New Report: 
**Inert (Hypoxic) Air Venting for Protection of Heritage**

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**This is Hypoxic Air:**  
Inert Air = Hypoxic Air  
I.e. air you can safely breathe, but in which common materials can not ignite or burn: Typically 5 % N₂ substitute 5 % O₂ 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

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**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…….

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

- **Mexico City:** 2400 m altitude
- **Rinconada Village:** 3100 m altitude  
  Equivalent to 1200–2440 m
- **Climbing:** 7200 m (without protection)  
  Equivalent to ≥5000 m  
  Typically equivalent to ≥2400 m

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**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

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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

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**Benefits to historical buildings and museums:**

- Applicable to small, vital rooms
- Applicable to very large room volumes, multi-room buildings
- Applicable to protection of high value artefacts, work of arts (as 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
- No health risk to predisposed individuals in public spaces (as for aircrafts)
- Power consumption of hypoxic air generator compressors
- Special fuels in laboratories etc may require lower oxygen concentration
- Formerly used nitrogen feed systems: Uneven concentrations, complexity

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**Heritage Building Case 1:**

**Arezzo Public Library - Listed Historic Building (Italy)**

145,000 items, some 13th century. Gross volume 6000 m³.

**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.

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**Heritage Building Case 2:**

**Historic Scotland - Stenhouse Conservation Centre (Scotland)**

Archive file storage room including computer terminal and server. 100 m³.

**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  Normal air, high altitude  Hypoxic air (inert air), sea level
Normobaric Normoxic Atmosphere  Hypobaric Normoxic Atmosphere

Hypoxic Air System versus Extinguishing System Installations

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