



Wheeling Jesuit University • National Technology Transfer Center • Center for Educational Technologies

April 20-21, 2006

# International Mining Health & Safety Symposium

## Mine Safehouse

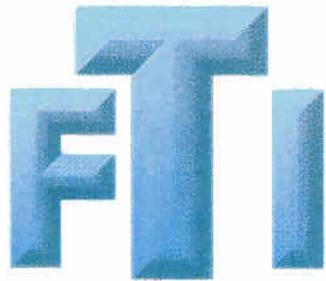
### *Products to Save Lives*

AB46-HEAR-4G-SUBMISSION

# Safehouses, Saferooms, Cache Houses

*-products to save lives*

***Built in cooperation with the following companies:***



**Fiber-Tech Industries, Inc.**



**WebCore Technologies, Inc.**



**For more information call Brett ( handler: (304) 755-8811 or email: [blchandler@clarktruck.com](mailto:blchandler@clarktruck.com)**

# **Mine Safehouse**

**SAFETFOAM Panels**

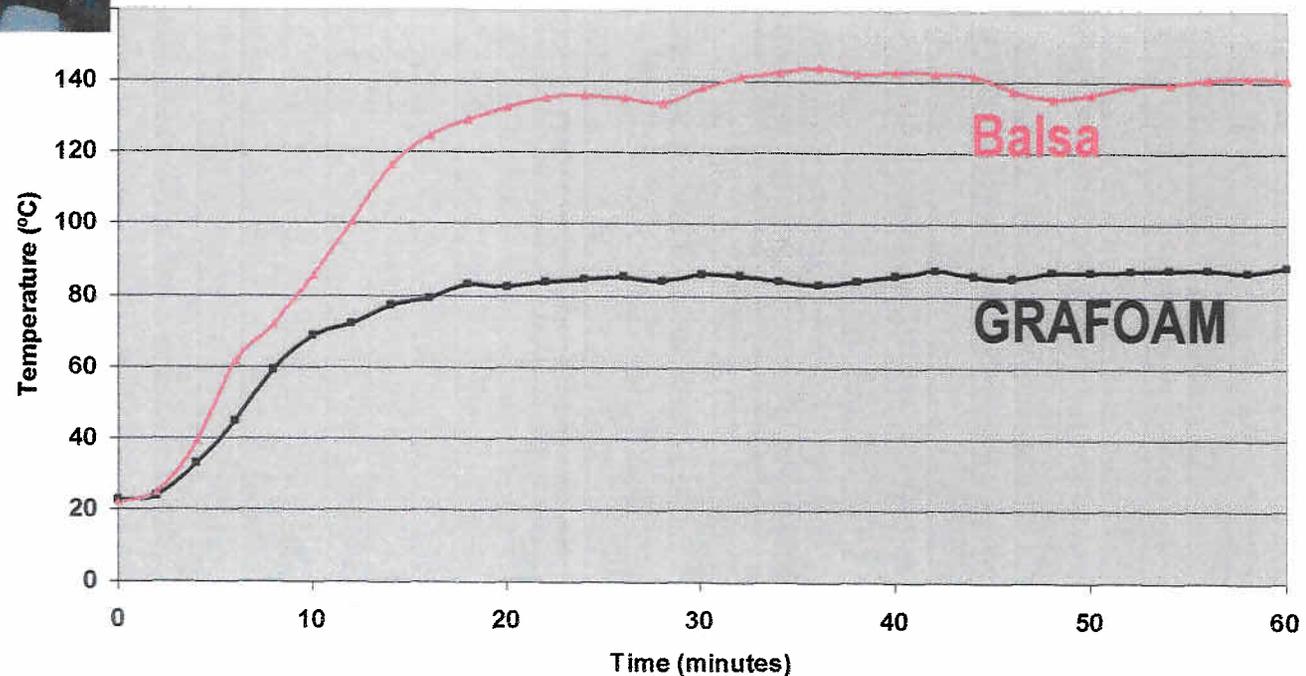
# GRAFOAM Carbon Foam as Core Material

- **Fire resistant**
  - Outstanding fire rating
- **Insulator**
  - GRAFOAM™ maintains its thermal protection at elevated temperatures
  - Will not melt or ignite
- **High strength and stiffness**
  - No thermal creep
- **Impact resistant**
- **Electromagnetic shielding**
- **Corrosion resistant**

# Fire Testing

- ✓ SAFETFOAM Panel *will* protect miners
- ✓ Maintains a safe environment inside
- ✓ Protects against heat transfer!!

Temperature on Backside of Panel

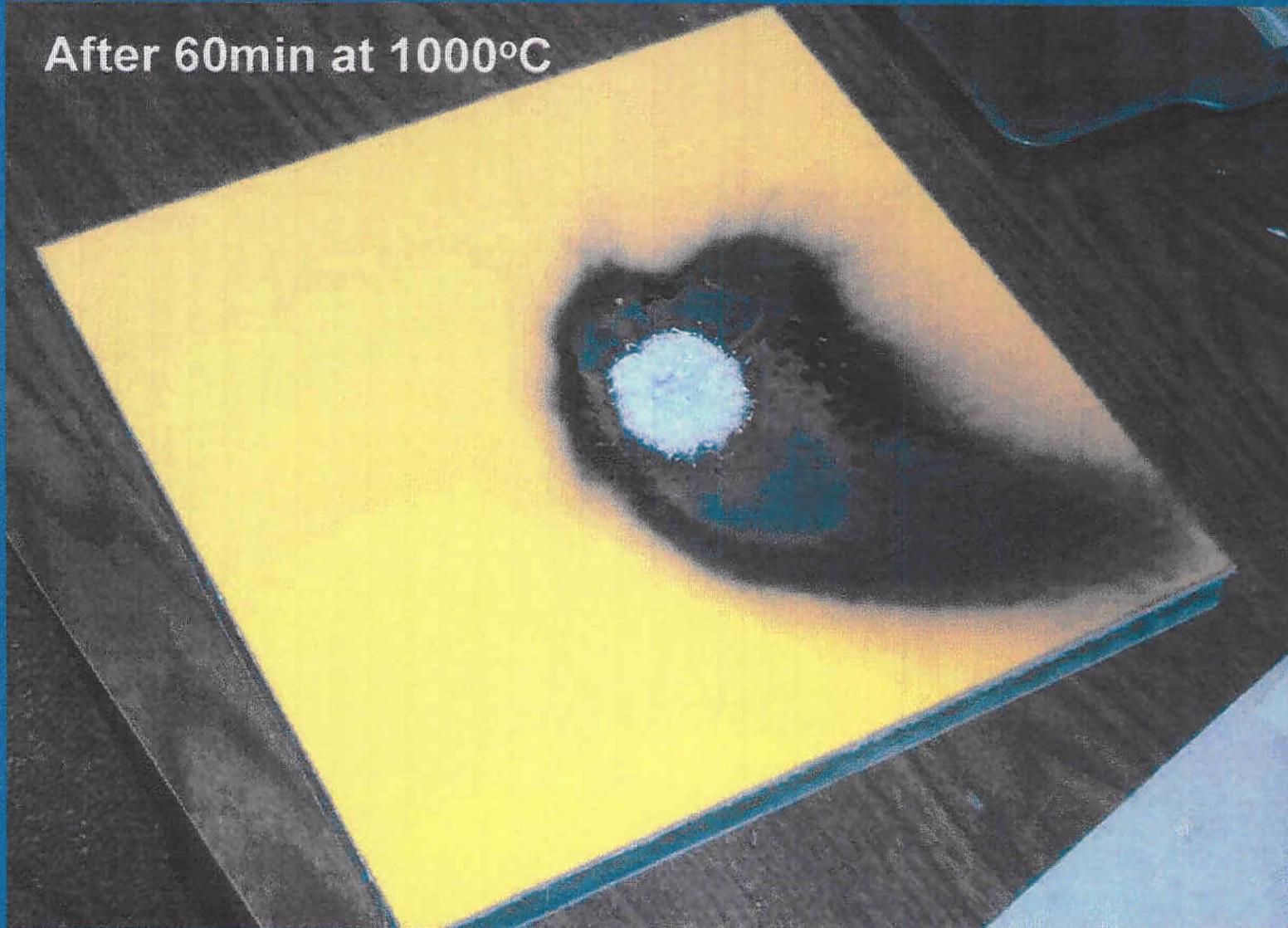


1000°C Flame

One Hour

# SafeTFoam Panel will Protect Miners

After 60min at 1000°C



# SafeTFoam Panel – Designed to Protect

GRAFOAM™ core

Impact Resistant -  
strength enhancement  
ribs

Insulates

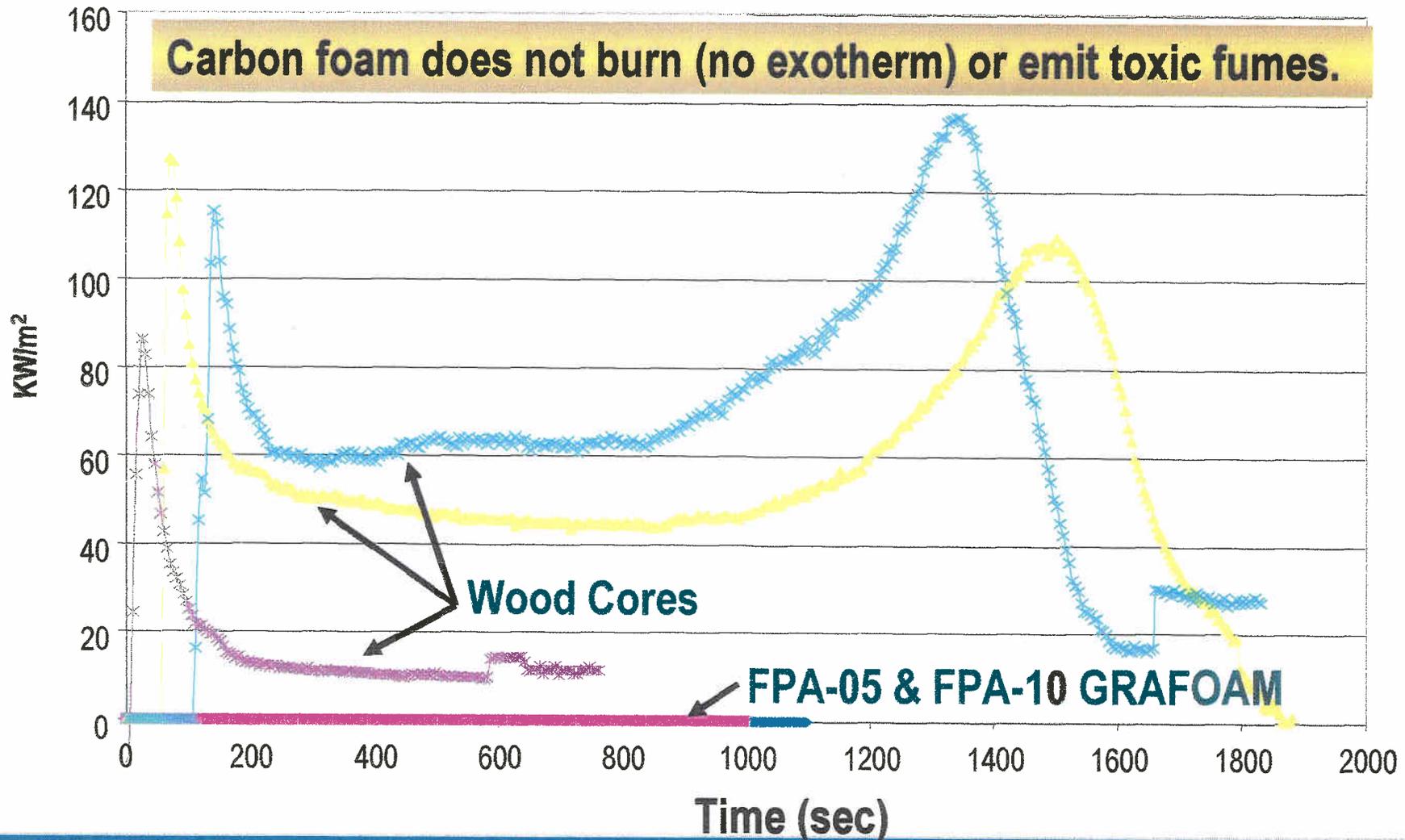
Fire Protection

Corrosion Resistant



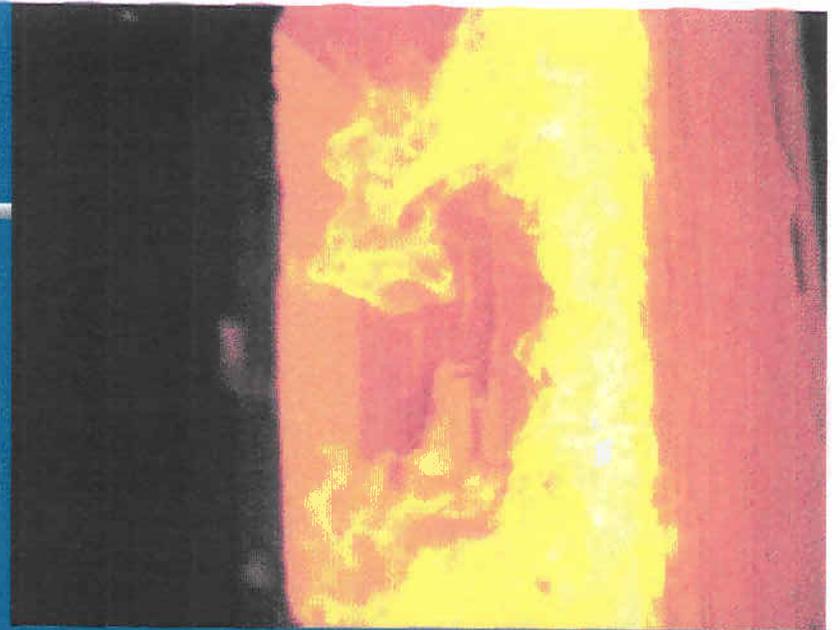
# Outstanding Fire Resistance – Cone Calorimeter Test

## Heat Release Rate at 25 kW/m<sup>2</sup>

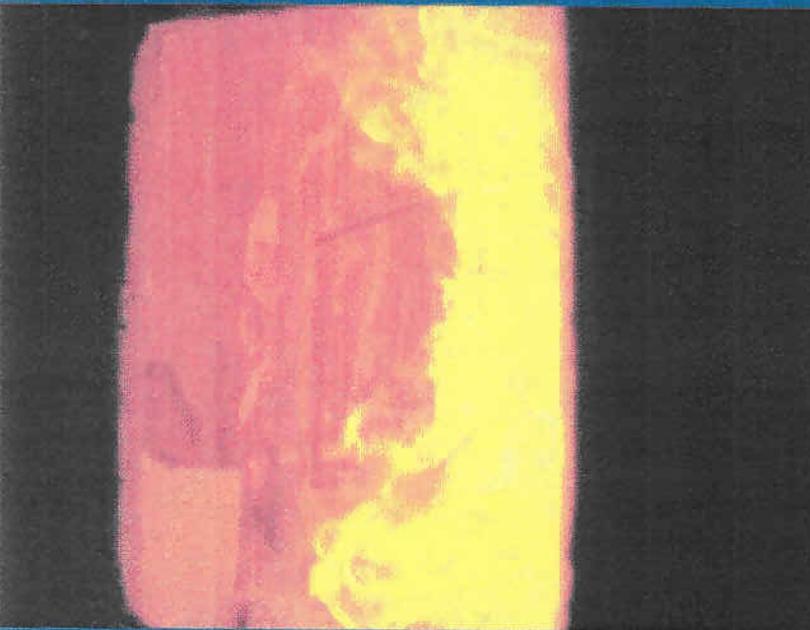


# GRAFOAM™ Prevents Heat Transfer through Panel

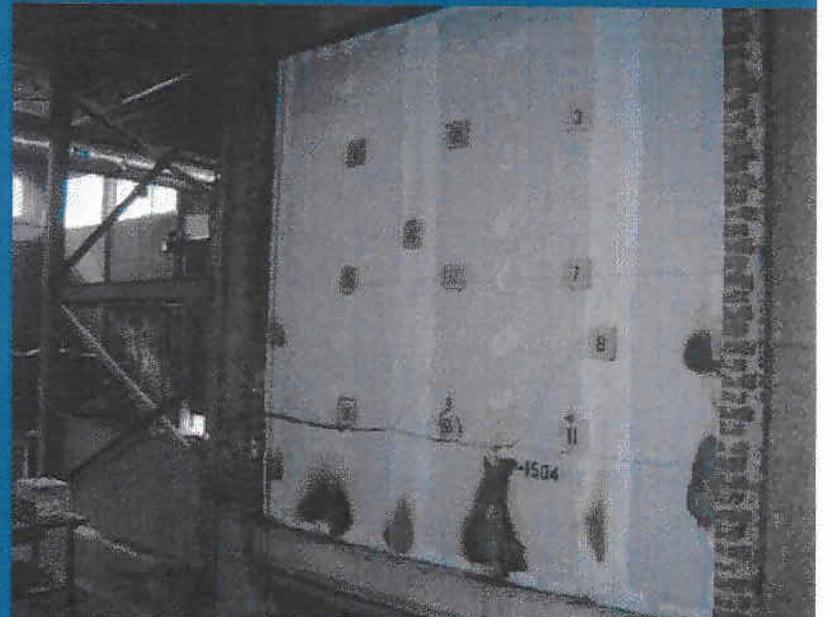
Material	Thermal Conductivity (W/mK)	Magnitude higher than Grafoam
GRAFOAM™	0.1	
Glass	1.1	11 X
Steel	46	460 X
Aluminum	250	2500 X



## ASTM E-119 Fire Testing



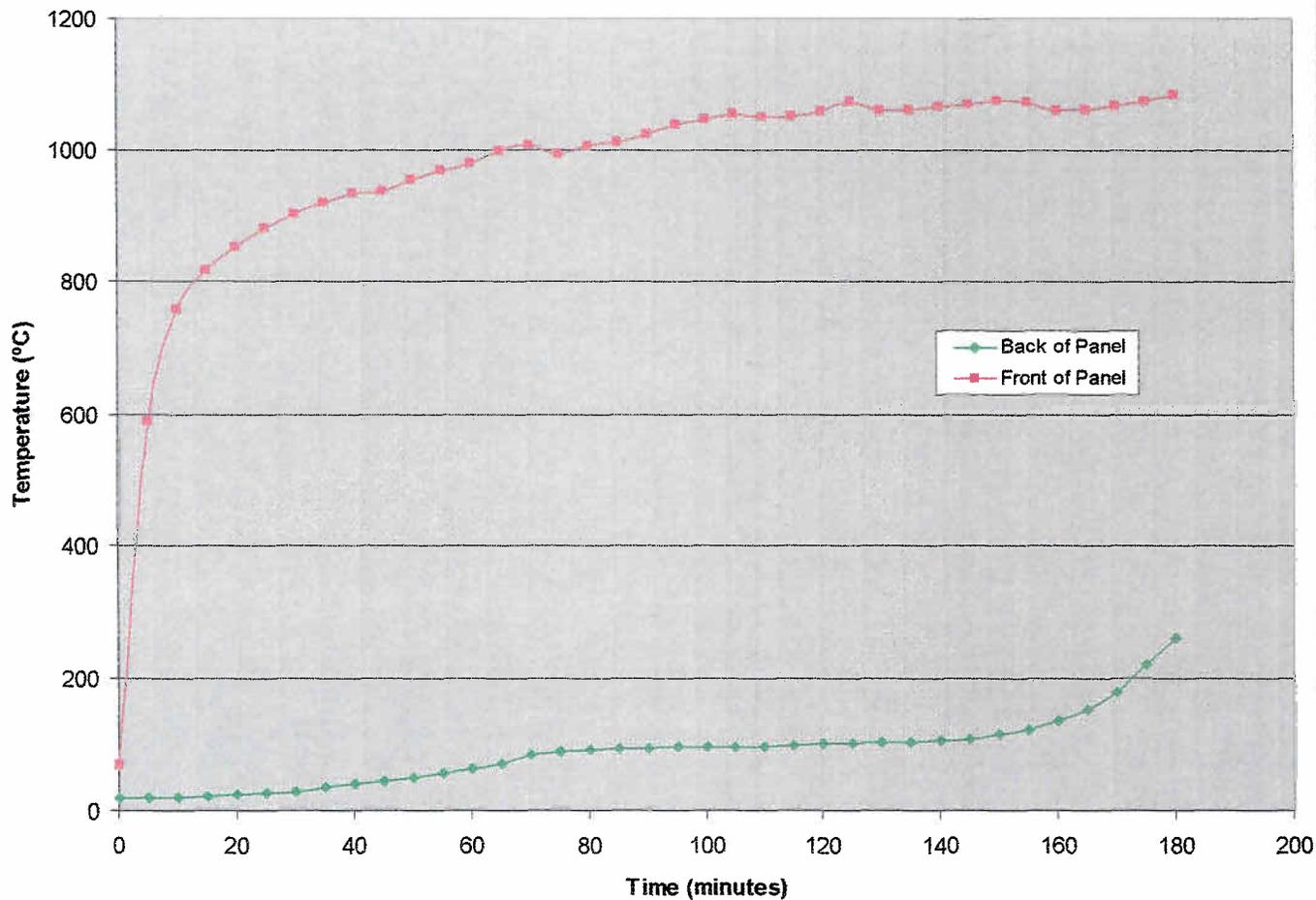
*Cold side –  
no burn  
through at  
3hrs*



# GRAFOAM™ Lasts over 2 Hours in Grueling Test

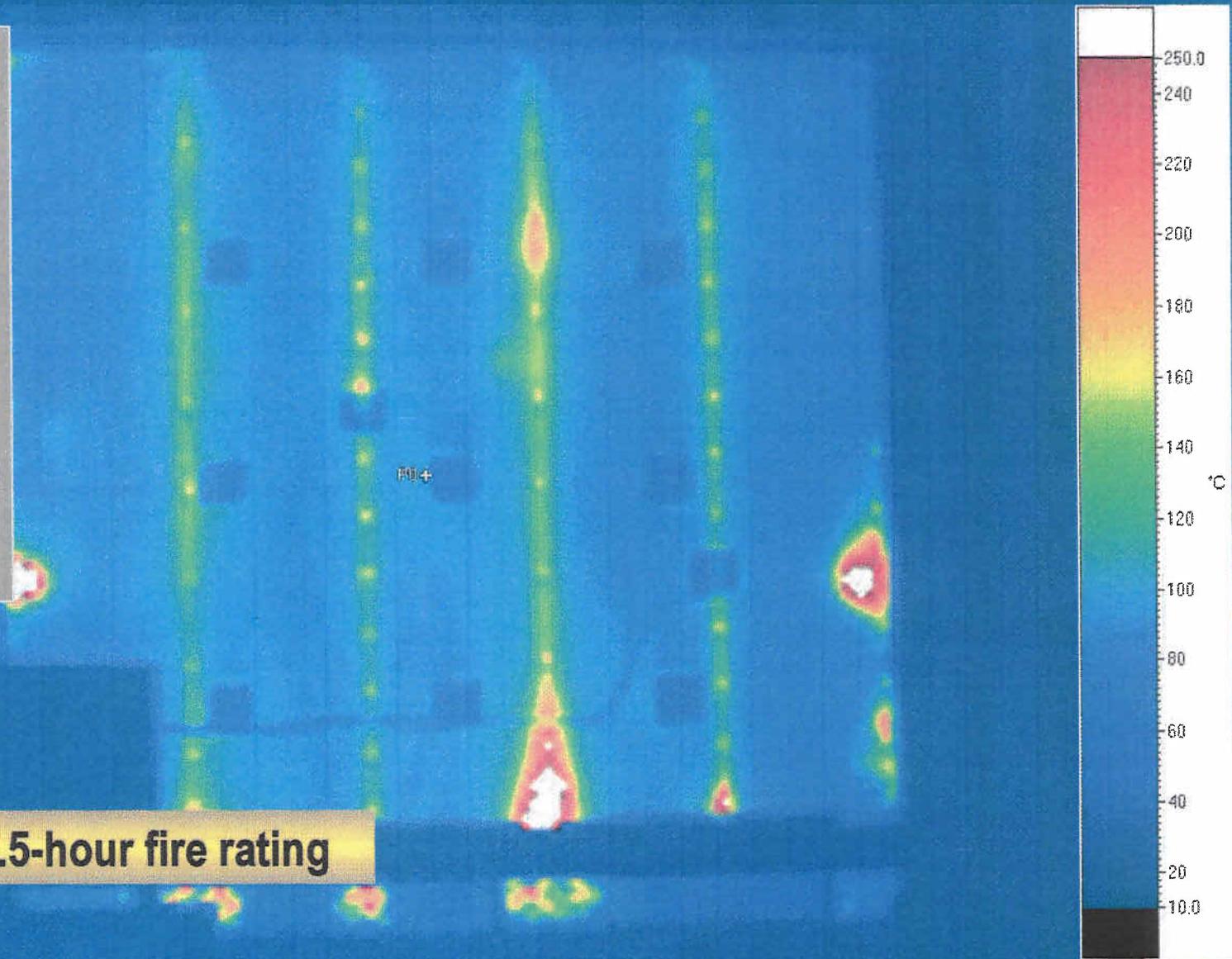
## ASTM E-119 Fire Testing

E-119 Time/Temperature Profile



# Fire Wall Test (ASTM E-119) Infrared Image

- ✓ Wall only fails on steel fasteners
- ✓ Steel >140°C rise on cold side
- ✓ GRAFOAM 80°C colder and *still* protecting



**Achieved 2.5-hour fire rating**

# Impact Test – GRAFOAM™ Resists Impacts



GRAFOAM™ panel withstands debris impact test under hurricane conditions

GRAFOAM™ panel will withstand 75 psi blast impact



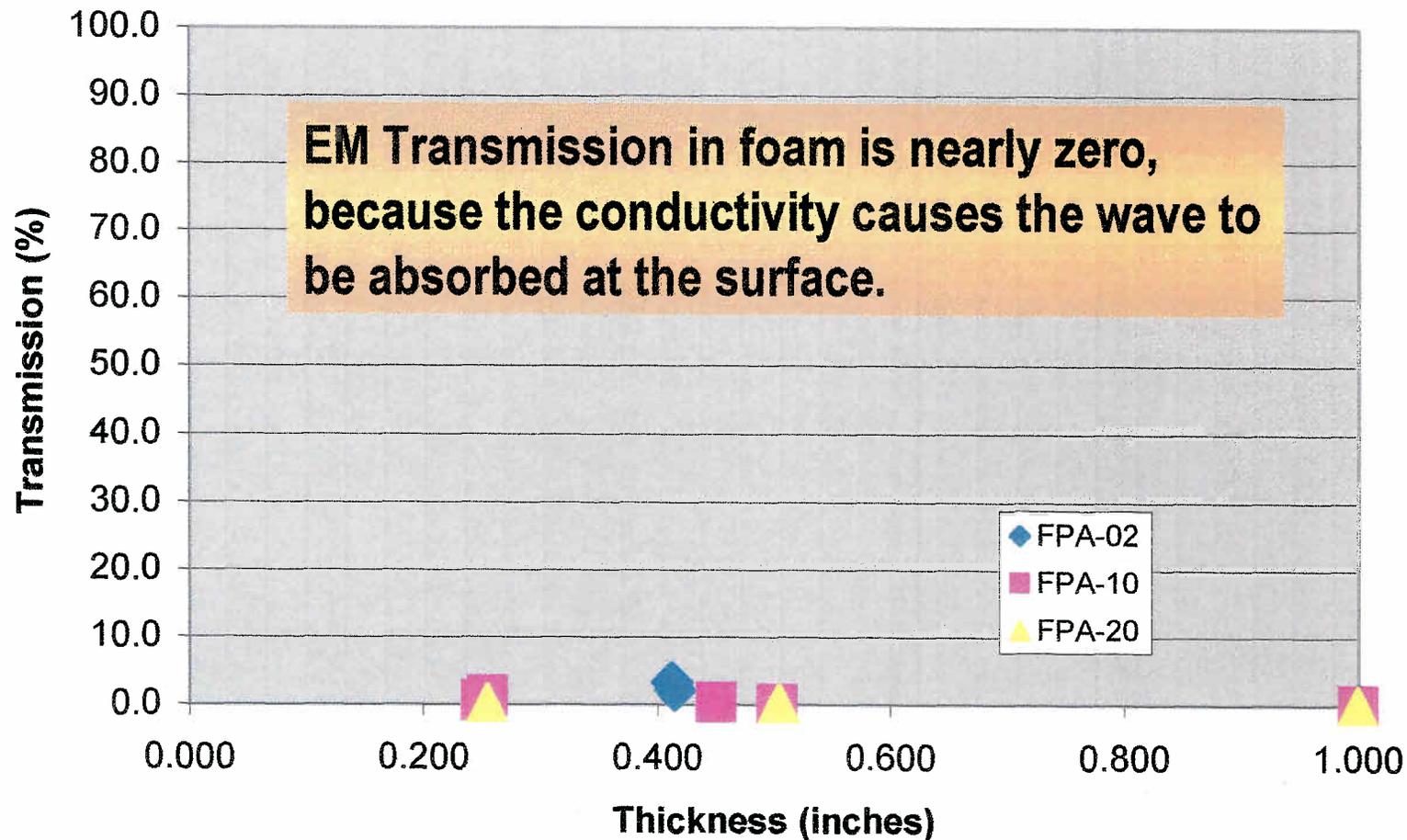
# GrafTech Carbon Foam – GRAFOAM™

- Largest Block Size
  - Nominal block size:
    - 1.8m long
    - 0.45 – 0.9m wide
    - 0.15m thick
- Large Capacity



# Electromagnetic Shielding (100-3000 MHz)

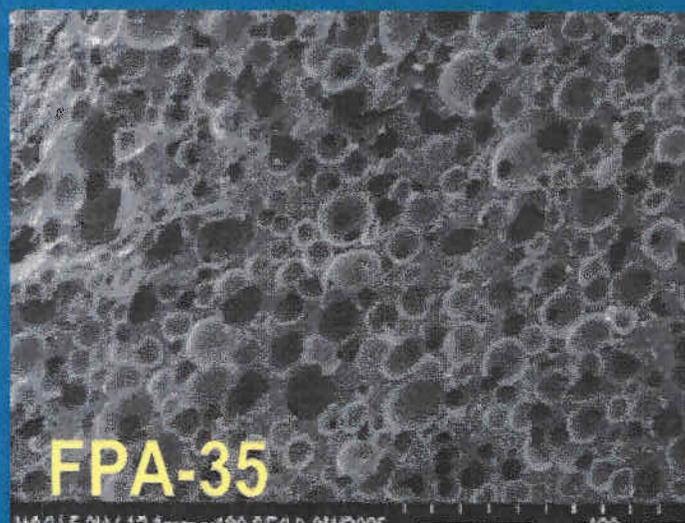
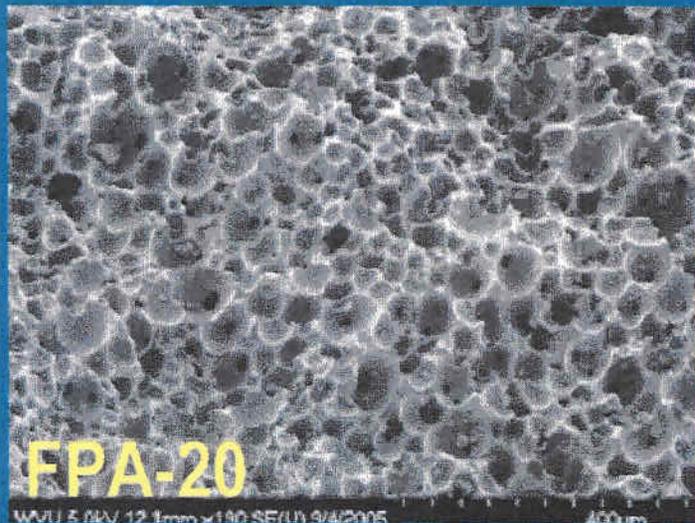
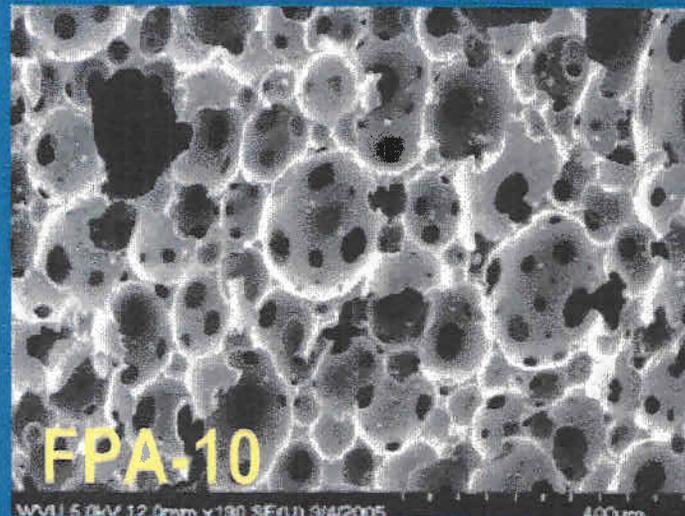
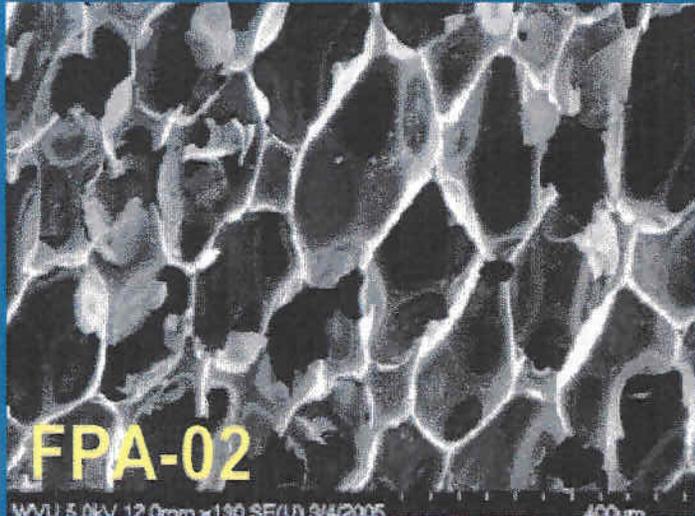
## EM Transmission vs Foam Thickness



# GRAFOAM is a Multi-Functional Core Material

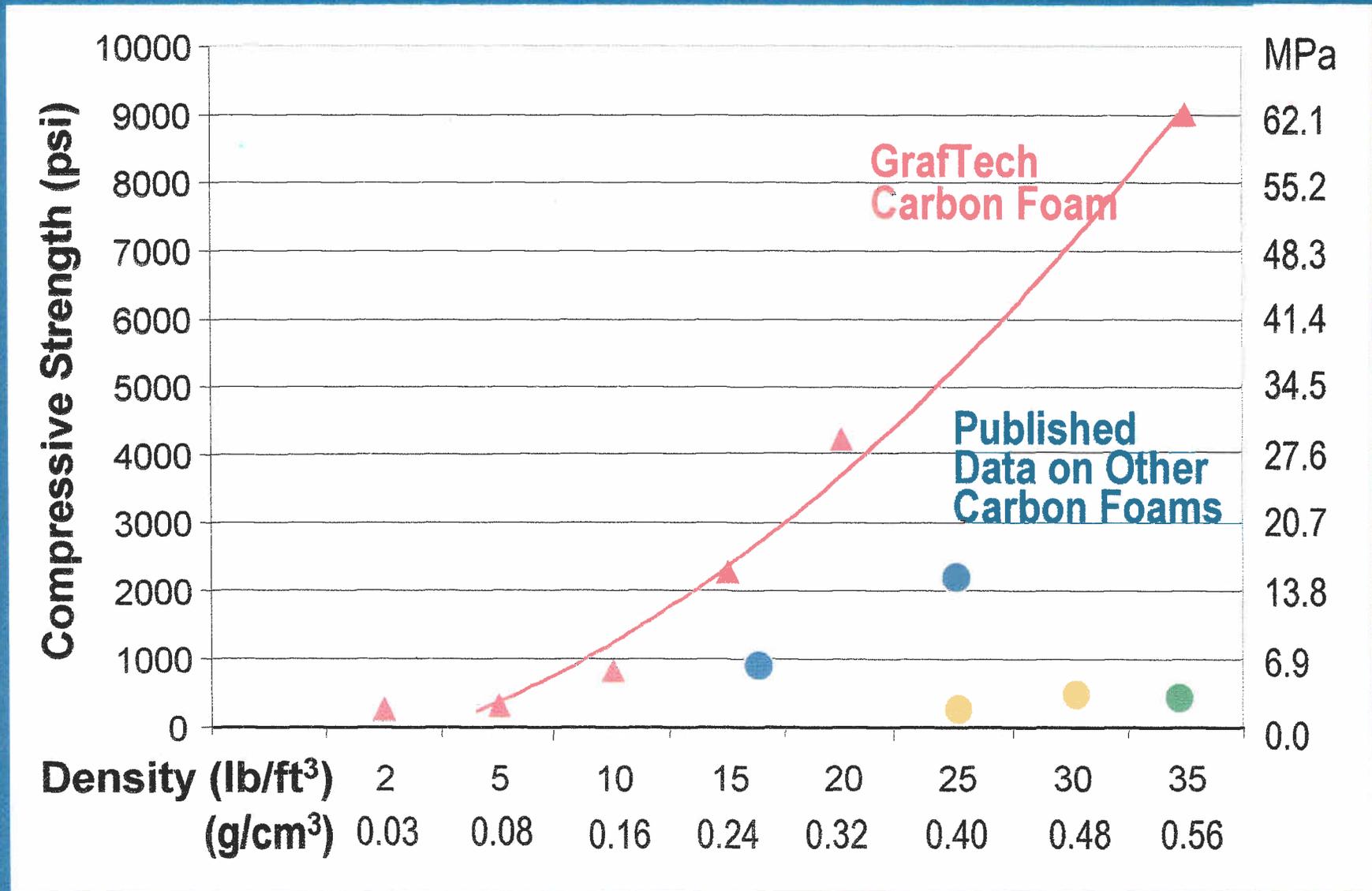
	Balsa Wood	PVC Foam	PMI Foam	Polyimide Honeycomb	Metal Honeycomb	Ceramic Foam	Carbon Foam
High Temp. Capability					√	√	√
Fire Resistance					√	√	√
Dimensional Stability			√				√
Thermal Insulation	√					√	√
Non-toxic Smoke Emission	√				√	√	√
Chemical Resistance			√	√		√	√
Electromagnetic Shielding					√		√
No Outgassing					√	√	√
Fungi Resistance					√	√	√

# Cell Structure – Topographical View



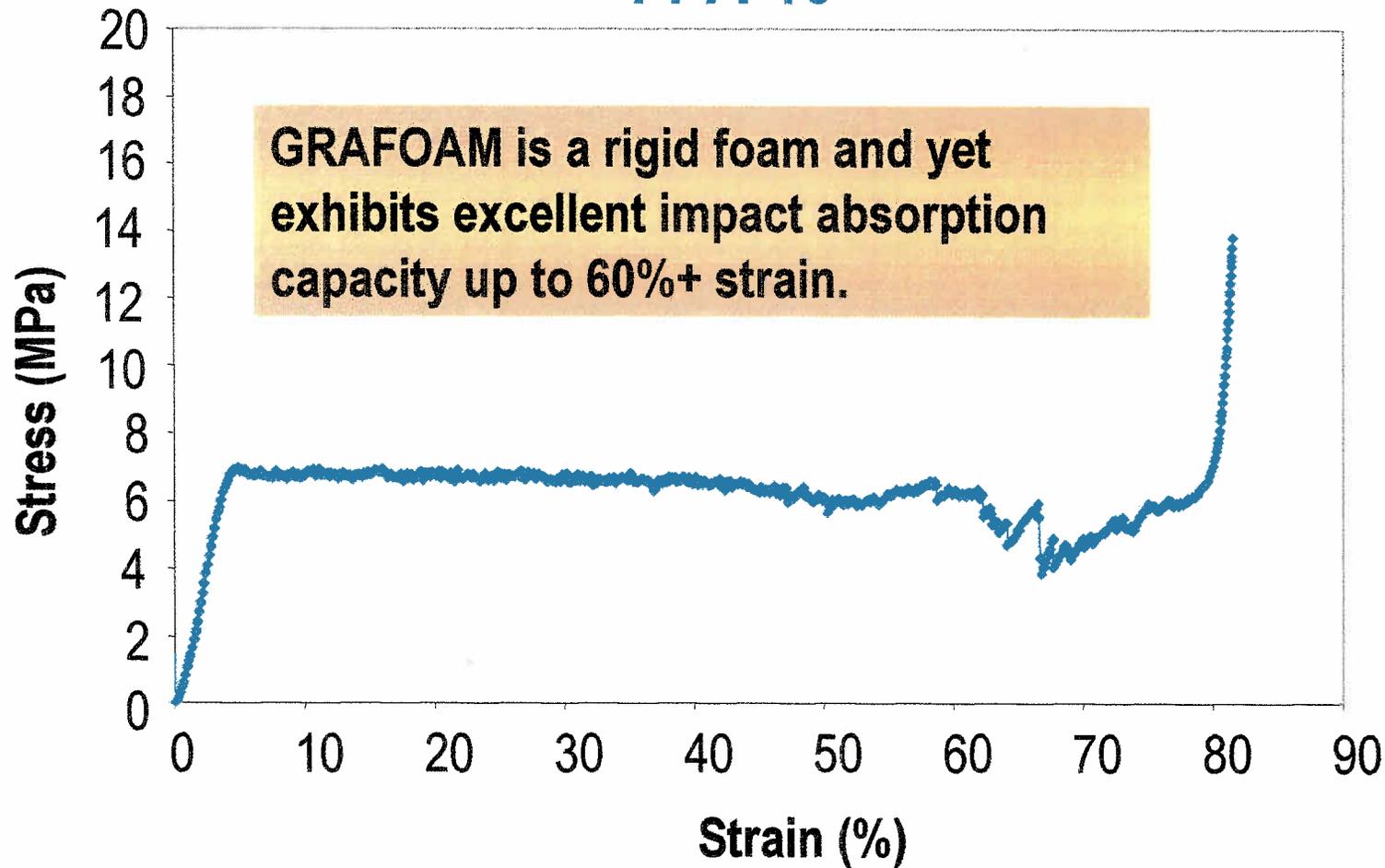
400 µm

# Compressive Strength



# Compressive Stress-Strain Curve

## FPA-10



# Mine Safehouse Design Parameters

## Functional Requirements

- Designed to accommodate 16 miners
- Provide 72 hours of breathable air
- Provision for
  - ✓ Food/Water
  - ✓ Toilet
  - ✓ Lighting
  - ✓ Medical Kit
  - ✓ Air conditioning
- Communication equipment

# Mine Safehouse Design Parameters

## Functional Requirements

- Air Tight to prevent ingress of toxic gases
- Waterproof
- Methane and temperature monitoring
- Additional breathable air units
- Lights signaling when to use the safehouse due to unsafe air conditions

# **Mine Safehouse**

## **Features**

# Mine Safehouse Design Parameters

## Functional Requirements

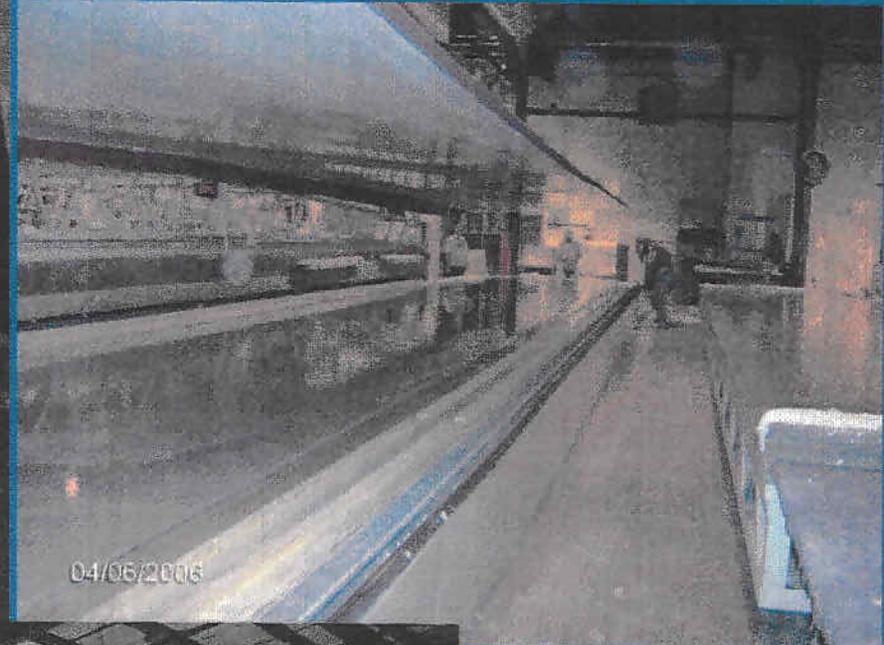
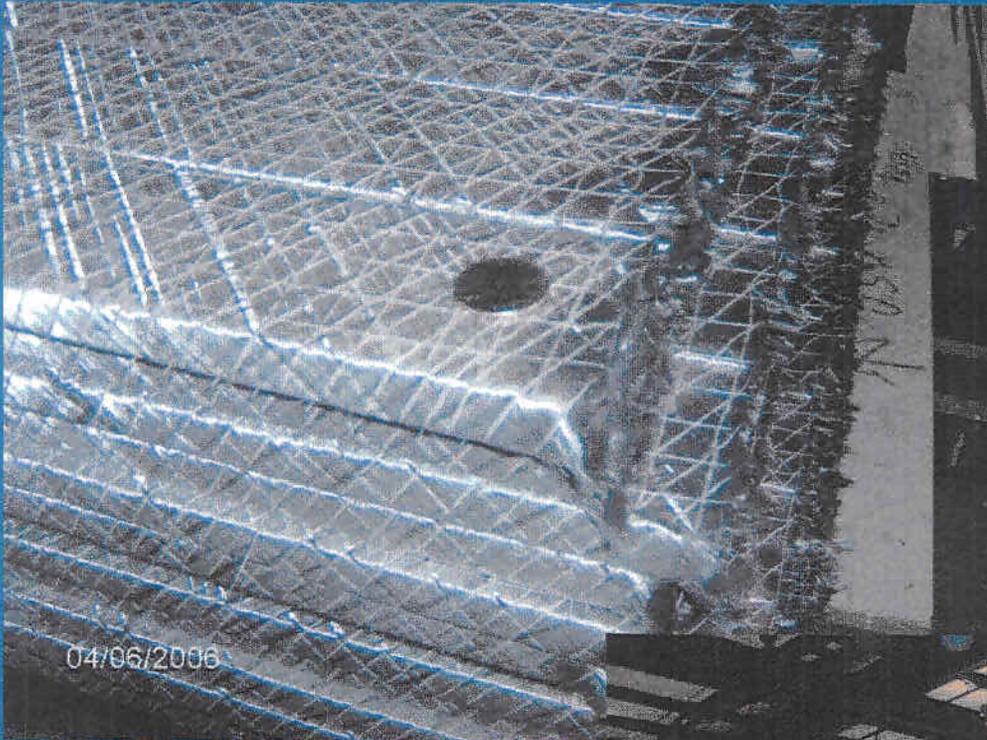
- Mobile design
- Survive repeated handling
- Puncture resistant
- Blast protection to 75 psi



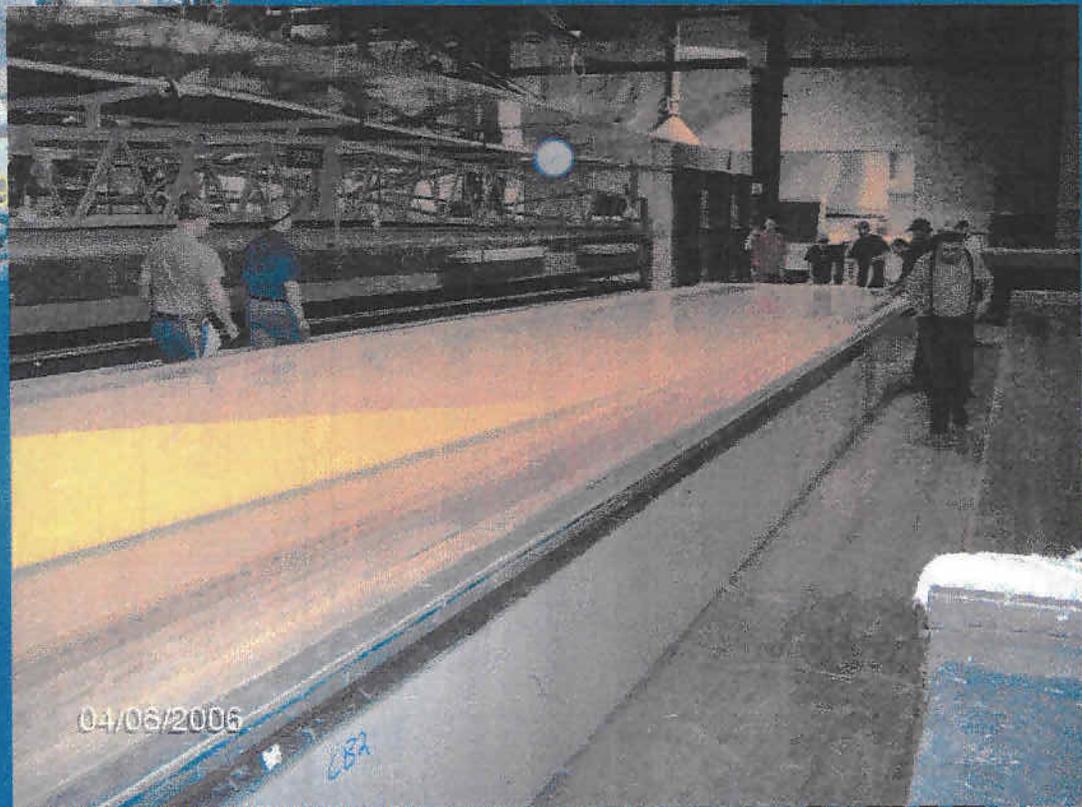
# **Mine Safehouse**

**Construction**

# Safehouse Panel Construction



# Safehouse Panel Construction



04/06/2006

CBA

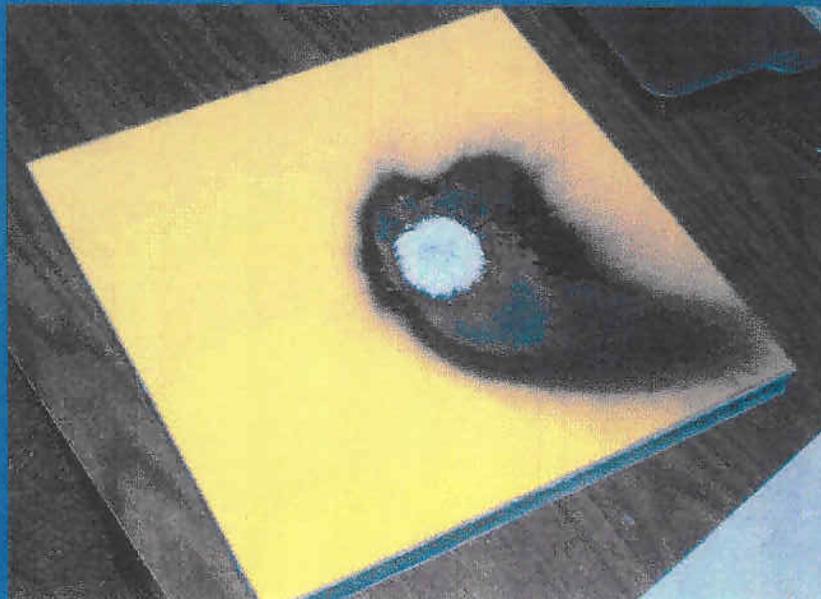
© 2005 GRAFTECH INTERNATIONAL LTD.

# Fire Retardence

Fire retardency of Mine Safe House will be accomplished through two steps

- Use of proven fire resistant structural panels and joints
- Coating the mine safe house with a tested fire retarding intumescent paint

After 60min at 1000°C



# Why CFC for Mine Safehouse?

- Mine safehouse built with composites structural panels will have the following advantages
  - Fire retardant without significant cost (i.e., no need for high temperature alloys)
  - Light weight for easy transportation
  - Durable for long term use in underground mine environment

Constructed Facilities Center is uniquely positioned to design and develop a composite safe house by leveraging its extensive R&D experience in structural composites.



# Fiber-Tech Industries, Inc

Another Celstar Company



North America's Largest Structural  
Fiberglass Panel Manufacturer



Over 30 years Manufacturing  
Experience



All Panels Custom Built to  
Customer Specifications

# **Mine Safehouse**

**Partners**

# Carbon Foam

**GRAFTech**  
*GrafTech International Ltd.*



# Tradition & Excellence

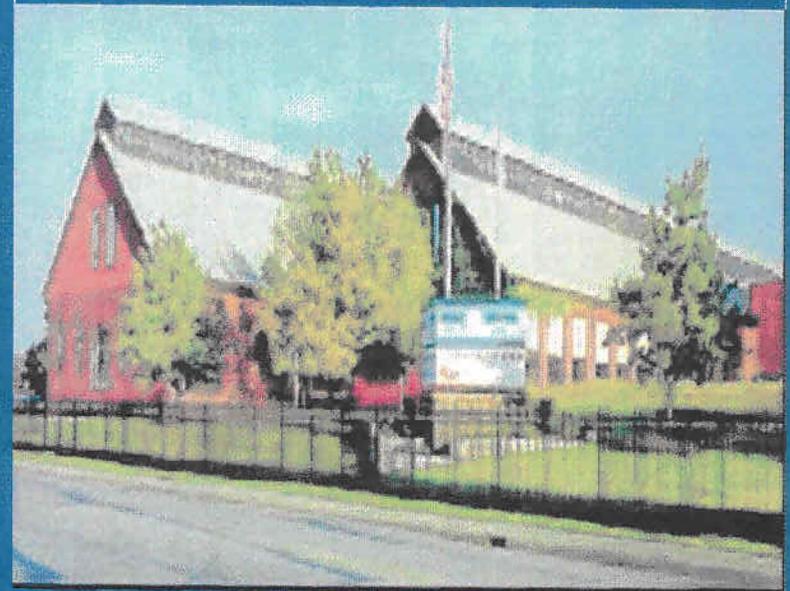


- 1886: Founded as the National Carbon Company

- GrafTech International Ltd.

- \$848 million revenue
- 3,900 employees
- Industry leading global supplier
- ISO & QS certified

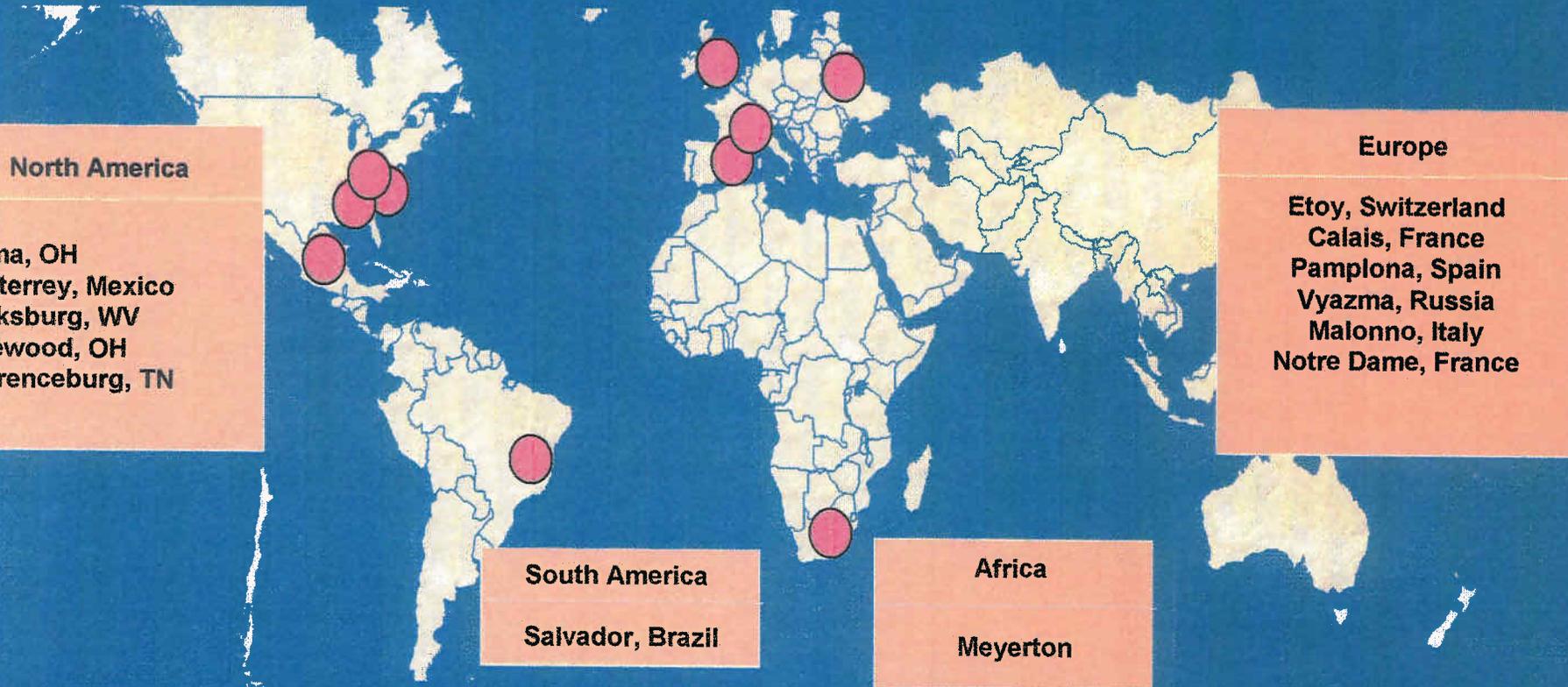
Factory A - Lakewood, Ohio



# GrafTech International LTD. Extensive Manufacturing Network

## GTI Vision

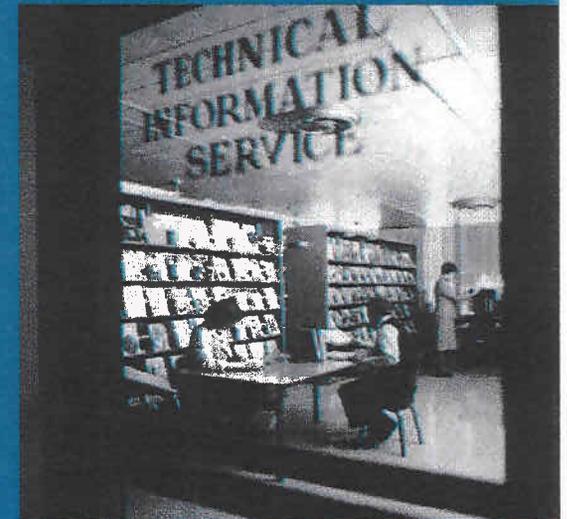
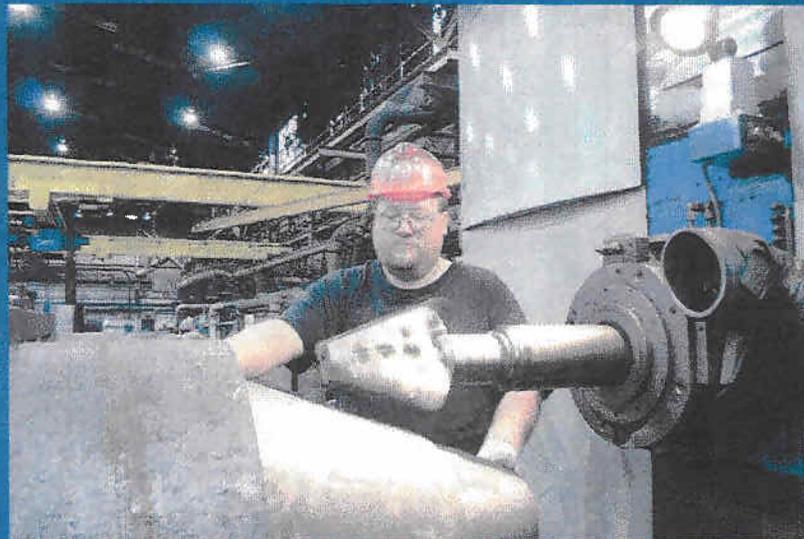
We enable customer leadership, in new and existing markets, better and faster than our competition, through the creation, innovation and manufacture of carbon and graphite material science based solutions.



# GrafTech Builds on Core Strengths:

## 100 years expertise in Carbon/Graphite Science

- Fuel Cells – Ballard partnership
- Electronic Thermal Management – displace Cu & Al in computers, TV screens, cell phones
- Electrodes – introduced revolutionary product in 2004
- GRAFOAM™ Carbon foam - aerospace, transportation, marine



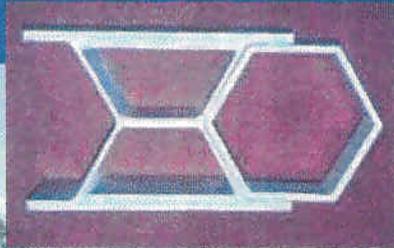
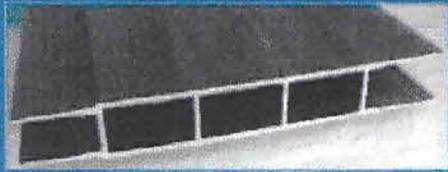


# Constructed Facilities Center – West Virginia University (CFC-WVU)

## Some of the R&D at CFC – WVU

- Development of structural fiber reinforced composite components (e.g., bridge decks)
- Rehabilitation of existing (concrete & timber) structures using glass and carbon composites to improve their service life and durability
- Research into advanced composite technologies
  - 1) nano composites
  - 2) fire retardant resins
  - 3) 3D stitched fabrics

# Composites Research



Composite Bridges



Bridge Rehabilitation



Composites for US Military Applications



WebCore Technologies, Inc.





# Fiber-Tech Industries, Inc

Another Celstar Company

*Three Manufacturing Locations in the U.S.*



Washington



Michigan



Ohio

[www.fiber-tech.net](http://www.fiber-tech.net)



# **Fiber-Tech Industries, Inc**

Another Celstar Company

*Serving the Construction, Marine, & Transportation Markets with Structural Fiberglass Reinforced Panels!*



**Up to 10' x 58' Seamless Panels**