EXPLANATORY OVERVIEW OF DENTAL NITROUS OXIDE SCAVENGER BREATHING SYSTEMS

The current recommended U.K COSSH exposure levels for nitrous oxide are **100 ppm** (parts per million) over an **8-hour TWA** (Time Weighted Average). Suggested methods for complying with this exposure level are:

- Use of an efficient **Active** Scavenger Breathing System
  (Definition: scavenging at the nasal mask; air flow rate 40 - 45 L/min)
- Natural Room Ventilation is vital but assisted methods such as a low level expelair fan, Room Air Changes; 12-15 per hour, opening a window or door, may help significantly.
- Staff rotation.

Below is an 'overview' of the most widely used types of Dental Breathing Systems manufactured by two American Companies; Porter Instruments & Accutron**:**

Modern Dental Scavenger Breathing Systems are divided into two distinct types – **Active and Passive; (The latter type is now defined as obsolete in dental settings, however, a definition is included for teaching and historical purposes only).**

Passive Systems

–original type manufactured by **Matrx** – consisted of 22mm clear corrugated hoses w/one way valve – gas passed from fresh gas outlet (22mm) along tubing to nasal hood on patients face with a blanking cap to prevent escape of waste gases (the nasal hood could either be blue (originally grey) autoclavable or Dynomite scented single use), then, as the patient exhaled, a valve opened in the expiratory hose and the expired air was forced out, by the patients normal expiratory effort, into the further length of tubing. Commonly, this tubing was then either 'hung' out of the window, or connected to a low-level wall vent block. More recently, these systems were also connected to a wall mounted AGS (Anaesthetic Gas Scavenging) System such as a MEC Purair 130 or Dental 2000. These units needed to be mounted no higher than one metre above floor level to have any efficacy. The transfer hose from the patient needing to be level or slope downwards, thus assisting the flow of waste gases, nitrous oxide being heavier than air. In cases where the receiver was mounted high up on the surgery wall then 'back-flooding' of gases could occur resulting in ambient pollution.

Note: The system type was available for approximately 40+ years and was not efficient, with potential for large amounts of waste gas leakage, resulting in ambient surgery pollution. *Historical note: In January 2009, Porter Instruments announced they had purchased the Matrx Nitrous Oxide Division from Midmark. In September 2009, Porter announced that they were discontinuing the Passive breathing system – with immediate effect.* ***No spare parts are available and this system is now obsolete****.*

Active Systems – Note: Active Dental Scavenger Breathing Systems require an active draw of 40-45 l/min at the nasal hood to operate efficiently.

The various types are:

Porter brown: Uses a 'double mask' and has proven to be the most efficient so far. (*Ref 1*) Consists of a corrugated hose connected to fresh gas outlet (22mm) passing via coaxial hose to the inner liner. As the patient exhales, a flapper valve opens in the inner liner and the gas passes to the outer hood, where it is collected and passed down the second set of coaxial tubes to a vacuum hose. In addition, due to the gap between inner liner and outer hood, pollution caused by mouth breathing or speaking can be lessened, as a percentage of the waste gases are 'sucked' back into the hood and exhausted via the vacuum hose. An adjustable vacuum control block on the end of the vacuum hose (please note: this block is designed to operate in the vertical position – not horizontal), which allows the air flow rate to be adjusted to 40-45 L/min. This unit is autoclavable and latex free. Designed to be either

connected to a HVE Port on central suction; AGSS wall outlet (special AGS probe/adapter required), or Miniscav unit.
Comment: Most efficient system currently available on U.K. market and widely used.

Silhouette: A radically new type of nasal mask/breathing system launched in 2015. Anatomic, low profile, and lightweight, fitting comfortably over the patient's nose allowing excellent access to all areas of the patient's mouth. Disposable for infection control, with an adhesive strip to secure the mask in place. Available in four sizes and retrofits to most flowmeters. Does not require the use of a reservoir bag.
Comment: Potentially an extremely efficient mask and system, however, unproven. The close fit of the mask theoretically offers enhanced scavenging efficacy, resulting in reduced nitrous oxide exposure.

Matrx: ANS (Autoclavable Nitrous Scavenger) Smooth white tubing and a collector cap over the nasal hood (can be noisy). Again, a single tube from fresh gas outlet (22mm) to nasal hood (blue autoclavable or single use scented) then gas is collected via a 'mushroom cap' with valving that directs it to a further length of vacuum hose – designed to connect to central suction.
Comment: Problems associated with the use of 'single' nasal mask – inefficient, with leakage around nasal area.

Accutron: This system has a grey or white corrugated hose from fresh gas outlet (22mm) to white coaxial tubing. Fresh gas passes up to the nasal hood (grey multi use or scented single use), is collected via a clear collecting cap (can be noisy) and passes down distal set of coaxial tubes to a vacuum line designed to connect to central suction. This system also has a vacuum control block, set halfway along the corrugated vacuum hose.
Comment: Good system to use if you want to utilise disposable scented nasal hoods. However, Similar leakage problems as above, with use of single nasal mask type. Available from 2012, the Clearview disposable double mask comprises: Clear outer mask with scented, coloured inner liner. Eliminating the need for a collector cap, the double mask offers a better anatomical fit, thereby giving more efficient scavenging.

Axess: In 2017, the new Accutron Axess system was launched – somewhat similar in design to the Porter Silhouette, but autoclavable. The system is available in three mask sizes.

Definition of Active/Passive Scavenging

"A Scavenging system, simply defined, is a means to collect and remove excess gases to prevent them from being vented back into the operating room. Installation of an efficient scavenging system is the most important step in reducing trace gas concentrations. It has been demonstrated that ambient concentrations have been lowered by 90 percent through the use of an efficient system". (*Ref 2***)**

The method of connecting an Active scavenger breathing system to an 'active' vacuum source continues to be a matter of some confusion. The definition of Active is:
Exhaust ventilation of Nitrous Oxide from the patient's mask should be maintained at an air flow rate of 40 - 45 L/min, measured by a ***calibrated*** *flow device and vented outdoors*.
This can be achieved in one of three ways;

- Suitable dental vacuum system – (high volume port)
- Centralised Anaesthetic Gas Scavenging System wall outlet (used with AGS Probe Adapter but **no** Receiver (Air break) is required - see definition below)
- Miniscav unit

Receiving System air breaks (preventing transmission of suction from the exhauster unit to the patient), sometimes called Barnsley Receivers, do not produce the 40-45 L/min vacuum and are considered unsuitable for use with dental active breathing systems. An example of this type of unit is the MEC Purair 130, (or MEC Dental 2000) which utilises a tubular receiver (airbrake). The role of the Receiving Unit is to provide a safe interface between the patient and the extraction flow rate. This is due to the original use of this equipment being for GA circuits and was designed to protect the air flow of the unconscious patient. Centralised Anaesthetic Gas Scavenging Systems (utilising a remote pump and surgery ags terminals) may also be observed employing the use of an air break. This is commonly mounted on a bracket adjacent to the ags terminal and connected via a hose / probe assembly. Passive systems (clear corrugated hose) were then vented via connection to the inlet on the air break.

It is important in this case to understand the difference between the **Extraction Flow Rate** and the **Induced Flow Rate (***Ref 3***)**. The **Extraction Flow Rate** operates between 130 and 80 L/min BS6834: 1987 – (replaced by BS EN 737-2 :1998) which has an extraction flow rate of only 25 to 50 l/min)) and is to ensure that the waste gases are adequately removed from the surgery. The importance of this flow rate is that if it falls too low, it may not be sufficient for waste gas removal. This would lead to the waste gases spilling out from the base of the receiving unit reservoir into the immediate working environment with resultant pollution.

The **Induced Flow Rate,** primarily for use with G A circuits, should be as low as possible, with the system ideally being ***Passive*** between the patient and the receiving unit and ***Active*** from the receiving unit to the exhaust point. In these cases, the induced flow rate can be as low as 0.5 L/min BS6834: 1997. (BS EN 737-2 has a maximum induced flow rate of 0.05 L/min). ***The value of the induced flow is the level of fresh gas flow that the receiving system is actively sucking on the patient circuit***. This is where an element of confusion arises. As the Purair 130 and 2000 are termed an 'Active' system, users are under the impression this makes the dental breathing system itself, 'active'. This is not correct. Currently, the only dental breathing system suitable for connection to a Purair 130 or the 2000D is the Matrx Passive type – and this is now discontinued and obsolete. As outlined above, the induced flow rate on the breathing system is minimal (0.5 l/min or 0.05 l/min), the main effort to drive the gases along the scavenging hose being through normal patient respiratory effort. Only once the gases reach the terminal outlet, does the extraction flow rate take over.

All the Active dental breathing systems have been designed by the Manufacturer (s) to be connected to a dental vacuum system – which must can generate enough flow to operate at the recommended 40-45 l/min for the duration of the procedure. This usually means occupying the high-volume suction port and as most dental surgeries currently only have one such port, this is consequently not popular. (Some chair manufacturers, for example, ADEC, provide a dual HVE option, with certain models, which addresses the issue.) The other main criteria is that the system is expired **outside** the surgery and building. It is not recommended that Tridac (Aspirade) models be used due to exhausted gases being exposed to motor arking.

If for some reason it is not suitable to utilise the dental vacuum system, the alternatives are: -

1) Connection to a centralised AGSS wall outlet (via a special probe adapter – please note: These AGS/Probe adaptors are designed to locate directly into the AGS outlet and **do not** require an airbrake (Barnsley Receiver) in circuit. They must be used with an Active Dental Breathing System which is capable of being adjusted to a flow rate of 40-45 l/min by a suitable flow limiter (vacuum control block) integral to the system. No other system type should be used e.g. old passive system type.

2) Connection to a Miniscav™ Active Scavenger unit – requiring an electrical socket and an external exit vent (15mm). The vent should have a downturn on the outside with an insect filter. Must only be used with an Active Dental Breathing System.

Excerpt from HTM02-01 (*Ref 4*)

Chapter 10 – Anaesthetic Gas Scavenging Disposal Systems
10.5: *Active Scavenging for dental installation is an entirely different concept. An active system is one in which there is a flow generated through the patient's nasal mask and this carries away the waste gases exhaled by the patient. This flow is in the order of 45 L/min and is achieved by connection of the mask (via a suitable flow-limiting adaptor) to either; a dental vacuum system or directly to an active scavenging system*
(BS/EN) wall terminal.

Appendix L – Important notes for use of medical vacuum and anaesthetic gas scavenging. Sections 8, 9 and 10 refer to Active Dental Scavenging Systems.

Ref 1: '*Clinical evaluation of the efficacy of three nitrous oxide scavenging units during dental treatment'* Certismo, Walton, Hartzell, Farris
General Dentistry September-October 2002.

Ref 2: NIOSH Technical Report: Control of Nitrous Oxide in Dental Operatories

Ref 3: BS 6834: 1987 / BS EN 737-2: 1998

Ref 4: Medical Gases Health Technical Memorandum 02-01: Medical gas pipeline systems. Part A: Design, installation, validation and verification. 2006.

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