

# Cargo Compartment alternative MPS testing using Low Pressure Dual Fluid Water Mist and Hypoxic Air

International Aero Inc.

FAA & JAA Repair Station IQNR108K

Fire Protection Laboratory



International Aircraft Systems Fire Protection Working Group  
November 5-6, 2003

# System Participants

- IAI
- FirePASS
- Air Liquide



## Background

Started looking at misting in 1998 as a Halon alternative along with condensed aerosols.

Full scale Cabin ground based testing  
**May 1999**

Flight test **Aug 2001**

Rebuilt the MPS device in **May 2003**

Testing on going



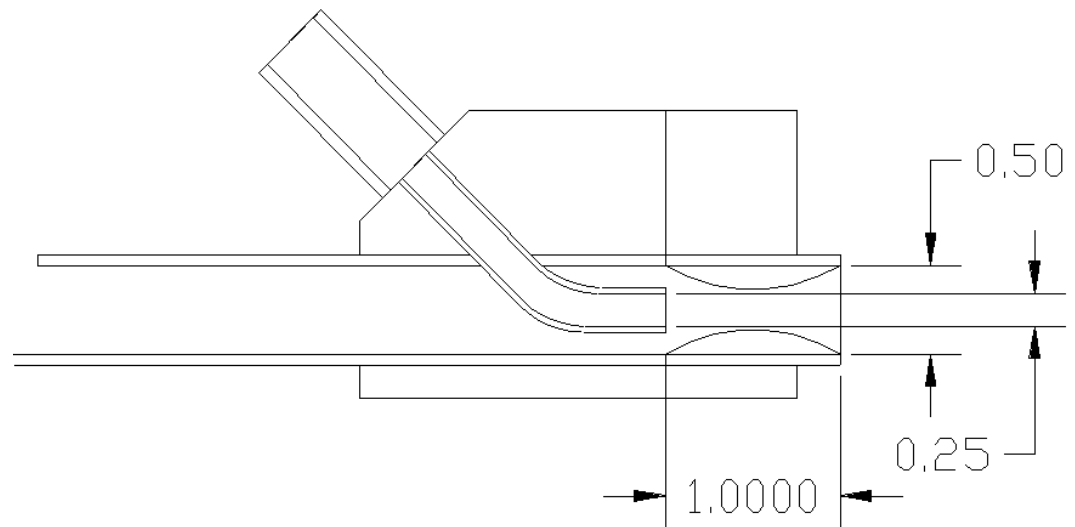


**We reconstructed  
the Cargo M PS  
device**

**Data collection in  
a LD3 cargo  
pallet alongside**

# Low Pressure Dual Fluid Nozzle

- US Navy patent
- IAI holds license
- works at 0.8 to 12 bar
- Liquid and gas are equal pressure



# Why LPDF

- Simple
- Hard to clog or plug
- Makes the same size droplet throughout the operating range (50 micron)
- Instills a tremendous amount of kinetic energy in the droplet for distribution
- Adjustable flow rates from the same nozzle (1-15 liters per minute)



# System Goals

Use existing systems and equipment where ever possible

Be lighter, cheaper and, more efficient

With a lower overall life time cost

be ready for the future

Be better than any gas system, Level of safety

- longer duration
- lower temperatures
- less damage to the air vehicle



# Extinguishing Agent chemistry

- **Name Air ; (Hypoxic Air)**
  - Snap listed in July 2003
- **UN Transportation Code UN1002**
- **Gas Properties:** Gas density (1.013 bar at boiling point) : 3.2 kg/m<sup>3</sup>
- Specific gravity (air = 1) (1.013 bar and 21 °C (70 °F)) : 1
- Specific volume (1.013 bar and 21 °C (70 °F)) : 0.833 m<sup>3</sup>/kg
- **Normal composition of dry air:**

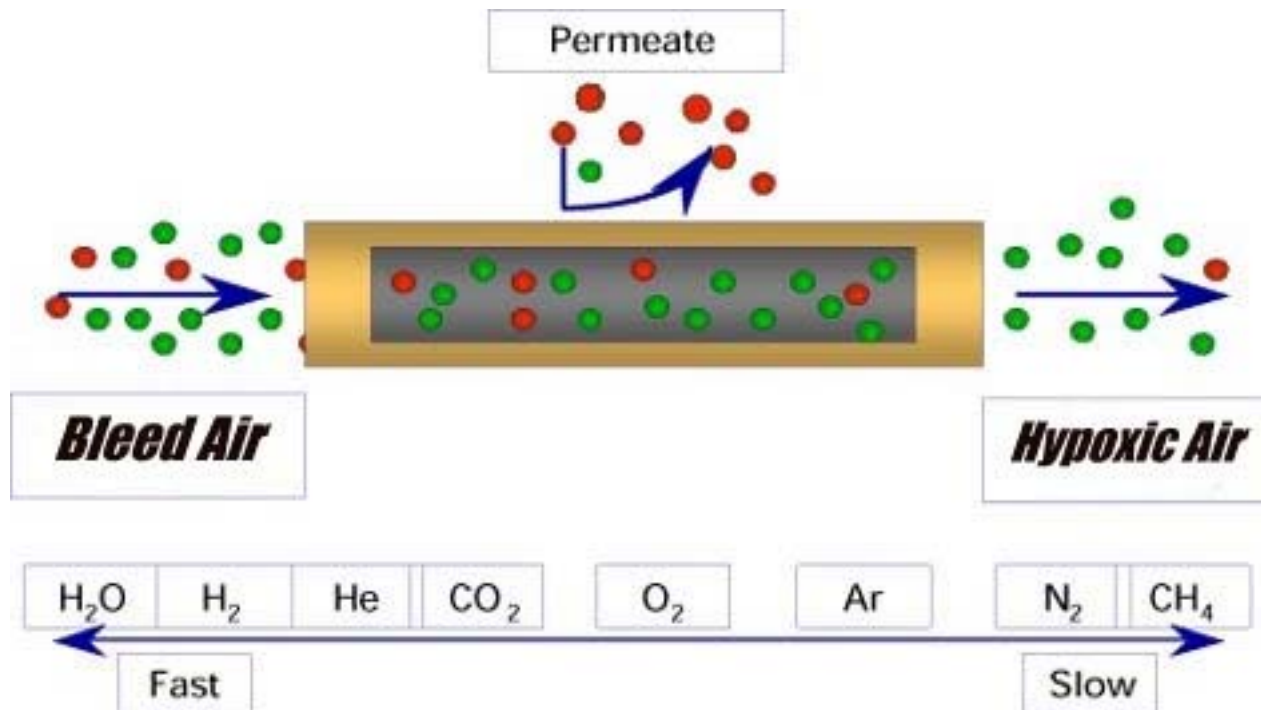
– <b>Gas Concentration</b>	<b>(% vol. ) ppm or ppb</b>	<b>Agent</b>
– N <sub>2</sub>	78.09%	
– CO <sub>2</sub>	330 ppm	
– H <sub>2</sub>	500 ppb	
– O <sub>2</sub>	20.94%	<b>15.2% or 10%</b>
– Ne	18 ppb	
– Xe	86 ppb	
– Ar	0.93%	
– He	5.2 ppm	
– Rn	6.10 <sup>-11</sup> ppb	
– Kr	1.1 ppm	



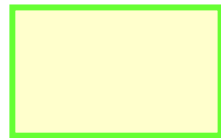


# Hollow Membrane Diagram

(it's just a bunch of small tubes that leak  $O_2$ )



# Key to system



Air Liquide "MEDAL"

Air Separation Reverse Osmosis Membrane



On



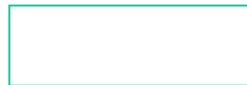
OFF



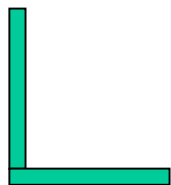
Air flow



Re circulated Hypoxic Air



Air conditioning Packs



Bleed air from Engines or APU



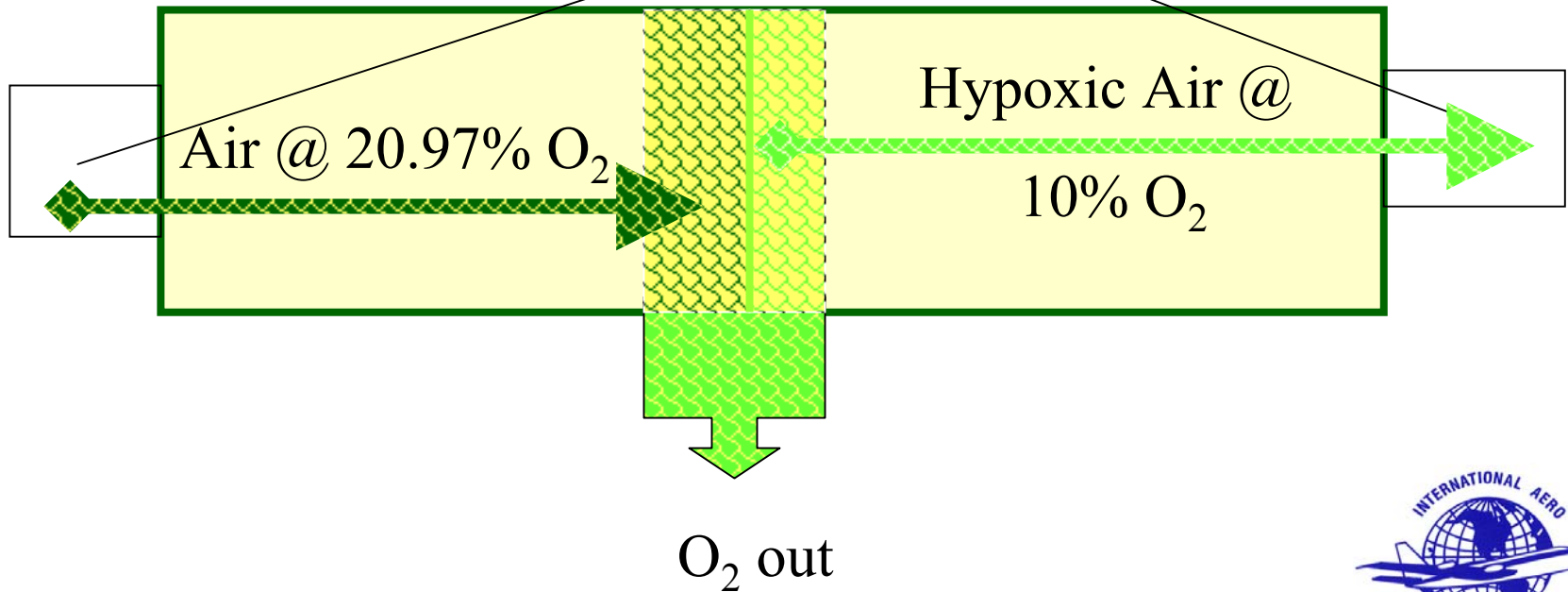
Control selector valve



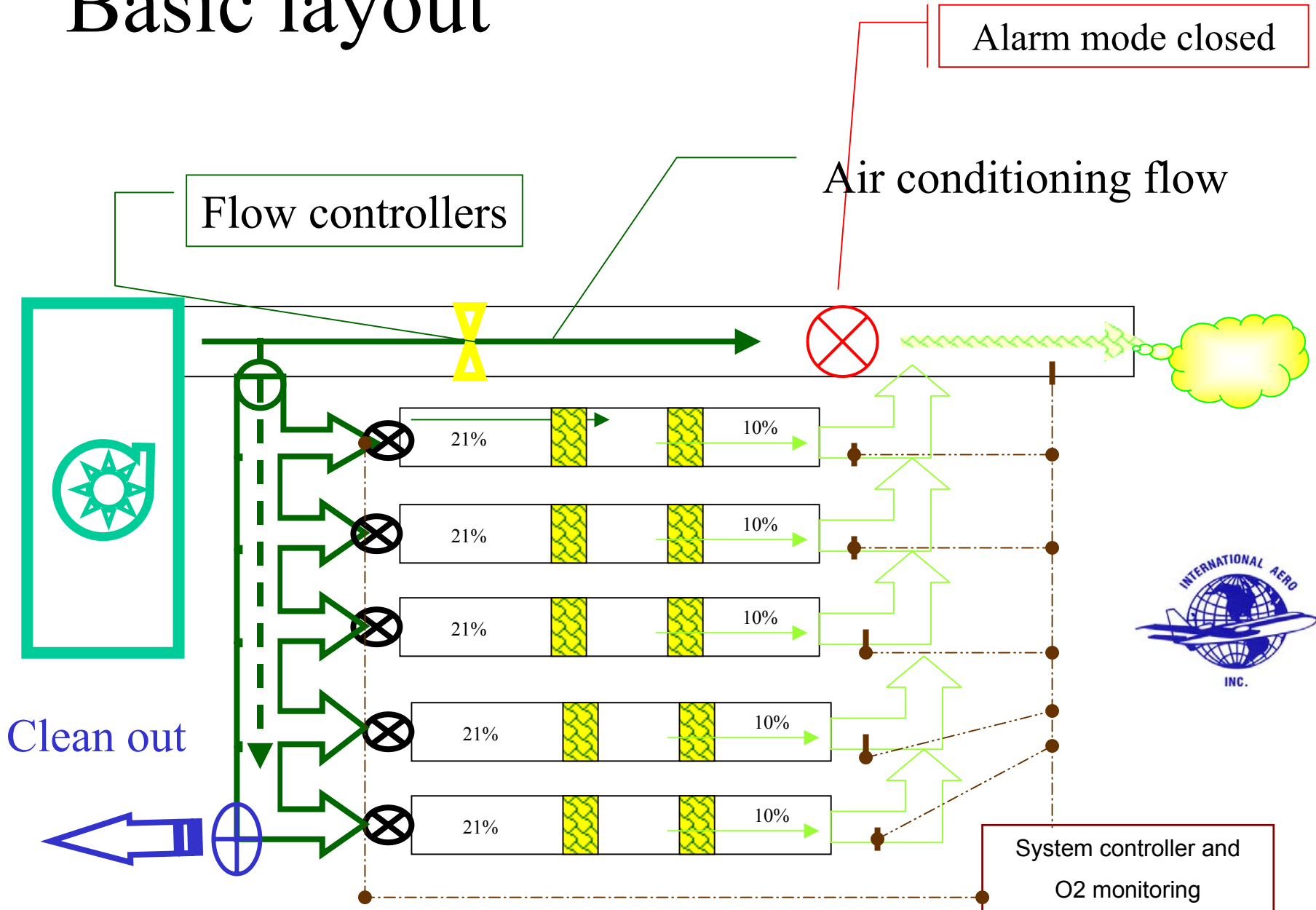
# MEDAL Membrane Filter

Bleed air or  
re-circulate air

Hypoxic air out  
to the system

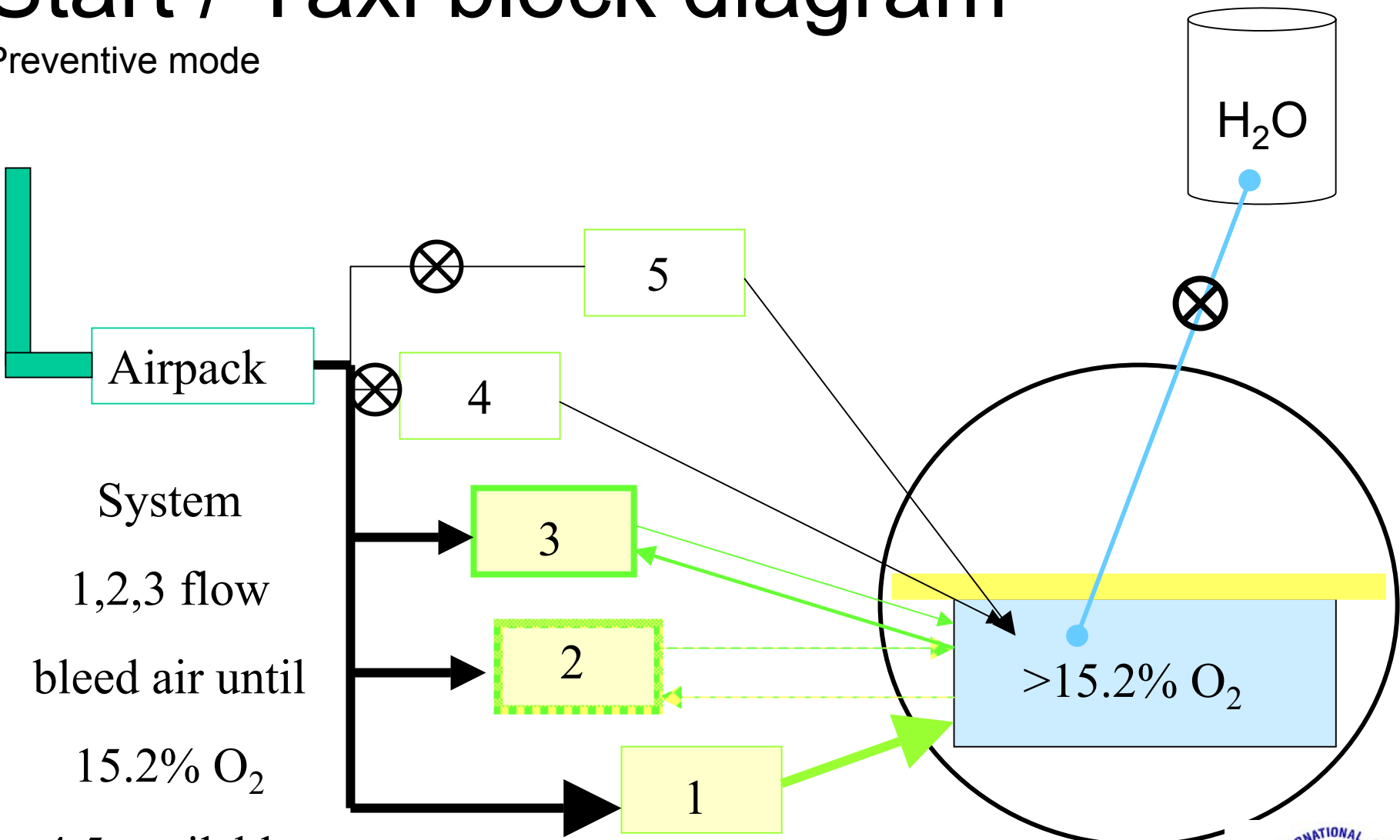


# Basic layout



# Start / Taxi block diagram

Preventive mode

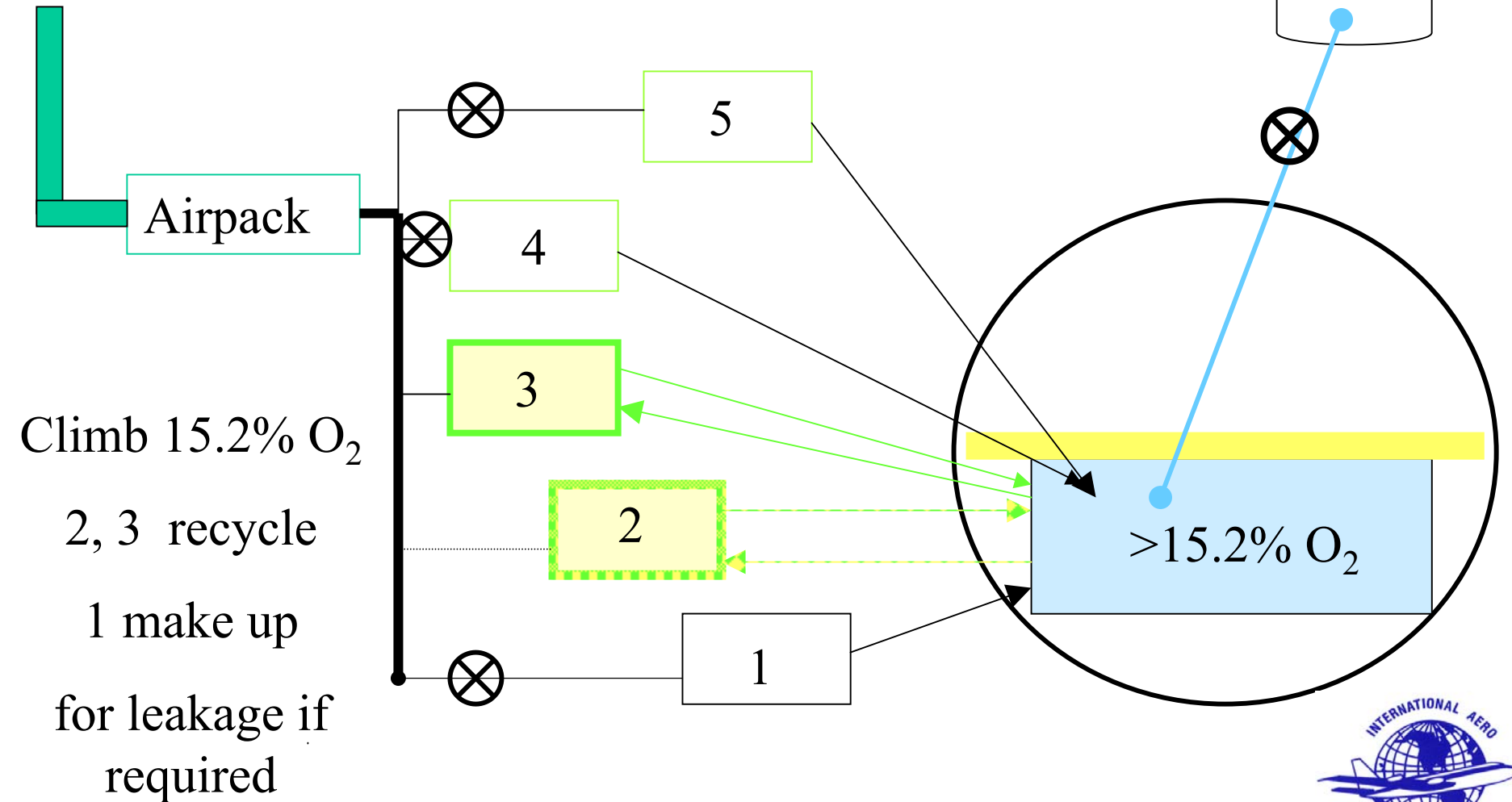


System  
1,2,3 flow  
bleed air until  
15.2% O<sub>2</sub>  
4,5 available  
if required



# Climb block diagram

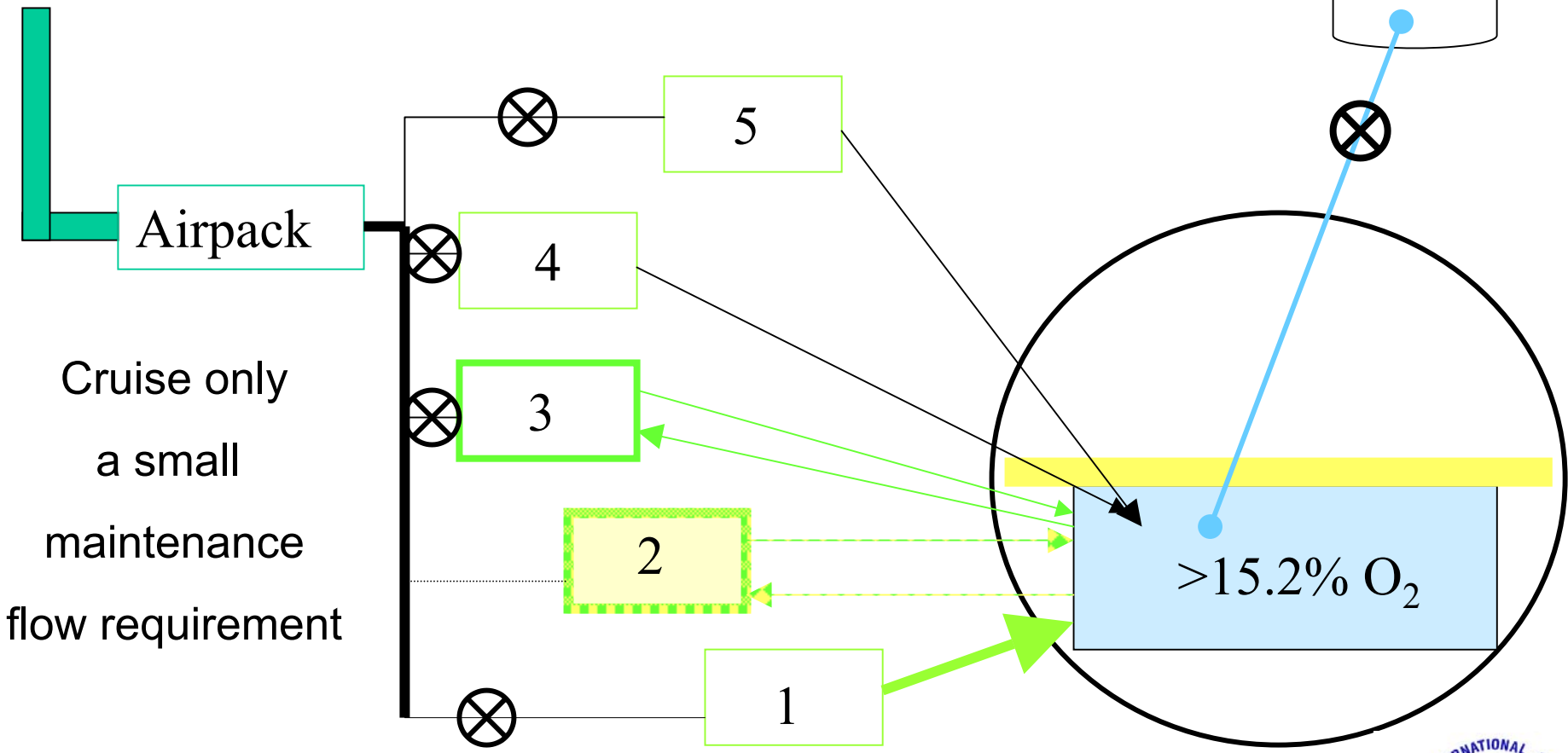
Preventive mode



Nov 2003 IAI proprietary

# Cruise block diagram

Preventive mode

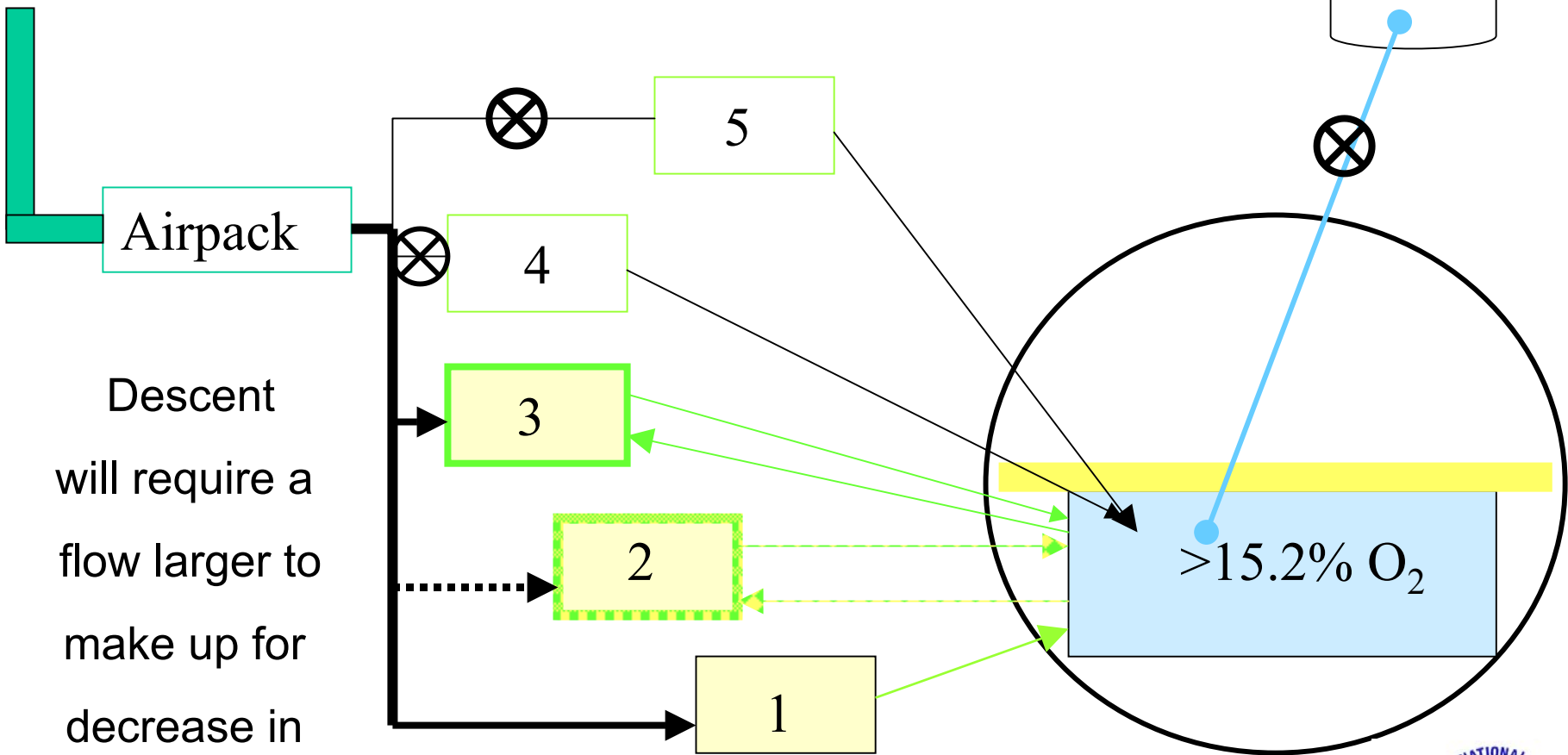


Cruise only  
a small  
maintenance  
flow requirement



# Descent block diagram

Preventive mode



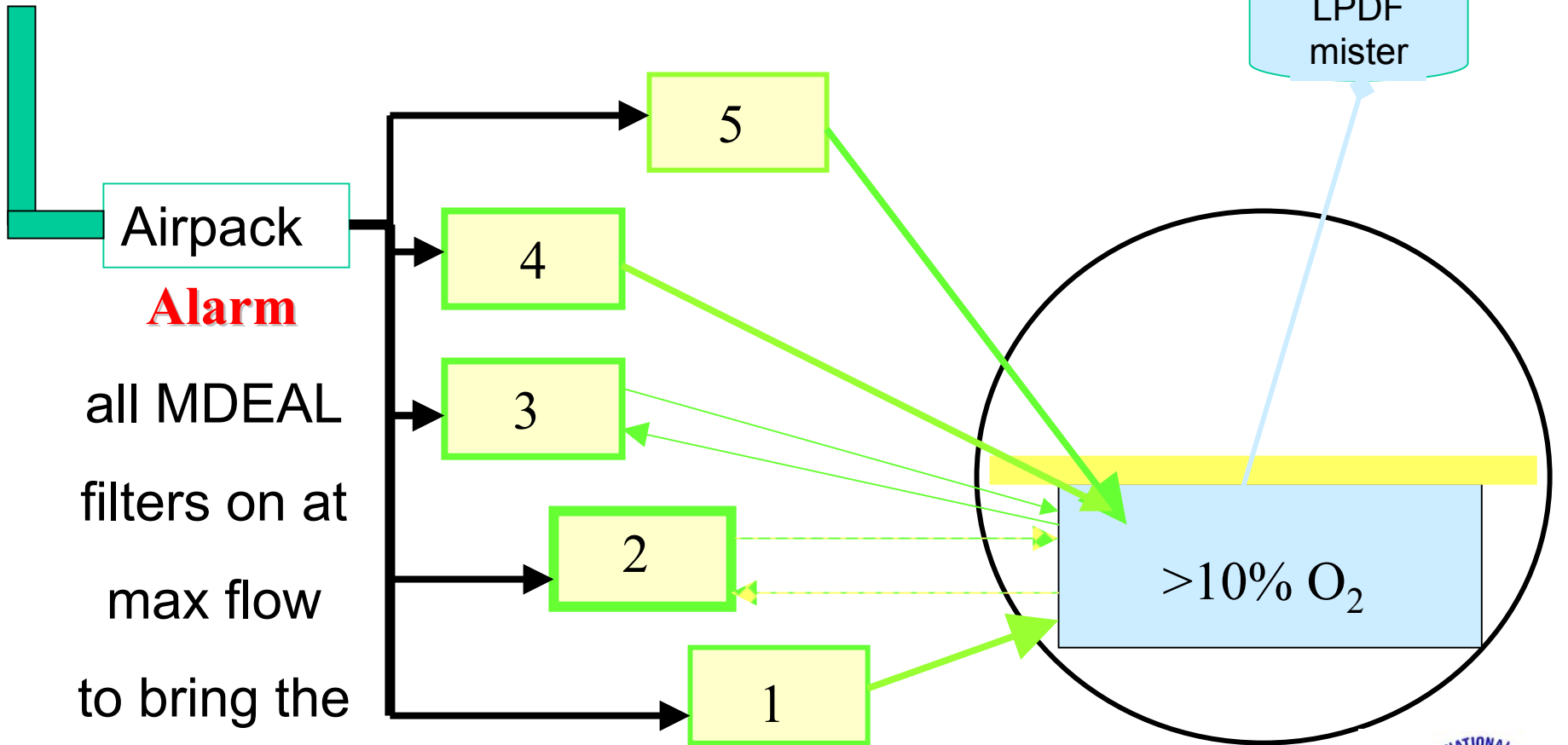
Descent  
will require a  
flow larger to  
make up for  
decrease in  
altitude





# Alarm Block Diagram

Inert mode



Cargo bay to

below 12.2 % O<sub>2</sub>

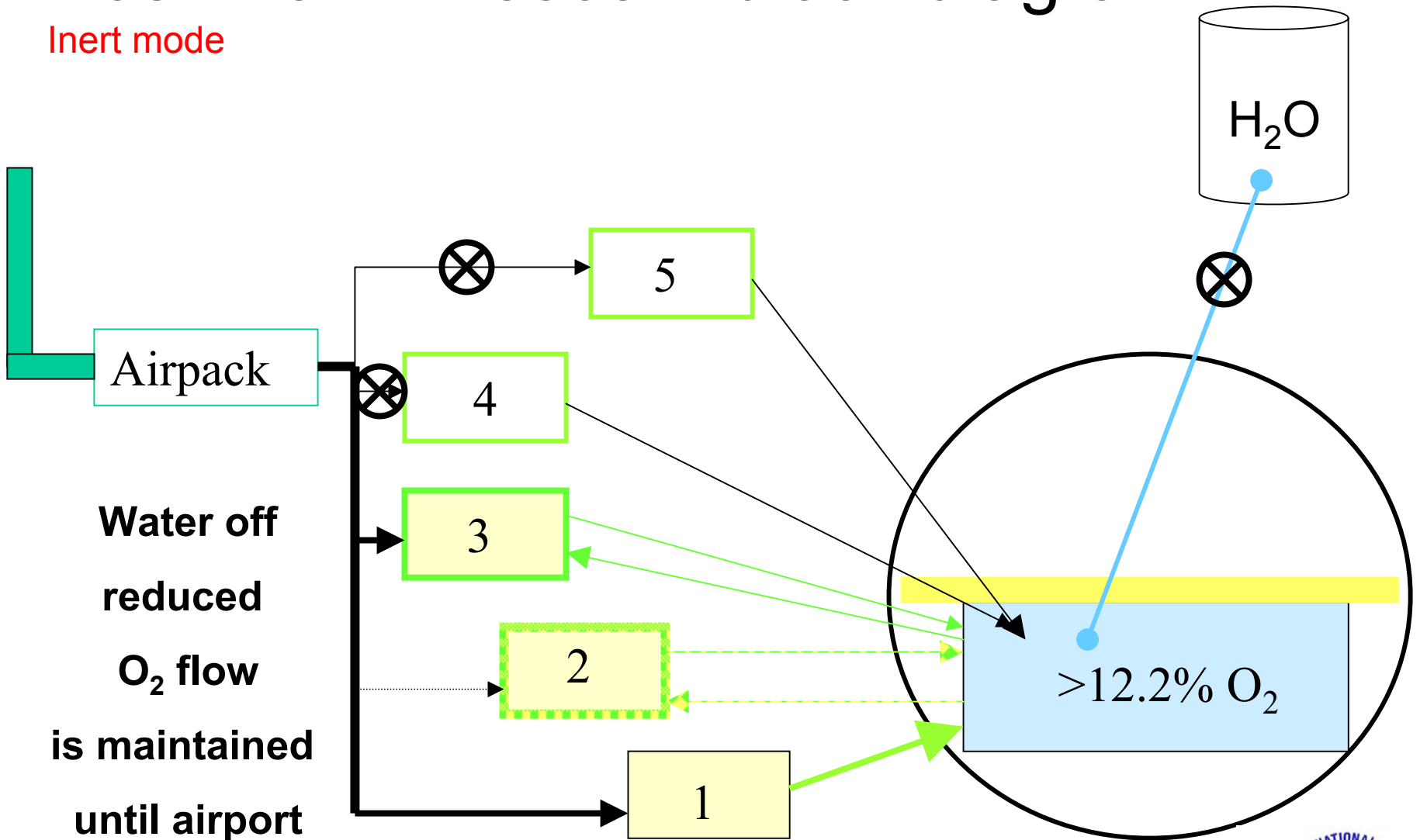
**Water mist for temp control**

Nov 2003 IAI proprietary



# Post Alarm Descent block diagram

Inert mode



Water off  
reduced  
O<sub>2</sub> flow  
is maintained  
until airport  
ARFF crew  
on scene



# Fusion of two technologies

- Advantages

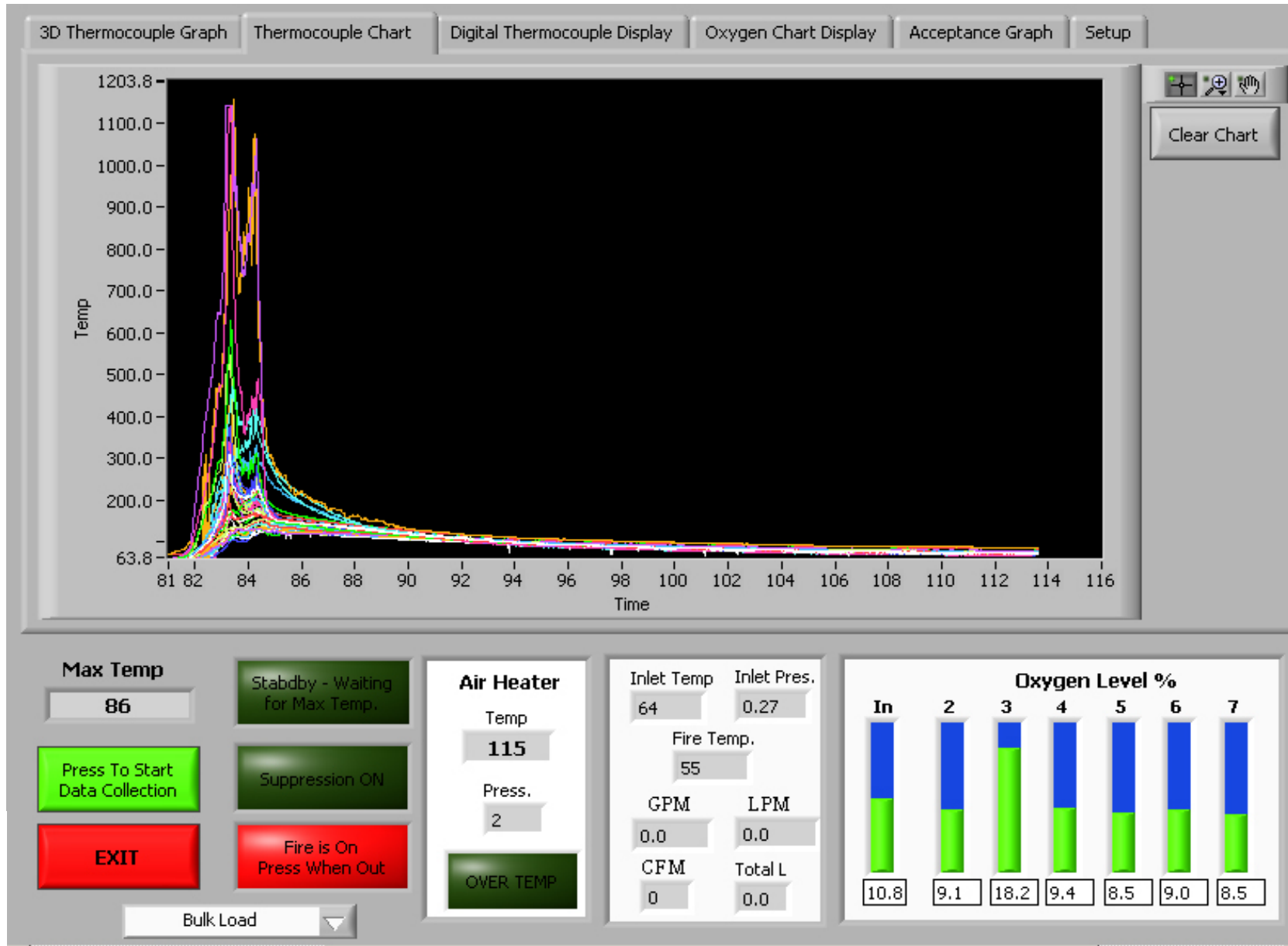
- uses existing systems
- light weight
- simple
- will operate as long as the engines are running
- “**Gate to Gate**” suppression
- No existing or foreseen future environmental impacts
- easily expandable for SFAR 88 or hidden fires, cabin water mist
- we are extinguishing the fires

- Obstacles

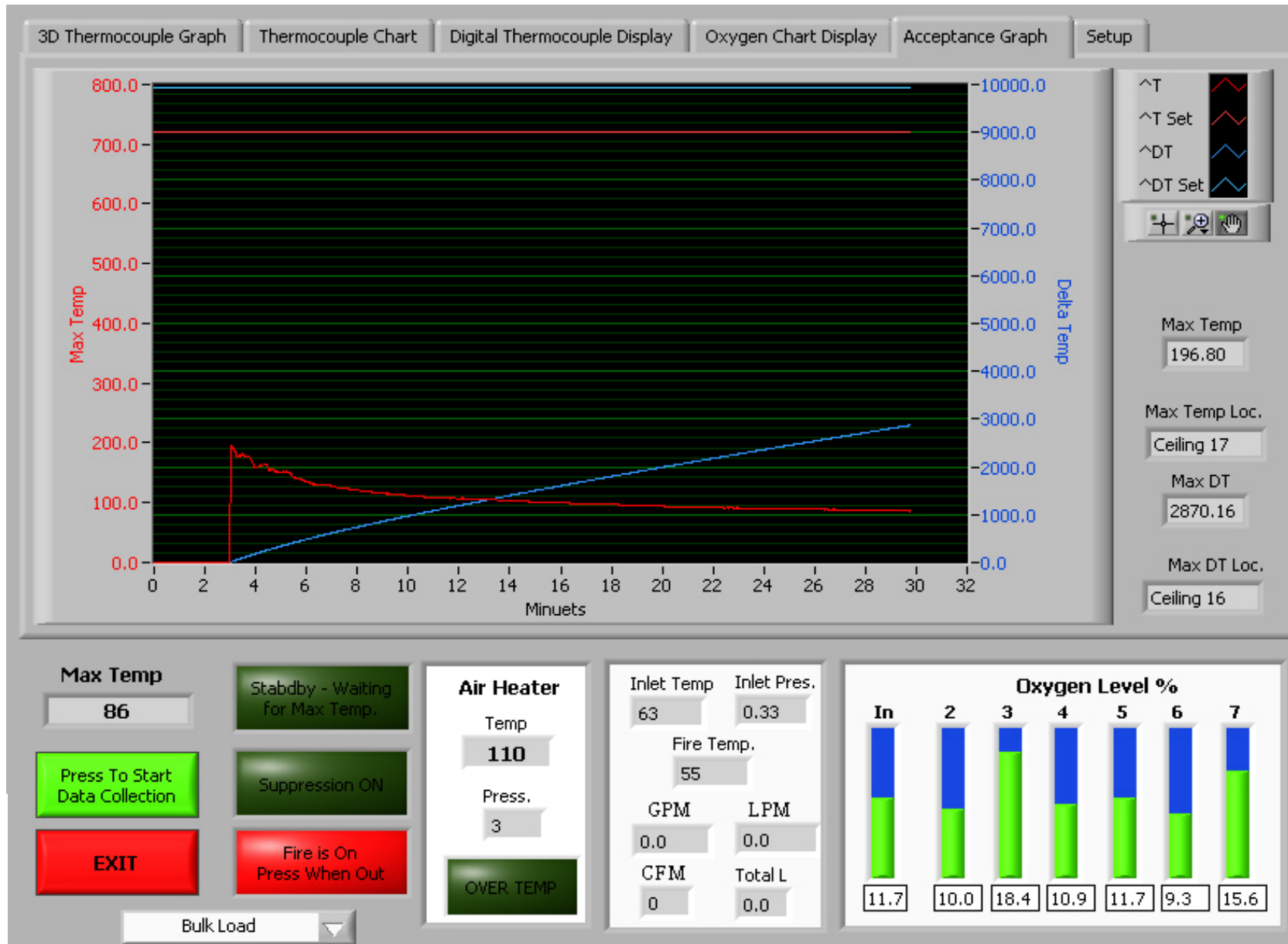
- New technology
- New paradigm in fire suppression
- will be hard due to existing thoughts on protection are “it **needs to be a GAS**”



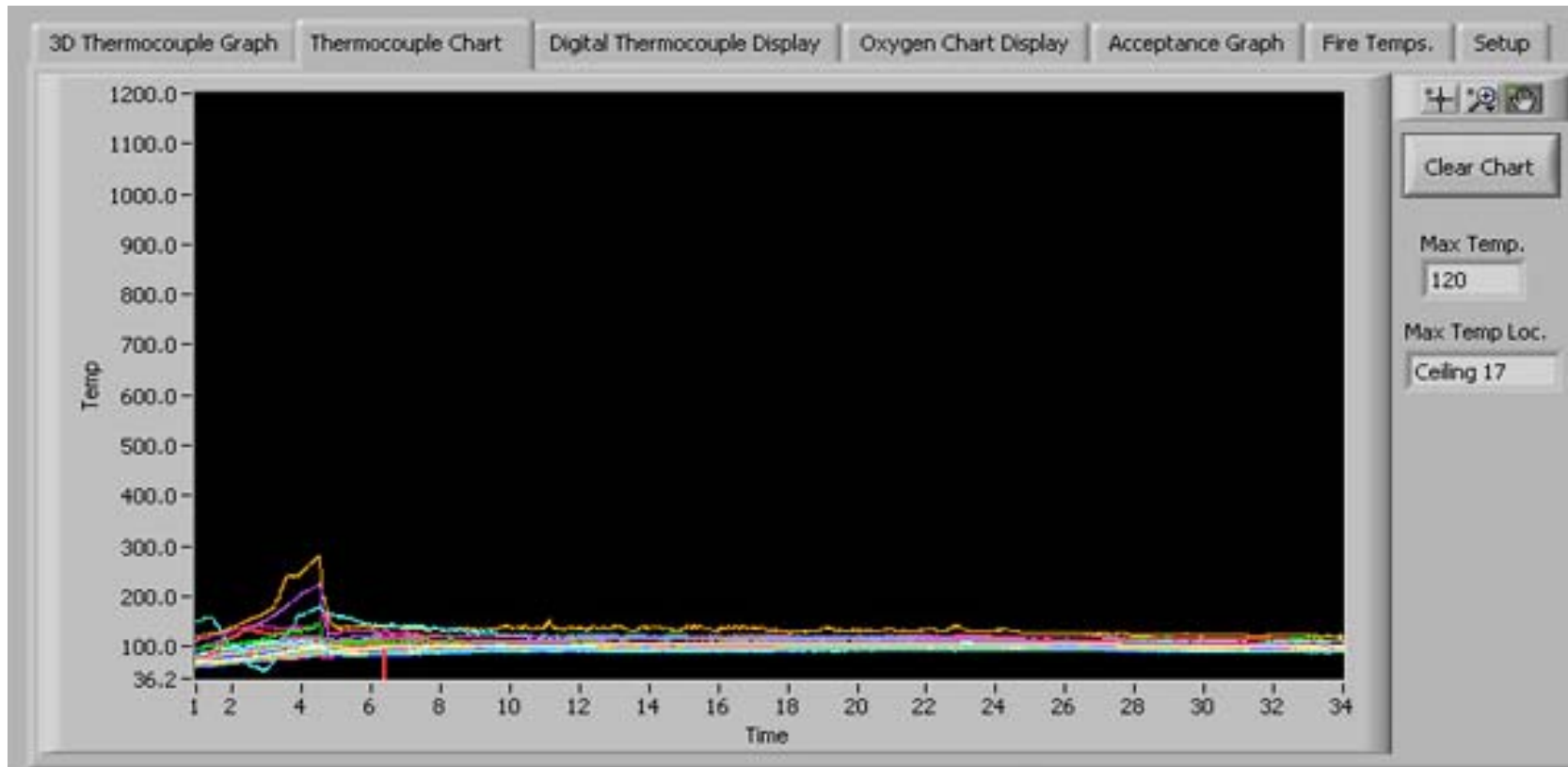
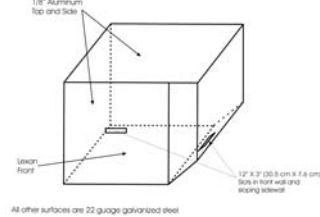
# Bulk Load Temp profile



# Bulk load MPS profile



# Container load Temp



**Max Temp**  
120

Press To Start Data Collection

EXIT

Stabdy - Waiting for Max Temp

Suppression ON

Fire is On Press When Out

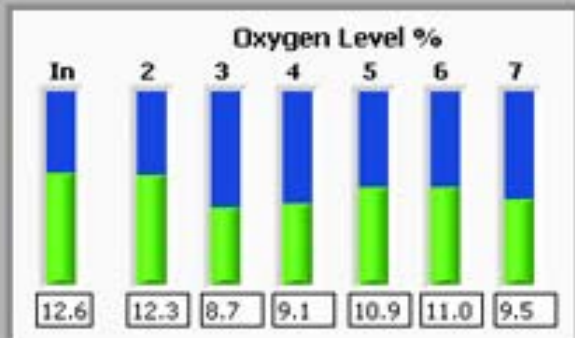
**Air Heater**

Temp 73

Press. 70

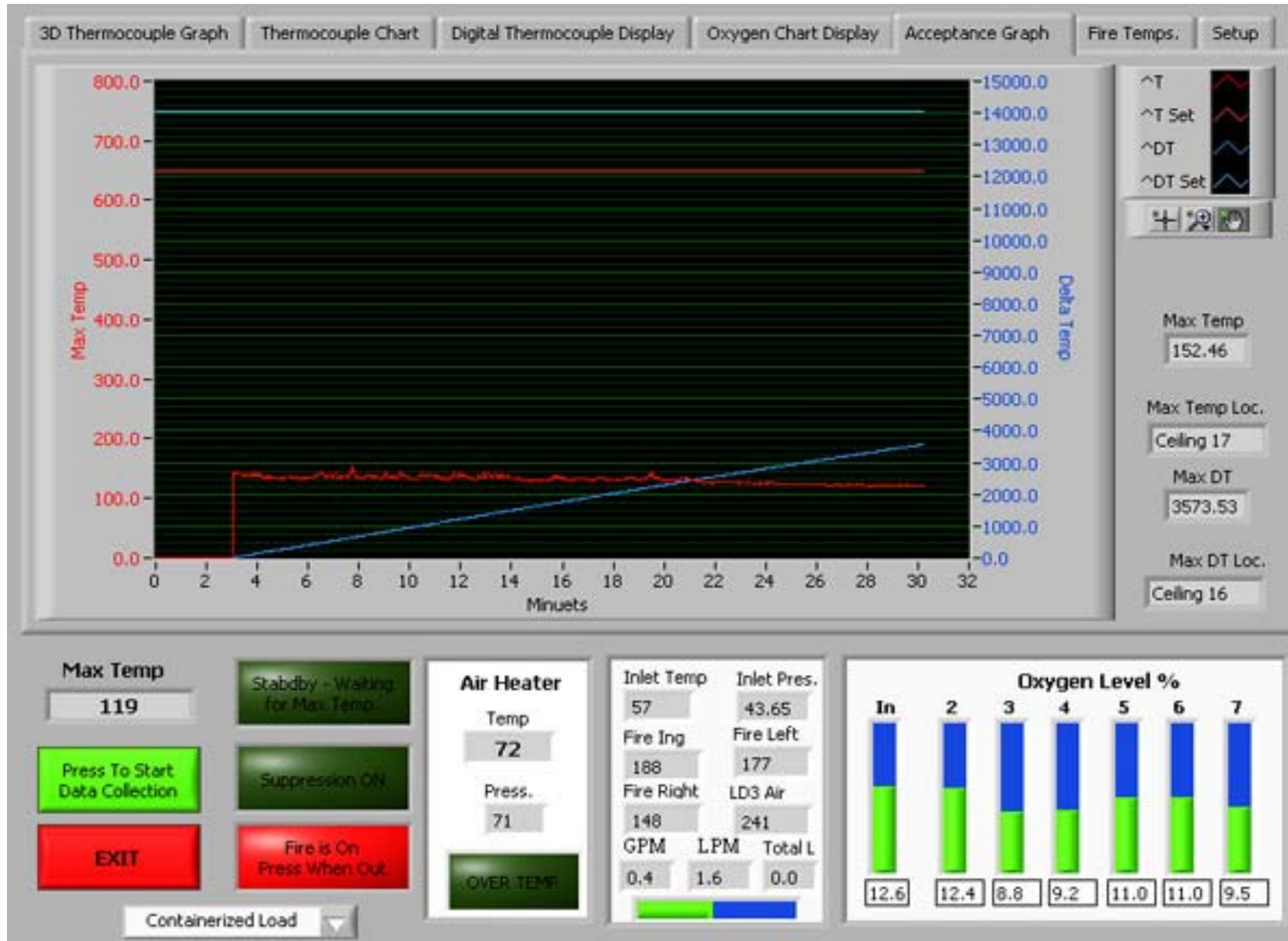
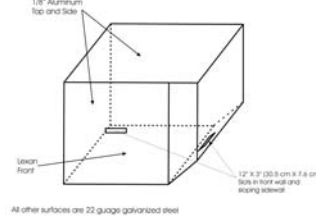
OVER TEMP

Inlet Temp	Inlet Pres.	
57	43.52	
Fire Ing	Fire Left	
197	189	
Fire Right	LD3 Air	
151	255	
GPM	LPM	Total L
0.4	1.6	0.0

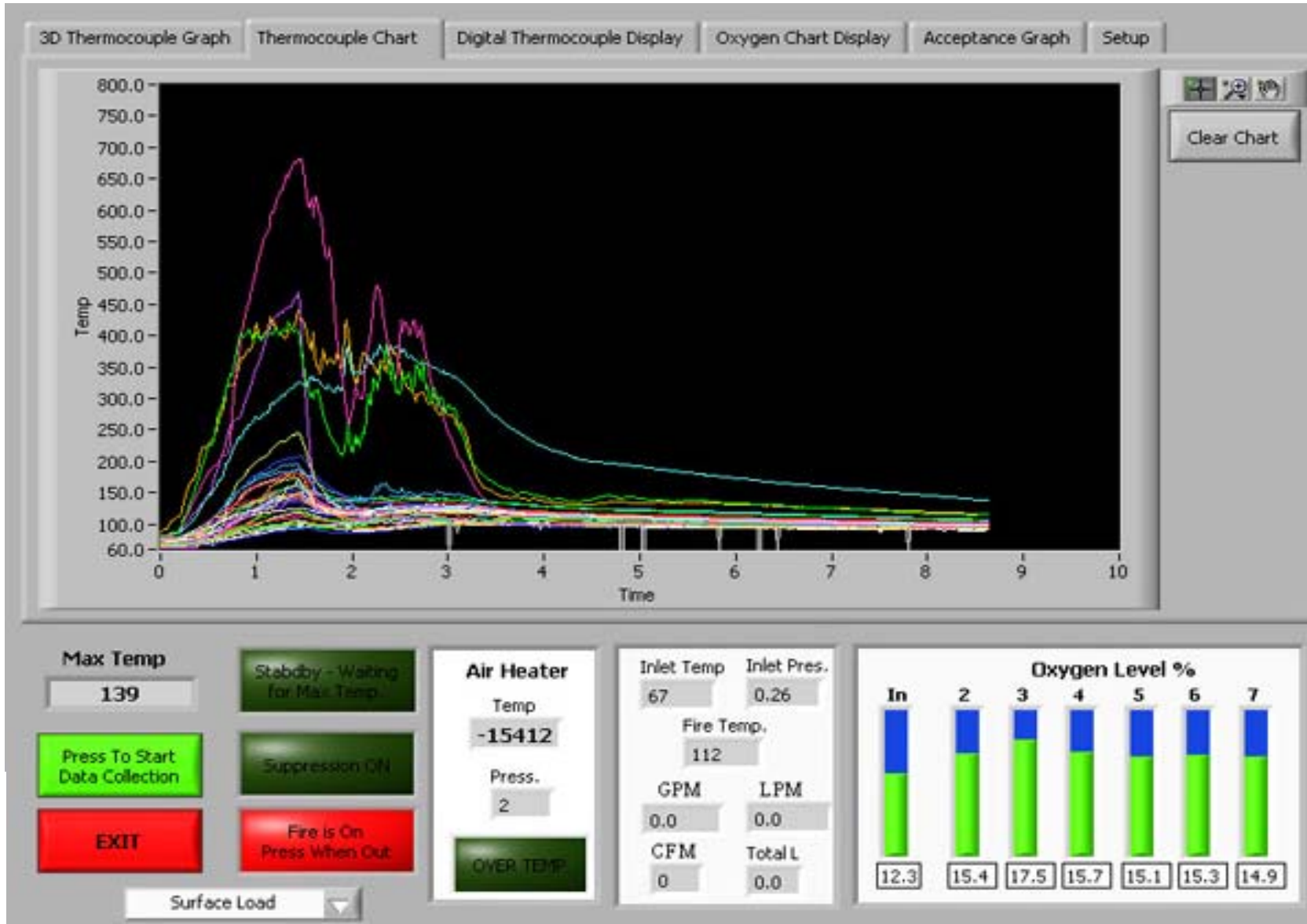
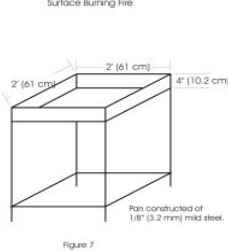


Containerized Load

# Container load



# Surface load (high) temp





# Surface load (high) MPS

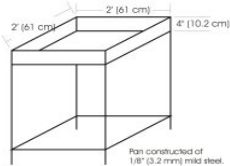
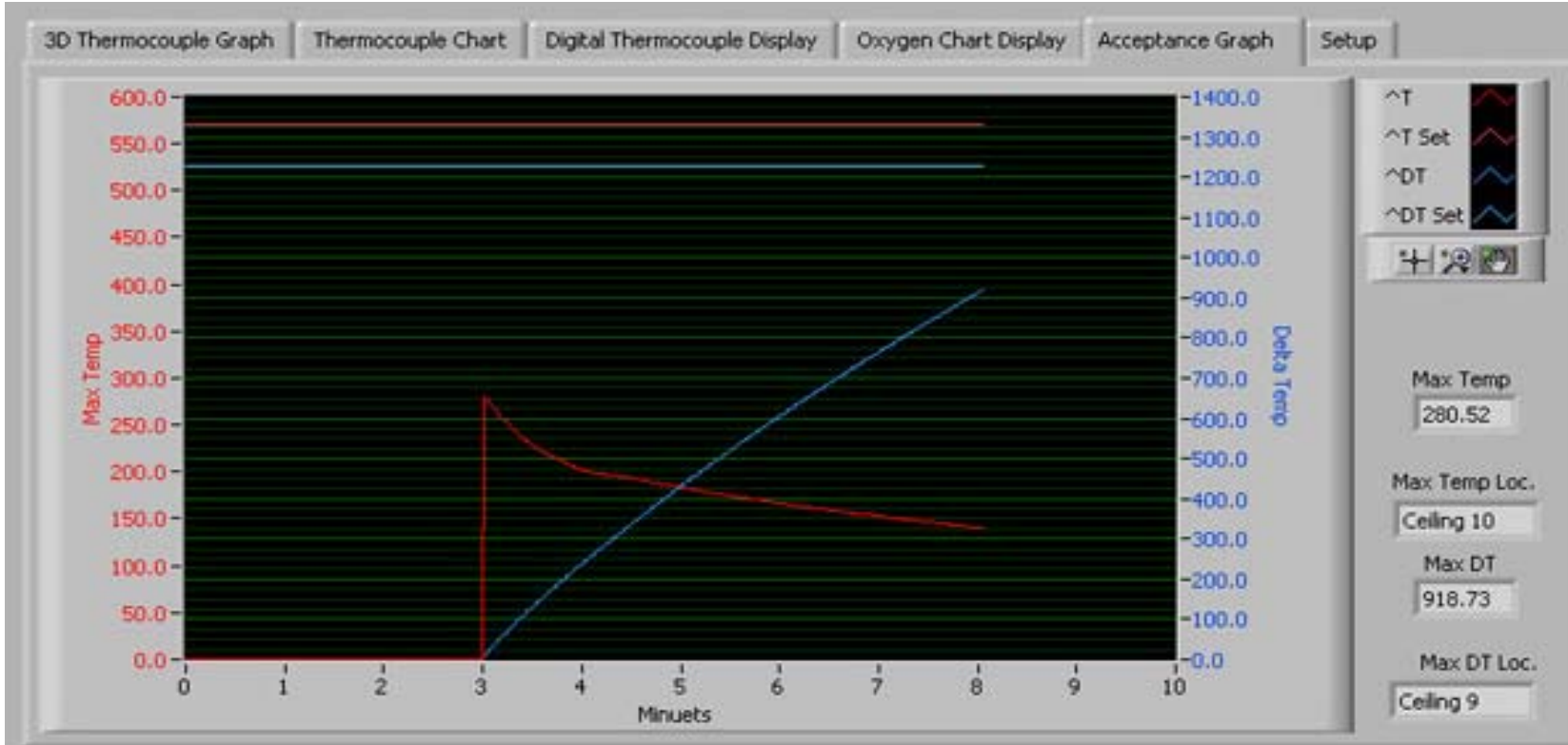


Figure 7



^T   
 ^T Set   
 ^DT   
 ^DT Set   
 Max Temp: 280.52  
 Max Temp Loc.: Ceiling 10  
 Max DT: 918.73  
 Max DT Loc.: Ceiling 9

Max Temp: 131  
 Stabby - Waiting for Max Temp  
 Press To Start Data Collection  
 Suppression ON  
 EXIT  
 Fire Is On Press When Out  
 Surface Load

**Air Heater**  
 Temp: -25250  
 Press.: 2  
 OVER TEMP

Inlet Temp: 67  
 Inlet Pres.: 0.25  
 Fire Temp.: 110  
 GPM: 0.0  
 LPM: 0.0  
 CFM: 0  
 Total L: 0.0

**Oxygen Level %**  
 In: 12.6  
 2: 15.3  
 3: 15.5  
 4: 15.7  
 5: 15.4  
 6: 15.5  
 7: 15.2



# Surface load (Mid) Temp

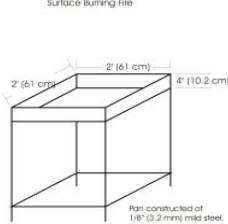
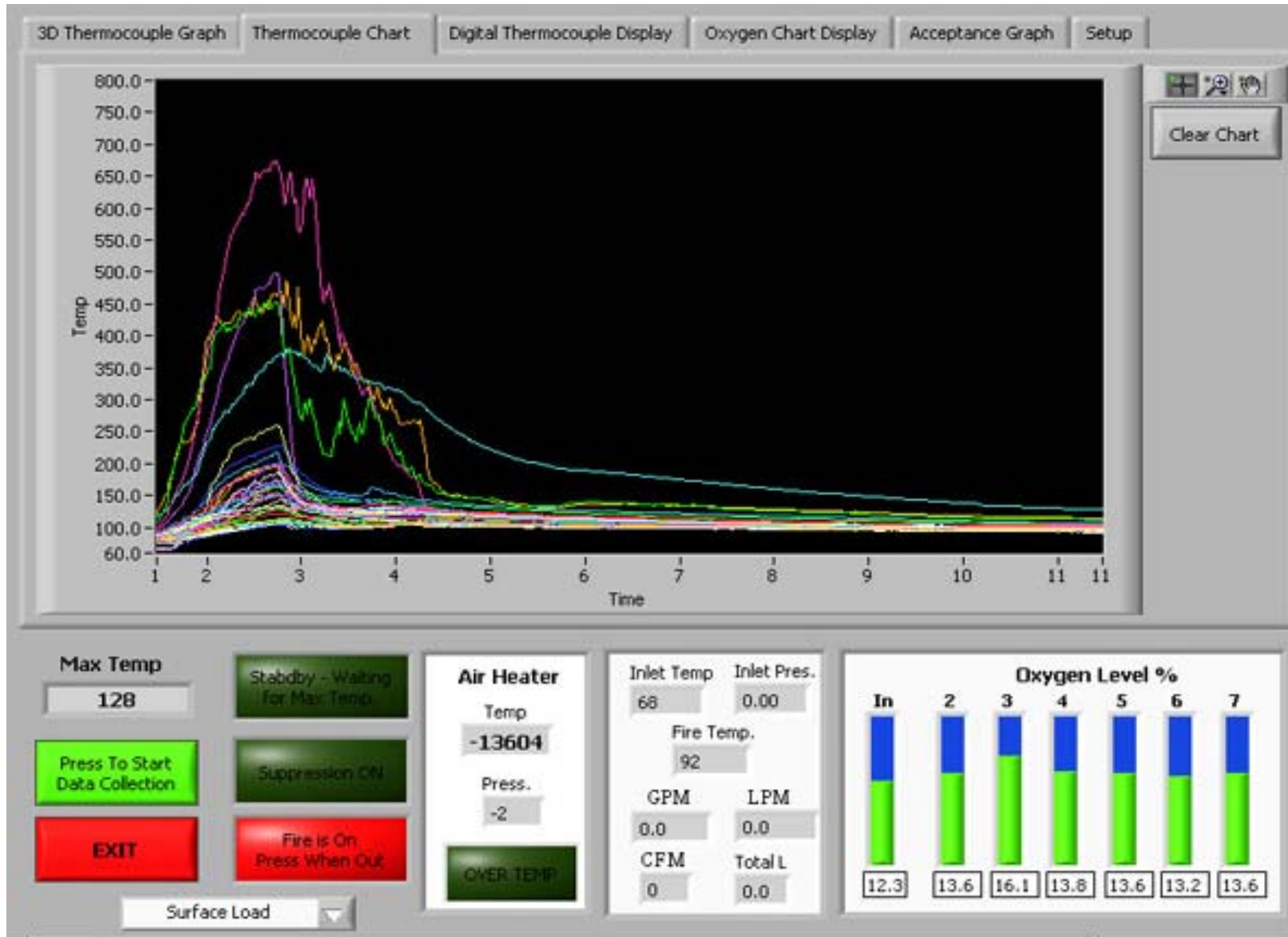
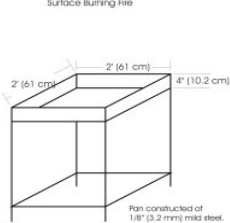
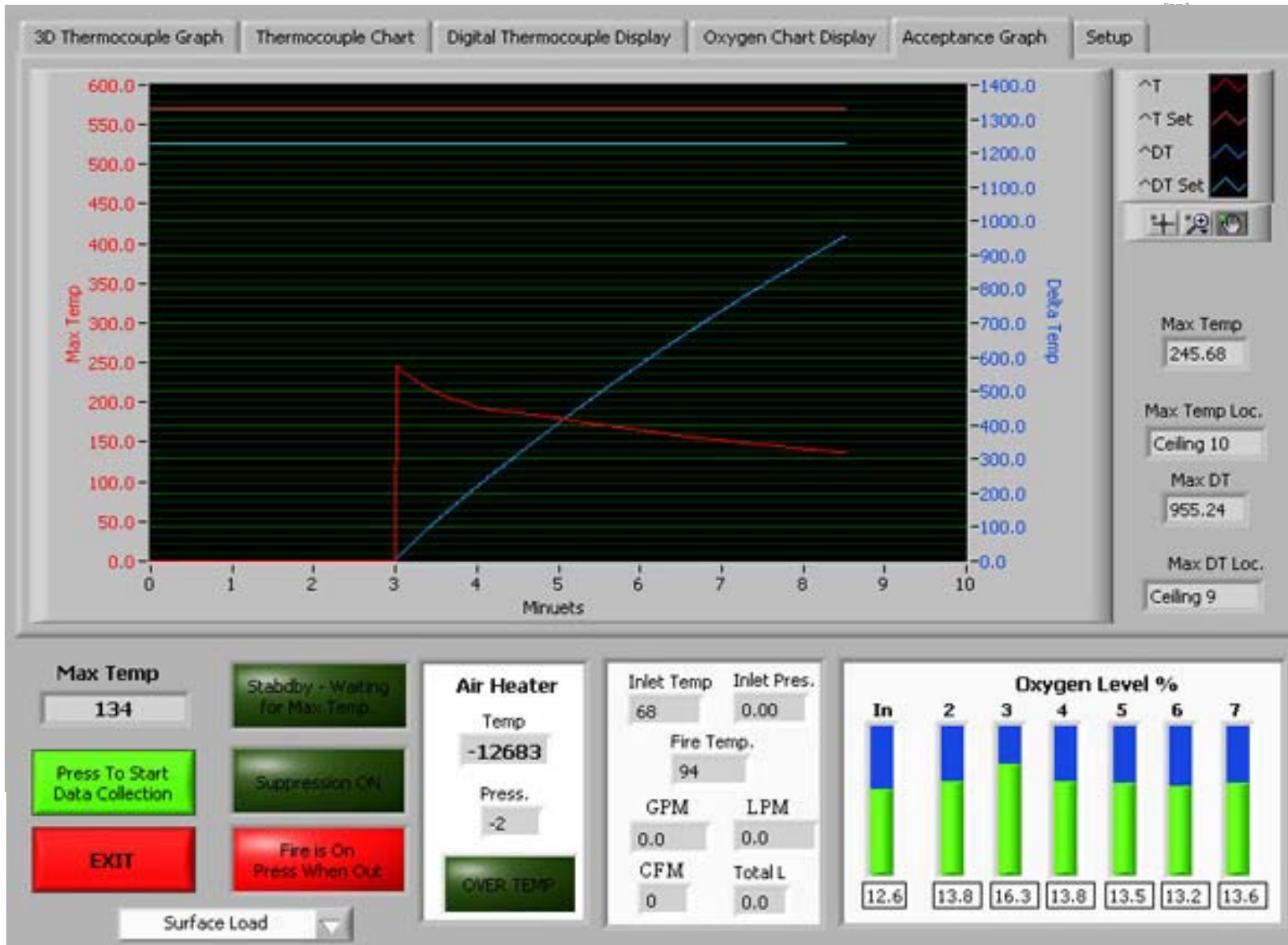


Figure 7





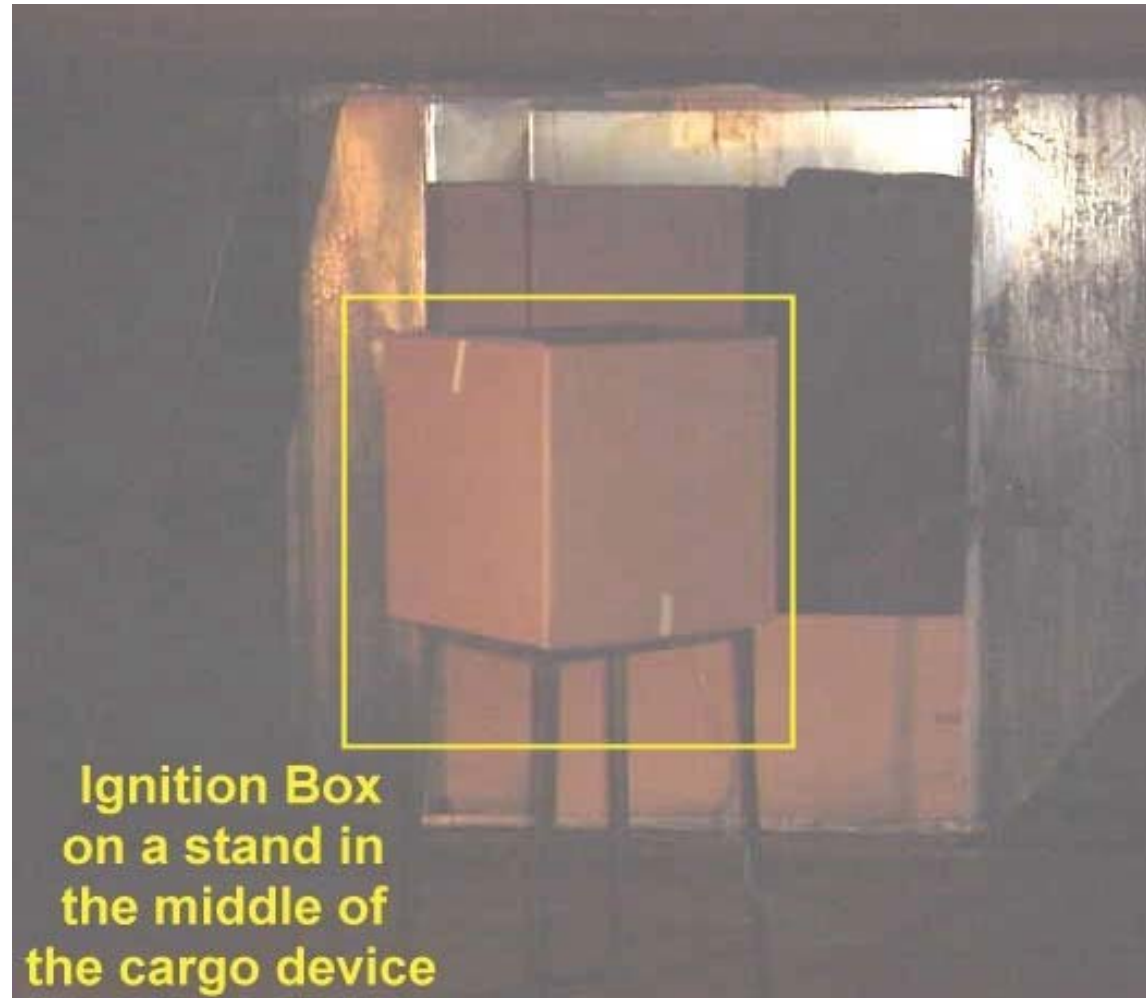
# Surface load (Mid) MPS



# Phase II FirePASS Preventive

Did two test to date 45  
minute and 90 minute

- Use the Bulk load igniter box
- Place in center of the Cargo MPS device
- reduce the O<sub>2</sub> to 14%
- apply power to the NiCrome wire
- Wait for the smoke to clear.

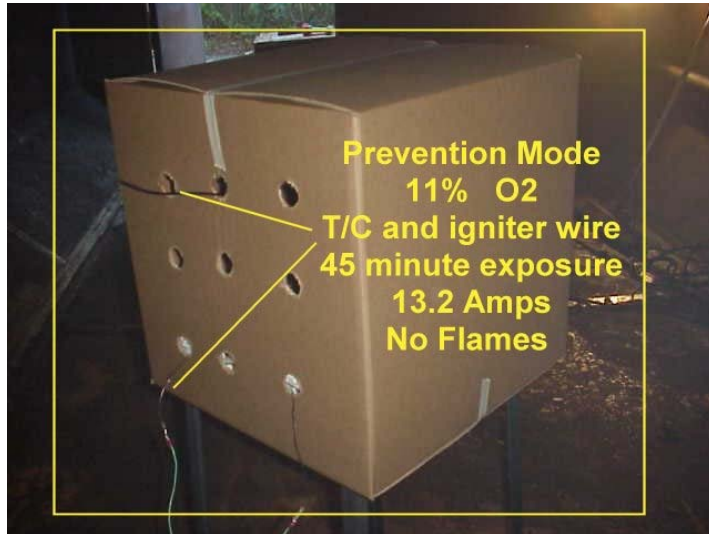


Ignition Box  
on a stand in  
the middle of  
the cargo device

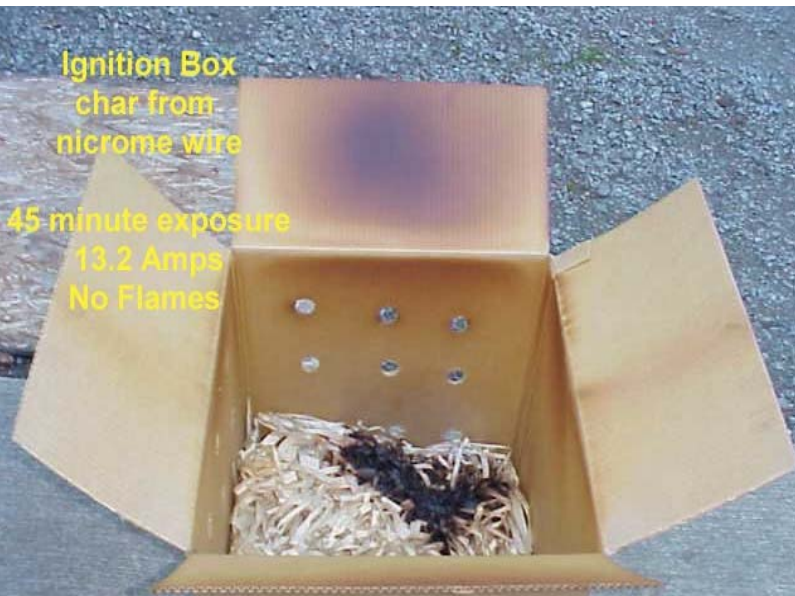
Fire Lab



# Test one last Thursday



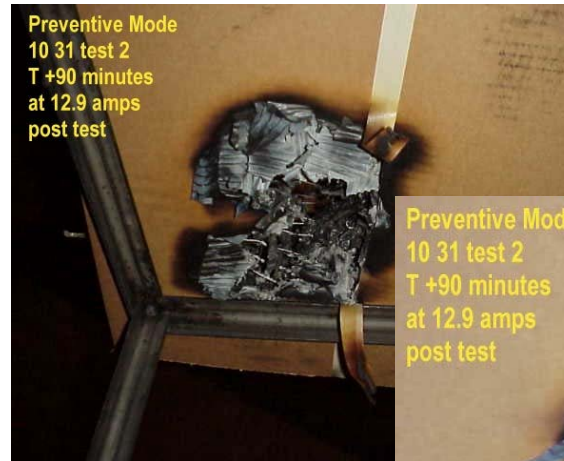
- 45 minute with power applied
- Temp went to 325 F for 10 minutes then stabilized at 145 F
- Some char and discoloration inside the box **NO FLAMES**

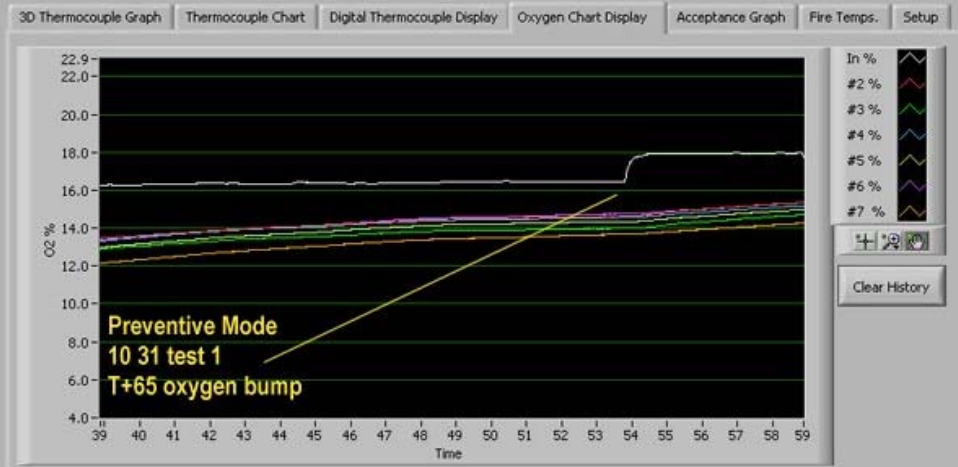
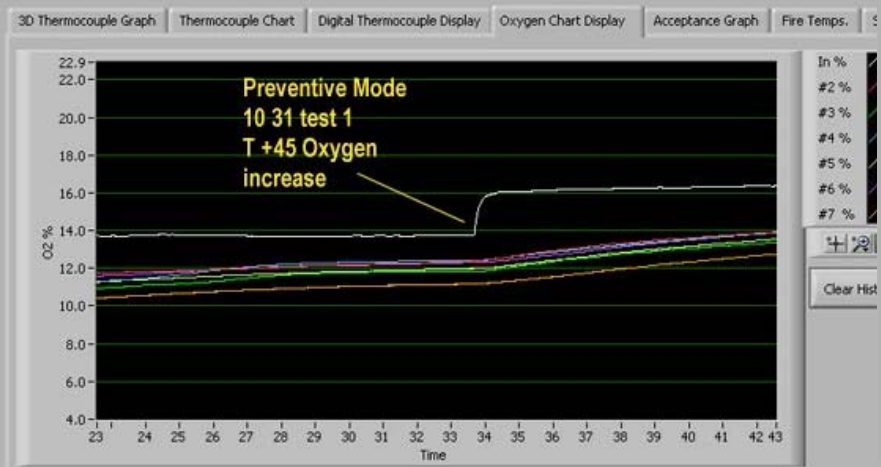


[detailed data at www.pyrogen.com](http://www.pyrogen.com)

# Test two last Friday

- Same test set up
  - (same box with new paper)
- 90 minute test
- Power applied at 14% oxygen content T=0
- Temps +350 F for 20 minutes
- after temp drop and stabilized at 137 F, we increased the O2 by 1% every 20 minutes
- ignition wire dropped and burned through the bottom of the box with **NO FLAMES**
- We started to see a 40 Deg F temp rise at 15.2% O2 at T+84 minutes. Stopped the test at 90 minutes
- future test planned





Max Temp: 74

Stabby - Waiting for Max Temp

Press To Start Data Collection

Suppression ON

EXIT

Fire is On Press When Out

Bulk Load

**Air Heater**

Temp	47	Inlet Pres.	14.20
Fire Ing	45	Fire Left	47
Fire Right	137	LD3 Air	50
GPM	0.0	LPM	0.0
Total L	0.0		0.0

OVER TEMP

**Oxygen Level %**

Location	O2 %
In	16.3
2	13.9
3	13.4
4	13.9
5	13.5
6	13.9

Max Temp: 73

Stabby - Waiting for Max Temp

Press To Start Data Collection

Suppression ON

EXIT

Fire is On Press When Out

Bulk Load

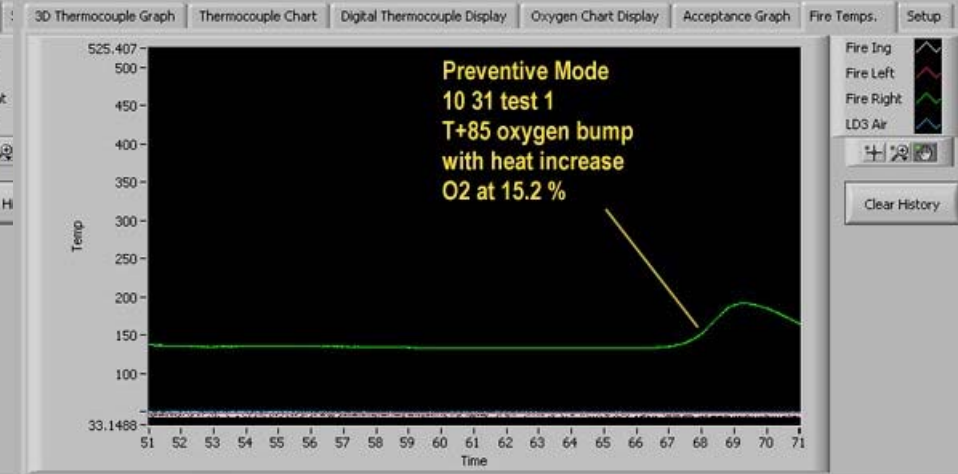
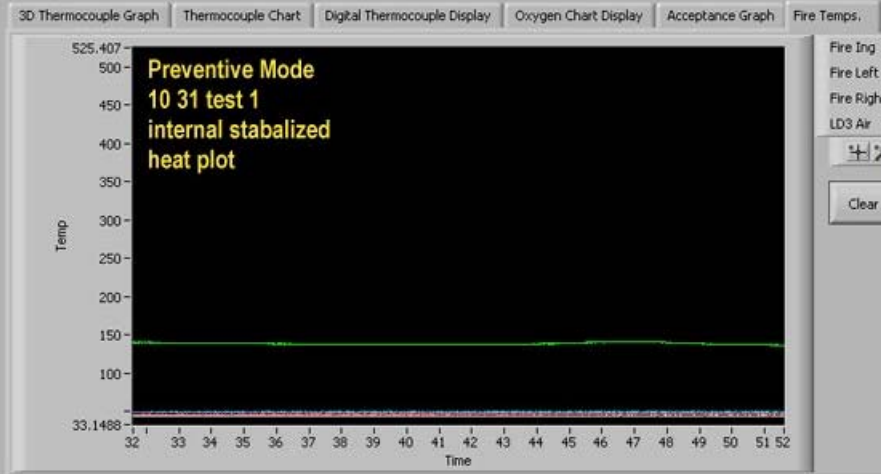
**Air Heater**

Temp	48	Inlet Pres.	14.01
Fire Ing	45	Fire Left	47
Fire Right	176	LD3 Air	49
GPM	0.0	LPM	0.0
Total L	0.0		0.0

OVER TEMP

**Oxygen Level %**

Location	O2 %
In	17.7
2	15.3
3	14.7
4	15.2
5	15.0
6	15.3
7	14.3



Max Temp: 74

Stabby - Waiting for Max Temp

Press To Start Data Collection

Suppression ON

EXIT

Fire is On Press When Out

Bulk Load

**Air Heater**

Temp	47	Inlet Pres.	14.21
Fire Ing	45	Fire Left	47
Fire Right	137	LD3 Air	50
GPM	0.0	LPM	0.0
Total L	0.0		0.0

OVER TEMP

**Oxygen Level %**

Location	O2 %
In	16.3
2	14.0
3	13.4
4	13.9
5	13.6
6	14.0

Max Temp: 73

Stabby - Waiting for Max Temp

Press To Start Data Collection

Suppression ON

EXIT

Fire is On Press When Out

Bulk Load

**Air Heater**

Temp	47	Inlet Pres.	14.09
Fire Ing	45	Fire Left	47
Fire Right	165	LD3 Air	49
GPM	0.0	LPM	0.0
Total L	0.0		0.0

OVER TEMP

**Oxygen Level %**

Location	O2 %
In	17.2
2	15.4
3	14.7
4	15.2
5	15.0
6	15.4
7	14.3

- Data was collected with virtual instruments constructed with “National Instruments” LabView DAQ software and a SCXI signal conditioner
- Test data and remote video observations available via TCP/ IP connection

**Data is updated and posted at**

<http://www.pyrogen.com/IAIfireLabmist.htm>

- For further information contact:

**John Brooks**

Director of Research

**International Aero Inc**

**11817 Westar Lane**

**Burlington Wa. 98233**

**P 360 757 2376 F 360 757 4841**

[jbrooks@pyrogen.com](mailto:jbrooks@pyrogen.com)

[www.pyrogen.com](http://www.pyrogen.com)







**“Your Interior Configuration Specialist”**

**Thank You**

No Animals real or imaginary were injured while performing these test

