

Anaesthetic nitrous oxide system loss mitigation and management

Technical update

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v1.0



Key Information

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Document information

Key words:	climate crisis, greenhouse gas, climate duties reporting
Key actions:	Nitrous oxide mitigation and management
Importance:	High
Health board reporting and auditing schedules:	National Sustainability Assessment Tool (NSAT) Statutory Compliance and Risk Tool (SCART) Environmental Management Systems (EMS) under development
External evaluation, monitoring and reporting	<p>Scottish Government, annual climate duties reporting. Data extracted from medical gas suppliers and attributed NHSS sites and communicated to each health board.</p> <p>Centre for Sustainable Delivery: National Green Theatre Programme is now facilitating support of the nitrous oxide mitigation directive. Data is extracted from medical gas suppliers and attributed to each NHSS site on a monthly basis. High emission sites are identified and contacted by the nitrous oxide programme lead to ensure visibility of problem by health board level stakeholders.</p>
Key documents	<p>Scottish Health Technical Memorandum (SHTM 02-01)</p> <p>Nitrous oxide mitigation implementation plan</p> <p>Manifold interim decommissioning protocol</p> <p>Evidence Based Policy Report: piped nitrous oxide mitigation</p> <p>NHSS sites can secure their N₂O BOC data via email request to Marta.Siwiek@nhs.scot.</p> <p>N₂O analytics dashboard under development</p>

1. Background

- 1.1. Anaesthetic N₂O remains in the atmosphere up to 120 years as a potent greenhouse gas and dominant ozone depleting substance. It's complete mitigation will be essential to meet our climate change duties and within the [NHS Scotland Climate Emergency and Sustainability Strategy](#) we aim to achieve net zero emissions of this agent by 2027.
- 1.2. It is estimated across all health boards that most of our anaesthetic N₂O emissions is due to system loss up to a magnitude of 83-100 percent. This is both costly and polluting.
- 1.3. Anaesthetic N₂O is typically supplied by a piped system within NHS acute sites. Scottish based research has repeatedly demonstrated that anaesthetic N₂O is limited in contemporary anaesthetic practice and that these piped systems are often

redundant. Much of the volume turnover is due to system loss, driven by system leaks, poor security or stock management.

- 1.4. All NHSS health boards should have already formed a nitrous oxide mitigation group in response to the implementation plan issued in May 2022. By September 2022, ten known NHSS piped N₂O supply systems have been minimised or all provision of anaesthetic N₂O has been removed with a further thirteen sites preparing for N₂O manifold decommissioning.
- 1.5. The Royal College of Anaesthetists and the Association of Anaesthetists, have dedicated environmental programmes and networks. The Association in particular supports the nitrous oxide project and actively promotes the lean mitigation approach as first developed in NHS Lothian.
- 1.6. To reflect this change in anaesthetic practice, the SHTM 02-01 was appended in 2021 clarifying that new theatres should not routinely include piped anaesthetic N₂O within their infrastructure. The national nitrous oxide mitigation implementation plan recommends that medical gas committees act as a facilitator to develop a board level programme.
- 1.7. Medical Gas committees should have representation from all the key stakeholder groups: piped medical gas authorised persons, soft facilities designated porter leads, pharmacy services, anaesthetists and clinical engineers.
- 1.8. Maintaining piped systems and minimising system loss are expectations of the SHTM 02-01. To fulfil this criteria health boards are fully expected to meet the costs associated with training designated medical porters, decommissioning or repair of piped systems and procuring any equipment needed for leaner supply delivery.
- 1.9. This is a technical document to facilitate the discontinuation or a leaner physical provision of anaesthetic nitrous oxide within NHSS acute sites. This document should be read in conjunction with the latest version of the nitrous oxide mitigation implementation plan.

2. Objectives

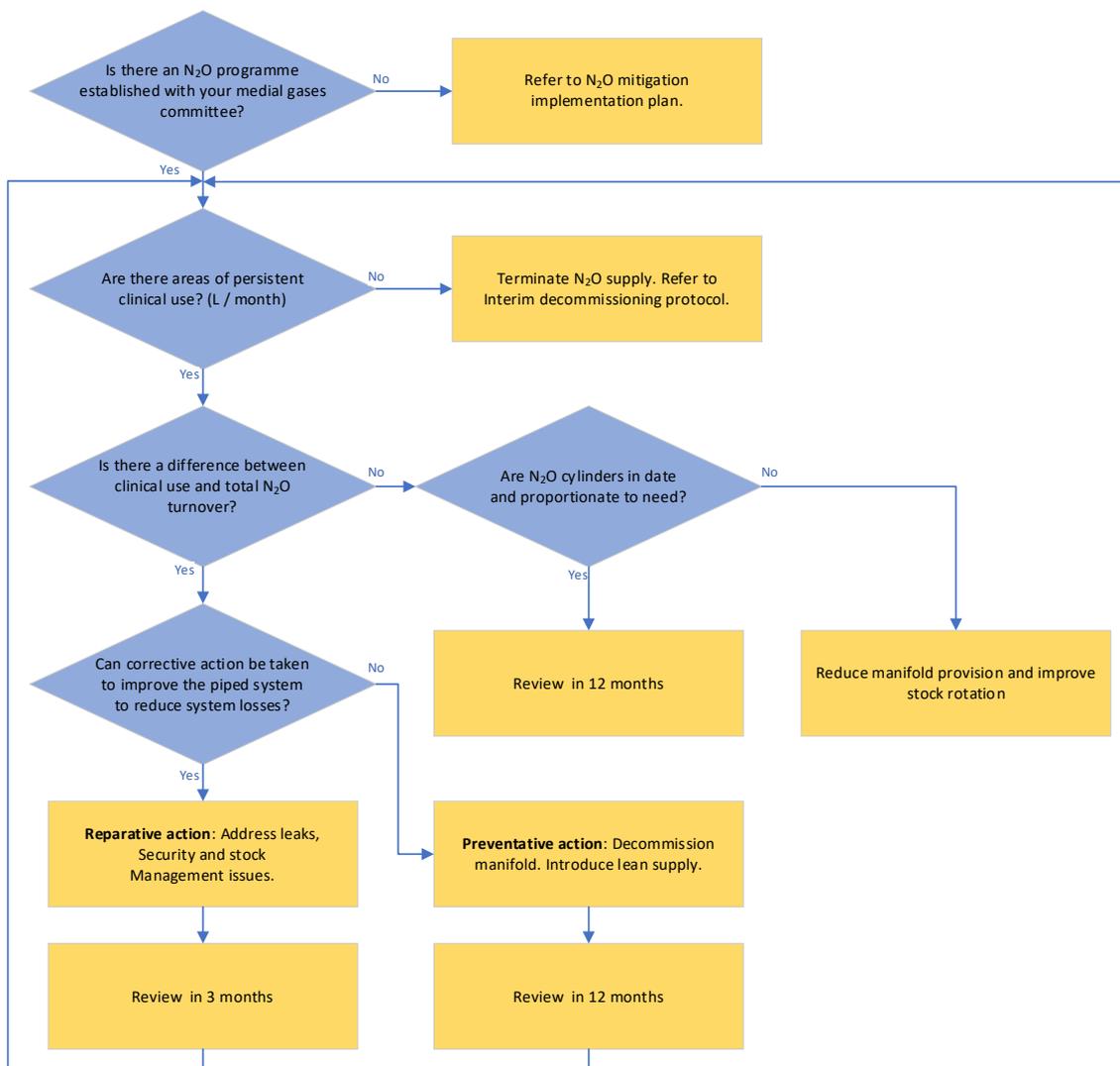
- 2.1 Remove anaesthetic nitrous oxide where not deemed clinically necessary
- 2.2 Establish the leanest physical supply of anaesthetic nitrous oxide
- 2.3 Ensure continued system monitoring and report of the system

3. Scope

- 3.1 Dentists and anaesthetists are encouraged to utilise the most environmentally favourable technique and this is embedded within national training programmes. Their clinical use is **not for consideration** within this document.
- 3.21 Green technologies **will not feature** with the nitrous oxide mitigation plans until at least 2024. Three distinct technology solutions are being considered nationally and are being assessed against: posology, utility, infrastructure compatibility, obsolescence and emission reduction capability versus cost.
- 3.3 This document clarifies process, reparative and preventative actions, financial considerations and barriers and facilitators.

4. Process

4.1 Decision making pathway.



5. Preventative action: decommission manifold

5.1 Where the nitrous oxide working group are satisfied that a piped N₂O system is redundant a formal request, to decommission an N₂O manifold, should be issued (email is suitable) from the clinical director of anaesthesia to the director of estates. All relevant stakeholders should be copied into the correspondence including the authorising engineer for the site, the chair of the medical gases committee and the director of pharmacy.

5.2 The interim decommissioning protocol should be referenced and any modification to the protocol discussed with the Health Board’s authorising engineer.

5.3 Lean Option 1: Portable cylinders at back of anaesthetic machines.

This approach may require retrofitting of N₂O yokes. Costs will vary, for example GE who manufacturers for Aisys and Carestation anaesthetic machines will supply and fit a yoke for £1,500 per machine. These can accommodate either a 141-D and 141-E sized cylinders. Sites may need to retrofit additional anaesthetic machines to ensure

machines can undergo scheduled maintenance by clinical engineering or manufacturer.

Retrofitting should be arranged through clinical engineering, new supply requests for 141-D or 141-E cylinders must be made to pharmacy procurement.

5.4 Lean Option 2: Portable mini manifold (cylinder on a trolley).

These can accommodate a 141-E or 141-F N₂O cylinder based on anticipated use. An N₂O cylinder trolley can be kept in a theatre/s that has persistent use of N₂O. Clinical engineering can arrange the appropriate trolley (approximately £110) and regulator for intended use (approximately £150) and pharmacy procurement will need to be advised on cylinder size requirements.

5.5 Lean Option 3: Bracketing 141-E and 141-F cylinders vertically to theatre wall.

Pharmacy can arrange the correct cylinders, estates will need to arrange bracketing and clinical engineering can source the appropriate regulators. 141-G is also tenable for bracketing; but requires training in its handling requirements. If this is a desired option, then theatre managers will need to ensure key staff are trained to facilitate 141-G cylinder changes safely.

6. Reparative action

6.1 If process mapping with all stakeholders has not yet been conducted, it may be prudent to request a session with the quality improvement team of the NHSS site.

6.2 System loss through leaks has consistently demonstrated to be the single biggest cause of N₂O loss.

- i. Loss through the pipeline infrastructure is more likely at terminal units (wall or pendant outlets) and valves. There are two options to consider a pressure drop test under permit or a leak assessment service offered by Beacon Medaes using N₂O frequency detection technology at a starting cost of £950. The Estates team has ownership of this and should choose the best course of action.
- ii. Medical devices; anaesthetic machines or flow meters connected to the terminal units may be defective and can be a source of loss and clinical engineering (medical physics) has oversight.
- iii. Medical devices or flow meters may be left on and clinical teams are responsible for minimising loss in this area.

6.3 Security has shown to be a problem in some NHS England sites and theft can be external or internal. N₂O is a recreational drug and chronic use is extremely harmful. Theft should be considered if system loss cannot be accounted for and this should be escalated by the medical gases committee to the Director of Pharmacy and site CEO.

6.4 Stock and procurement management, is key to ensuring cylinders are rotated from the emergency reserve supply into the active banks and that we have the correct supply arrangements with the medical gas supplier. Facilities and pharmacy procurement responsibility.

7. Financial implications

- 7.1 NHSS Health boards are expected to provide the necessary resources to drive down system loss of N₂O as a strategic priority. However, in practice NHS sites have found decommissioning manifolds to be a cost saving measure. Costs implications will vary and are dependent on a respective NHS site's pipe management contracts and the choice of lean N₂O supply sites may choose to opt for.
- 7.2 The cost of upkeep of manifolds is a core expense. Contract costs for external medical gas contractors for annual inspections to meet Planned Preventative Maintenance (PPM) requirements is £4,000-£6,000, the replacement of ageing manifolds £6,000-£10,000 and the installation of new manifolds with associated piped infrastructure around £45,000. Additionally, piped infrastructure requires the oversight an authorised person and an authorised engineer, all of which will have an impact on costs.
- 7.3 The Western General Hospital in NHS Lothian was the primary investigative site for the nitrous oxide project and their hard facilities management is an NHS Lothian service. In 2019/20 the system registered loss of 792,000 litres per annum, or 432 tonnes in carbon equivalents. The decision to decommission, rather than refurbish, the failing and redundant piped system cost them £150. Conservatively, the site avoided £6,000 expenditure on refurbishment and recurrent annual costs associated with medicine purchase, cylinder rental and PPM approximating £6,500. Moreover they have mitigated an environmental impact cost of at £35,000 attributed to nitrous oxide emissions.

8. Barriers and Facilitators

- 8.1 Specific training is a requirement within the SHTM 02-01 for specialist 'designated porters' that are responsible for moving and replacing cylinders for a piped medical gas system. Many health boards have been derelict in meeting this basic training obligation over a protracted period of time; and this is reflected in the quality of stock and manifold management. Moreover it posed health and safety risk for the porters themselves as large cylinder can cause injury if mishandled. The medical gases committee within there Terms of Reference are obliged to ensure safe handling of all medical gas cylinders by NHS staff and ensure that soft facilities directorate understand all training requirements and are compliant.
- 8.2 Specific training must be provided for all clinical staff who handle portable cylinders. The medical gases committee must ensure and support such training. Anaesthetic nitrous oxide is not an emergency agent and portable cylinders should be utilised fully with a spare cylinder in a secure store nearby should the agent deplete.
- 8.3 All staff should be made aware that N₂O is a greenhouse gas and that surplus residual gas within cylinders are vented, under MHRA obligations, when returned to BOC prior to refilling and as such forms part of our emission footprint.
- 8.4 Process mapping is a useful tool to articulate roles of different stakeholders and identify opportunities to improve processes and communication. A facilitator can be provided by your quality improvement directorate.