The Canadian Coalition for Green Health Care
Coalition canadienne pour un système de santé écologique

NITROUS OXIDE TOOLKIT

CENTRAL SUPPLY SYSTEM DEACTIVATION GUIDELINE

2025 EDITION

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This toolkit has been adapted from the *Nitrous Oxide Toolkit: Centralized Supply System Deactivation Guideline* developed by Providence, a U.S.-based health care organization, with their permission. We have modified the content to align with the Canadian health care context while maintaining the original intent and key principles. We sincerely appreciate Providence's work in developing this valuable resource.

This adaptation was completed under the Canadian Coalition for Green Health Care's (CCGHC) Preparing Canada's Health Care Buildings for Net-Zero project, made possible with investment from the Government of Canada's Low Carbon Economy Implementation Readiness Fund.

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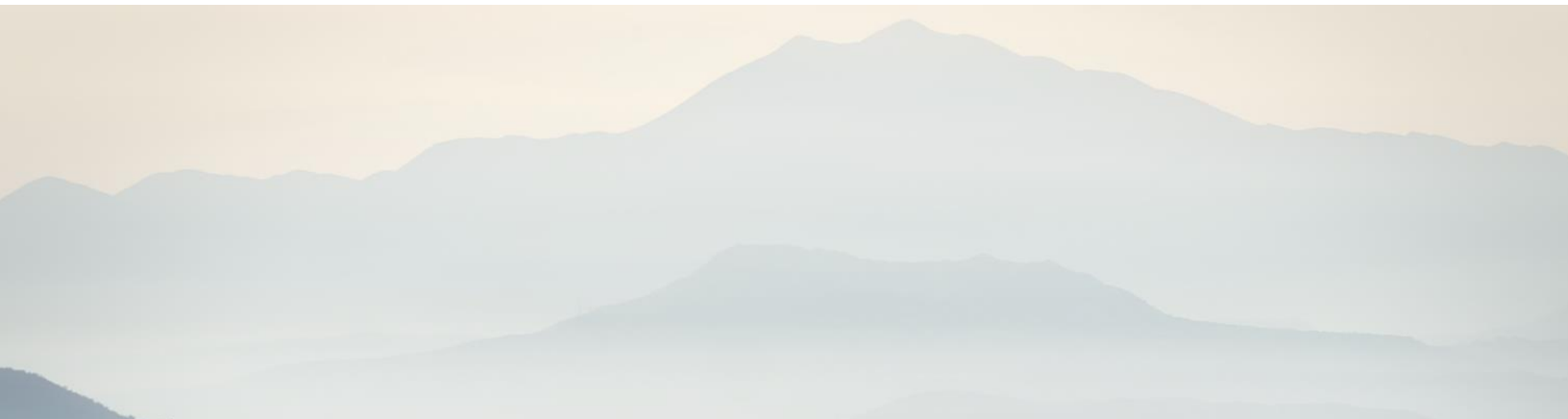
INTRODUCTION

The Canadian Coalition for Green Health Care (CCGHC) is a national leader in advancing environmentally responsible health care. Dedicated to promoting sustainable practices across Canada's health sector, CCGHC collaborates with health care facilities, NGOs, government entities, individuals, students, and businesses to minimize the environmental impact of health care operations. By encouraging innovation, sharing knowledge, and implementing green initiatives, CCGHC aims to instigate systemic changes that lead to a more sustainable and climate-resilient health care system.

One critical issue is nitrous oxide (N_2O), a powerful greenhouse gas commonly utilized in health care settings. Emissions from central supply systems are a significant contributor to greenhouse gas releases and unnecessary expenses. This toolkit equips Canadian health care climate champions with step-by-step guidance for assessing, deactivating, and optimizing supply systems - helping to cut emissions, improve efficiency, and enhance patient safety.

CCGHC's Nix the Nitrous Team has adapted this resource from the Nitrous Oxide Toolkit: Centralized Supply System Deactivation Guideline, developed by Providence, a U.S.-based health care organization, with their permission. This work is part of the Preparing Canada's Health Care Buildings for Net-Zero, a project supported by the Government of Canada's Low Carbon Economy Implementation Readiness Fund.

By implementing best practices, hospitals can reduce emissions, lower costs, and contribute to Canada's climate goals. For more information on the toolkit and project, visit: https://greenhealthcare.ca/nix-the-nitrous/



SUMMARY

NITROUS OXIDE (N_2O) ELIMINATION OR MITIGATION VIA TRANSITION TO PORTABLE SUPPLY SYSTEMS

SITUATION

In alignment with the Canadian Coalition for Green Health Care (CCGHC) initiatives that will reduce greenhouse gas (GHG) emissions from health care buildings, the organization is supporting the Nix the Nitrous / Pas de Protoxyde Canada campaign to eliminate the clinical use of nitrous oxide (N_2O) or transition the N_2O supply from the central supply system to a more efficient delivery system utilizing portable E-cylinders at the point of care.

BACKGROUND

"N2O is regarded as [a] predominant greenhouse gas for the 21st century. Nitrous Oxide has a global warming potential (GWP) 300 times that of CO2 and persists in the atmosphere for 114 years. Once in common use as an adjunct for anesthesia, the demand for N2O has waned considerably with the advent of new anaesthetics and changes in practice. Some facilities continue to use N2O for self-administered conscious sedation during childbirth or for pain control in emergency departments."[1]

The central supply systems supplying N_2O throughout hospitals are inefficient, with losses typically around 70-99% of purchased volumes from leakage. The Ontario and British Columbia hospitals which conducted audits of their central supply systems found their N_2O waste was greater than 90%, resulting in excessive

[1] *Source: Clause P.2.1, CSA Z7396.1:22, Medical gas pipeline systems - Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems. © 2022 Canadian Standards Association. Please visit store.csagroup.org*

and unnecessary GHG emissions in the hundreds to thousands of tonnes of CO_2 equivalent per year.

As anesthesia practices have evolved over the past few decades, many anesthesiologists have eliminated N_2O from their clinical practice, most critically as a carrier gas which was the impetus for large centralized systems. This elimination is supported by the Canadian Anesthesiologists' Society December 2024 Position Statement:

> *"Eliminate or minimize the use of nitrous oxide to the extent possible given local resources, location and clinical context. If there is no viable alternative and the use of nitrous oxide is still needed in some areas, central nitrous oxide pipelines should be replaced by portable E-cylinders."*

The primary motivation for implementing these changes is reducing greenhouse gas emissions and financial costs savings, while simultaneously improving operational efficiency and resilience. Additionally, these modifications aim to mitigate potential health and safety risks stemming from persistent N_2O leaks and losses.

ASSESSMENT

Work pioneered at Providence hospitals in Montana and Oregon as well as Ontario, Quebec, and British Columbia hospitals found that this wastage can be eliminated by deactivating the central supply system and no longer using N_2O clinically, or it can be reduced to <1% by deactivating the central supply system and instead utilizing portable E-sized N_2O cylinders (commonly referred to as E-cylinders) where there is a perceived clinical need.

RECOMMENDATION

Deactivate the central N_2O supply system and either eliminate N_2O from your hospital or transition it to a point-of-care supply where it is still clinically needed.

ASSEMBLE YOUR TEAM

PROJECT COORDINATOR

Coordinate team members, action items, and guides the project through all three phases of implementation.

FACILITIES LEAD

Ideally, the Facilities Lead role is filled by the health care facility's 'Qualified Operator' as defined by CSA Z7396.1-22 T.2, who is accountable for the central medical gas supply systems in the Facility. This may be someone from Facilities Management, Biomedical Engineering, or even your medical gas maintenance provider. The Facilities Lead is a critical subject matter expert with action items throughout the project, with an emphasis on Phase 3 - Deactivation.

OPERATING ROOM DIRECTOR

The Operating Room Director has operational, educational, and leadership responsibility for the Operating Rooms and Perioperative departments, often including managerial oversight of Anesthesia Technicians. Involvement of the OR Director is most critical in Phase 2 - Establish the Portable Supply - as this involves logistic and workflow considerations within (& beyond) the department, as well as facilitating appropriate staff training and education.

ANESTHESIA LEAD

As the traditional user of N_2O, the engaged support of the Anesthesiology department is paramount to success. The Anesthesia Lead serves as a representative of the department in gathering data, soliciting feedback, providing education, and clinical leadership - particularly in Phase 1 and Phase 2.

Hospital Leadership should be engaged and informed throughout implementation to support the project through leadership, accountability, and communication support!

PHASE 1: ASSESSMENT

NITROUS OXIDE UTILIZATION

RELY ON STRONG PRECEDENT

Nearly all audits of large central N_2O supply systems conducted in Canada and the US have shown >85% loss when comparing purchased N_2O to clinical use.

In addition to typical leaks in a gas distribution system at fittings, valves, and terminal units, "N_2O is known to permeate non-metallic materials including the plastic hoses connected to medical gas pipelines including hoses in articulating arms, and connected to anaesthetic machines. Because these hoses are connected to the medical gas pipeline under pressure, they give off N_2O 24 hours a day, 7 days a week and can constitute the majority or all of the consumption of N2O in a healthcare facility."[2]

This has led to strong statements in support of deactivating these central supply systems from the Canadian Anesthesiologists' Society (CAS), Association des Anesthésiologistes du Québec (AAQ), and the Association des médecins d'urgence du Québec (AMUQ).

Based on these precedents, decreasing clinical relevancy, and the financial and environmental advantages of deactivating central supply systems, many hospitals have reasonably skipped measuring their system losses and proceeded directly to deactivating their central supply systems.

CALCULATIONS - IF NEEDED

Although not necessary, in some hospitals, auditing the nitrous oxide leakage has been helpful in justifying the project to leadership and stakeholders. This calculation involves comparing the purchased N_2O to the clinical usage. Audits

[2] *Source: Clause P.2.2, CSA Z7396.1:22, Medical gas pipeline systems - Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems. © 2022 Canadian Standards Association. Please visit store.csagroup.org*

often identify large N2O leaks. If no large N2O leak is identified using one year's data, this does not mean leaks will not appear in subsequent years. This means periodic leak audits need to be performed as long as central N2O is not deactivated, increasing the maintenance burden of these systems.

Gather purchased central N_2O supply data (annualize):
Request at least 12 months of itemized N_2O invoice data from your purchasing department or directly from the medical gas vendor (Airgas, Linde, etc.). If possible, request the following data elements:

- Invoice number
- Delivery date
- Facility name
- Ship-to address
- Item description (type of cylinder)
- Number of each cylinder type per order
- Amount N_2O (kg) per cylinder
- Cost ($) per cylinder

Not all medical N_2O cylinders are used to supply the central system. When determining the total amount of centrally supplied N_2O, be sure to include ONLY the large (≥20 kg) central cylinders/containers (typically size 44). Nitrous oxide cylinders containing <20 kg are considered portable and used in clinical settings (cryotherapy, sedation, analgesia, etc.) not supplied by the central system.

Gather clinical N_2O use data (annualize):
Clinical use data can be gathered from the EMR or directly from anesthesia delivery machine logs. Getting data directly from the anesthesia delivery machine logs may require support from your Biomedical Engineering department. Helpful data elements are:

- Facility Name
- Date of Surgery
- Anesthesiologist name
- Operating room
- Total N_2O volume (L) per surgery
- Total N_2O duration per surgery

When gathering clinical use volume data (N_2O litres) from the electronic medical record (EMR). Align the clinical report to the central supply system data interval (delivery dates) and normalize the data to a 12- month period. Some EMR products have clinical N_2O volume reports pre-built (i.e. Epic SlicerDicer), while others may

require an analyst to build a custom report to query the N_2O fresh gas flow data from anesthesia records.

Alternatively, you can survey anesthesiologists to assess individual and group practices to estimate volume(s) of clinical N_2O use.

Convert clinical N_2O usage data (litres) to kilograms:

508.4 litres N_2O = 1 kg N_2O

Calculate the % N_2O loss:

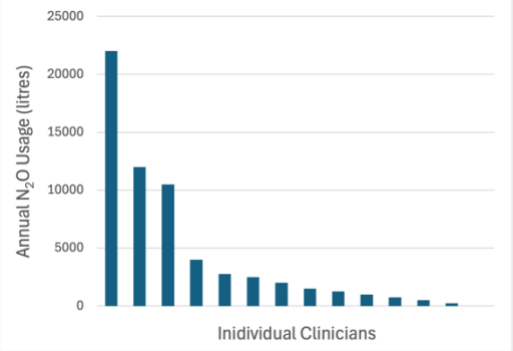
$$\%\ of\ N_2O\ Loss = \frac{Central\ Supply\ N_2O(kg) - Clinical\ N_2O(kg)}{Central\ Supply\ N_2O(kg)} \times 100$$

Calculate the greenhouse gas (GHG) emissions:
GHG emissions are measured in units of metric tonnes of CO_2 equivalents (tCO_2e). The conversion for kilograms N_2O to tCO_2e is as follows:

1 kilogram N_2O = 0.298 tCO_2e

It is not uncommon for larger hospitals N_2O supply systems to have losses in the hundreds to thousands of tCO_2e per year from nitrous oxide.

***Consider:* Assess individual clinician N_2O utilization:**
Clinical use of N_2O can vary dramatically between individuals and departments according to practice habits, with some people using N_2O every day, while others rarely or never use N_2O. Assessing individual practices can provide useful measures to engage clinicians on the patient, financial and environmental harm related to N_2O in practice and encourage the judicious use of N_2O.



Consider: **Estimate E-cylinder exchange frequency for each clinical location:** This can be a good time for clinical stakeholders to reassess their use of N_2O and consider eliminating it from clinical practice completely as many anesthesiologists and hospitals are choosing to do based on the strong supporting evidence.

However, if some portable cylinders are still needed, it is important to address the concerns that may arise regarding the logistics and regulations surrounding safe storage, transportation, and exchange.

To determine the Periodic Automatic Replenishment (PAR) level for N_2O E-cylinders (sometimes referred to as ***Size 5***) you divide the annual clinical usage amounts by the amount in an E-cylinder.

1 E-Cylinder N_2O = 3.2 kg N_2O = 1,626 litres N_2O

Clinical use of N_2O can vary dramatically between institutions, with implications for E-cylinder exchange frequency. For example, within Providence, the single clinical location with the highest N_2O use requires approximately 22 N_2O E-cylinders per year (exchanging a cylinder roughly every 17 days), while most other locations throughout the health system might exchange a cylinder less than once per year, quarter or month - many others have simply eliminated clinical use and withdrawn N_2O.

FACILITY INFRASTRUCTURE

Gather inventory of N_2O delivery units (anesthesia machines): In preparation for Phase 2: Establish Portable Supply System, an inventory of anesthesia machines and other N_2O delivery units (N_2O sedation/analgesia machines) are needed. Different machine makes/models have different

requirements and interfaces to receive portable N_2O E-cylinders. Many machines have an integrated N_2O yoke with attached cylinders, while some machines may require a retrofit yoke kit to receive an N_2O E-cylinder (see photos below - *Phase 2: Clinical Use*). In addition, the different machines' low-pressure alarm thresholds and displays must be understood prior to the transition to portable N_2O E-cylinders.

If possible, collect the following elements for the machine inventory:

- Make and model
- Use (anesthesia, sedation, analgesia)
- E-cylinder physical location
- Is an N_2O E-cylinder already in place?
- Is a machine retrofit required?
- Low pressure threshold for N_2O Residual volume (litres) at time of alarm (estimate)

The low-pressure threshold for each machine make/model can be found in the technical specifications or by contacting the manufacturer. For example, the GE Aisys C2 anesthesia machine triggers an alarm when the N_2O E-cylinder pressure reaches 381 psig, at which point the machine will continue to deliver an additional 95-100 litres before the N_2O flow is discontinued. This residual E-cylinder volume was determined empirically at Providence Portland Medical Center and helps provide a rough estimate for consideration in other systems and alarm thresholds. Pneumatic anesthesia machines may require operator vigilance to determine timing of E-cylinder exchange, as they may not have a low-pressure alarm.

Gather central N_2O supply system component inventory:
Prior to *Phase 3: Deactivation of Central System*, an inventory of the central N_2O supply system is needed to prepare for appropriate removal, disabling and/or labeling of system components (terminal units, zone valves, zone alarms, and supply system alarms).

In addition, the terminal unit inventory helps identify each clinical department/location with potential access to the central N_2O supply system. These departments must be engaged throughout the transition to ensure clinical care is uninterrupted.

If possible, collect the following elements for the central system inventory:

- Component (terminal unit, zone valve, zone alarm, supply system alarm)
- Physical location
- Area(s) served
- Clinical department(s) served

Facilities Management and/or your medical gas maintenance vendor (e.g. PMG Systems, Class 1, or other Qualified Persons) will have a medical gas preventative maintenance report to assist with this as is required by CSA Z7396.1:22 15.1.3.

Note that in Canadian hospitals, central N_2O supply systems are often piped throughout many areas of the hospital beyond the operating rooms, even where N_2O is not typically used (e.g. diagnostic imaging). Refer to CSA Z7396.1 Table F.2 for potential areas to double check and work closely with your vendor and Facilities Management team to ensure the inventory is accurate.

PHASE 2: ESTABLISH PORTABLE SUPPLY SYSTEM

STORAGE

This section applies only if your hospital continues to use N2O clinically. Depending on your facility's needs, you may require a portable supply system and associated storage in specific areas, such as labor and delivery, to maintain availability, while discontinuing its use in other areas, like the emergency room and operating room.

Confirm location & logistics of primary portable medical gas storage room:
Most facilities have a primary portable medical gas storage room, which is often located in a central location to receive and store a variety of portable compressed gas cylinders (oxygen, CO2, medical air, N_2O, argon, NO, etc.) for subsequent use throughout the facility.

The design and operation of these primary storage rooms are subject to O.Reg. 67/93: Health Care and Residential Facilities - Section 74, CSA Z7396.1: Medical Gas Pipeline Systems, and the Canadian Centre for Occupational Health and Safety requirements. Nitrous oxide storage of greater than 1820kg (4000lb) is in accordance with CGA G-8.1and NFPA55. Furthermore, CSA Z7396.1 Table C.1 Section 5.9 defines compliance requirements for safe storage and handling.

Work with your organization's Occupational Health and Safety Services team to ensure that you follow any corporate policies specific to your organization on the handling, use, transport, and storage of compressed gas.

Determine department responsible for ordering & management of portable cylinders:
Most commonly, the Respiratory Therapy department is responsible for the ordering and initial management of portable medical gas cylinders, although other departments could include - Facilities, Safety Manager, or specific clinical managers. Regardless, the responsible department(s) and personnel should be

engaged to coordinate the processes to order, receive, and store full (for use) and empty (for return) N_2O E-cylinders per your organization's internal corporate policy.

Determine facility N_2O E-cylinder PAR level for primary storage room:

Facility PAR (periodic automatic replenishment) level for the primary storage room should be set appropriately to ensure adequate on-site supply of N_2O and in collaboration with Facilities, Respiratory Therapy, and the OR Director. The Periodic Automatic Replenishment (PAR) level will depend, in part, on the capacity and logistics of the primary storage room, as well as the frequency of potential delivery from the medical gas vendor. A reasonable initial PAR level could be 4-5 N_2O E-cylinders in the primary storage room. Ideally, the determination can be further informed by clinical use data gathered earlier. For example, an initial suggested PAR level could provide storage for one month's facility-wide N_2O utilization as follows:

$$Facility\ E\ cylinder\ PAR\ level = \frac{Mean\ clinical\ N2O\ consumption\ per\ month\ (litres)}{1500\ litres\ per\ cylinder}$$

Of note, if needed, aluminum N_2O E-cylinders to be used in the Magnetic Resonance Imaging (MRI) department should be accounted for separately. However, N_2O is not typically used in MRI departments.

Do additional N_2O E-cylinders need to be stored in clinical department(s)?
If deemed necessary, additional N_2O E-cylinders can be stored in clinical departments, but such storage must be compliant with your corporate policies and OHSS requirements.

HANDLING & EXCHANGE

Determine department responsible for N_2O E-cylinder handling and exchange:
Usually, anesthesia assistants are the best-suited personnel to assume responsibility for the handling, transport, and exchange of N_2O E-cylinders at the point of care. Anesthesia assistants are accustomed to fielding calls from

clinicians to assist in anesthesia support and are in the best position to respond to clinicians' requests to exchange N_2O E-cylinders. Anesthesia assistants commonly fall within the managerial oversight of the OR Director, whose leadership is required to facilitate this operational transition.

Define N_2O E-cylinder handling & exchange protocols:

E-cylinder handling and exchange protocols should be created in collaboration with the Lead Anesthesia Assistant, OR Director, Anesthesia Lead and Biomedical Engineering department. These practices should also be in accordance with your internal policies. Key components include (1) storage and handling (2) cylinder exchange procedures.

Additional issues to consider:

- Certain types of O-rings between the N_2O E-cylinder and the yoke connection can corrode following prolonged exposure to N_2O. These O-rings should be inspected and replaced as needed during cylinder exchange.
- The N_2O E-cylinder post valve should remain CLOSED when not in clinical use to eliminate low-level leaks within the anesthesia machine. Clinicians should open the post-valve immediately prior to use, while the anesthesia assistants should confirm post-valve closure on the N_2O E-cylinder(s) during the end-of-day anesthesia machine shutdown protocol. See the following images for more detail.

Design & deliver N_2O E-cylinder management competency program:

As E-cylinder management may represent a skillset beyond what is considered a core competency of anesthesia assistants, a clinical competency program could be established to ensure consistent knowledge and skill. This program should be designed and administered in collaboration with the Biomedical Engineering and Anesthesiology departments.

E-cylinder post valve stem

CLINICAL USE

Identify & engage department(s) utilizing centrally supplied N_2O:
Use the central supply system terminal unit inventory to identify each location and clinical department with access to the central supply system. The department/unit managers for each department should be engaged to determine the extent to which N_2O is clinically used and whether barriers exist to the transition to a portable supply system or eliminate its use from the area completely.

Confirm compatibility of N_2O delivery units with portable N_2O E-cylinders:
Typically, the most common and relevant N_2O delivery units are anesthesia machines, but may also include portable sedation or analgesia units used in Labor/Delivery *(for reference, an N_2O E-cylinders lasts approx. 6 hours at normal breathing rates on a portable Nitronox cart)*, ICU, or Emergency Dept. Compatibility of N_2O E-cylinders with all relevant delivery units should be confirmed. Some anesthesia machines, for instance, must be retrofitted to accept a N_2O E-cylinder, while others have integrated N_2O cylinder yoke attachments.

Integrated N_2O E-cylinder Attachment

Retrofitted N_2O E-cylinder Attachment

In ORs with anesthetic machines that are unable to hold N_2O E-cylinders or it is preferred to keep two oxygen cylinders, a common solution is to have a portable N_2O E-cylinder on a dolly brought in from a convenient central location when needed. Consider your needs and whether to leave the anesthetic machines configured for using N_2O during the startup check and manually bypassing it when N_2O is not connected; or disabling N_2O in the maintenance settings and reenabling it on days that it may be used based on the case load.

ORs frequently using N_2O may elect to have an N_2O cylinder wall mounted in the OR, so long as it conforms to their internal storage and handling procedures.

Establish criteria to trigger exchange of a N_2O E-cylinder:
The Anesthesia Lead, in collaboration with the project team, should define the conditions at which a N_2O E-cylinder is considered "empty" and in need of exchange. For some, "empty" could be defined as the low-pressure alarm threshold on the anesthesia machine.

It is important to recognize that gas suppliers never want to see cylinders returned completely empty, as that involves a different process before they can refill. When correctly filled and stored (or in use), any size N2O cylinder will maintain a head pressure of 745 psig at 70 degrees F until ¾ or more of the liquid has vaporized. Once cylinder pressure drops below half, it should be considered empty and replaced. That will leave only a very small amount of liquid in the cylinder. This is different than an oxygen cylinder which decreases in volume linearly.

Ultimately, the timing of E-cylinder exchange should be at the discretion of the anesthesia clinician at the point of care.

Define Anesthesiology Department education module:
The Anesthesia Lead should assist with designing and delivering an educational module for the impacted department(s) to ensure that all clinicians are informed and prepared. Specific issues for emphasis could include:

1) Whether or not each anesthesia machine will be connected to an N_2O cylinder or made available in a convenient location for connection as needed
2) The N_2O E-cylinder post-valve should remain closed when not in use
3) Individual clinicians are responsible for opening the valve prior to clinical use
4) The anesthesia assistants will confirm closure of the valve during end-of-day machine shutdown procedures
5) Low pressure alarm thresholds and interfaces (machine checkout & real-time alarms) should be presented for each anesthesia machine make/model in the facility
6) The residual N_2O volume in the E-cylinders at the low-pressure threshold should also be communicated
7) Clinicians should receive instruction on the safe handling and exchange of N_2O E-cylinders

PHASE 3: DEACTIVATION OF CENTRAL SYSTEM

1

Determine responsible person for medical gas supply system:
In Canada, this responsibility may fall under the Facilities Management leadership team, Biomedical Engineering leadership, and/or OHSS leadership. Engage with your leadership teams to determine who is most appropriate. Medical gas maintenance vendors are also valuable resources for Phase 3 of the project and can often be contracted to do this work.

2

Conduct a risk assessment to consider operational and value implications:
A risk assessment should be completed to identify and address potential local risks, challenges, and benefits associated with this transition to portable N_2O supply systems.

3

Guidance for decommissioning under CSA Z7396.1:
CSA Z7396.1:2022 Clause 11.5.2.9 states that: "When a medical gas system or any part of a system is permanently decommissioned, the affected system or part shall be cut and capped at the point of decommissioning as determined by the health care facility, and all associated shut-off valves, terminal units, indicators, alarms, and unburied pipeline shall be removed, if accessible."[3]

In a Canadian decommissioning context, a healthcare facility may leave the accessible pipeline untouched. This approach is considered as temporarily decommissioning and significantly reduces the costs, allowing it to be reenabled at a future date if ever required. Project stakeholders should determine if this is the appropriate approach for your site. This is the most common method of decommissioning existing N_2O systems.

[3] *Source: Clause 11.5.2.9, CSA Z7396.1:22, Medical gas pipeline systems - Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems. © 2022 Canadian Standards Association. Please visit store.csagroup.org*

DISCONNECT

If your site is not eliminating N_2O from clinical practice, some sites choose to conduct a Disconnection Trial to test the process logistics of the portable supply system established in Phase 2 where appropriate. Evaluate the relevancy of the trial disconnection to your site with project stakeholders to determine if it's needed.

Anesthesia machines and other clinical delivery units (sedation/analgesia units, etc.) can be easily disconnected from the central supply system hose couplings or wall terminal units. This disconnection does not disrupt the central supply system "behind the walls" and the anesthesia machines can be reattached to the central supply system within seconds if needed.

Disconnect all delivery units from central supply system terminal units or couplings:
Anesthesia machines and other clinical N_2O delivery units (sedation, analgesia, etc.) should be disconnected from the central N_2O supply system at the wall terminal unit or hose coupling.

N_2O Terminal Unit

Label each terminal unit:
During the disconnection trial, the point of disconnection should be clearly labelled indicating the nature of the trial and instructing staff to NOT reattach to the central system. Follow guidance in CSA Z7396.1 Section 15.1.5.

Trial Period:
Start and end dates for the disconnection trial should be determined and communicated to relevant departments. A common and reasonable disconnection trial period is 1-2 months. Once the portable supply system processes are in place, there should be no delay in starting the disconnection trial while preparing for the subsequent Depressurization and Deactivation steps.

Solicit feedback from stakeholders & address concerns prior to depressurization:
At the conclusion of the disconnection trial, feedback from stakeholders should be solicited. Any concerns or challenges should be addressed prior to proceeding to Depressurization Trial.

DEPRESSURIZE

A depressurization trial is discussed here which depressurizes the N_2O distribution system but leaves the manifold supply intact and available to repressurize. Evaluate the relevancy and need of the trial to your site with project stakeholders. Often both depressurization and deactivation (removing the manifold supply tanks) are performed together.

Draft & distribute hospital-wide communication:
Prior to depressurization of the central supply system, a hospital-wide communication should be distributed. All clinical departments with access points (i.e. terminal units) to the central system should already be engaged and well-prepared following Phase 2 and the Phase 3 - Disconnection Trial (if applicable). However, staff must be aware that the central system will be depressurized and any attempt to reconnect machines will NOT result in the clinical delivery of N_2O via the central supply system.

Confirm all zone and supply system alarms are disabled prior to closure of the central valve:
Prior to depressurization, the Facilities Team must identify and disable all low-pressure alarms in the central N_2O supply system. Zone alarms and alarm panels should be labelled as “DISABLED” or “INACTIVATED.” As part of the communication, contact information should be included to field any alarm-

related questions and concerns which may arise immediately following depressurization.

Trial Period
Start and end dates of Depressurization Trial should be determined. A common and reasonable trial period is 1-2 months, during which time the Facilities Team can prepare for deactivation.

Close central valve (immediately downstream from central manifold):
To start the trial, the central valve should be closed and the N_2O supply system depressurized. The entire pipeline should be bled out either at that point (using the main abnormal pressure switch DISS port and manifold bleed valves), or another suitable point capable of venting gas to atmosphere at a suitable rate.

Zone valves must remain open during this process. Certain terminal units, such as the Tri-Tech cartridge design, require full line pressure to properly seat. If a zone upstream remains pressurized while the zone is drained (as in a staged departmental approach) and there is any leakage through that zone valve, these units may not seat correctly, leading to continuous leaks. This staged approach is generally discouraged.

Solicit feedback from stakeholders & address concerns prior to deactivation:
Prior to final deactivation, another round of stakeholder feedback should be solicited with concerns addressed.

DEACTIVATE

Remove components:
Upon deactivation of the central system, the following components should be REMOVED:

- Central N_2O supply compressed gas cylinders and/or cryogenic containers.
- Drop hoses, if applicable.

Disable components:

Upon deactivation, the following components should be DISABLED:

- Zone and Supply System Alarms: disabling procedure is specific to alarm make/model. Refer to manufacturer for details.
- Zone Valves: all visible main and zone shut off valves should be CLOSED, with valve handles either removed or labels applied.
- Terminal Units: terminal units can be addressed as described in CSA Z7396.1. Annex A.15.1.5
    - Terminal Units completely removed, capping optional as the pipe cannot be repurposed for any patient care use. No labels required if no gas ID visible.

    - Terminal Units plugged or blanked off, providing that is possible. In some cases, gas bodies would need to be heated up for removal before a flush surface is possible. No labels required if no gas ID visible.
    - DISS Terminal Units may be made tamper resistant by installing keyed DISS lock-out devices (not mandatory). Labeling is optional, but recommended regardless.
- Central manifold – removal is optional.

Label Components:

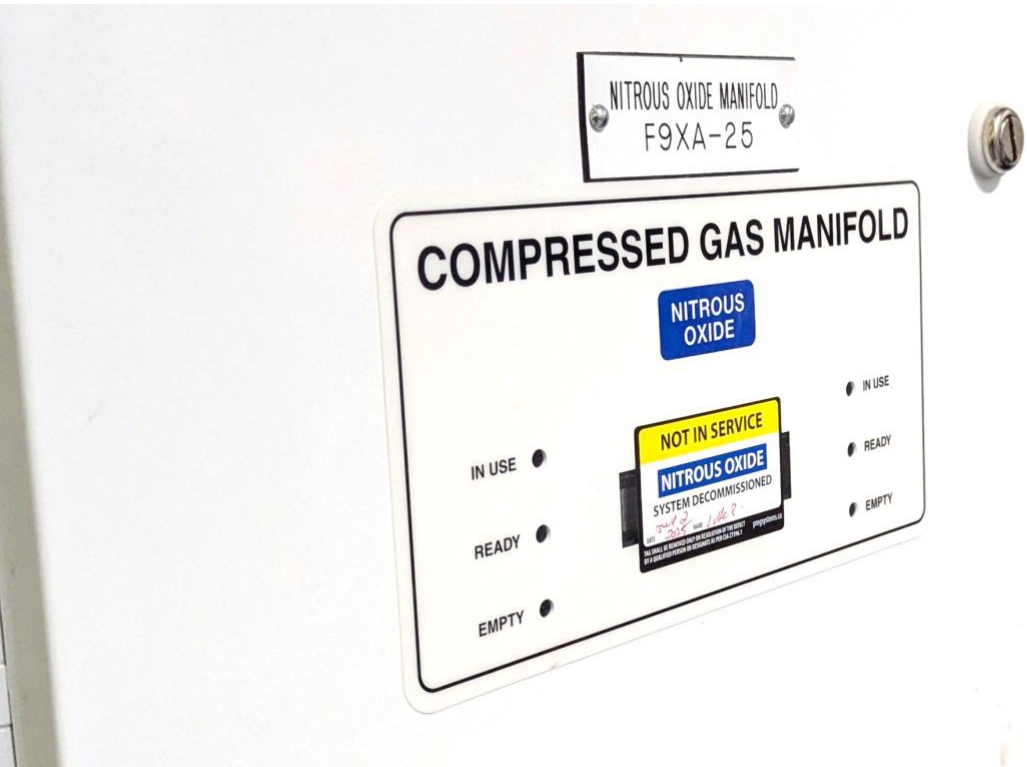
All central N_2O supply system components should be clearly labeled as INACTIVE or DISCONTINUED in accordance with labeling regulations. Components that should be labeled are the following:

- Zone and Supply System Alarm Panels
- Valves
- Terminal Units

Consider consultation with your Accredited Inspection Body:

Local or regional medical gas system certifiers may be helpful as subject matter experts with operational/technical support and applicable regulatory requirements.

Additionally, Engineering firms can provide support, especially those with representation on the CSA Technical Sub-Committee. Consider adding them, and/or a CSA Qualified Service Technician, Installer, or Operator.



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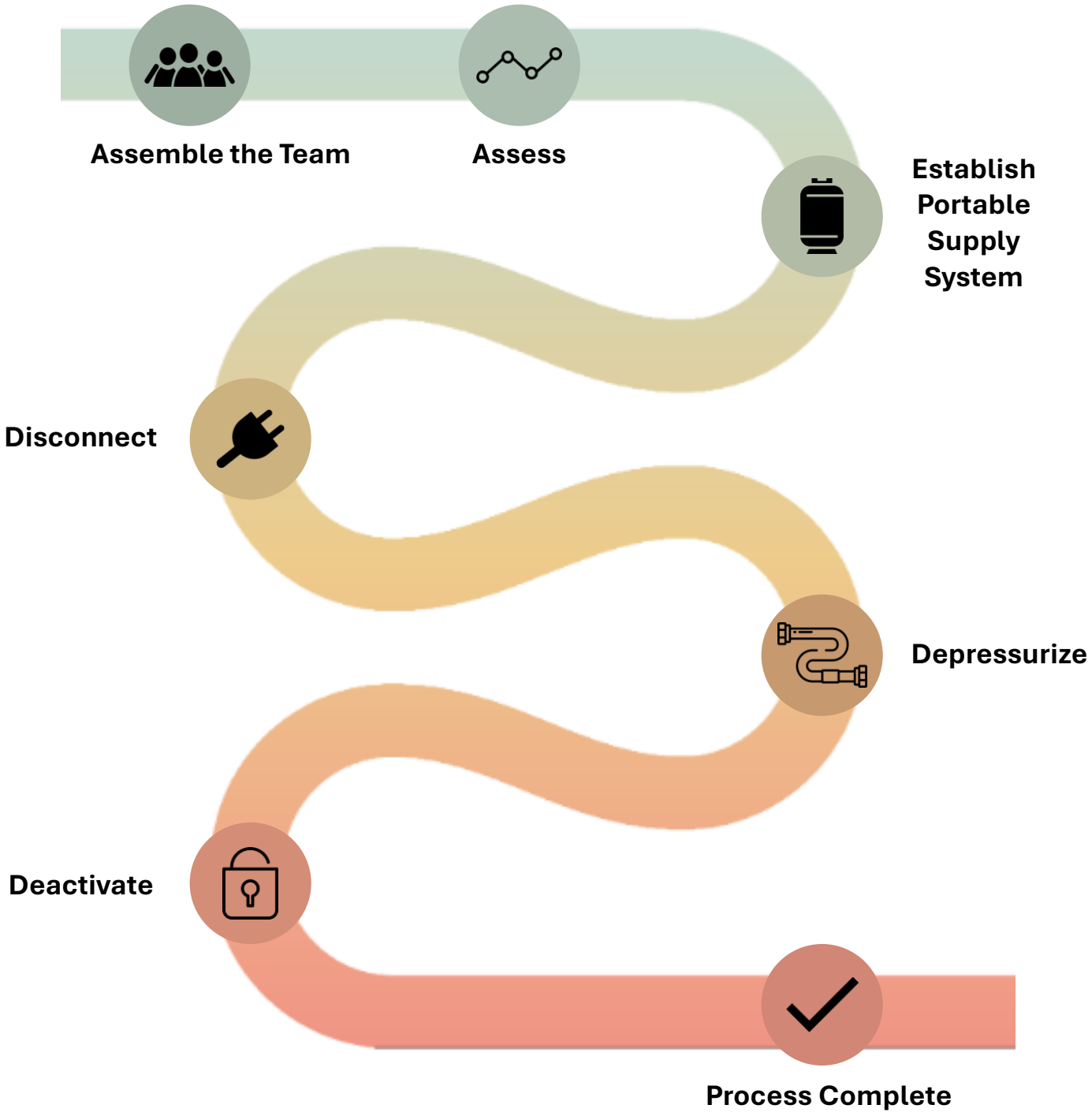
APPENDIX

Nitrous Oxide Central Supply Deactivation: A Step-by-Step Guide



Tips and Tricks

Stratify clinical N_2O use data by location to predict cylinder exchange frequencies and facilitate logistical planning

Contact the medical gas vendor directly to request supply reports

Go on a tour! See the system elements in person to better understand the reports, infrastructure, and processes

Frequently Asked Questions

Q: Our systems are regularly tested without finding leaks. How do we know we are losing these large amounts of nitrous oxide?
We test the overall efficiency of the system by comparing the amount supplied to the amount clinically delivered (via anesthesia machines) rather than trying to find isolated physical leaks. When viewed as a whole system rather than as individual components, we find a large degree of waste and inefficiency. We know how much nitrous we put into the system vs the amount used clinically, and we see a huge discrepancy.

A large portion of this is due to N_2O's ability to permeate non-metallic materials when under pressure, so these components are continuously giving off N_2O, as described in the Phase 1 – Assessment. This type of leakage does not show up in testing performed by the health care facility.

Q: Are we required to have centrally supplied nitrous oxide?
No. The Canadian Standards Association (CSA) provides the guidelines for the design and construction of medical facilities. These guidelines do NOT require central nitrous oxide supply systems.

Q: Does this mean we are losing clinical access to nitrous oxide?
This is a decision for the project stakeholders. Many healthcare facilities have eliminated clinical access to nitrous oxide due decreasing clinical relevancy as standards of care have changed over the past few decades. However, if clinical access is still desired, the portable nitrous oxide supply cylinders will provide immediate, reliable access at all relevant clinical locations. This initiative is largely aimed at reducing N_2O waste, financial, and environmental costs - not availability.

Q: Are these portable e-cylinders big enough? Will we have to change them frequently? Will this be a logistical challenge?
The frequency of portable E-cylinder exchanges will vary depending on the amount of clinical use at a particular location within a particular facility. Within Providence, the single location with the highest clinical use should exchange an E-cylinder

approximately once every 2.5 weeks. Most locations will need to exchange E-cylinders far less frequently.

Q: What are the expenses related to this program?
Some anesthesia machines may require a simple retrofit in order to accept a N_2O e-cylinder. If you already have e-cylinders in place there is little to no investment.

There are additional labour costs to physically decommission the system and limited parts cost for the tamperproof plugs or blanks. Deciding to this work in-house or contract it out may also change the economics.

Many hospitals however have found the costs of decommissioning are far less than the ongoing maintenance and N_2O procurement and payback can be very quick.

Q: This sounds complicated. Is this hard to do?
In essence, the data clearly show the extent of the problem (phase 1), the portable supply system is reliable and efficient (phase 2), and deactivating the central supply system (phase 3) is straightforward- disconnect, depressurize and label the components appropriately.

ADDITIONAL RESOURCES

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