

# Hermetically Sealed, Oxygen-Free Inert-Gas Display and Storage Case

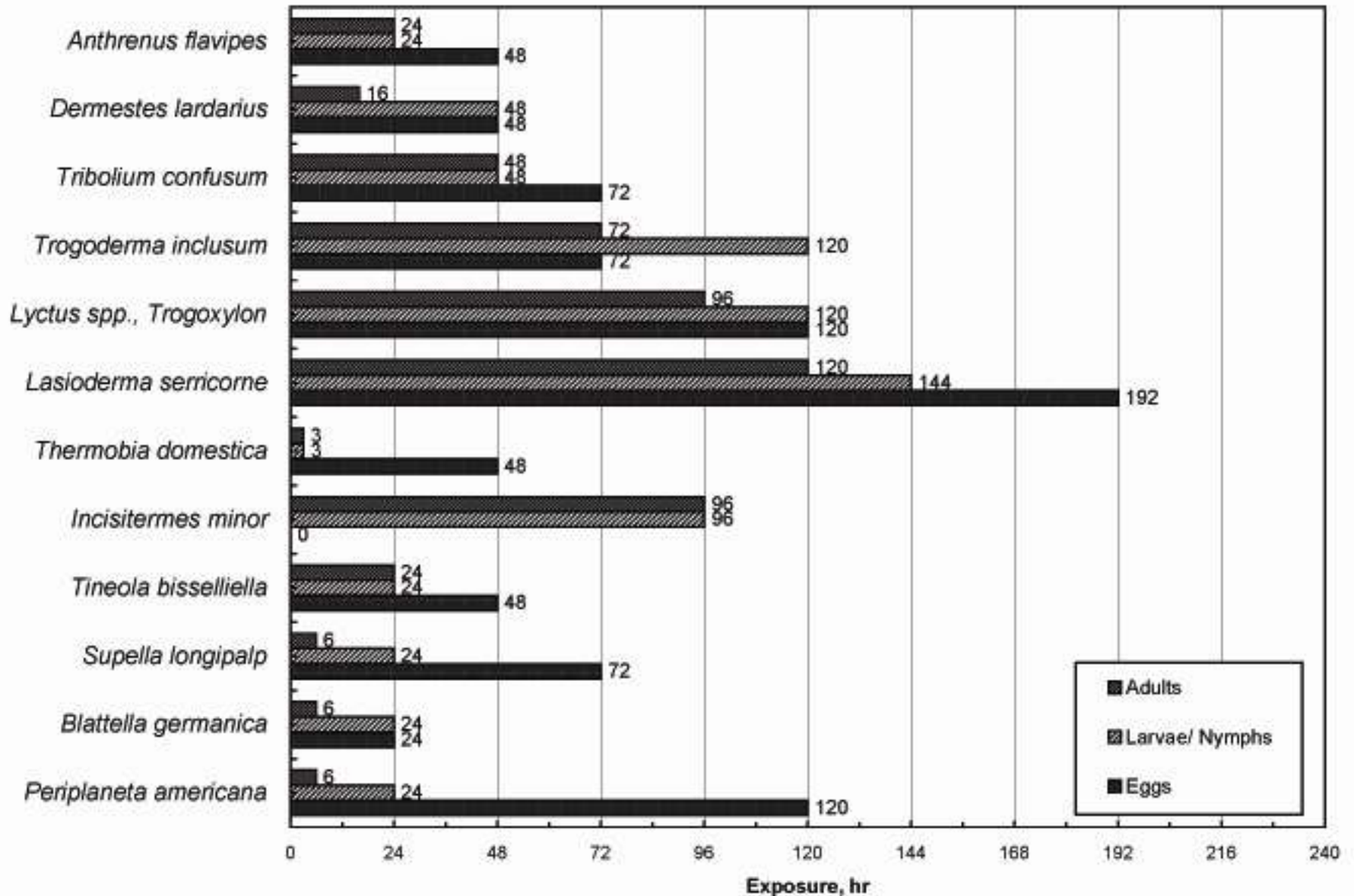
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# Environmental Parameters

- Temperature
- Relative humidity
- Light
- Air pollutions
- Particulate matters
- Shocks and Vibrations
- Oxygen

# Insect Mortality vs. Insect Species and Life Stages

At 25 C, 50% RH, and less than 0,1% Oxygen in nitrogen environment



# Chemical Deterioration of Organic Materials

- Proteins and Fats - Auto-Oxidation
- Celluloses – Hydrolysis - Oxygen Required?

# Air Sampling of Off-Gassing Volatile Organic Compounds from Egyptian Royal Mummies



# Auto-Oxidation of Fats: Egyptian Royal Mummies

- Found high concentrations of
  - Small carboxylic acids
  - Alcohols and ketones
  - Esters of alcohols and small carboxylic acids
- Break down of fats into smaller volatile fatty (carboxylic) acids while emitting alcohols and ketones.



## Anoxia

At temperature 22 C  
Relative Humidity 35%  
7,500,000 lux-hr  
(8 hours/day at 50 lux for 70 years)

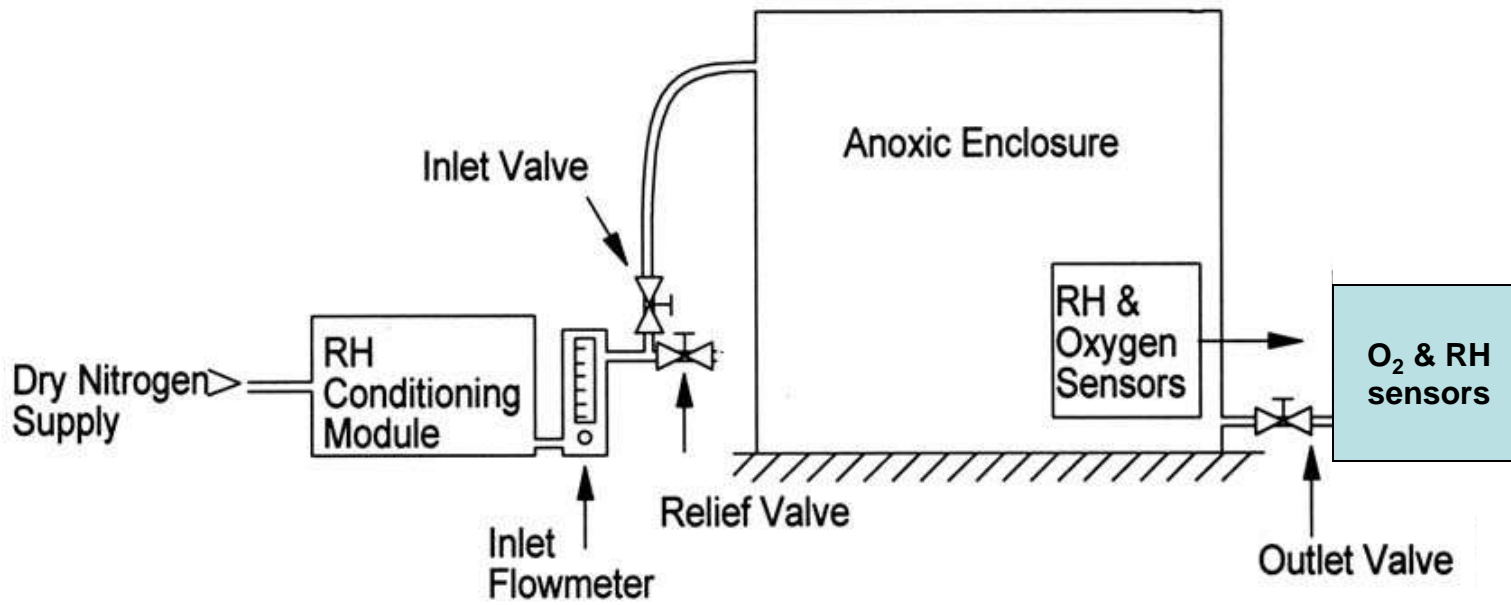
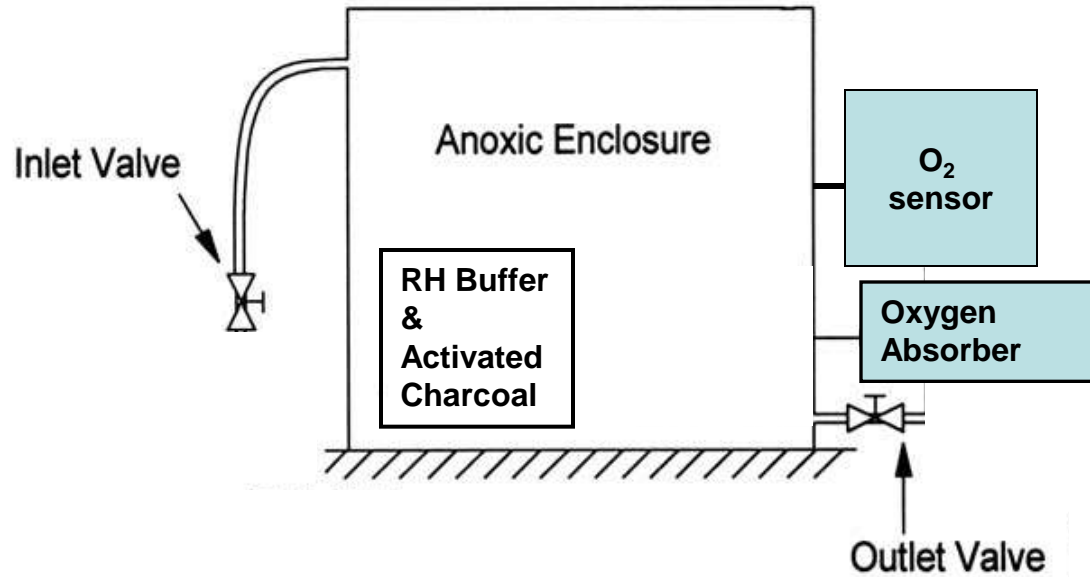


## Air

# Design Concepts

- should not be dependent on any mechanical or electrical systems;
- should require little maintenance, no more often than every two years;
- it should be possible to manufacture and test the cases in developing countries;
- the cost per case should be kept as low as possible.

# Static vs. Dynamic Anoxic System



# Temperature Effect on Sealed Cases

- 10 C increase produce 3.4% increase in either the volume or the pressure
  - Rigid enclosures
    - 34 millibars or 0.50 psi (pound per square inch)
    - 351 kg on 1 m x 1 m area
  - Bellows or balloons (allowing pressure to remain equilibrium with the environment)
    - 34 liters for 1 m<sup>3</sup> case

# Barometric Pressure Effect on Sealed Cases

- The STD atmosphere - 1013.25 millibars
- Hurricane Ike (Category 4 in 2008)- 935 mbar
  - Pressure difference of 78 millibars or 805 kg over 1 m x 1 m area
  - Volume change of 8.3%
- Air transport – 2000 m elevation
  - Pressure reduction of 195 millibars
  - Volume change of 24%

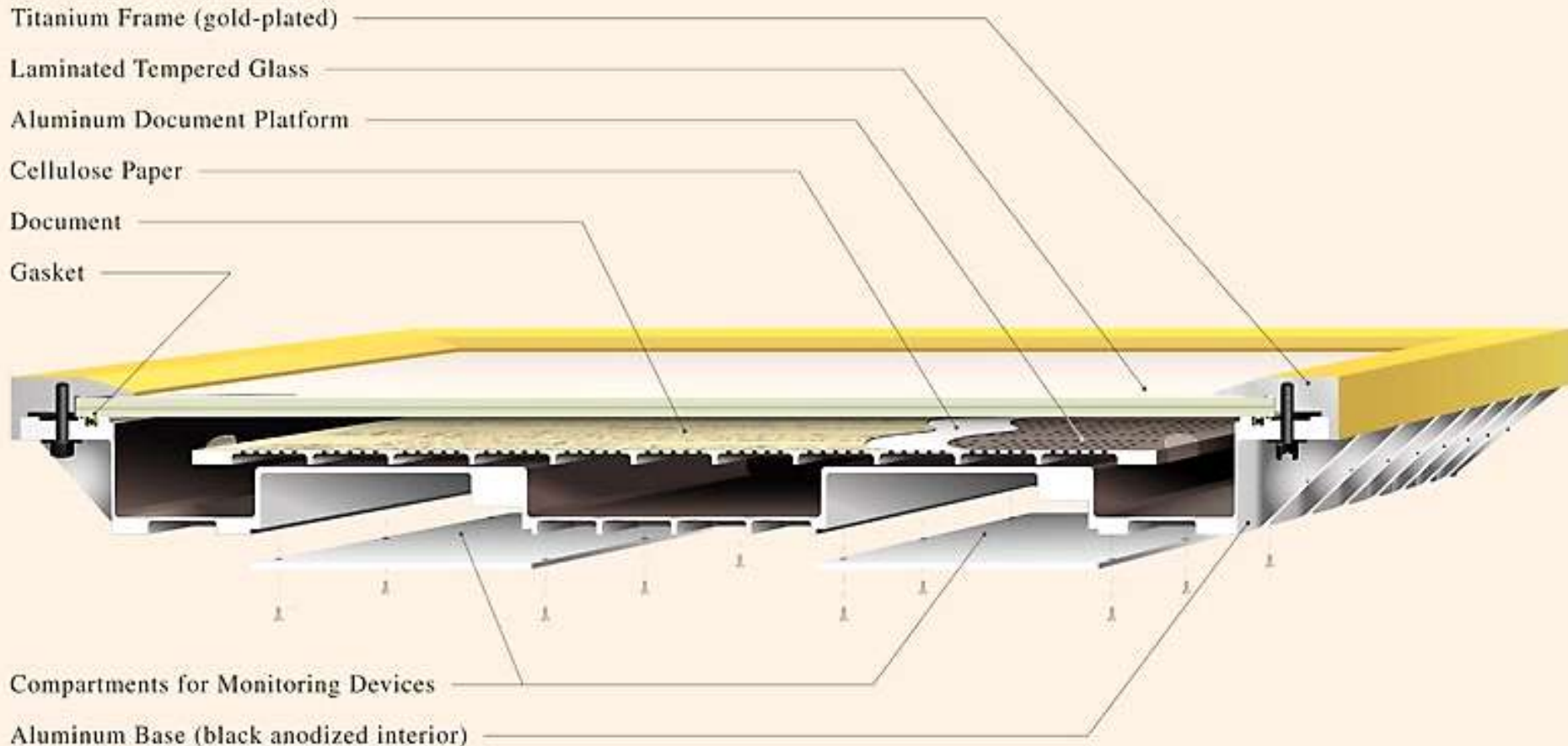
# Options

- **Fixed Volume**
  - Heavy (Strong) construction to withstand pressure changes
- **Flexible Volume** (Case pressure is maintained an equilibrium with the environment)
  - Light construction with a bellows (made with an oxygen barrier sheet)

# Fixed Volume Example: The U. S. Charters of Freedom

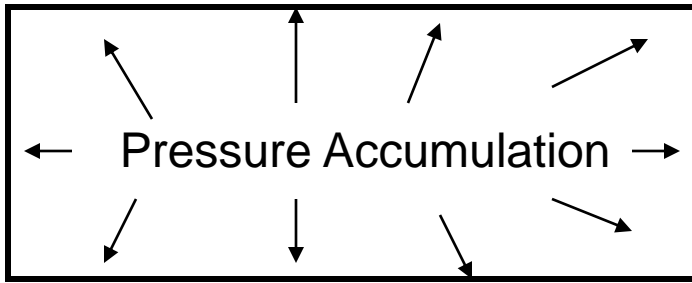
(National Archives and Records Administration/National Institute of Standards and Technologies)

## Cross Section of Encasement



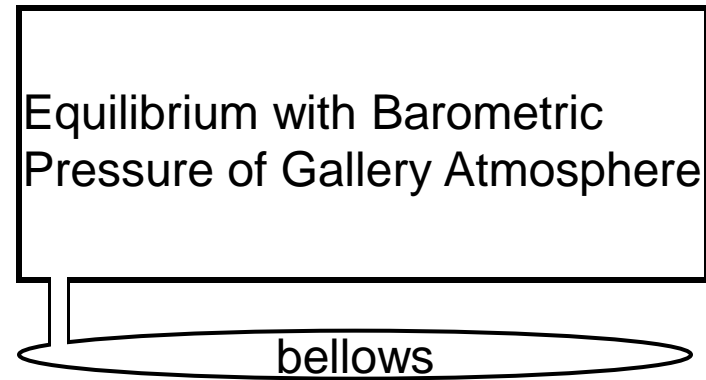
# Flexible Volume Example: GCI-Design of Hermetically Sealed Cases

Temperature increase or  
barometric pressure changes



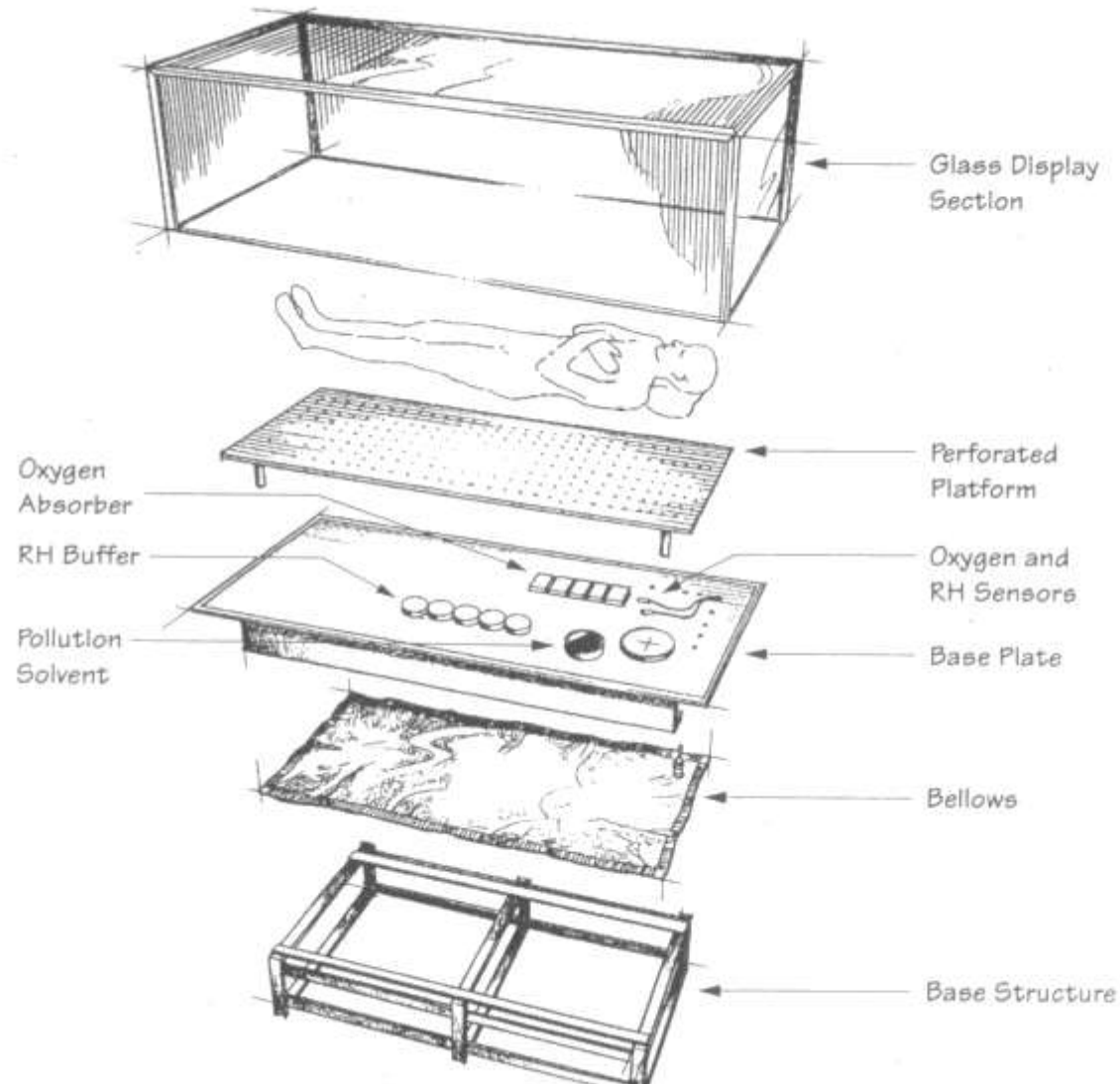
Strong construction required.

Attach an expandable/contractible  
bellows to the case to allow volume changes



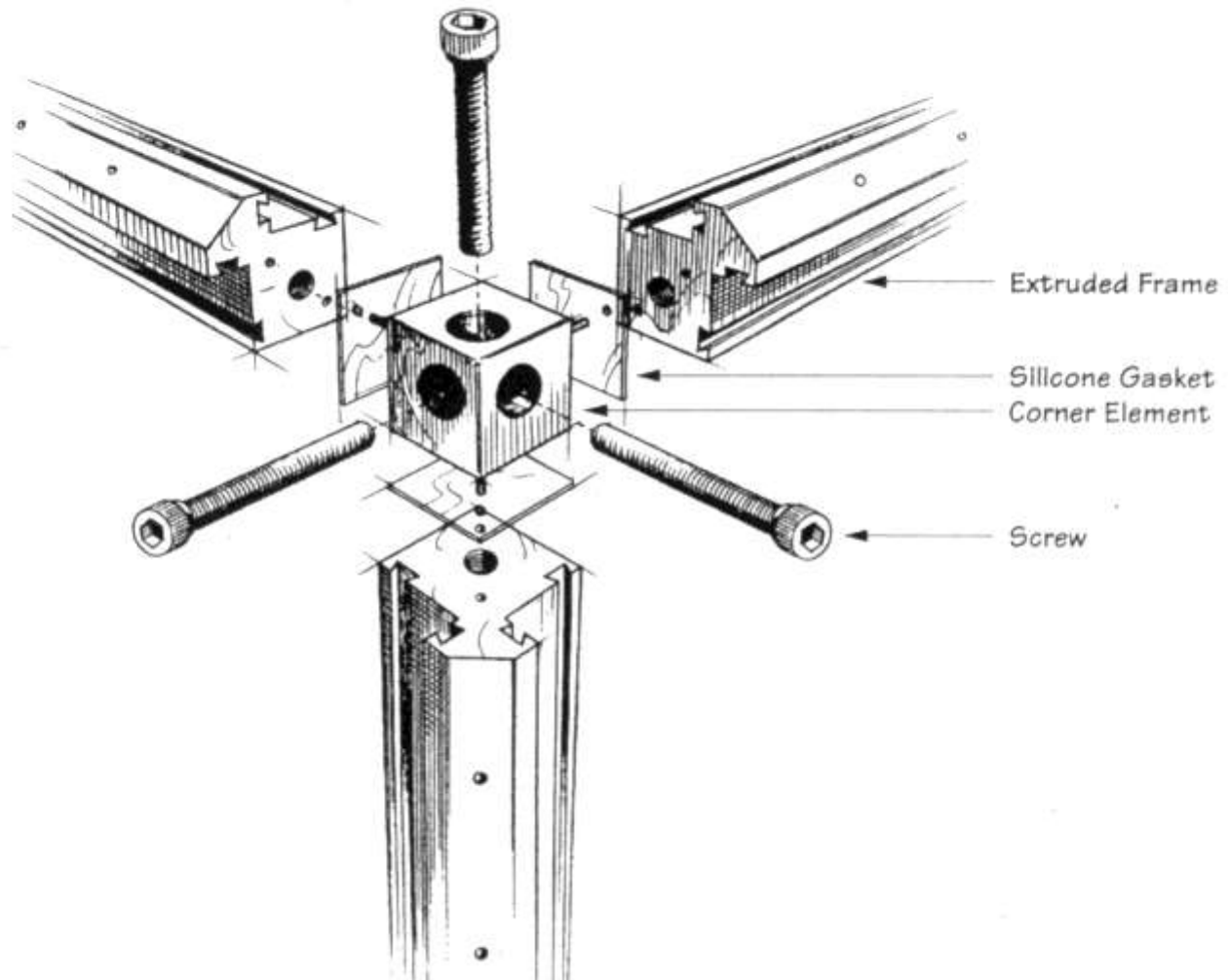
Light construction possible.

# The GCI-Designed Hermetically Sealed Inert Gas Filled Oxygen-Free Case



# Joining of Extrusions at Corners

## Bolt-On Design----No-welding

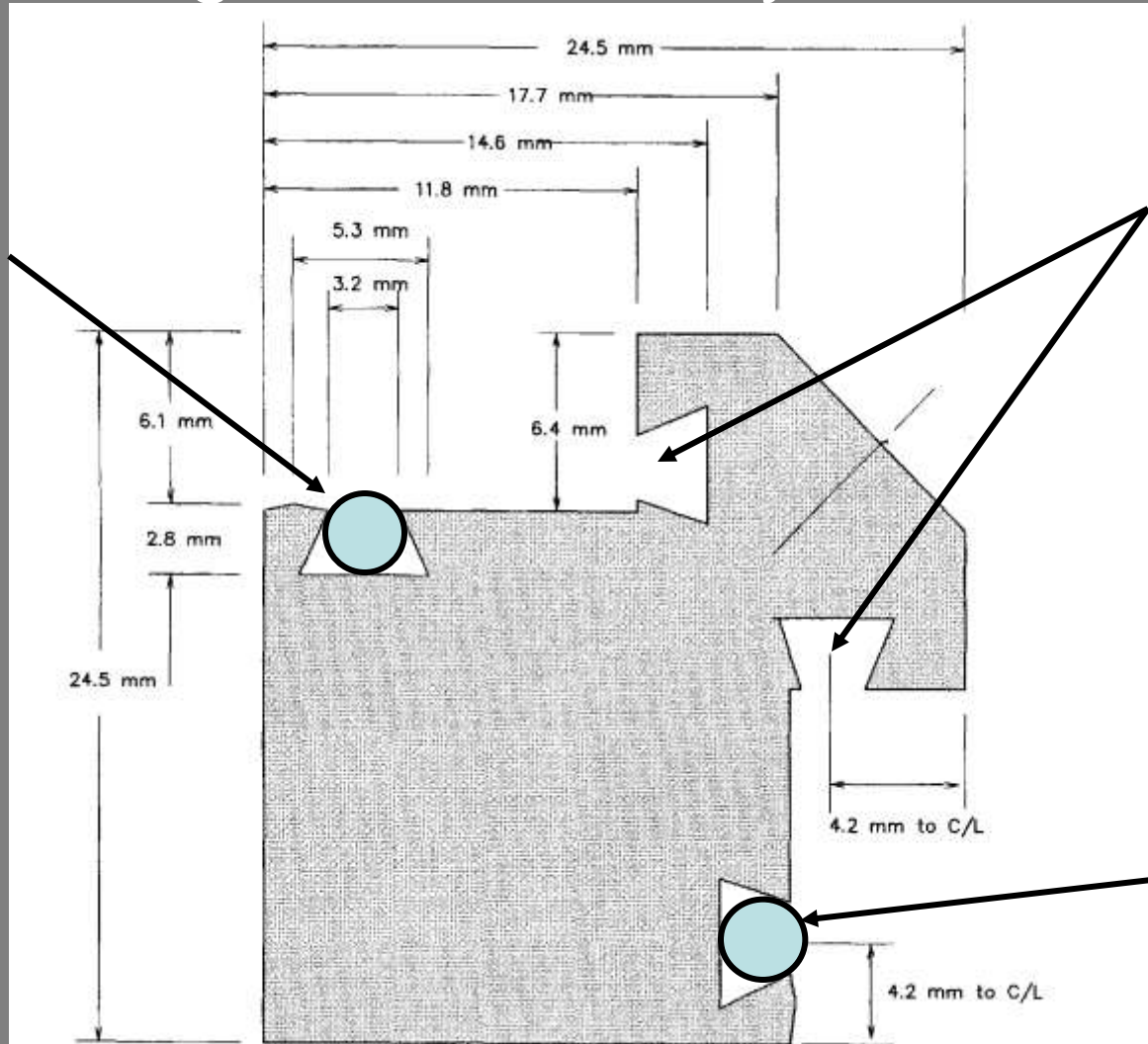


# Frame - Custom Designed Aluminum Extrusion

## Cross Section

### O-Ring Seal and Easy Assembly

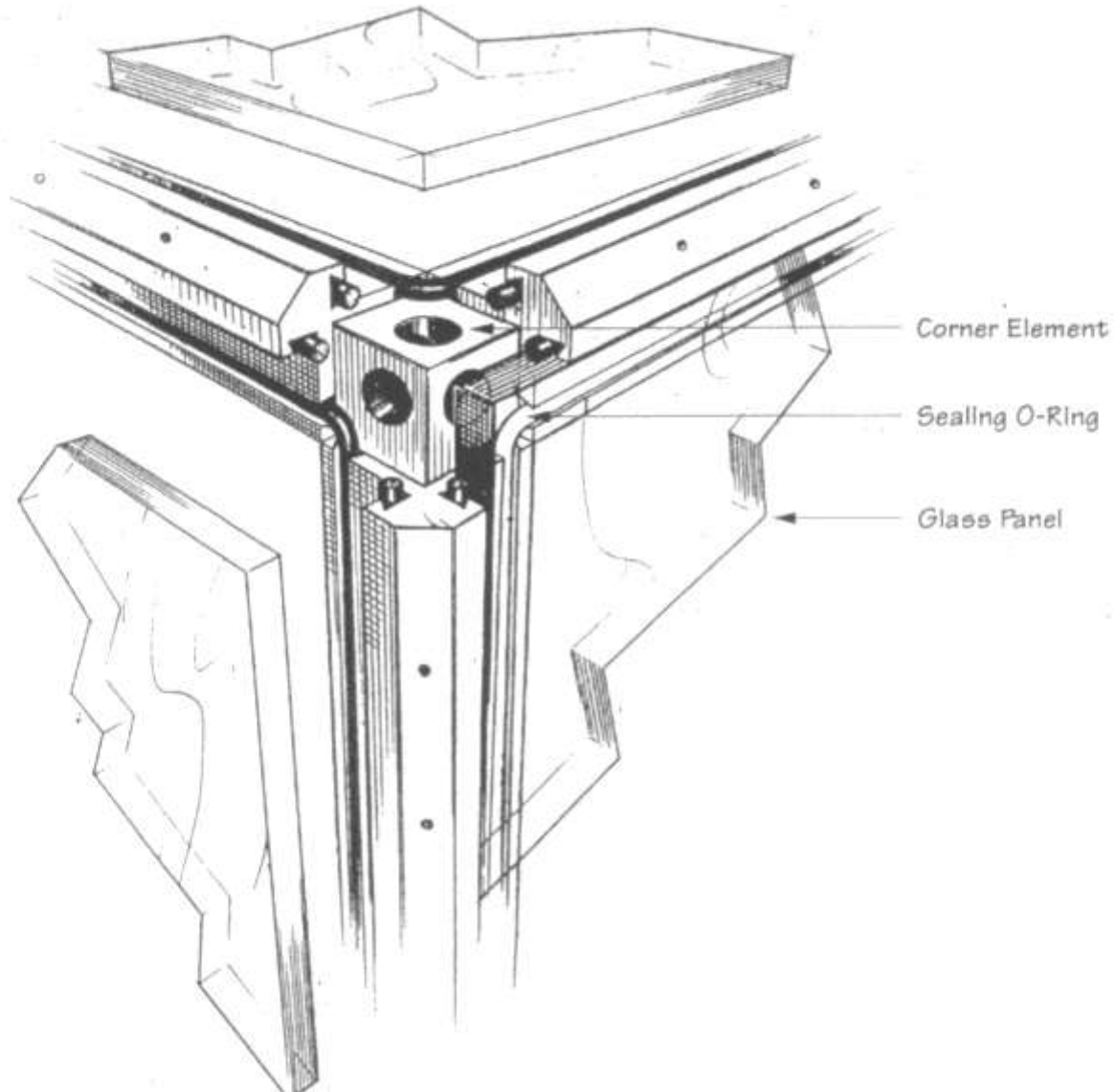
Sealing O-ring



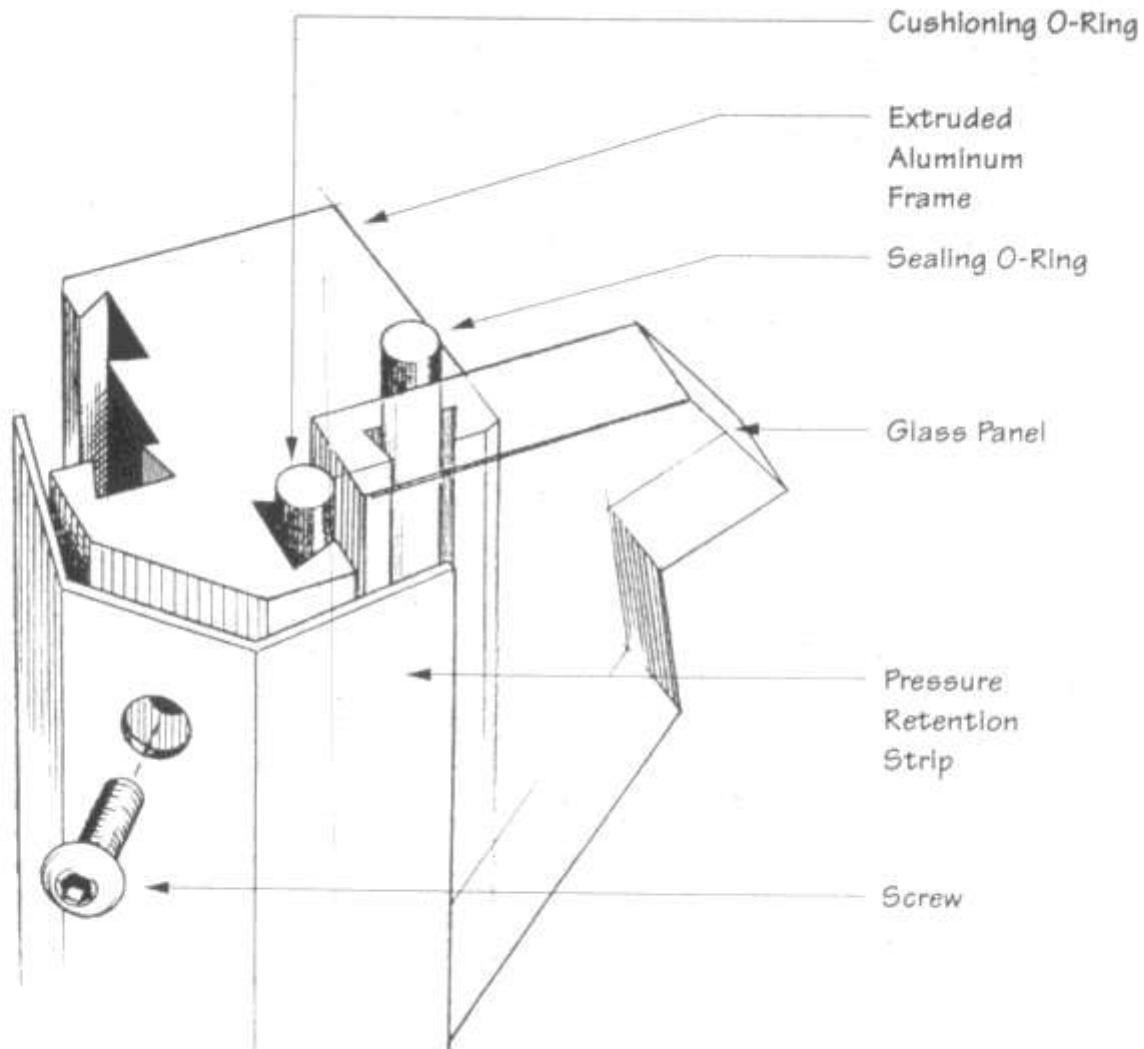
Groove for  
Cushion

Sealing O-ring

# Extrusion Frame and Panels

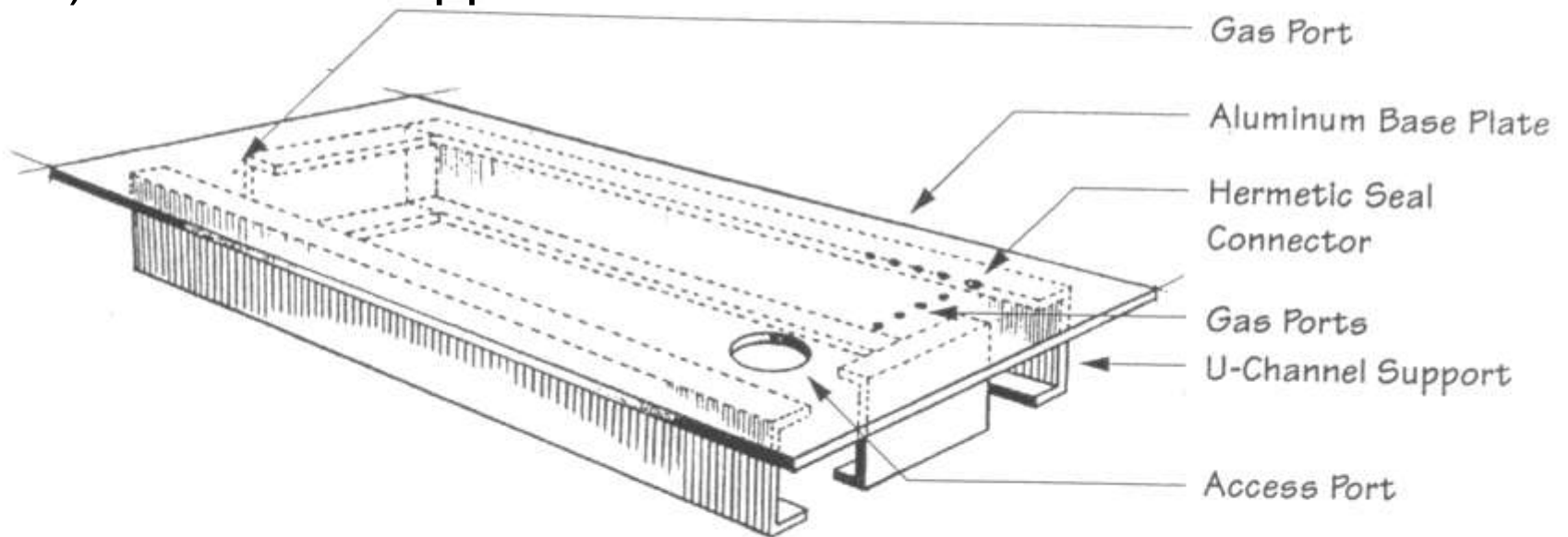


# Use of Pressure Retention Strips to Simplify Tightening of O-Ring Based Hermetic Seal



# Aluminum Base Plate Design

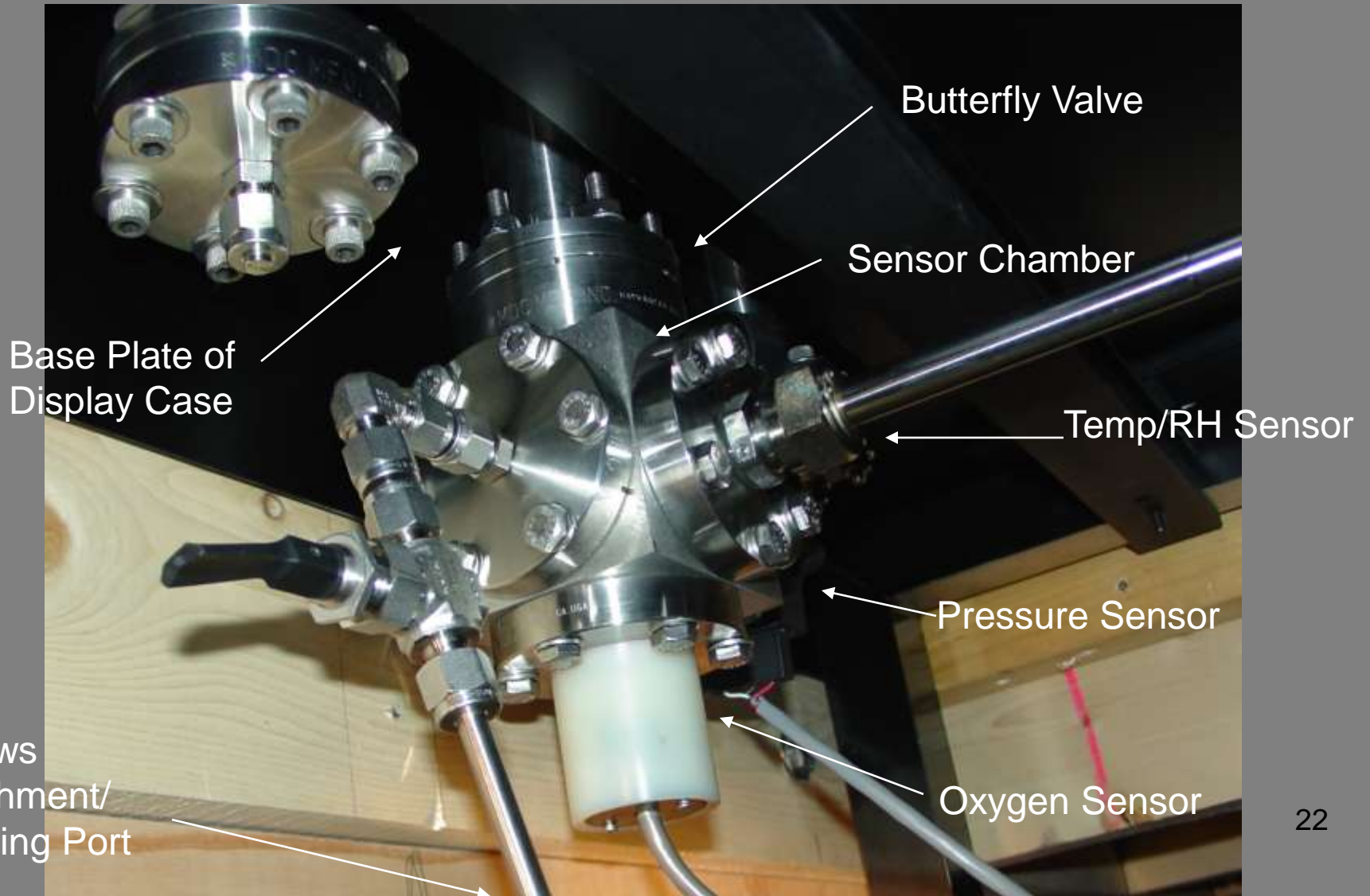
- 1) Service access for placement/replacement of silica gel and activated charcoal
- 2) Purging ports
- 3) Sensor connections/access
- 4) Structural support



# Monitoring

- Separable Instrumentation Chamber
  - Periodic calibration
  - Sensor replacement
- On-line Monitoring
  - Attached sensor chamber
  - Single case
- Periodic Monitoring
  - Detachable instrument chamber
  - Multiple cases

# Sensor Chamber for On-Line Monitoring and Servicing



# On-Line Monitoring and Alarms

Oxygen Monitor

Audible/Viewable  
Alarms & Manual  
Cut-off

Datalogger/  
Controller

Backup Power  
supply

Internet Modem

Temp/RH  
Monitor

Relay Switches  
with manual  
Override switches

# Detachable Monitoring Chamber



Portable Pump



Aspiration-Type O<sub>2</sub> Monitor



Temp/RH Monitor

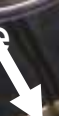


Instrument Chamber

From Case



Back to Case

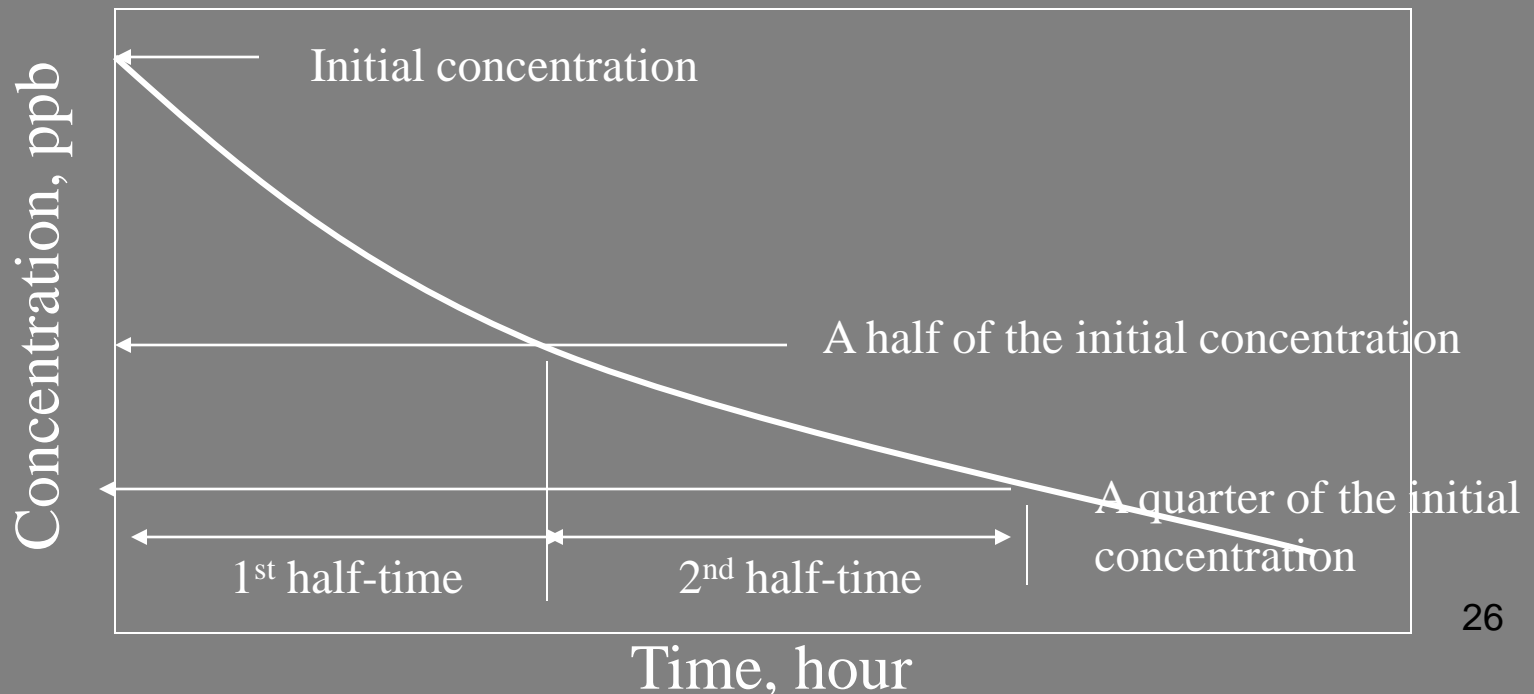


# Performance Evaluation and Designing of Service Interval

- Determination of air-tightness
  - Air exchange (change) rate vs. oxygen leak rate
- Determination of oxygen absorber amount
  - Amount calculation
  - Placement methods

# Determination of Air Change Rate

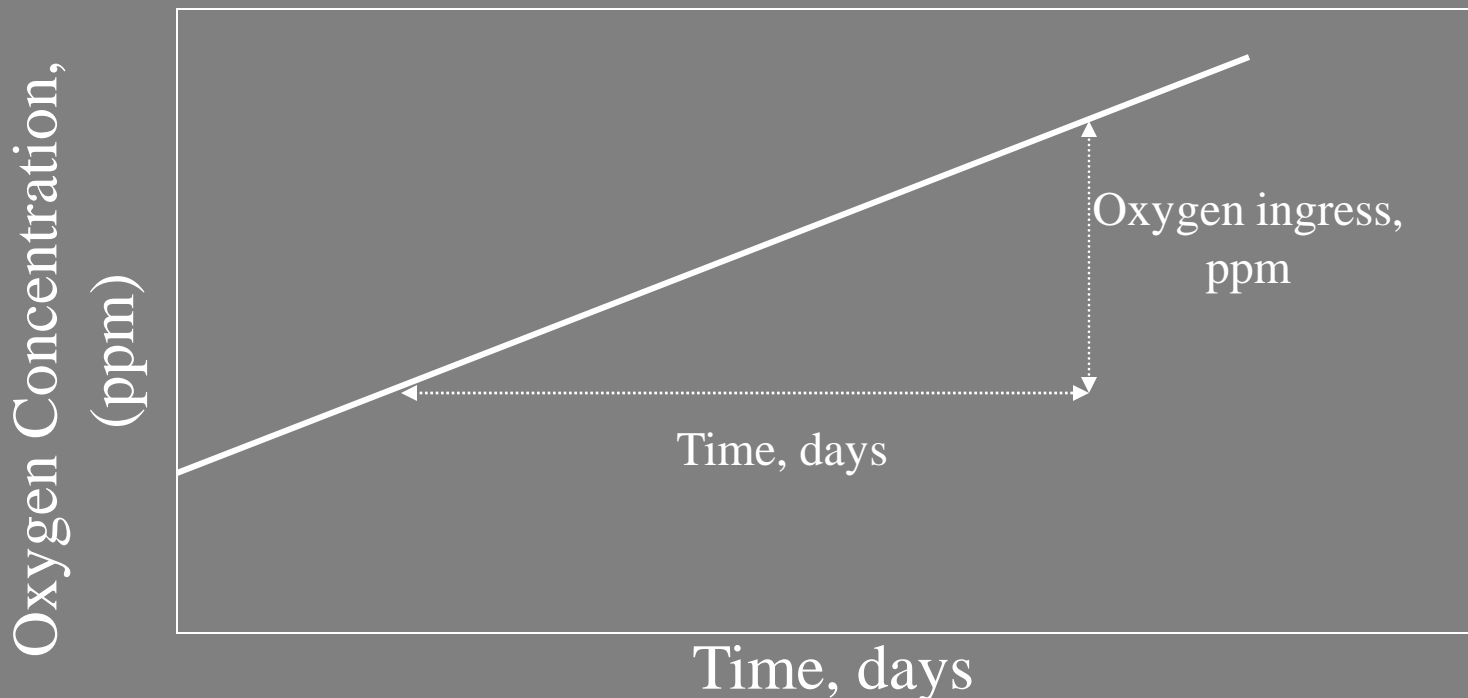
- Dilution method: determination of the half-time for the time takes one air change
- Inject a tracer gas, such as  $\text{SF}_6$  gas, into a display case and mix it well.
- Measure the concentration of the gas in the case as a function of time.



# Determination of Air-Tightness of Oxygen-Free Cases

- Rate of oxygen ingress in the case (ppm/day):  
= (Oxygen ingress) / (Elapsed time)

Typical GCI cases: 3 – 6 ppm/day

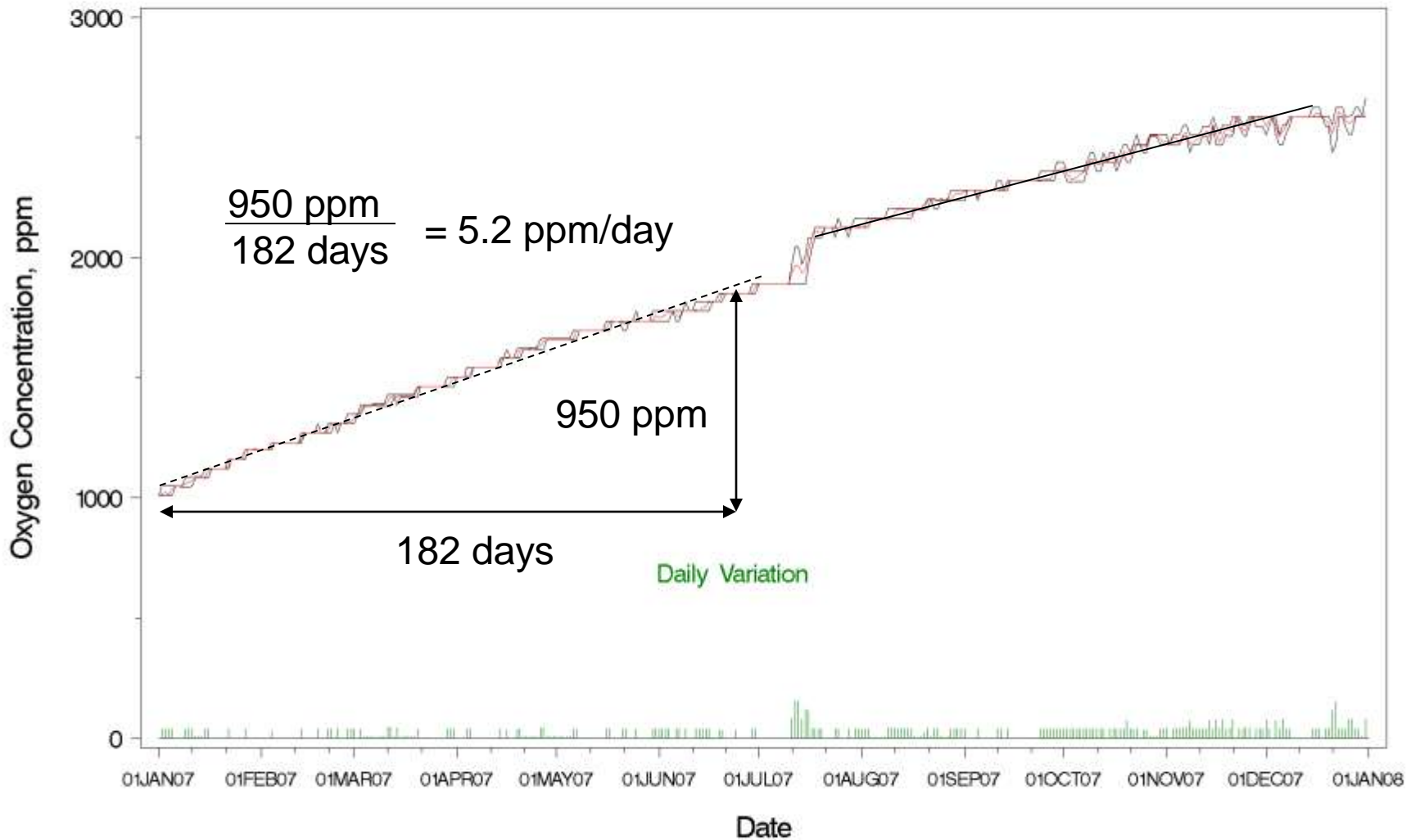


# Daily Maximums, Minimums, Averages and Variations of Oxygen Concentration

First Photograph Case Located at the Harry Ransom Center

2007

Without oxygen absorber placed in the case



# Oxygen Absorbers



<p>穴のないORの袋等に 封して下さい。 中に多量の水で洗浄し、 乾燥して下さい。</p>	<p>separating it from other materials. Close the mouth of the bag, and dispose of it by incineration. (Do not accumulate more than one pound of RP in a single bag.) ● If the contents enter the eyes or mouth, wash the affected area immediately with water and consult a doctor.</p>	<p>穴のないORの袋等に 封して口を縛り、早めに焼却して下 さい。 ● 中味が目や口に入ったら、直ちに多量の水で洗浄し、 医師に相談して下さい。</p>
<p>ス化学</p>	<p>MITSUBISHI GAS CHEMICAL</p>	<p>MGC 三菱ガス化学</p>
<p>RP System Agent™ DO NOT OPEN DO NOT EAT</p>	<p>RPシステム 金属酸化 防止剤</p>	<p>RP 剤 錆防止剤 身べらねせん</p>
<p>After use, collect "RP" in a plastic bag without any holes, separating it from other materials. Close the mouth of the bag, and dispose of it by incineration. (Do not accumulate more than one pound of RP in a single bag.) ● If the contents enter the eyes or mouth, wash the affected area immediately with water and consult a doctor.</p>	<p>● 廃棄の際は他の物と区分し、穴のないポリ袋等に 集めて口を縛り、早めに焼却して下さい。 ● 中味が目や口に入ったら、直ちに多量の水で洗浄し、 医師に相談して下さい。</p>	<p>● After use, collect "RP" in a plastic bag without any holes, separating it from other ma- terials, and dispose of it by in- cineration. (Do not accumulate more than one pound of it in one bag.) ● If the contents enter the eye or mouth, wash with wa-</p>

# Determination of Oxygen Absorber Amounts

- Estimate the volume (cubic centimeter, cc) of oxygen in the case over one year
  - Length x width x height x oxygen leak rate x 365 days
  - Example: 1 m x 1 m x 1 m x  $5 \times 10^{-6}$ /day x 365 day
- Identify the capacity of oxygen absorber
  - Example: 2000 cc per packet
- Determine the number of packets needed in a year
  - Volume / packet capacity
  - Example : 9 packets of 2000 cc packet per year

# Egyptian Royal Mummies



# The Constitution of India



# The Declaration of Arbroath (Scottish Declaration of Independence)



# First Photo Graph at Harry Ransom Center, University of Texas, Austin



# Summary

- Completely passive sealed system
  - Oxygen absorber, RH buffer, and activated charcoal
  - Neither electrical nor mechanical system needed for maintaining the anoxic environment
- Light weight construction (therefore, lower cost)
  - Use of bellows for pressure equilibrium
- Environmental monitoring and audible alarm possible if needed
- Oxygen-leak rate less than 5 ppm per day possible.
- Maximum size – about 2 meters
  - Limitation from a design uses 6 mm (1/4 inch) glass
  - Can be re-designed for a larger cases
- Minimum size tested - 22 liter volume