Fire Suppression in a Class E Cargo Compartment

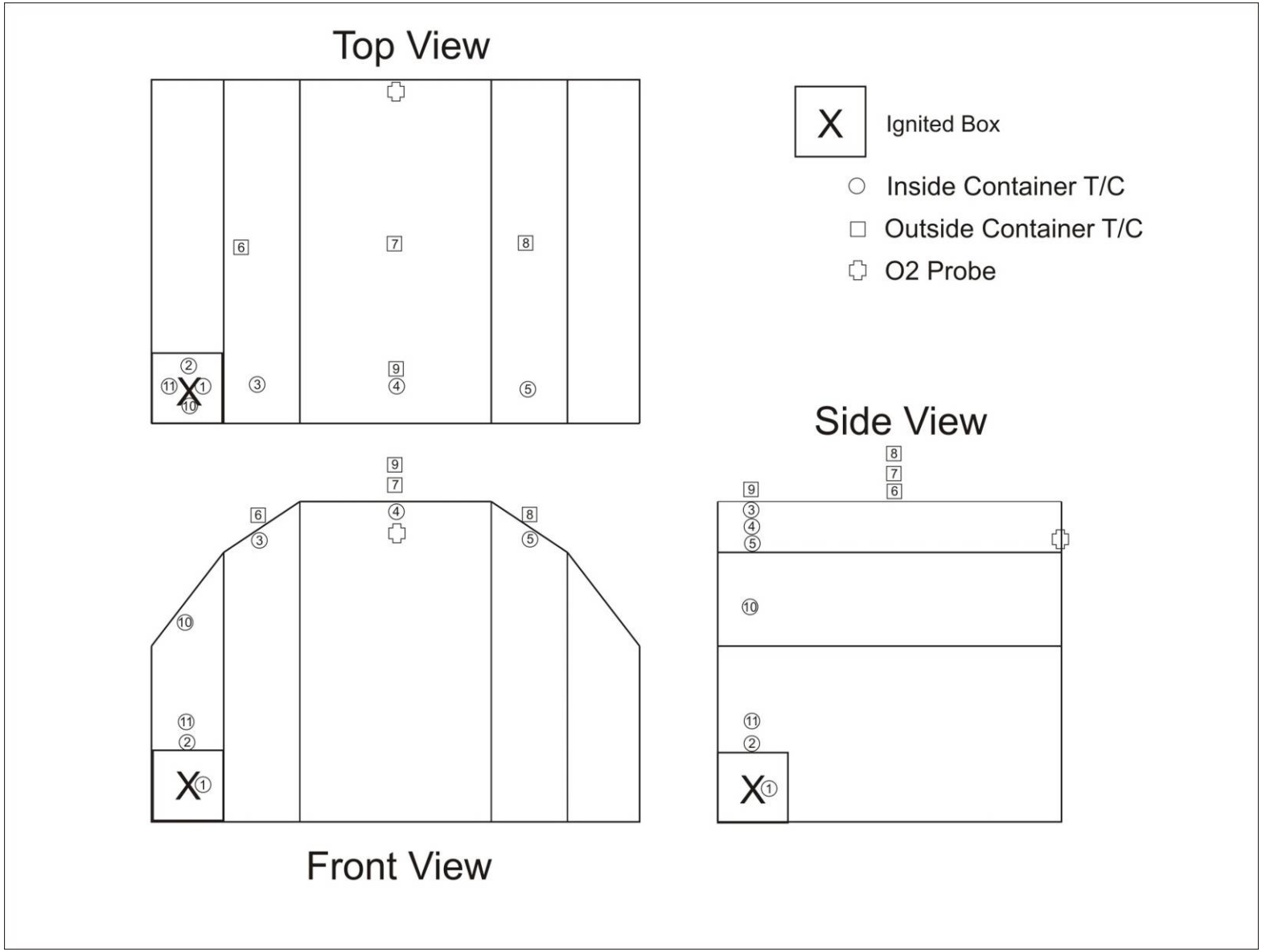
Federal Aviation Administration

Presented to: International Aircraft Systems Fire Protection Working Group, Köln, Germany

By: Dhaval Dadia, FAA Technical Center Atlantic City, NJ

Date: May 11-12, 2011

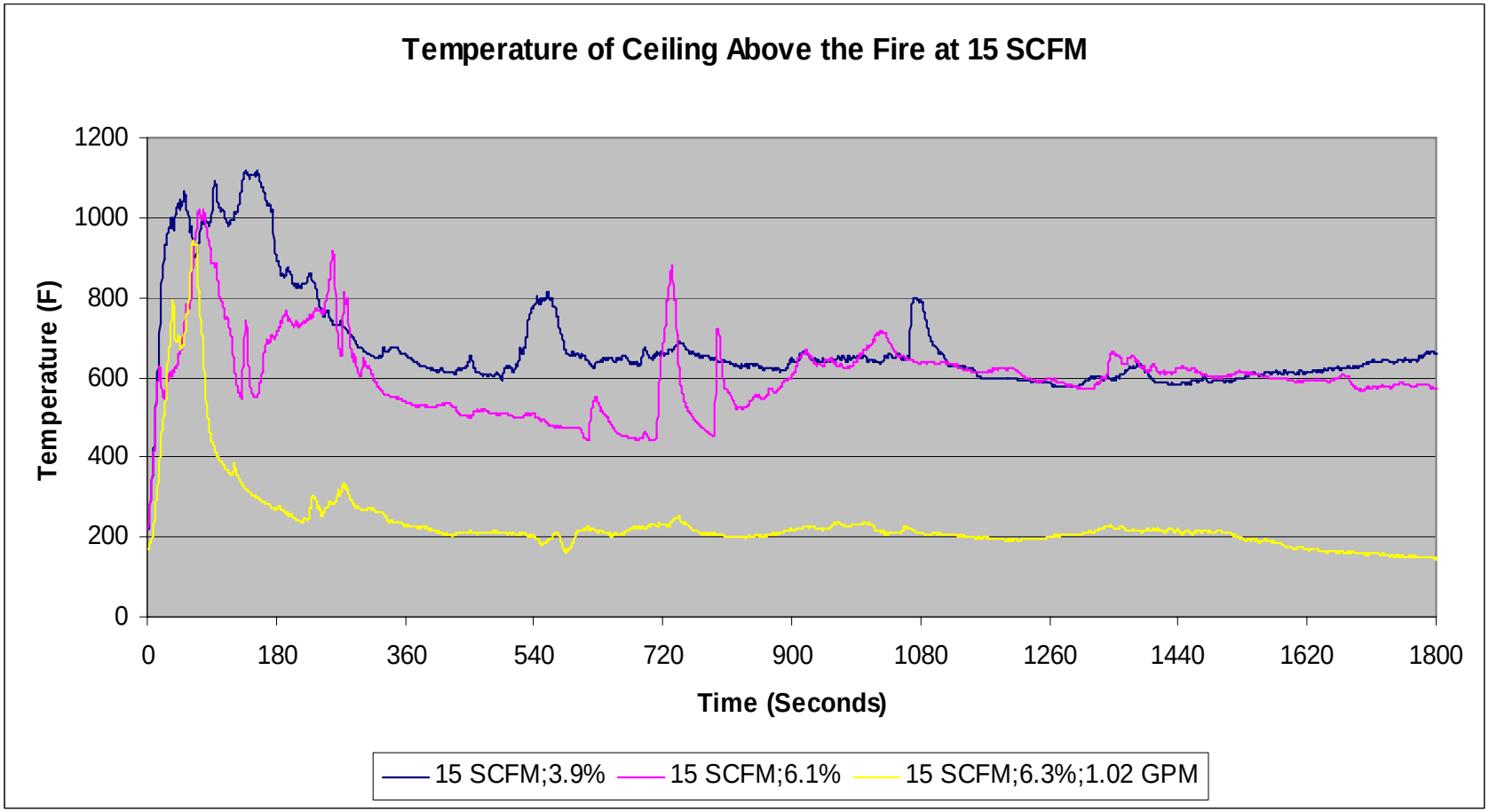
Galvanized Test Cargo Container


Top View
X
Ignited Box
Inside Container T/C
Outside Container T/C
O2 Probe
Side View
Front View

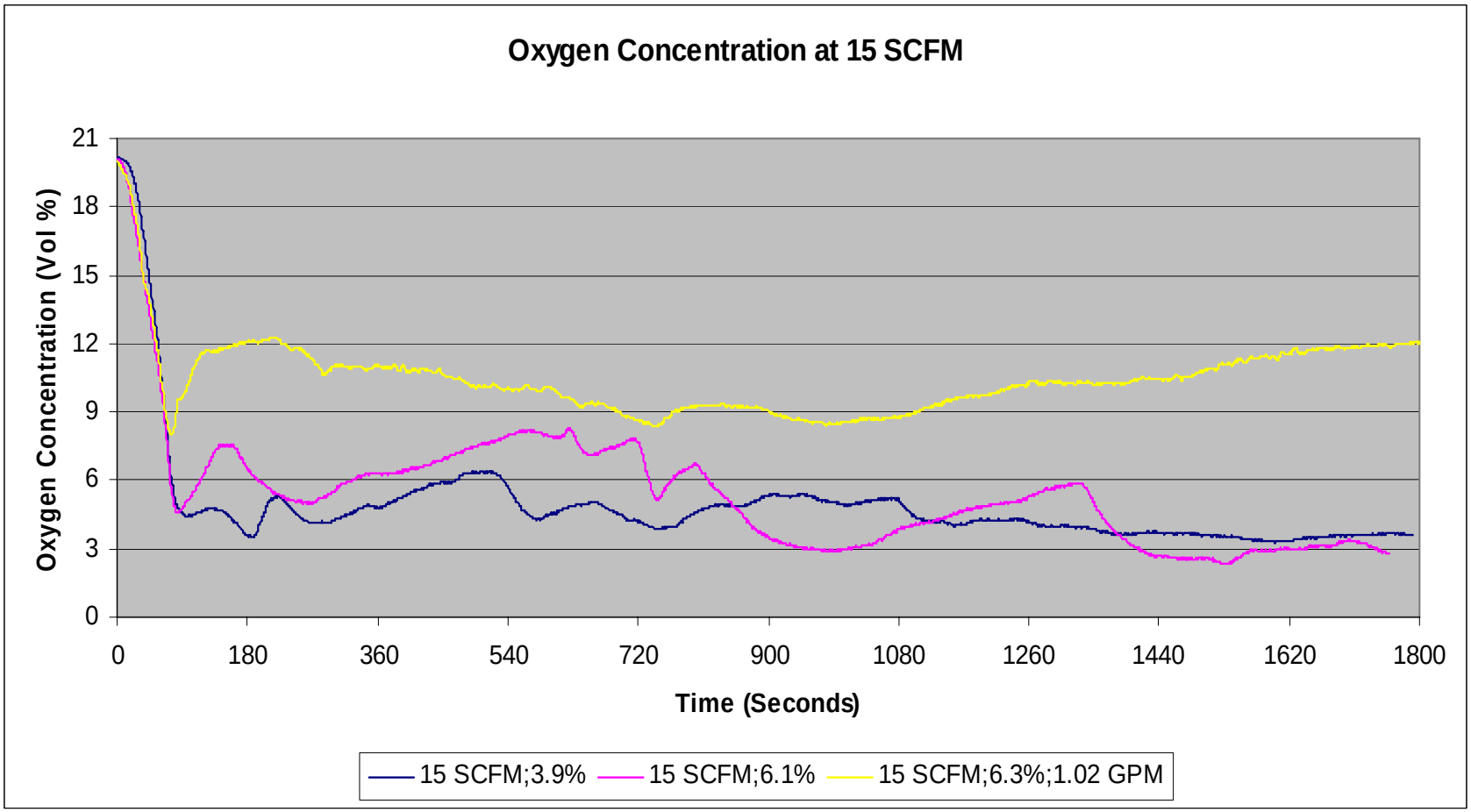
NEA Test Matrix

Flow Rate	Concentration of Oxygen in NEA		NEA + Water
15 SCFM	3.9%	6.1%	6.3%+1.02 GPM
18 SCFM	5.5%	7.7%	7.7%+1.02GPM
20 SCFM	6.7%	8.8%	8.7%+1.02GPM

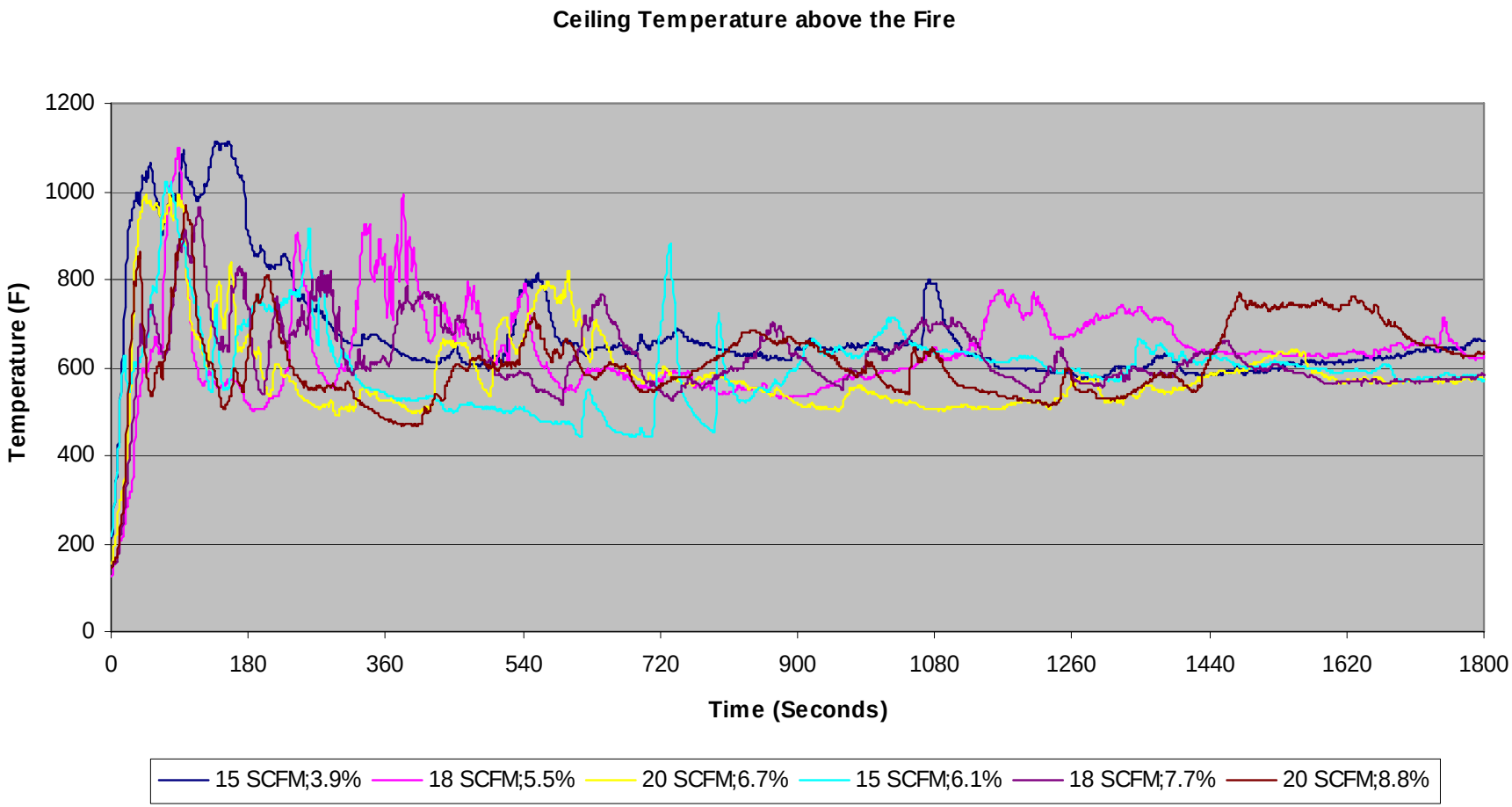
Temperature Profile at 15 SCFM



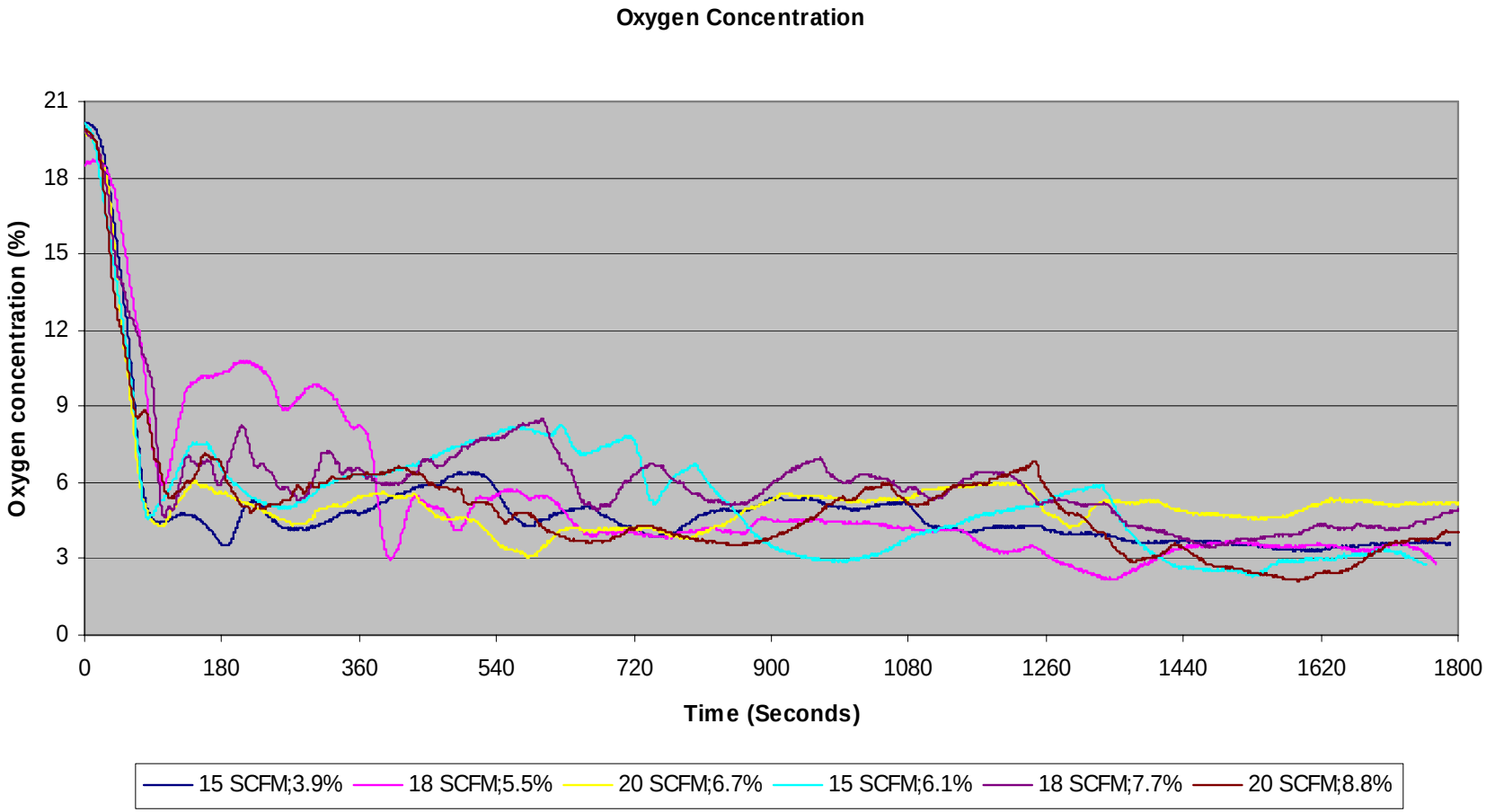
Oxygen Conc. Profile at 15 SCFM



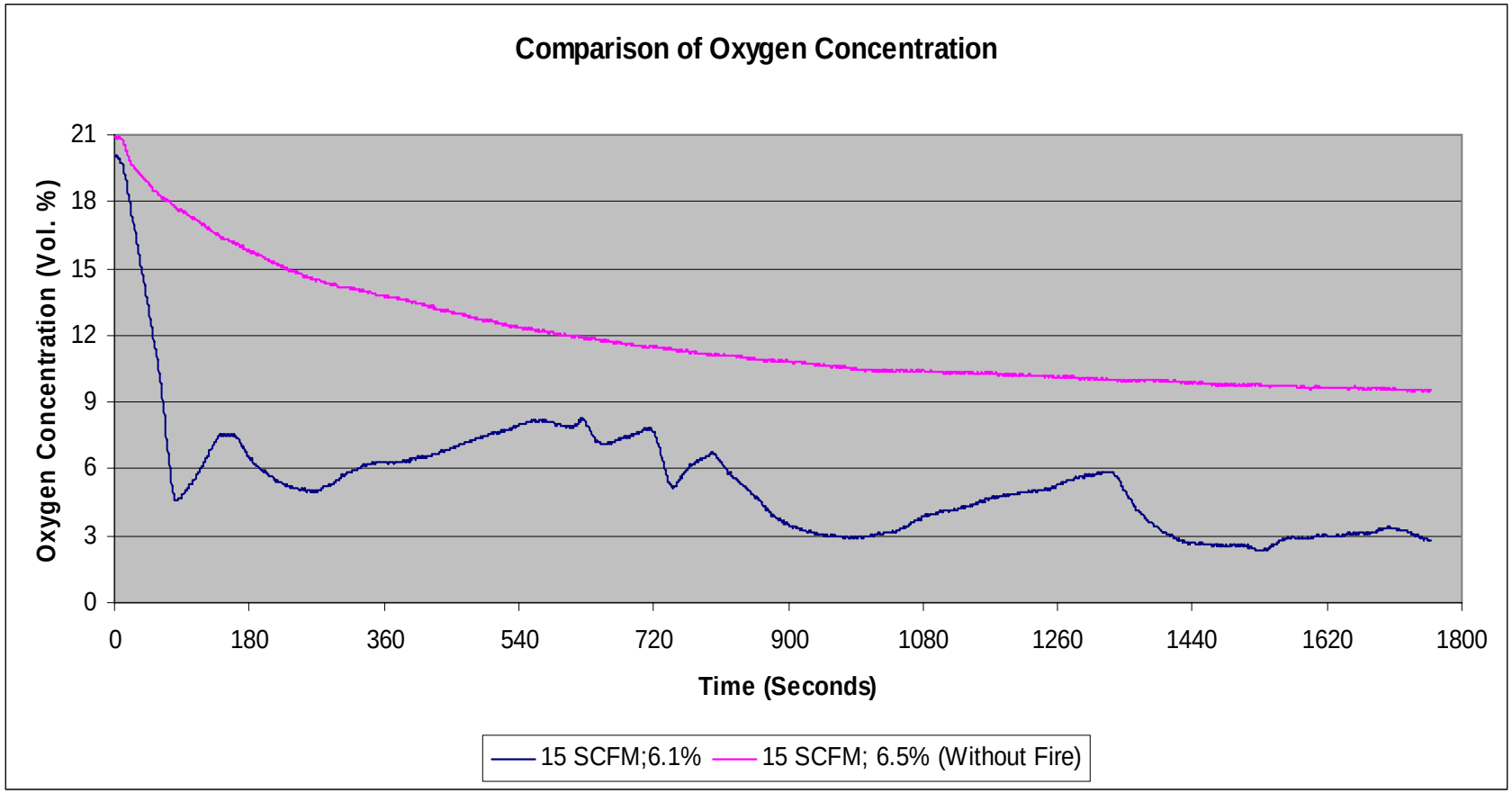
Comparison of Temp. profiles



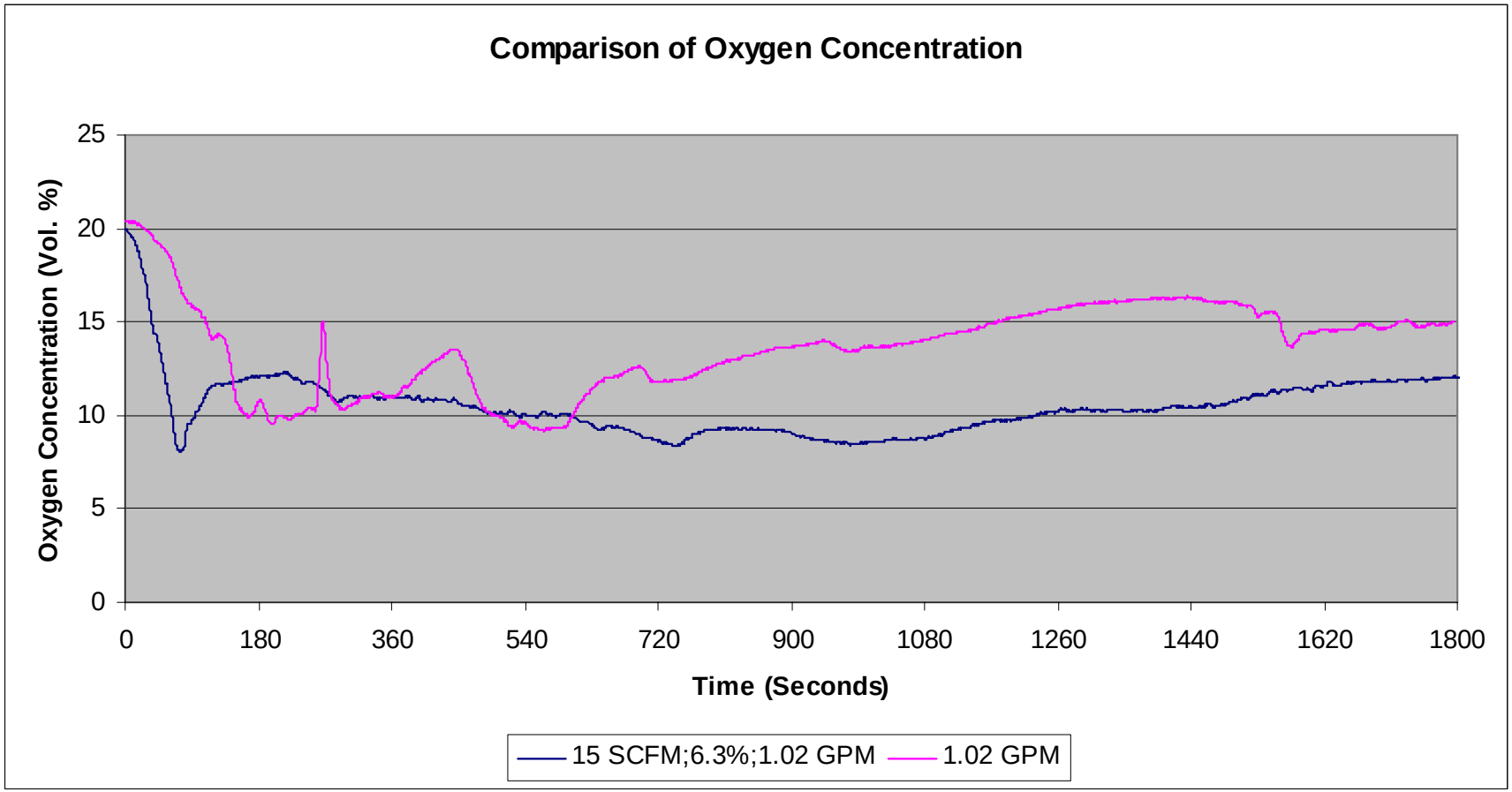
Comparison of Oxygen Concentration



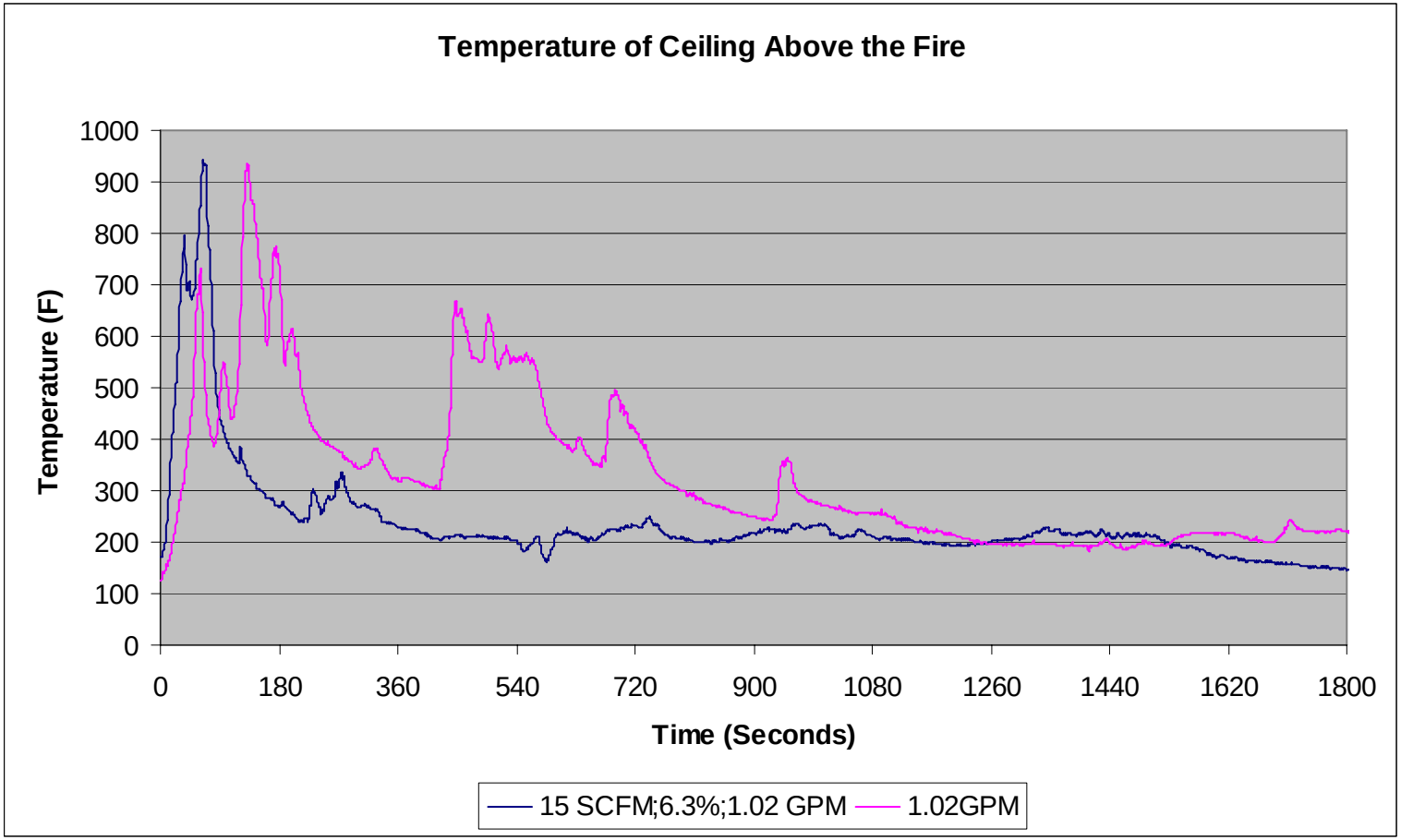
Comparison of Oxygen Concentration Agent: NEA



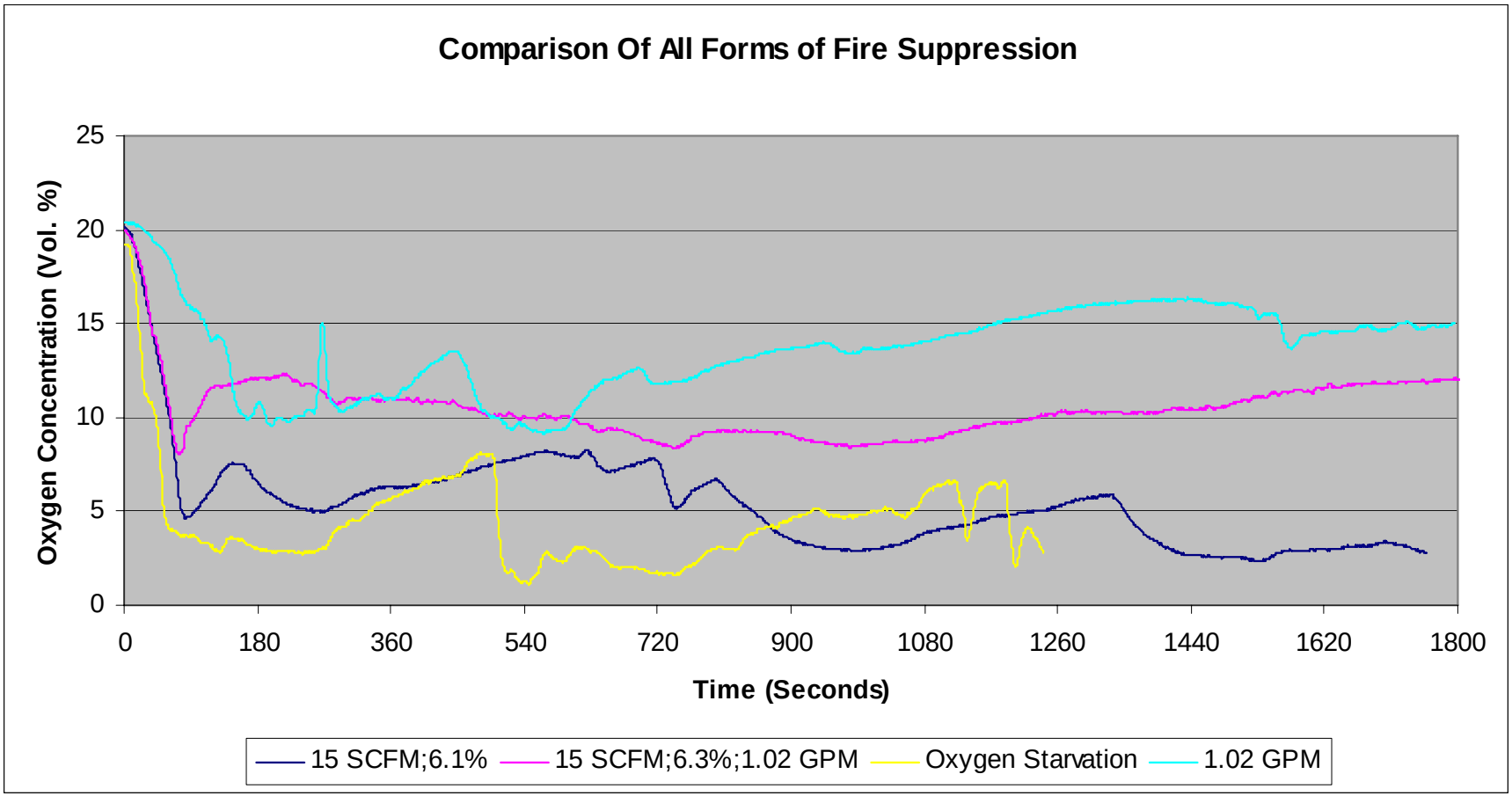
Comparison of Oxygen Concentration Agent: Water



Comparison of TC#3 Agent: Water



Comparison of Oxygen Concentration



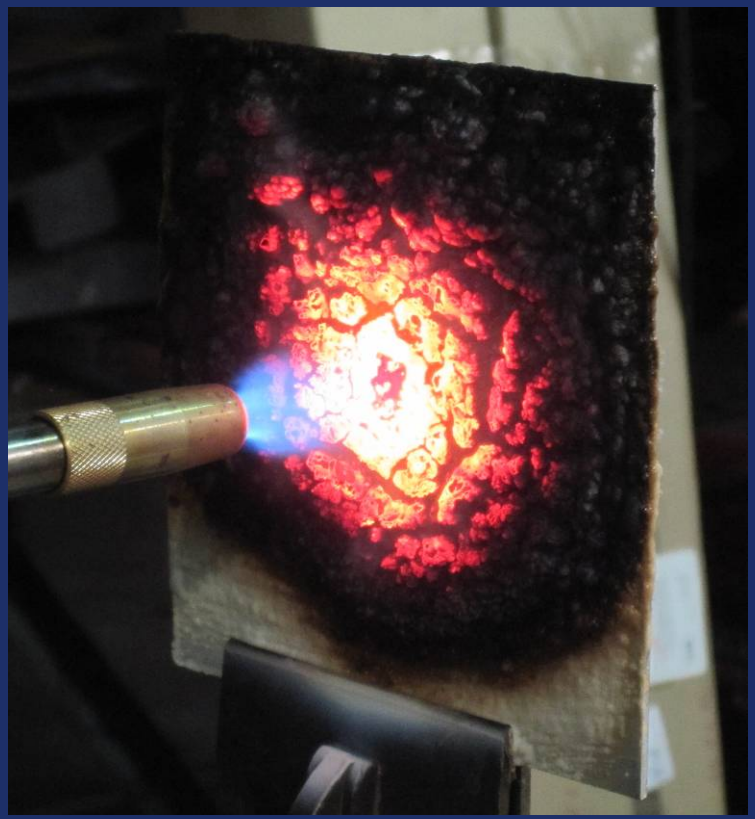
Observations

- **Temperature and oxygen concentration profiles are similar when using only NEA with changes in oxygen concentration.**
- **The least amount of boxes burnt were at lower flow rates of NEA at the higher oxygen concentration i.e. 15 SCFM;6.30%.**
- **Using water along with the NEA enhances the strength of the fire suppression system.**

Future Work

- **Conduct tests using ANSUL foam**
- **Conduct tests with Lithium Batteries in the container**

Utilizing Intumescent Paint in the Packaging of Lithium Batteries



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What is Intumescence?

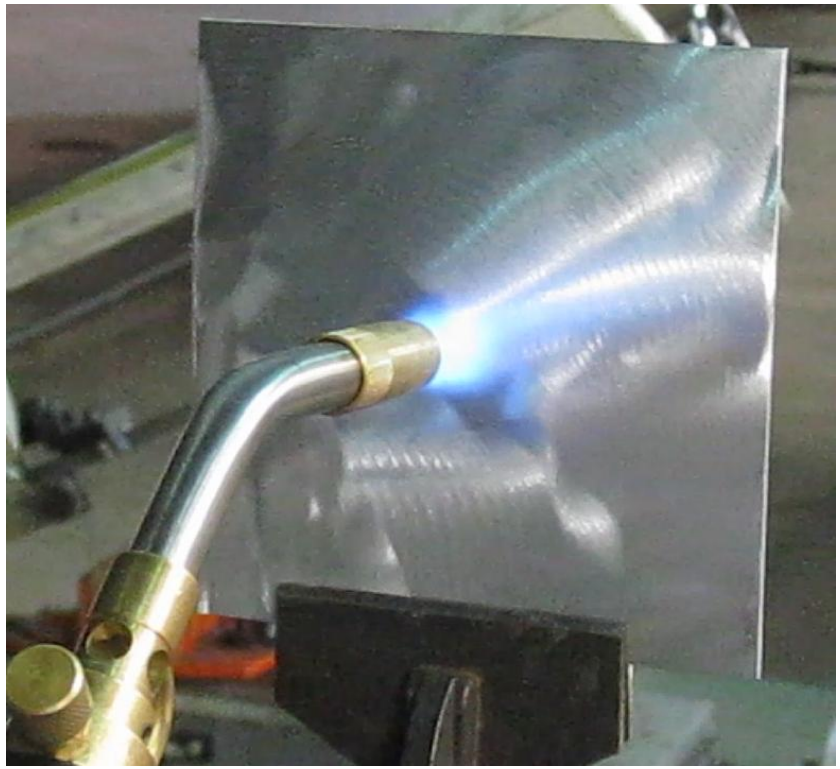
- **The swelling of certain substance when they are heated.**
- **An Intumescent coating provides passive fire protection most commonly used in the construction industry.**

How it Works

- **Intumescent coatings expands on heating, which acts as a thermal barrier that protects the underlying material.**
- **Intumescent coatings contain ingredients that are bound together by an adhesive.**
  - An acid source (dehydrates the carbonization source)
  - A carbon source (charring agent)
  - A blowing agent (allows the char to swell and produce the multi-cellular protective layer)

Test Setup

- **5” X 5” test sample**
- **Propane torch placed 2” away from the surface**

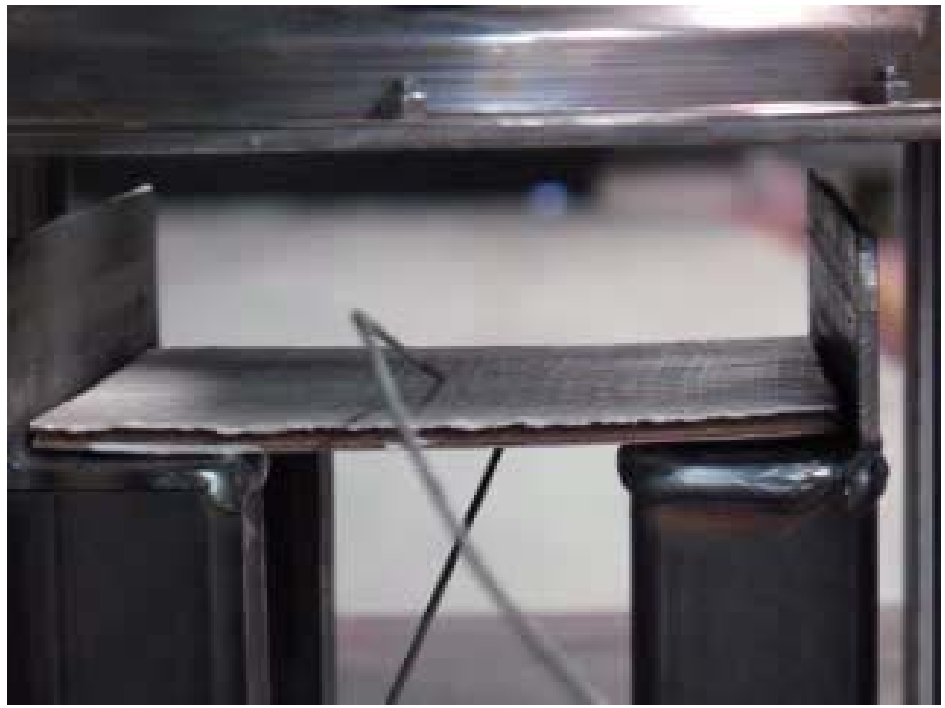


Comparison of Aluminum Sample

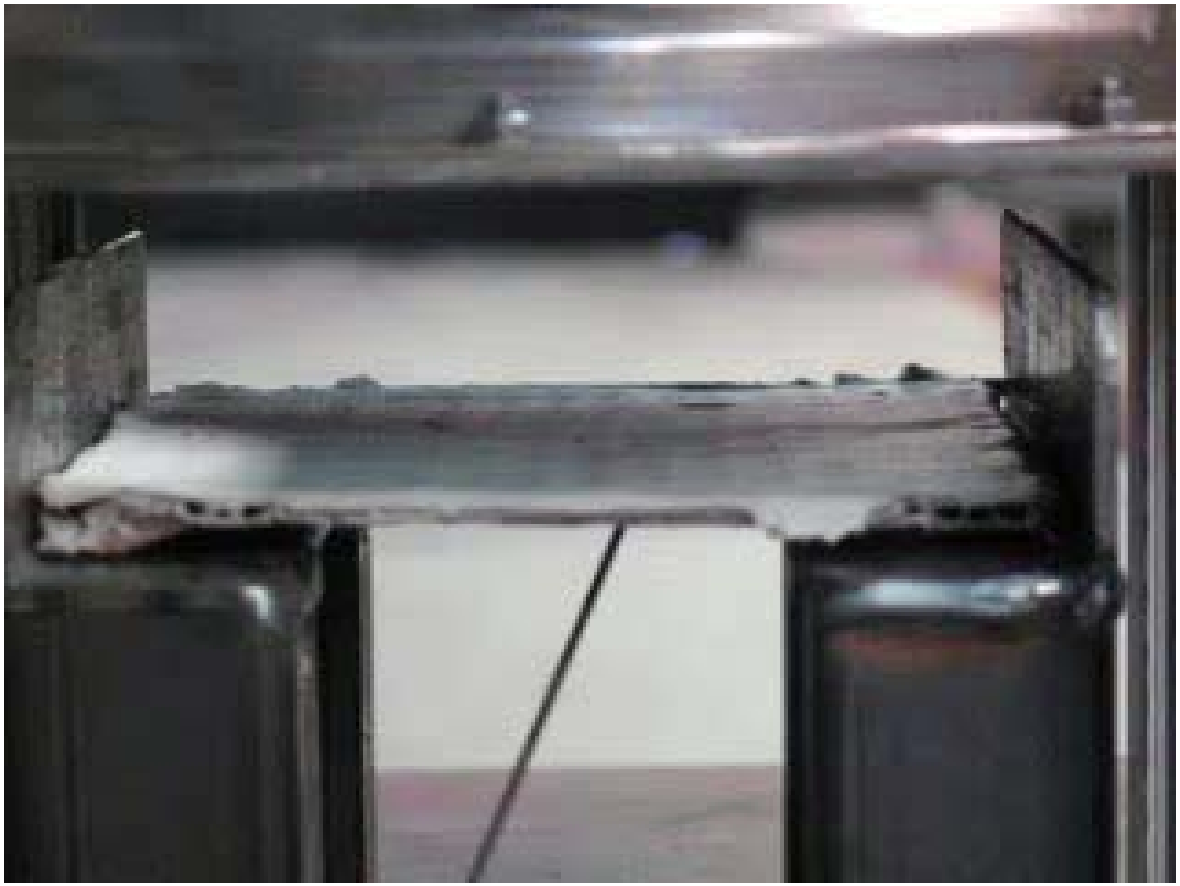
Comparison of Cardboard Sample

Test Setup

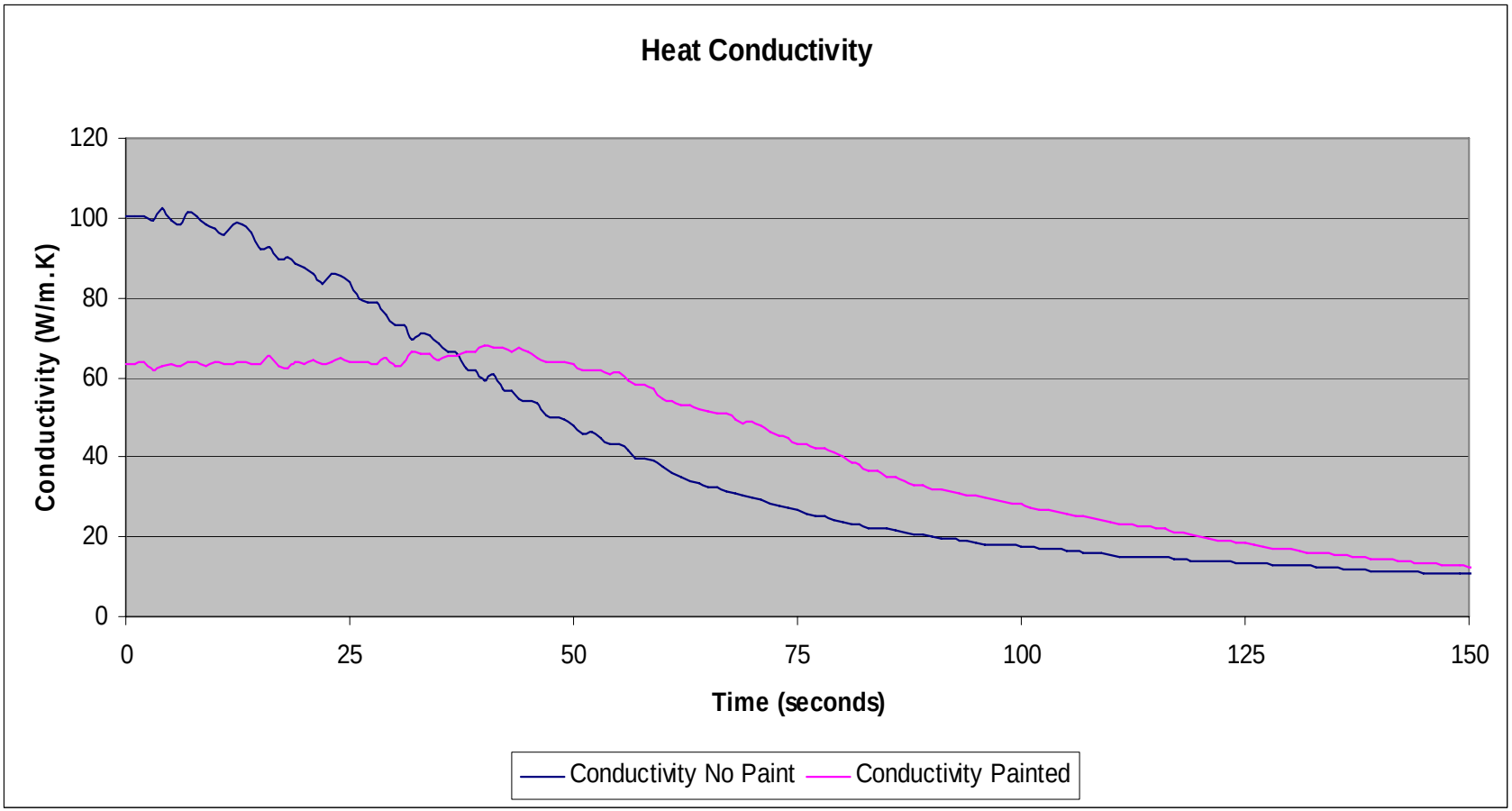
- **5” X 5” Sample**
- **Cone Heater placed 2” above the sample**
- **Heater controlled by a variable transformer**
- **Two thermocouples measure temperature above and below the sample**



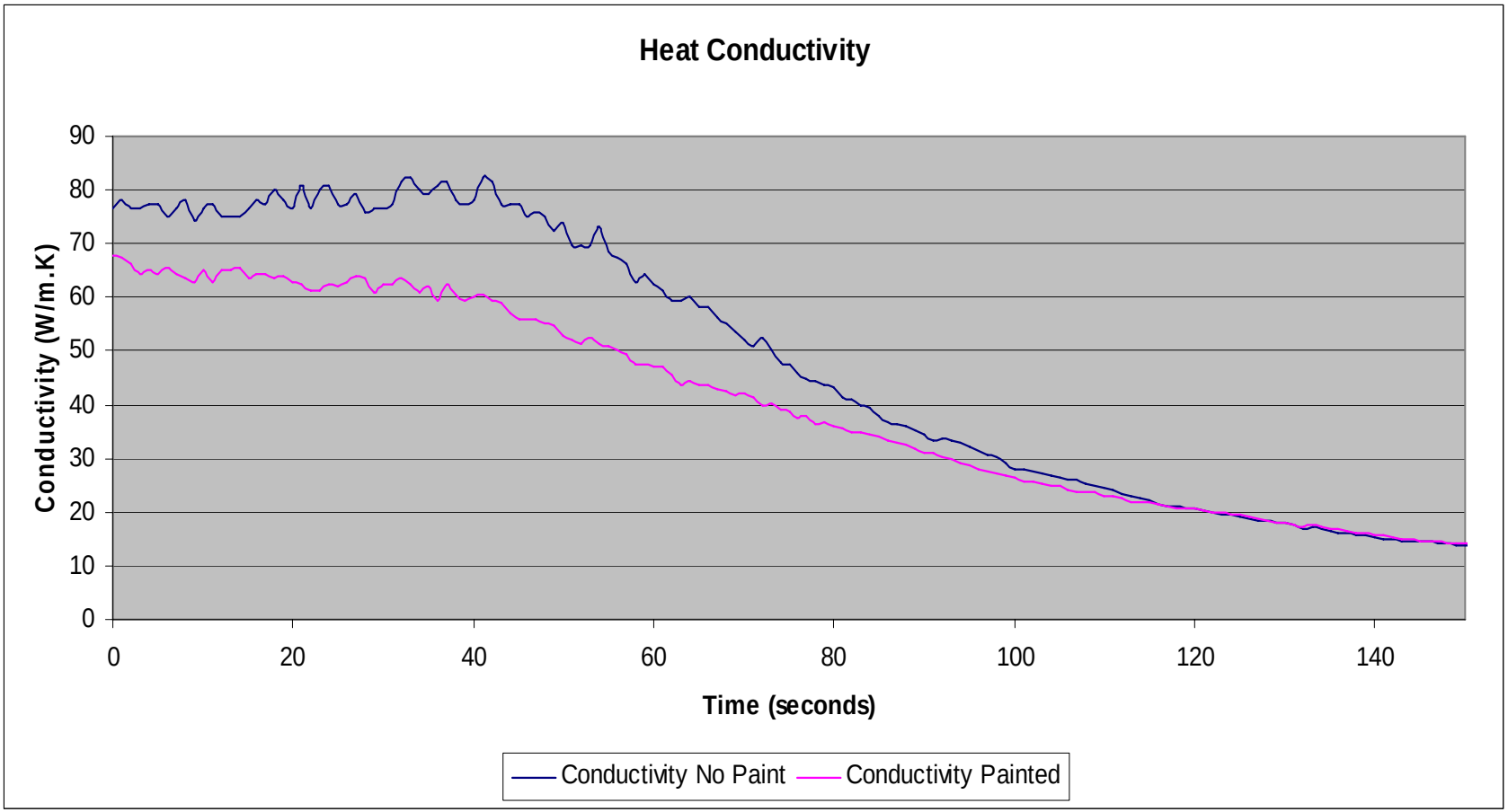
Cardboard Sample Under A Cone Heater



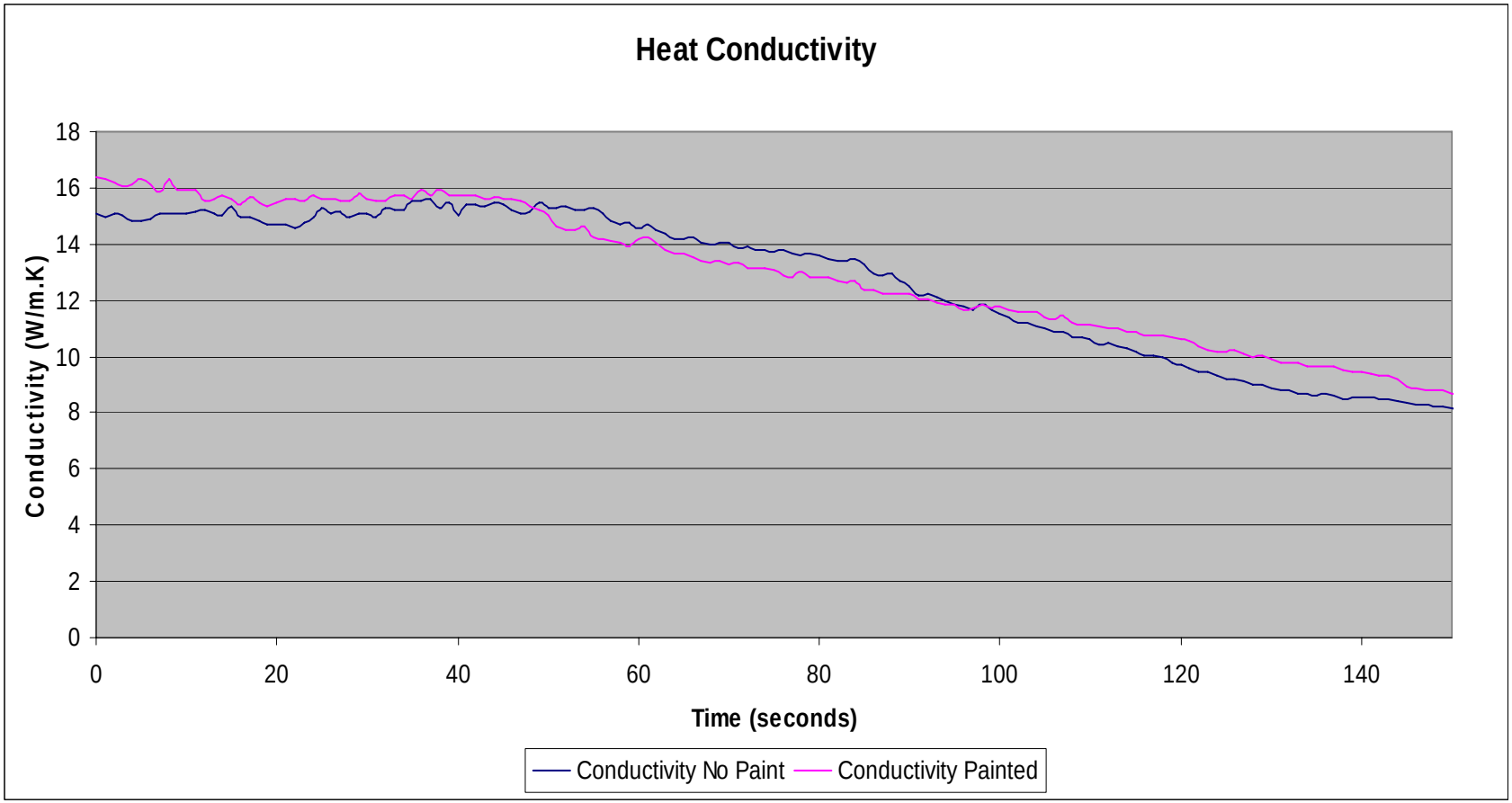
Heat Flux of 44.5 kW/m^2



Heat Flux of 34.9 kW/m^2



Heat Flux of 24.5 kW/m²



Observations

- **Intumescent paint works extremely well on metals when exposed to fire directly.**
- **Cardboard covered with intumescent paint protects itself when exposed to fire but only for a short period of time.**
- **At higher heat flux, intumescent paint protects the cardboard from igniting immediately.**
- **At lower heat flux, intumescent paint seems to be ineffective in protecting the cardboard. This might be due to slower chemical reactions at lower heat flux.**

Future Work

- **Cover packaging dividers with intumescent paint to observe heat transfer from a battery in thermal runaway to its surroundings.**
- **Cover the exterior of a lithium battery container in intumescent paint and place it in a cargo container fire.**