



T: 0131-244 23  
E: alifia.chakera

For action: **Chief Executives**  
**NHS Strategic Facilities Group Members**  
**Directors of Pharmacy**  
**Medical Directors**

9 May 2022

Dear Colleagues,

## **NITROUS OXIDE MITIGATION IMPLEMENTATION PLAN**

Nitrous oxide is an environmental pollutant with a long atmospheric life and is both a greenhouse gas and an ozone depleting substance. Many NHS teams within Scotland have recognised that their nitrous oxide manifold is redundant or excessive compared to actual need and are ready to decommission or reduce provision of this supply.

The Nitrous Oxide Mitigation Implementation Plan issued with this letter draws attention to how to access funding, educational and advisory resources as well as reporting frameworks. The Implementation Plan should be shared widely and tabled for discussion at your next Health Board's next Medical Gases and Sustainability Committee Meetings to escalate this work. Any questions or support with the Implementation Plan should be directed to [alifia.chakera@gov.scot](mailto:alifia.chakera@gov.scot).

The Implementation Plan issued with this letter is version 1, the first of several iterations as we begin the journey to zero emissions. The Implementation Plan and its future iterations will be published at: <https://nhssustainabilityaction.co.uk/>.

I wrote on 18 November 2021 setting out an interim protocol for the decommissioning of nitrous oxide manifold as there is a risk that the gas contained within surplus cylinders will be released to the atmosphere on return to the manufacturer. I wish to remind Health Boards to ensure that the interim protocol, available at [https://www.sehd.scot.nhs.uk/dl/DL\(2021\)41.pdf](https://www.sehd.scot.nhs.uk/dl/DL(2021)41.pdf), is followed until further notice.

I thank you for your co-operation in this matter.

Yours faithfully,

Alan Morrison  
Deputy Director for Health Infrastructure, Investment and PPE



Written by Alifia Chakera, Healthcare infrastructure and PPE Division Scottish Government

Reviewed by Caitlin Hamlett for Health Facilities Scotland(HFS) and Graeme Dunn and Ian Sandford,  
Authorising Engineers, NHS Scotland on behalf of Ian Storrar Hard Facilities Management HFS

Issued by Alan Morrison Healthcare Infrastructure and PPE Division, Scottish Government

# **NHS Scotland Nitrous Oxide Mitigation IMPLEMENTATION PLAN**

VERSION 1.0 | 26/04/2022

# Introduction

## Purpose

Nitrous oxide (Dinitrogen oxide) is a potent greenhouse gas and dominant ozone depleting substance which remains stable in the atmosphere up to 120 years (IPCC, 2013). Medical nitrous oxide conferred 28,274 tonnes in carbon equivalents in 2018/19 within NHS Scotland (NHSS). This was close to 82 % of the total anesthetic gas footprint<sup>1</sup>. It is a substance regulated by COSHH and chronic occupational exposure has been associated with B12 anaemias' (Henderson et al., 2003).

The draft NHS Scotland Climate Emergency and Sustainability Strategy 2022-2026 sets out an aim of zero emissions of nitrous oxide by 2027 as part of its ambition to achieve a net-zero emissions health care service by 2040. This will be challenging. This plan outlines opportunities to mitigate nitrous oxide emissions thus preventing environmental damage and limiting exposure risk to staff and care givers.

## Assumptions and Constraints

This implementation plan addresses how to mitigate nitrous oxide (N<sub>2</sub>O) emissions at an NHS site level. This plan is the first of several iterations that will be issued over the next 5 years as we strive to drive down emissions of this agent.

NHSS will evaluate its N<sub>2</sub>O mitigation against its 2018/19 baseline. Recent waste analysis has demonstrated that N<sub>2</sub>O loss from piped systems at NHS sites range between 83-100 percent. Early analysis of piped Entonox® systems indicate national waste is close to 40% (Chakera, 2021). Application of catalytic cracking technologies require excellent technique by patients and staff to correctly use a mask system when administering demand value Entonox®. Even with a well fitted mask seepages around the face seal are inevitable. As such a conservative estimate of N<sub>2</sub>O capture through this system is placed at 50% although we believe capture will be higher with improvements in technique. Deeper emission reduction will require continuous revision of clinical practice towards more environmentally favorable therapies and avoidance of superfluous or prolonged prescribing analgesic Entonox®.

Alternatives to cracking technology are also being explored. We will continuously test and assess new technologies and apply the most up to date knowledge across all facilities. All persons involved in the use or supply of N<sub>2</sub>O should consider how to mitigate emissions of this agent.

Comments and suggestions to improve N<sub>2</sub>O mitigation and inform future iterations of this implementation plan should be emailed to [alifa.chakera@gov.scot](mailto:alifa.chakera@gov.scot).

## Scottish national recommendations

1. Nitrous oxide piped systems should not be routinely introduced into new theatre suites.

---

<sup>1</sup> National procurement data include BOC and collation of NHS pharmacy supply extracts

2. Each Health Board that purchases nitrous oxide products must establish a multidisciplinary project group to work towards zero emissions of this agent.
  - a) Medical Gas Committees (MGCs) are accountable for the comprehensive supply and management of these agents within NHSS sites and should establish nitrous oxide mitigation working groups across all sites under their purview.
  - b) MGCs should embed monitoring of the nitrous oxide mitigation projects with their committee meetings.
  - c) Waste should be eliminated, and the leanest nitrous oxide supply should be introduced.
3. Health Boards are required to report on mitigation of this agent within their Annual Public Bodies Duties Climate Change reports.
4. Environmental monitoring of nitrous oxide is encouraged in clinical areas where there is prolonged patient usage of Entonox® and potential risk of inadequate ventilation. SG central funding is available and health boards finance teams should formalise funding requests to [beata.burkinshaw@gov.scot](mailto:beata.burkinshaw@gov.scot)
5. Catalytic cracking technology is being reviewed centrally. Health Boards with an established nitrous oxide waste mitigation protocol will be prioritised. Its application will be limited to areas where there is verified clinical evidence of Entonox® use from a demand valve.
6. Health professionals should continuously strive toward giving the most environmentally favorable anaesthetic or analgesic without compromising patient care.

## Developing Future Recommendations

*Mothers in labour frequently rely on analgesic Entonox®. Whilst catalytic cracking can reduce direct emissions of N<sub>2</sub>O it cannot completely mitigate this agent. The programme lead is keen to develop a collaborative mitigation approach working with expectant mothers, delivery suites teams and antenatal services to explore and articulate a full suite non-pharmacological and pharmacological options.*

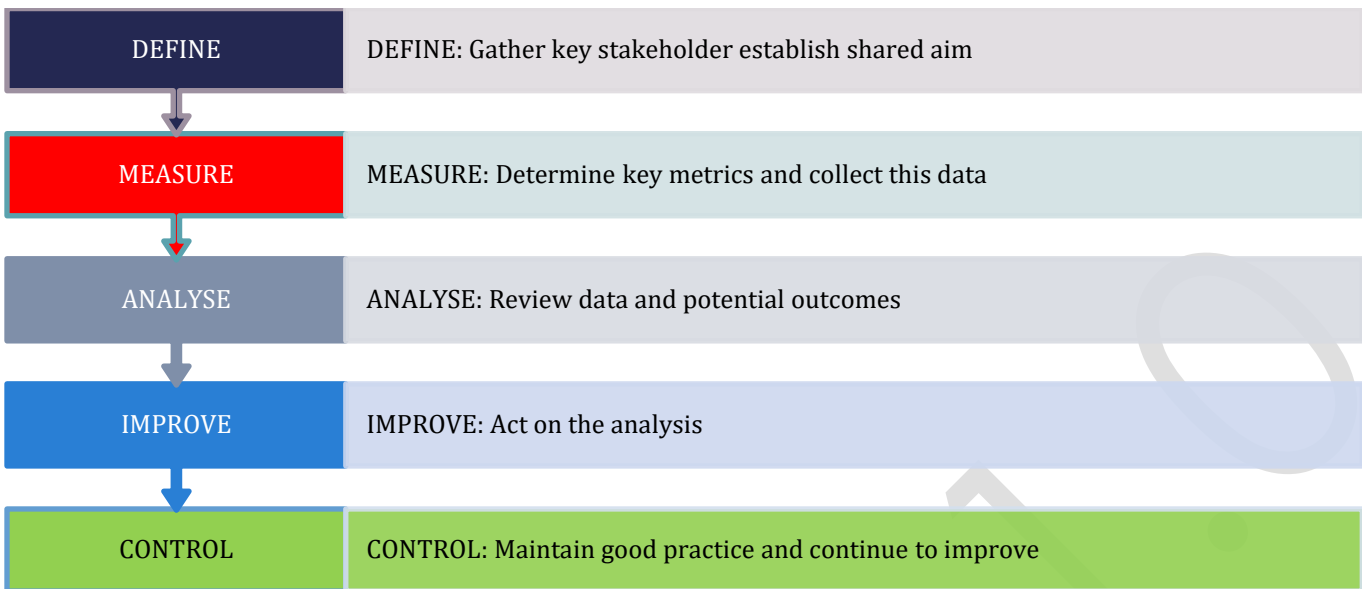
*Future recommendations may require that education and training on the environmental impact of different analgesic techniques for labour should be made available to expectant mothers and care givers by antenatal services and delivery suite teams.*

## Implementation Plan

### Overview of Implementation

*The national nitrous oxide programme promotes the use of lean six sigma DMAIC frame/cycle to implement this plan (outlined below) and advocates that all stakeholders involved in the supply and administration of this agent are engaged with mitigation efforts from the outset.*

## DMAIC



### Implementation schedule

31 May 2022

- All sites using nitrous oxide products should establish a mitigation project group

30 June 2022

- Centralised Recording Framework should be available via Environmental Management Systems

31 July - 30 September 2022

- Undertake mitigation activities
- Progress report to be delivered at National Medical Gases Pipeline Systems Advisory Group (NMGPSAG) and NHS Scotland Environmental Sustainability Group (NESG).
- Escalate system challenges and resource needs such as environmental monitoring devices.

30 September 2022

- Review next steps to drive down N<sub>2</sub>O emissions.

31 March 2022/23

- Nitrous oxide waste management processes to be included in updated version of the NHSS Sustainability Assessment Tool (NSAT)

### Engagement and recruitment

Key stakeholders

Estates and Soft facilities management

Anaesthetists and theatre staff

Delivery teams for Entonox® manifolds

Medical Physics /Clinical Engineers

QAS pharmacy services and procurement

Quality Improvement hub

Medical Gases Committee

Sustainability Leads

Patients, especially expectant mothers

## Establishing a nitrous oxide project team

- *Establish Board level project coordinator – nominated from MGC*
- *Recruit stakeholders, telegraph education date*
- *Review high-level metrics: cylinder turnover for last 12 months/operation data and share with stakeholders*
- *Establish Health Board level education event*

## Kaizen blitz /education event

- Each Board should host an education session with key stakeholders involved in the supply or use of N2O
- Utilise webinars/power point resources with QI or sustainability lead acting as facilitator
- <https://nhssustainabilityaction.co.uk/conference/nhs-scotland-sustainability-conference-2021/> \*Go to innovation in anaesthetics
- Keep each event to under an hour, share resource links
- Identify a project lead for each site and supply Entonox® and nitrous oxide
- Agree initial working parameters

## Lean implementation: DMAIC cycle 1

### Define: gather teams establish aims

- Register QI nitrous oxide project teams at each site in collaboration with medical gases committee, estates, soft facilities, pharmacy and clinical services.
- Recommend team undertake an initial process mapping session with a dedicated QI facilitator to understand different supply functions and uses of nitrous oxide product with a site.
- Tasks, roles and reporting times lines should be agreed.
- Review and agree methodology and approach

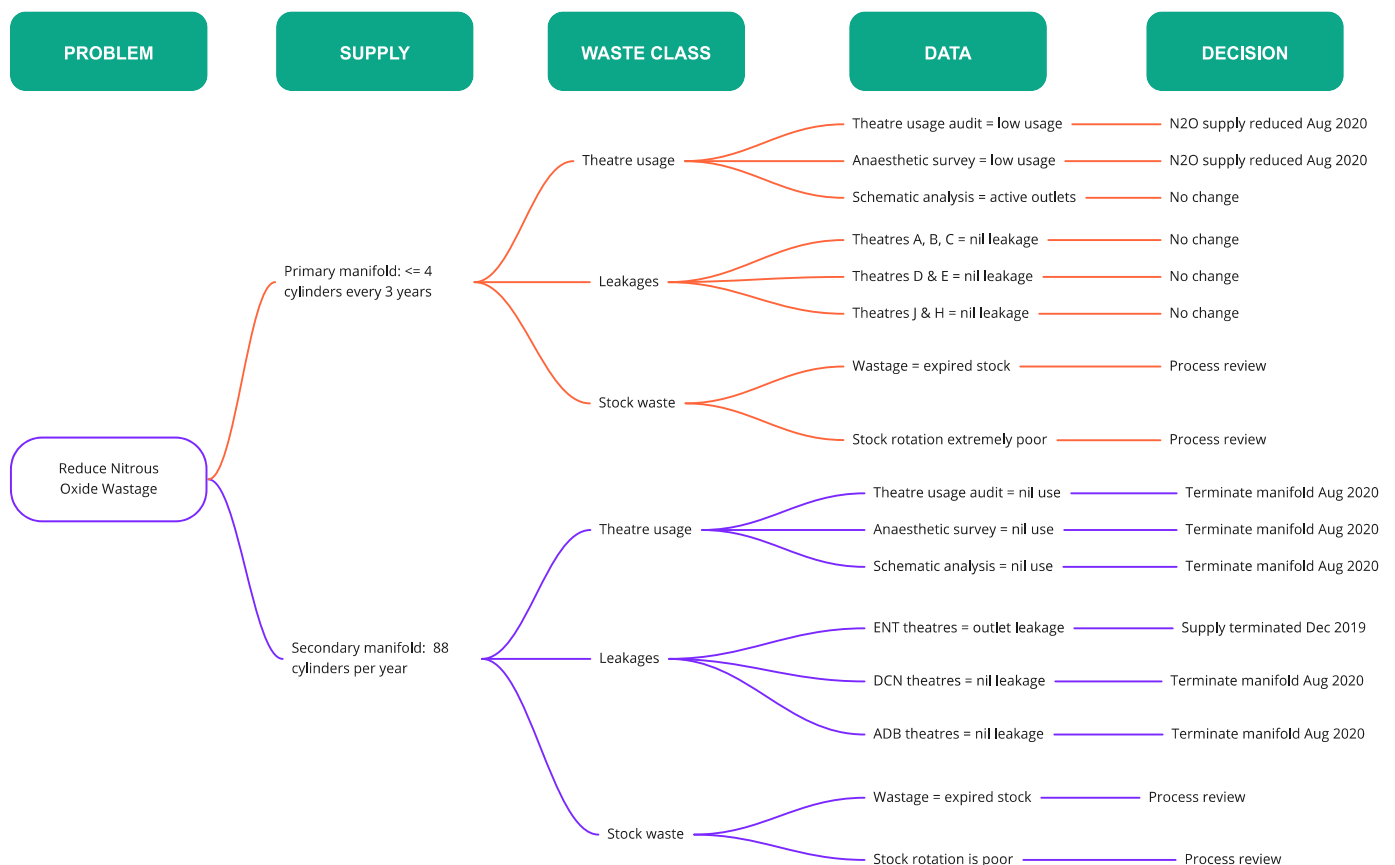
- If reviewing Entonox® supply this should be a separate project
- Determine who is collecting what metrics and co-ordination

## Measure: Quantify turnover for each manifold and quantify corresponding clinical use

- Supply and turnover of nitrous oxide products should be determined by pharmacy and facilities
- Review schematics of each N2O supply systems and corresponding outlets,
- Clinical assessment of nitrous oxide use should be undertaken by clinical stakeholders. Qualitative survey and staff interviews' often adequate. Quantitative analysis can be labour intensive but may justify type of leaner supply needed.
- Undertake an evaluation of stock management and security and review of maintenance contracts.

## Analyse: what can be determined what needs further investigation

### Decision Tree analysis exemplar



## Improve

- This will be driven by the analysis

May involve:

- Replacing degrading nitrous oxide outlets
- Removing supply from clinical areas where nitrous oxide is not used
- Terminating a manifold supply in its entirety: see interim decommissioning protocol
- Smaller portable supply/ or nearby mini manifold
- Environmental monitoring device within delivery suite
- Further investigation: Including a pressure drop test.

## Control

- At a board level nitrous oxide mitigation should be a standing item with the medical gases committee until fully mitigated.
- Process mapping may need to be repeated and should be strongly considered especially if gaps in cylinder management come to light.
- Significant challenges must be escalated to the appropriate persons.
- If zero utility of nitrous oxide is achieved at a site this concludes the project. However persistent utility of nitrous oxide will require repeated cycles of investigation and monitoring.
- Nationally this should remain a standing item for NESG and NMGPSAG

## Information Resources

### Technical documents

*Interim decommissioning protocol*

[https://www.sehd.scot.nhs.uk/dl/DL\(2021\)41.pdf](https://www.sehd.scot.nhs.uk/dl/DL(2021)41.pdf)

### Webinars

*Mitigating anesthetic gases innovation café 9 40 minutes*

<https://nhssustainabilityaction.co.uk/conference/nhs-scotland-sustainability-conference-2021/>

*Stakeholder engagement 23 minutes*

<https://cai.mediasite.com/Mediasite/Play/826cc744eef24459afed6ffb5c6a24d41d>

### Digital reports

<https://nhssustainabilityaction.co.uk/resources>. NHS and Scottish Government staff can login/register with NHS or SG email address.

- *Scottish nitrous oxide procurement data excel spread sheet updated quarterly*
- *Piped nitrous oxide waste assessment toolkit*
- *Evidence-based Policy Brief mitigating waste from piped nitrous oxide systems*



# Mitigation Technologies

## Horizon Scanning: technology be assessed or purchased

- *Nitrous oxide parts per million (PPM) environmental monitoring equipment for delivery suites estimated cost £3,000 per health board. Test of PPM technologies underway. Anyone with prior experience of these technologies should contact [alifia.chakera@gov.scot](mailto:alifia.chakera@gov.scot)*
- *Cost and value of catalytic cracking technologies being trialed and assessed.*
- *Novel technology Envirolieve™ potentially reduces total consumption of Entonox® to be reviewed and assessed.*

## Constraints associated with mitigation technologies

### *Nitrous oxide catalytic cracking technology:*

- *Product is expensive, with single market competitor. We are keen for other medical device manufactures to enter this market.*
- *Will reduce N<sub>2</sub>O emissions but cannot achieve zero emissions as agent is lost through mask seepages. Avoiding system waste and reducing clinical use remain the mitigation cornerstone.*
- *Arrangements with delivery suites are not directly compatible with existing centralised destruction units and infrastructure adjustments will need to be made. This review is taking place centrally with the authorising engineers.*
- *Catalyst will not work where a volatile agent is present*
- *Effective with a single mask administrative technique – is not suitable for dental anaesthesia.*
- *Various forms of this technology will be trialed within delivery suites, endoscopy units, emergency departments. Scottish Ambulance service to trial N<sub>2</sub>O Capture device.*
- *At present its application will be restricted to demand valve administration of Entonox®.*
- *Independent assessment of this technology will be warranted to understand the true percentage of N<sub>2</sub>O that is captured on patient expiration when optimally using a double mask administrative technique with patients.*

## Performance Monitoring

NHS Scotland Sustainability Assessment Tool (NSAT) GHG emissions reporting section be updated to include nitrous oxide monitoring from 2022/23 onwards.

## References

### REFERENCES

Chakera, A. (2021) 'Abstracts', *Anaesthesia*, 76, pp. 10-88. [Abstracts of the Annual Congress 2021 23-24 September 2021, virtual conference: Anaesthesia: Vol 76, No S6 \(wiley.com\)](#)

Henderson, K., A, Matthews, I., P, Adishes, A. and Hutchings A, D. (2003) 'Occupational exposure of midwives to nitrous oxide on delivery suites', *Occupational Environmental Medicine*, 60, pp. 958-961.

IPCC (2013) *Fifth Assessment Report, Chapter 8: Anthropogenic and Natural Radiative Forcing*. Intergovernmental Panel on Climate Change. Available at: [https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_Chapter08\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf) (Accessed: 15 January 2021).