Positive Pressure Ventilators (PPV) & AMCA 240 Updates

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- Joined AMCA in February 2019
- Responsible for development of AMCA's education programs; staff liaison for the Education & Training Subcommittee
- Projects include webinars, online education modules, presentations at trade shows, AMCA Speakers Network and other duties as assigned.

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- Bachelor’s degree in Mechanical Engineering
- Background in business manufacturing, R&D, production, and customer satisfaction
- Volunteer firefighter experience

Positive Pressure Ventilators (PPV) & AMCA 240 Updates

Purpose and Learning Objectives

The purpose of this presentation is to provide participants with knowledge about Positive Pressure Ventilators (PPVs), their history and current application, and how AMCA Standard 240 was developed.

At the end of this presentation participants will be able to:

1. Explain what entrained/induced airflow is.
2. Explain what backpressure is.
3. Describe how and why AMCA 240 benefits firefighters.
4. Identify an AMCA Certified PPV on the AMCA website.

Firefighting Ventilation

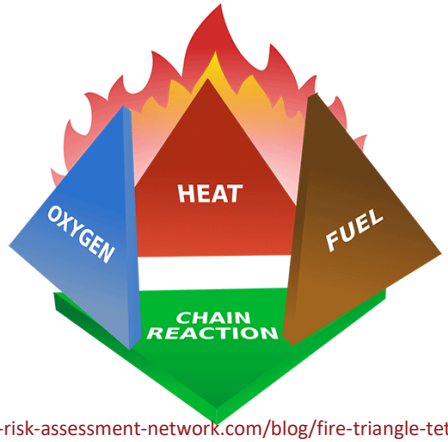
1. Beginning of PPVs
2. Adoption of PPVs
3. Cone (Door Seal) vs Column Airstreams
4. Electrification
5. Battery PPVs
6. Staying Current

Firefighting Ventilation – Beginning of PPV

- Negative Pressure Ventilators
  - In the 1940's and 50's firefighters began repurposing boat and plane propellors as non-permanent equipment to evacuate smoke from buildings so occupants could re-enter.
  - Difficult setup in windows or doors; often electric
- In the early 1970's Controlled Airstreams began repurposing movie production ventilators for use on the fire ground. This was the start of PPV tactics on the fire ground.

Firefighting Ventilation – Adoption of PPVs

- By 1990's PPV tactics were taught to many departments throughout USA.
- Benefits
  - Setback >> Entrained Air
  - Faster & Easier to setup
- Skepticism
  - Feeding the fire with 1 of the 3 components in the fire triangle/tetrahedron
  - Important to have water on the fire and flow path established before ventilation.



https://fire-risk-assessment-network.com/blog/fire-triangle-tetrahedron/

Photo by Zachary Newton

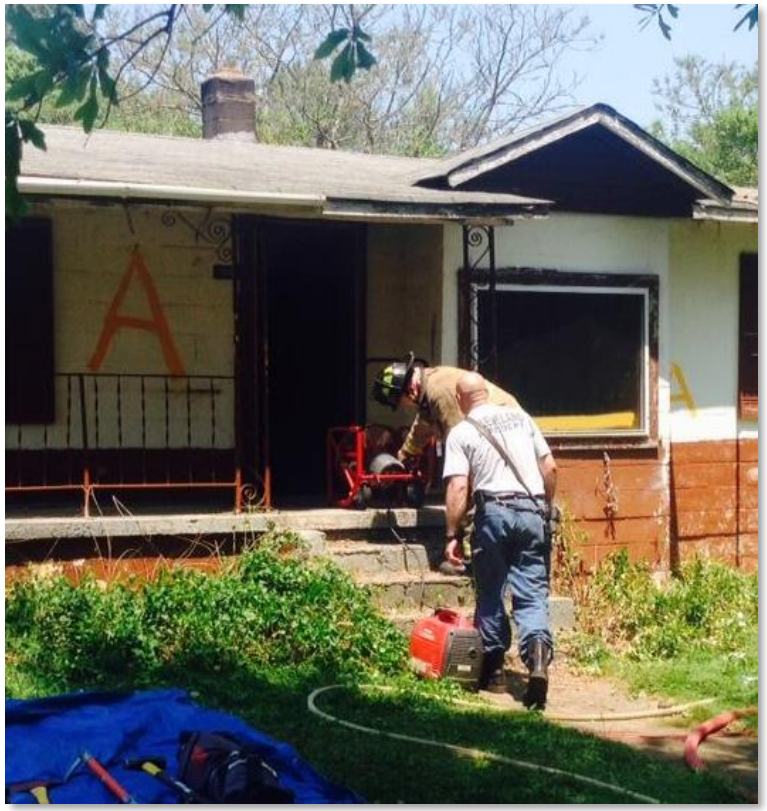
Firefighting Ventilation – Cone vs Column (Vane Axial Fans)

- Sealing the doorway was the method to prevent bidirectional flow at the entrance for many years.
- Later, airstream conditioners were integrated into front guard.
  - Benefits airflow **through** the doorway
  - Creates higher pressure in the structure and aids ventilation in complex structures
  - Bidirectional flow inevitable to some degree, work to your advantages
  - Farther setback distances

https://www.fireengineering.com/firefighting/a-closer-look-at-a-bidirectional-flow-path/#gref

Firefighting Ventilation – Electrification

- High CO levels measured in overhaul stage
- Electrification of ventilators continues to this day
  - Low Noise
  - Less Maintenance

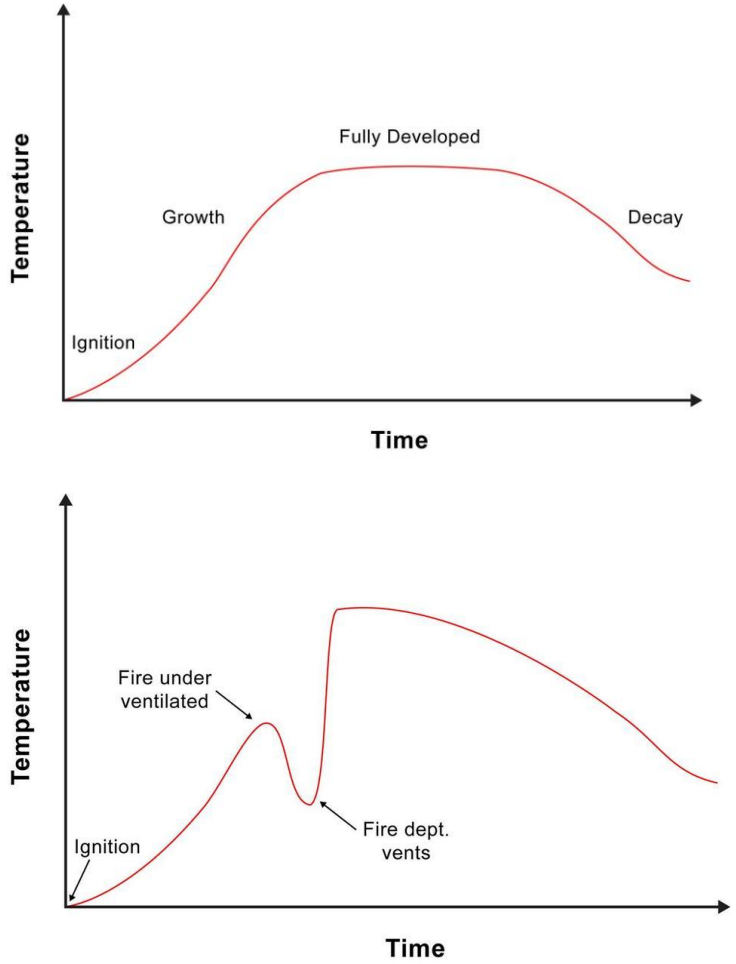


Firefighting Ventilation - Battery PPVs

- Electric fans were tied to a generator for years, until around 2005 when the first battery PPVs began showing up.
- Lithium-ion battery technology
  - Added Reliability
  - Size & Weight
- Battery PPVs now generally accepted for certain applications.

Firefighting Ventilation – Staying Current

Illustration by Paul Combs - https://paulcombsart.com/

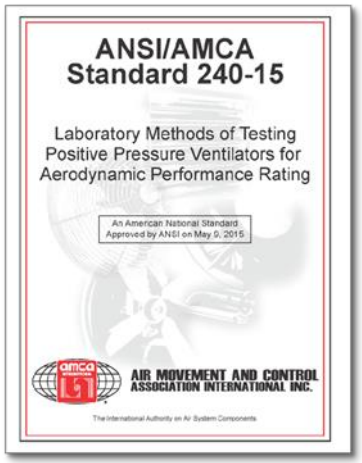


https://www.nist.gov/el/fire-research-division-73300/firegov-fire-service/fire-dynamics

Video: Introduction to AMCA 240 – Positive Pressure Ventilators

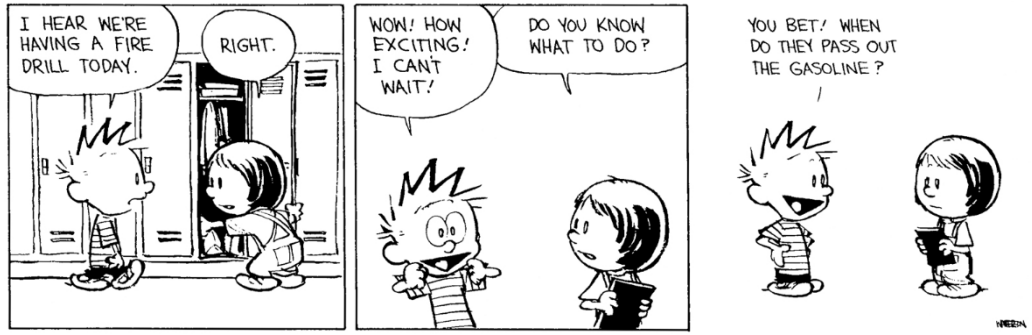
AMCA 240 – Why was it needed?

- In the 80's and 90's there was a Wild West era for approaching airflow performance of PPVs.
- Positive feedback loop created when exaggerated airflows from manufacturers, which in turn made fire departments require larger airflows.



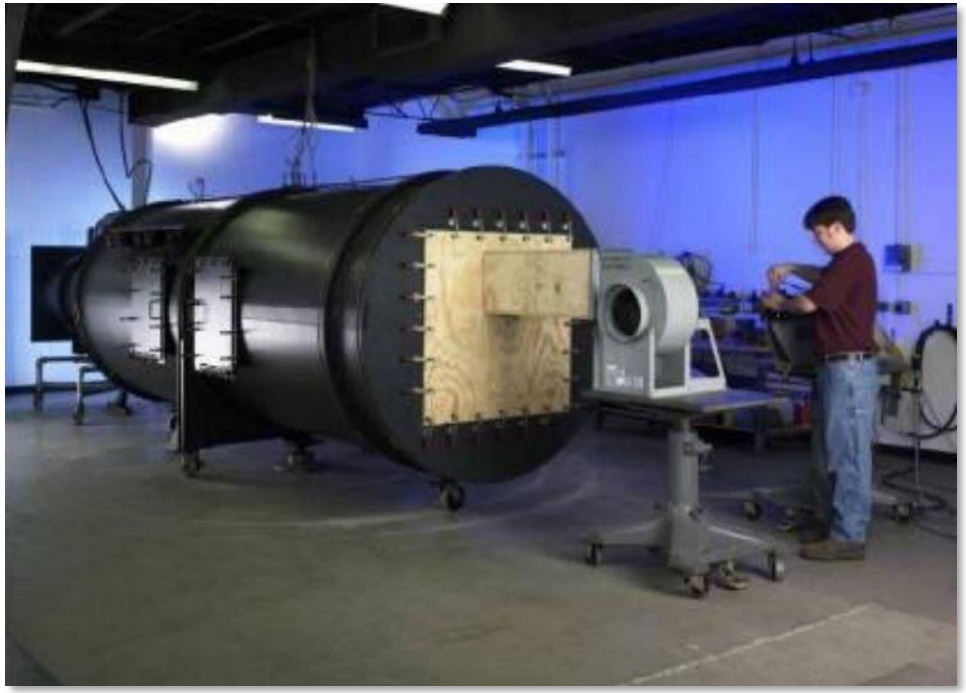
AMCA 240 – How it Began

- In 1996, a group of manufacturers came together with AMCA to create a standard that incorporated PPV tactics that include airflow from **entrained airflow, also known as induced air.**
- The AMCA 240 Standard was born with collaboration from manufacturers, experienced firefighters and AMCA professionals.



AMCA 240 – What is it?

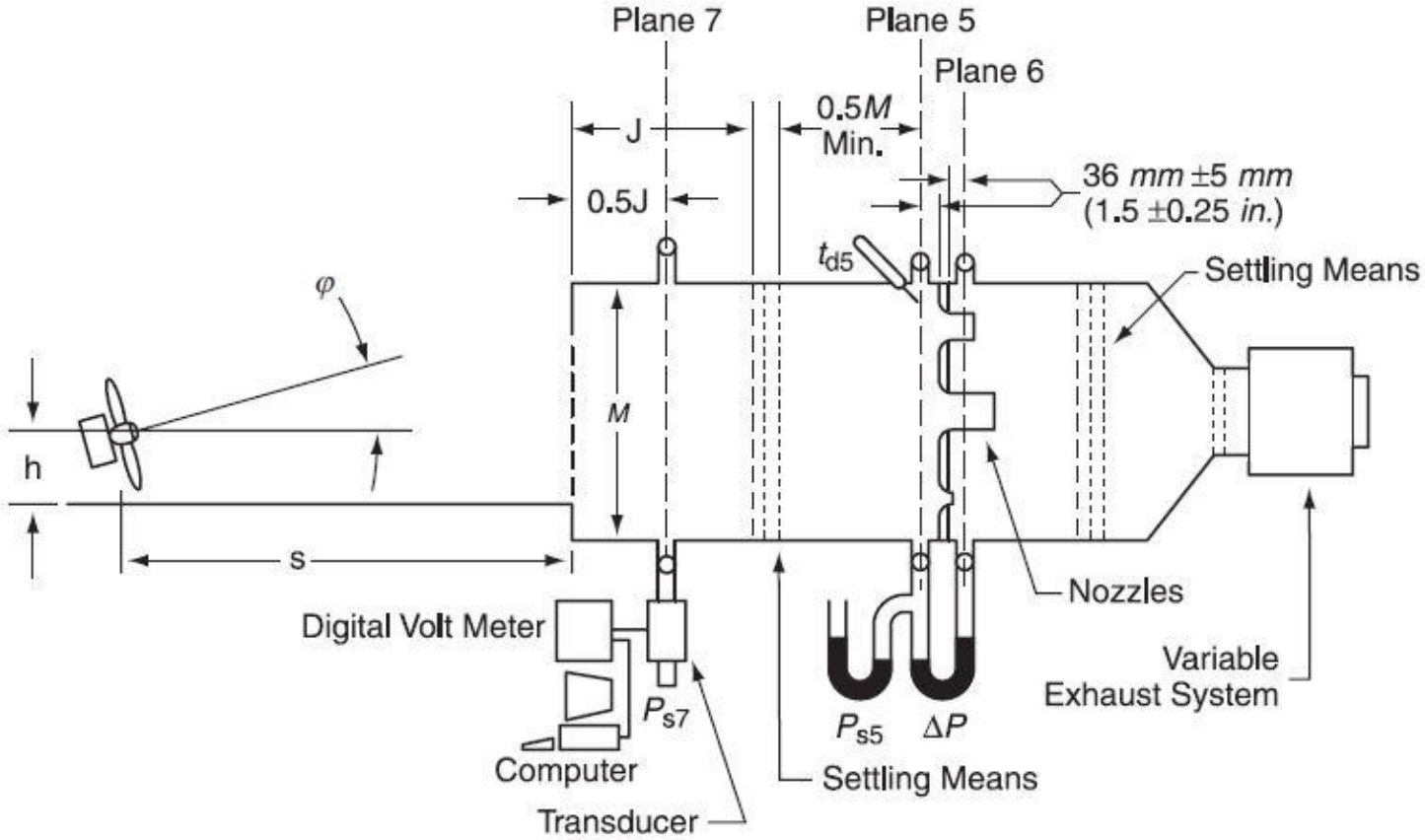
- AMCA 210 with setback distance & doorway



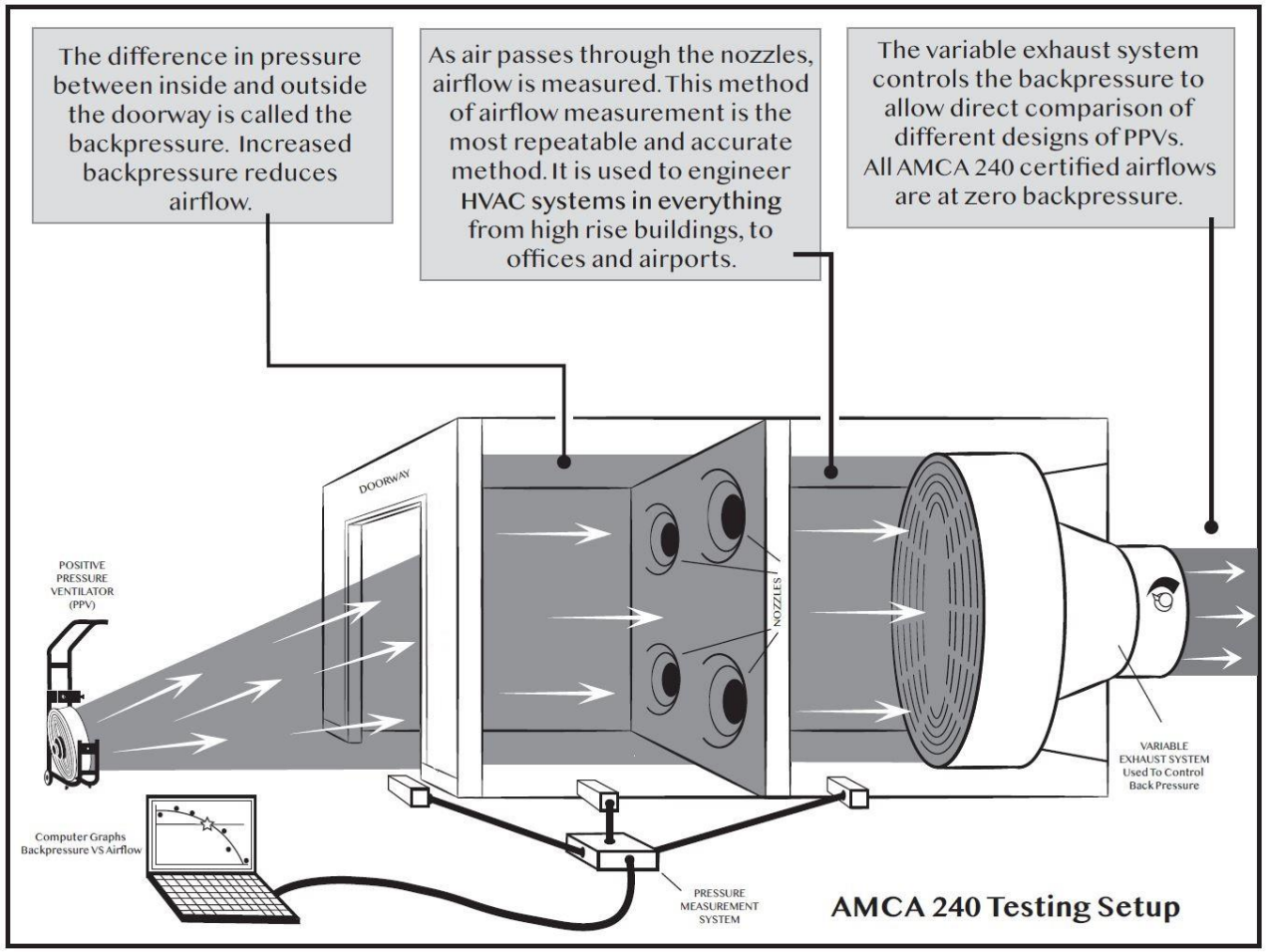
AMCA 210 Example Test Setup

AMCA 240 Example Test Setup

AMCA 240 – Behind the Wall



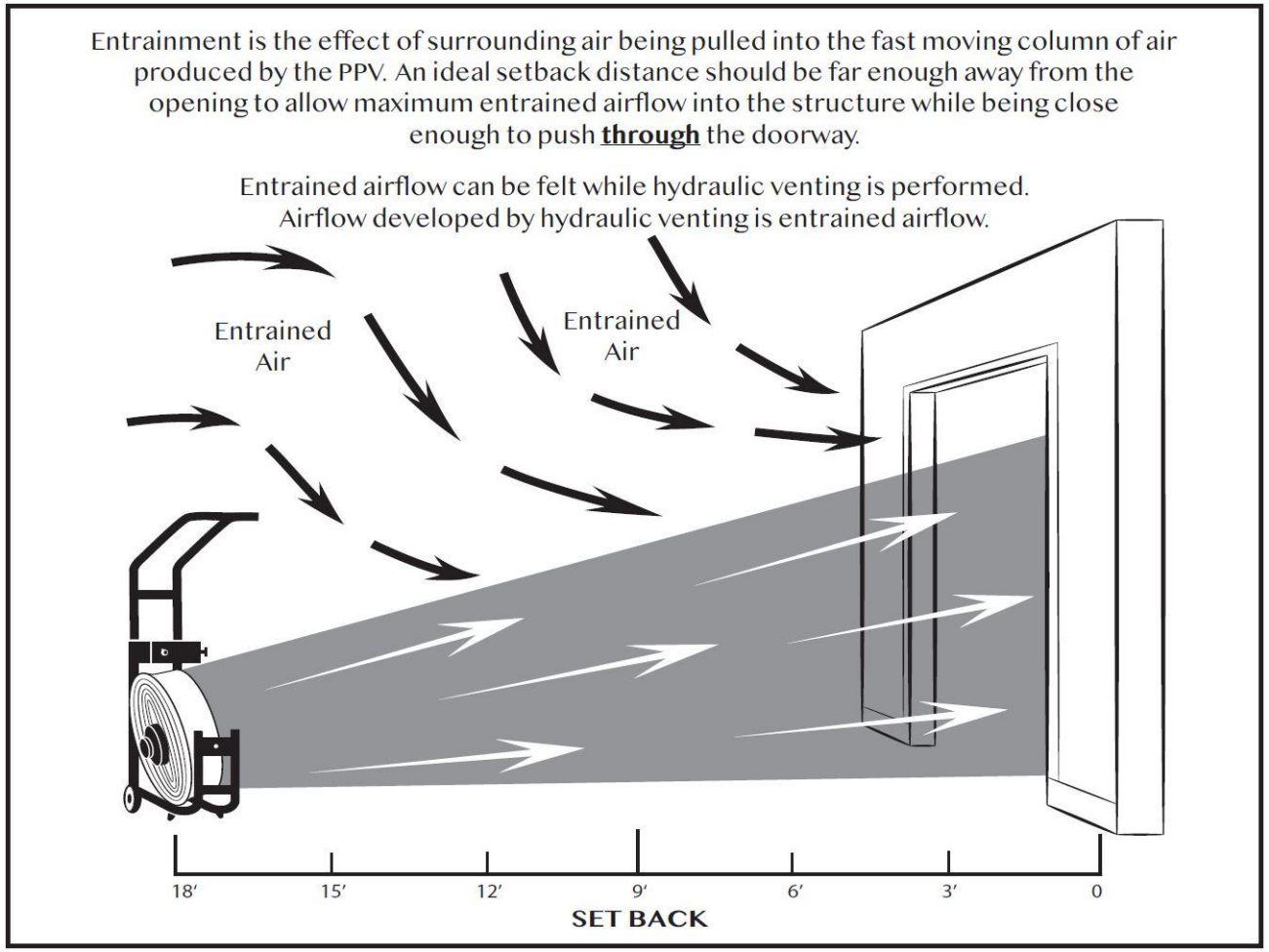
AMCA 240 – Backpressure



- Why zero backpressure?
  - Little research available at the time
  - Continuing research shows that zero backpressure can be common on fire ground
  - Following water on the fire and exhaust openings established, negative and near zero backpressures are realistic

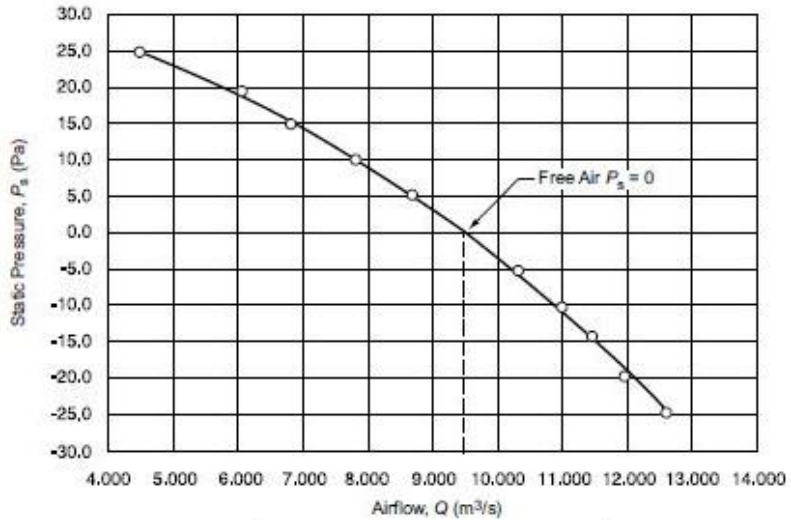
AMCA 240 – Entrained/Induced Airflow

- Surrounding air pulled into fast moving column of air
  - Fast Air = Lower Pressure
  - Slow Air = Higher Pressure
- Hydraulic venting is entrained airflow



AMCA 240 – Test Data

- Backpressure VS Airflow Curve
- 10 Airflow Measurements
  - 5 Negative, 5 Positive
- 1 psi = ~ 6,900 Pa
  - 1 atm = 14.7 psi = 101 kPa
  - 0.0036 psi = 25 Pa



TEST #761-P04 02/08/95

AMCA Laboratory – Arlington Heights, Illinois

UNIT

Name:	Windmaker 324
Model No.:	ADF1-P24
Impeller Dia:	0.61 m
Appurtenance(s):	Windmaker, Type D Misting Nozzles

SETUP

s =	3.05	m
ϕ =	11	°
h =	0.46	m

DATA

t_{ab} =	27.3	°C
t_{wb} =	18.5	°C
p_b =	745.4	mm Hg

i determination	N (rev/s)	t_{as} (°C)	P_{vs} (Pa)	ΔP (Pa)	t_{sf} (°C)	P_{vf} (Pa)
1	58.32	28.9	-24.6	1461.1	28.9	-24.6
2	58.37	28.8	-20.1	1307.1	28.8	-20.1
3	58.38	28.8	-14.4	1210.3	28.8	-14.4
4	58.43	28.7	-9.9	1106.4	28.7	-9.9
5	58.43	28.4	-5.2	988.2	28.4	-5.2
6	58.48	28.2	4.7	702.4	28.2	4.7
7	58.43	28.1	9.9	557.1	28.1	9.9
8	58.50	28.0	14.7	422.2	28.0	14.7
9	58.52	27.8	19.4	338.3	27.8	19.4
10	58.52	27.8	24.6	189.5	27.8	24.6

i determination	ρ_0 (kg/m³)	$P_s = P_{vf}$ (Pa)	$Q_i = Q_f$ (m³/s)
1	1.1460	-24.6	12.609
2	1.1460	-20.1	11.921
3	1.1460	-14.4	11.469
4	1.1460	-9.9	10.963
5	1.1460	-5.2	10.380
6	1.1460	4.7	8.740
7	1.1460	9.9	7.779
8	1.1460	14.7	6.788
9	1.1460	19.4	6.070
10	1.1460	24.6	4.535

CURVE COEFFICIENTS

K_0 =	30.589620
K_1 =	0.318340
K_2 =	-0.372880

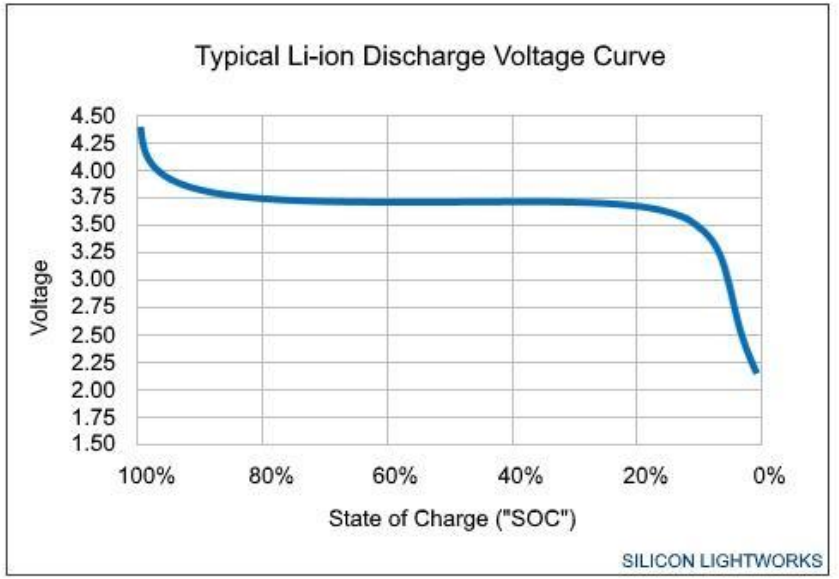
AIRFLOW AT FREE AIR

Q_f = 9.494 m³/s

Tested by RDK

AMCA 240 – 5 Year Review Updates

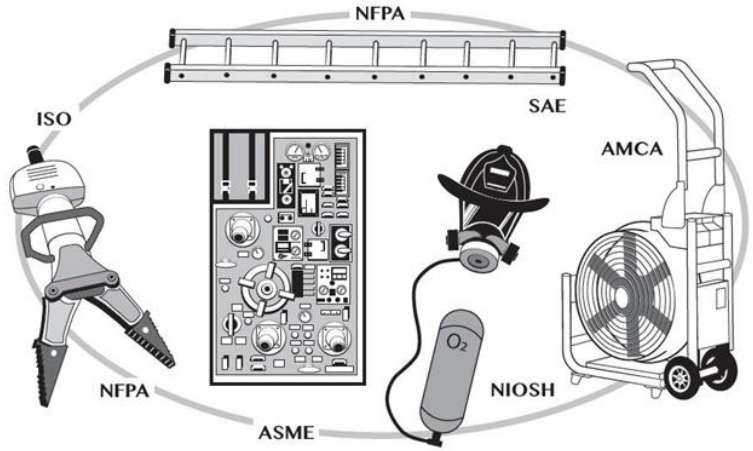
- Battery-Powered PPVs
  - DC Power Supply
  - Supplementary Runtime Test
  - Test Reports
- Doorway size
  - Required for international lab capability



https://siliconlightworks.com/li-ion-voltage

AMCA 240 – How it Benefits Firefighters

- AMCA Certified PPVs are publicly available
  - Certify > Certified Product Search > Positive Pressure Ventilator
- Established in 1917 for HVAC Industry
- Standardized Results
  - SAE, ISO, NFPA, ASME, etc.



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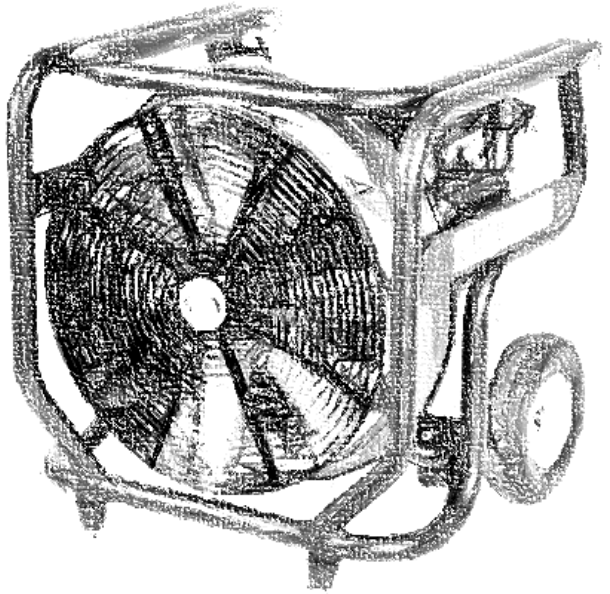
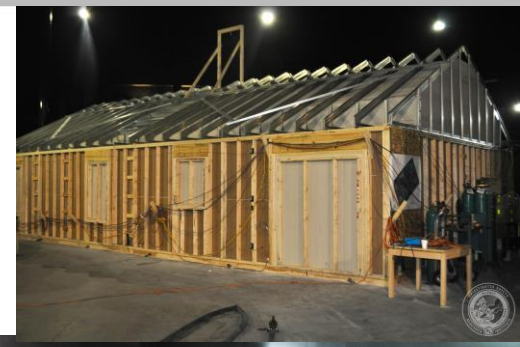
Determining the best PPV for you

- What fits in your compartment?
- Power source
  - Gas / Battery Electric / AC Electric / Water Driven
- Airflow Measurement Method
  - Compare Apples to Apples
  - AMCA Certified vs “According to AMCA 240”
- Features and Accessories



More Firefighting Ventilation Info

- UL's FSRI Team
  - Coordinated Attack (Balance between PPV and PPA)
  - Reducing Backpressure
    - Exhaust/Outlet larger than 2:1 compared to Entrance/Inlet is ideal
- NIST
  - High Rise Buildings (Positive Pressurized Stairwells)
- Across the Pond
  - Stefan Svensson – Swedish Firefighter/Professor
- Your Regional Fire Instructors
- Trusted Manufacturer of PPVs



Resources

- **AMCA International**: www.amca.org
- **ANSI/AMCA Standard:** www.amca.org/store

  > 240-15: Laboratory Methods of Testing Positive Pressure Ventilators for Aerodynamic Performance Rating *(Available for purchase)*
- **Video:** Introduction to AMCA 240 - Positive Pressure Ventilators: www.amca.org/videos
- **UL Firefighter Safety Research Institute**: ulfirefightersafety.org
- **NIST:** www.nist.gov

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Questions?

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- Wednesday, March 31
- 12:00-1:00pm CT
- ***Impact of Duct Fitting Selection***
- Presenter: Pat Brooks, Senior Project Manager, SMACNA

>> For additional webinar details go to: *www.amca.org/webinar*