy 2022-2026.

8.2 If you require any further information or guidance, please contact the National Green Theatres programme team at: cfsdghs@nhs.scot.

8.3 The following tables display the current practice of single use and highlights the potential cost savings with the change to multi-dose canister in treatment by Health Boards.

Glasgow					
Gas type	Total number of patients treated with single use canister	Total cost of single use canisters (£)	The number of multi-dose canisters it would take to treat the same number of patients in column 2	Total cost of multi-dose canisters used instead of single use canister(£)	Total potential cost saving if adopted multi-dose canisters (£)
SF6	201	8928.42	67	3300.42	5628.00
C2F6	325	16129.75	108	7029.75	9100.00
C2F6	67	no change	no change	no change	no change
C3F8	49	2342.69	16	970.69	1372.00
				Total	**£16,100.00**

Ayr					
Gas type	Total number of patients treated with single use canister	Total cost of single use canisters (£)	The number of multi-dose canisters it would take to treat the same number of patients in column 2	Total cost of multi-dose canisters used instead of single use canister(£)	Total potential cost saving if adopted multi-dose canisters(£)
C2F6	126	6253.38	42	2725.38	3528.00
C2F6	0	no change	no change	no change	no change
C3F8	6	286.86	2	136.70	150.16
				Total	**£3678.16**

Edinburgh					
Gas type	Total number of patients treated with single use canister	Total cost of single use canisters (£)	The number of multi-dose canisters it would take to treat the same number of patients in column 2	Total cost of multi-dose canisters used instead of single use canister (£)	Total potential cost saving if adopted multi-dose canisters (£)
SF6	126	5596.92	42	2068.92	3528.00
C2F6	310	15385.30	103	9924.13	5461.17
C3F8	84	4016.04	28	1913.80	2102.24
				Total (£)	**£11091.41**

(Dundee price details will be present before publishing)

Dundee					
Gas type	Total number of patients treated with single use canister	Total cost of single use canisters (£)	The number of multi-dose canisters it would take to treat the same number of patients in column 2	Total cost of multi-dose canisters used instead of single use canister (£)	Total potential cost saving if adopted multi-dose canisters (£)
SF6	41	0	8	0	
C2F6	228	0	46	0	
C3F8	62	0	12	0	
				Total (£)	**0.00**

Aberdeen					
Gas type	Total number of patients treated with single use canister	Total cost of single use canisters (£)	The number of multi-dose canisters it would take to treat the same number of patients in column 2	Total cost of multi-dose canisters used instead of single use canister (£)	Total potential cost saving if adopted multi-dose canisters (£)
SF6	127	5641.34	42	2085.34	3556.00
C2F6	228	11315.64	76	7299.04	4016.60
C3F8	62	2964.22	21	1412.57	1551.65
				Total (£)	**£9,124.25**

9. Appendix

Table 1: Canister sizes – national ordering figures from each supplier

Supplier	SF6 (30ml)	BVI C2F6 (30ml)	BVI C3F8 (30ml)	Altomed C2F6 (15ml)	MISS Opthalmics SF6 (50ml)	MISS Opthalmics C2F6 (50ml)	MISS Opthalmics C3F8 (50ml)
Glasgow	201	325	49	67			
Ayr		126	6	2			
Edinburgh	126	310	84				
Dundee					41	228	62
Aberdeen	127	14	4				
Inverness	multi-dose	multi-dose	multi-dose	multi-dose	multi-dose	multi-dose	multi-dose
Total	454	775	143	69	41	228	62

Table 1.1: List of Hospital sites

Glasgow: Gartnavel Hospital	Dundee: Ninewells Hospital
Ayr: University Hospital Ayr	Aberdeen: Aberdeen Royal Infirmary
Edinburgh: St John's Hospital	Inverness: Raigmore Hospital

Table 2: Millilitres ordered vs wasted based on current practice: Carbon savings by moving to multi-dose canisters and avoiding the unspent gas being expelled.

	Total ml's ordered	Volume of unspent gas from single use (ml)*1	Co2 eq. per ml	Co2 saved (kg's)
Altomed C2F6 (15ml)	1035	345	0.076	26.22
Sub Total		**as above**		
BVI SF6 (30ml)	13620	9,080	0.164	1489.12
BVI C2F6 (30ml)	23250	15,500	0.076	1178
BVI C3F8 (30ml)	4290	2,860	0.078	223.08
Sub Total	**41,160**	**27,440**		
MISS Opthalmics SF6 (50ml)	2050	1,650	0.164	270.6
MISS Opthalmics C2F6 (50ml)	11400	9,120	0.076	693.12
MISS Opthalmics C3F8 (50ml)	3100	2,480	0.078	193.44
Sub Total	**16550**	**13250**		
	58745	41,035	kg's	**4074**
			Tonnes	**4.07**

***1 This table shows the calculation breakdown of unspent gas from single use**

	Total number of canisters	Total volume	Total volume used to treat patient	Patients treated	Unspent gas (ml)
15ml	69	1035	690	69	345*2
30ml	1372	41160	13720	1372	27440
50ml	331	16550	3310	331	13240

*2 This amount will remain unchanged as, with a patient dose ~10ml, the 15ml cannot be used for multiple patients.

This table compares one single use canister of each size compared to multi-dose showing the increase in patient numbers and reduction of unspent gas

	Single use canister			Multi- dose canister		
	Volume used per patient	Patients treated	Unspent gas (ml)	Volume used per patient	Patients treated	Unspent gas (ml)
15ml	10	1	5	10	1	5
30ml	10	1	20	10	3	0
50ml	10	1	40	10	5	0
Totals		**3**	**65**		**9**	**5**

Table 3: Reduction in aluminium and associated Co2e emissions

Scotland Orders of single dose canisters	BVI SF6 (30ml)	M.I.S.S Opth SF6 (50ml)	BVI C2F6 (30ml)	M.I.S.S Opth C2F6 (50ml)	BVI C3F8 (30ml)	M.I.S.S Opth C3F8 (50ml)	Total
No. of canisters	454	41	775	228	143	62	1703
Reduction in required canisters	**303**	**33**	**517**	**182**	**95**	**50**	**1180**
Weight per canister (g)	10.8	18	10.8	18	10.8	18	
Total weight saved (g)	3272.4	594	5583.6	3276	1026	900	14838.3
Total weight saved (kg)	3.2724	0.594	5.5836	3.276	1.03	0.9	14.64
Total weight saved (tonnes)	0.003	0.001	0.006	0.003	0.001026	0.0009	0.015
GHG conversion factor (kg/Co2e)*	9.11	9.11	9.11	9.11	9.11	9.11	
KG/Co2e saved	29.81	5.41	50.87	29.84	9.35	8.20	133.48
Tonnes/Co2e saved	0.030	0.005	0.051	0.030	0.009	0.008	0.133

Assuming that the weight per canister is directly proportional to the known figure of 27g for a 75ml canister. (M.I.S.S Opthalmics Ltd 3 Ryder Court, Saxon Way East, Corby, Northamptonshire NN18 9NX. UK Registered No: 5243460 England and Wales, email received 21 May 2025)

Formula:

$$\frac{Known\ Weight}{Known\ volume} \times Canister\ Volume\ (ml) = Canister\ weight\ (g)$$

Canister Volume (ml)	Canister Weight (g)
75ml	27g
1ml	0.36g
15ml	5.4 g
30ml	10.8g
50ml	18 g

10. References

[1] Public Health Scotland – Discovery data [Accessed July 2024]
[2] What Is Vitrectomy (2019). What Is Vitrectomy? [online] American Academy of Ophthalmology. Available at: https://www.aao.org/eye-health/treatments/what-is-vitrectomy.
[3] GOV.UK. (n.d.). Fluorinated gases (F gases). [online] Available at: https://www.gov.uk/guidance/fluorinated-gases-f-gases
[4] Vervalcke, S *et al* (2026) Atmospheric lifetime of sulphur hexafluoride (SF_6) and five other trace gases in the BASCOE model driven by three reanalyses Available at: https://doi.org/10.5194/acp-26-391-2026