New Report:

Inert (Hypoxic) **Air Venting for Protection of Heritage**

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by
COWI
on behalf of
HISTORIC SCOTLAND
RIKSANTIKVARIEÄMBETET
in support of
cost

This is Hypoxic Air:

Inert Air = Hypoxic Air

Inert air. I.e. air you can safely breathe, but in which common materials can not ignite or burn: Typically 5 % N_2 substitute 5 % O_2 in normal air.

This is Hypoxic Air Venting:

Protected rooms or buildings vented continuously with premixed inert air, produced at site 24 hrs a day. Protected areas: Occupied or non-occupied

A NEW Fire Protection Method:

It is **not** an extinguishing system
It is **not** an inert gas extinguishing system
It is **not** a full-time inert gas system
It is **not** passive fire compartmentation
It is **not** an active fire protection system
It is **not** fireproof paint……..

Occupations in Hypoxic Air: Travel, Living, Health, Fire Safety



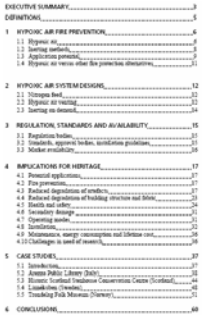


Mexico City:	2400 m altitude
Rinconada Village:	5100 m altitude
Aircraft Cabin:	Equivalent to 1520-2440 m
Climbing:	≤7200 m (without protection)
Athlete Training:	Equivalent to ≤7000 m

24h Fire Prevention: Typically equivalent to 2400 m (hypoxic air = inert air)

Independent Introduction to:

System concepts
Implications and benefits to heritage
System designs for storage rooms, buildings
Four pilot object evaluations in Europe
Reduced degradation
Health
Regulations, standards
System providers
Market



Airconditioning Redefined

Was: Control of temperature, humidity

Now: Control of temperature, humidity and fire safety

Historical Buildings and Museums: Applications to Gain the Most from Inert Air Venting

Prevent ignition (no initial smoke, heat damage)
Prevent backdraught
Fully benign to environment (pure air components – slight change of concentrations)
Not toxic
No residue
No risk of corrosion
Allow considerable room leakage (protects even if doors open for evacuating content)
Do not run empty
No refilling, transport of agent. No resetting of system.

continues…

benefits to historical buildings and museums…continued:

Applicable to **small, vital rooms**

Applicable to **very large room volumes, multi-room buildings**

Applicable to protection of **high value artefacts, work of arts**
(no other protection system to better protect items sensitive to smoke, particles, water, corrosive gases or mechanical impact)

Positively contribute to **the diminishing of normal deterioration of organic and non organic objects and decorations** in historical buildings.

Inherent simplicity offer **high reliability**

No nozzles, pipes or equipment required within protected area

Drawbacks

1. **Health risk** to predisposed individuals in public spaces (as for aircrafts)
2. **Power consumption** of hypoxic air generator compressors
3. **Special fuels** in laboratories etc may require lower oxygen concentration
4. Formerly used **nitrogen feed systems**: Uneven concentrations, complexity

Heritage Building Case 1:
Arezzo Public Library - Listed Historic Building (Italy)

145 000 items, some 13th century. Gross volume 6000 m^3.

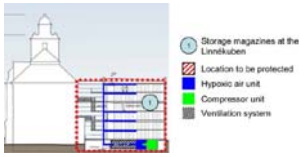
Recommendations: Should gain the most from inert air venting benefits. Moderate challenges to incorporate installation. Central or local inert air units. Power demand 25 up to 300 kW within air change rate extremes.

Heritage Building Case 2:
Historic Scotland - Stenhouse Conservation Centre (Scotland)

Archive file storage room including computer terminal and server. 100 m^3.

Recommendations: Moderate challenges to incorporate self-contained installation. Power demand 0.5 up to 4.9 kW within air change rate extremes.

Heritage Building Case 3:
Linnékuben (Sweden)



5200 m³ new storage of 4000 herbarium specimens of Carl Linnaeus. Non-public areas.

Recommendations: Should gain the most from inert air venting benefits. Most simple to incorporate. Power demand 22 up to 260 kW within air change rate extremes.

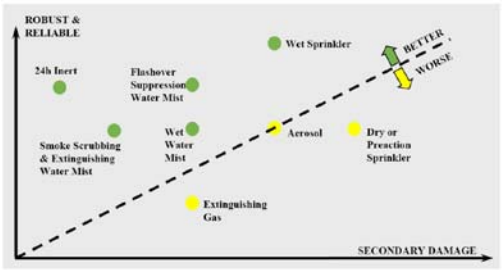
Heritage Building Case 4:
Trøndelag Folk Museum (Norway)

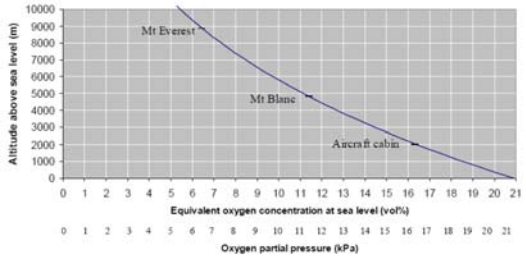
Non-public artefact multi-room storage in cellar at open air museum. 1200 m³.

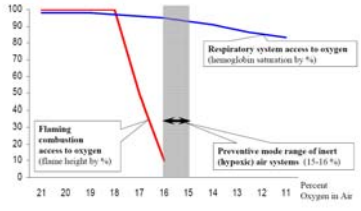
Recommendations: Offer the least challenge – most simple to incorporate. Power demand 5 up to 60 kW within air change extremes. Energy recycling to be considered.

Part II

Historical Buildings and Museums: Fire Protection Options





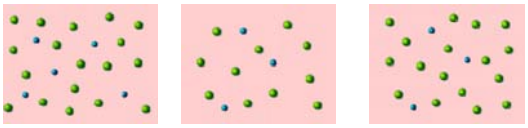


Human respiratory system hardly affected –

- combustion process effectively prevented.

Comparing inert air to normal air at sea level - and to air at mountain summits

Green dots: Nitrogen molecules Blue dots: Oxygen molecules

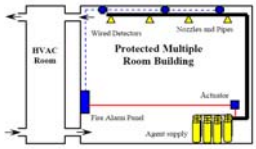


Normal air, sea level
Normobaric Normoxic Atmosphere

Normal air, high altitude
Hypobaric Normoxic Atmosphere

Hypoxic air (inert air), sea level
Normobaric Normoxic Atmosphere

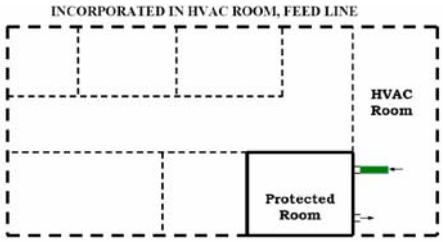
Hypoxic Air System versus Extinguishing System Installations



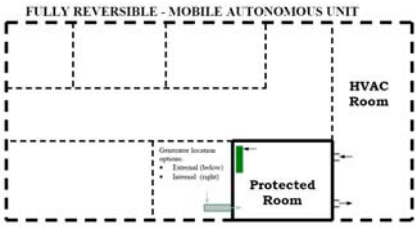
EXTINGUISHING SYSTEM
Conventional

FIRE PREVENTION AND EXTINGUISHING
Hypoxic Air Venting

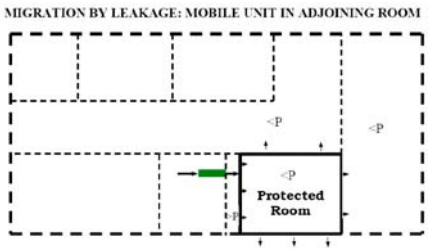
Installation Methods - A



Installation Methods - B



Installation Methods - C



How to Install Hypoxic Air Venting for Fire Protection?

Basically one need one or more hypoxic air generators.

But, although hardware-wise installations are straightforward:

Design of inert air venting systems strictly linked to: Air change rates, airconditioning, infiltration, duration of occupation, fuel types, fire safety goals and health requirements at the premises.

Therefore, planning must involve professional engineering within **FSE, HVAC and HSE disciplines**.

History of Hypoxic Air for Fire Protection

End of 1990-ies: Nitrogen feed systems (to create hypoxic air)

1999-present: Hypoxic air venting patented

>50 installations in Europe - early ones were nitrogen feed systems

Unsettled market - intellectual property rights

Hypoxic air venting and nitrogen feed systems available on market

Developments and Application Testing: Year 2000 to Present

- **Telecom** (installed systems)
- **Computer suites** (installed systems)
- **Libraries**, **heritage**, **historical** (installed systems)
- **Freezer warehouses** (installed systems)
- **Aircrafts** (installed cargoes; approved/recommended by FAA)
- **Aerospace**
- **Mining**
- **Maritime**
- **Military**
- Etc