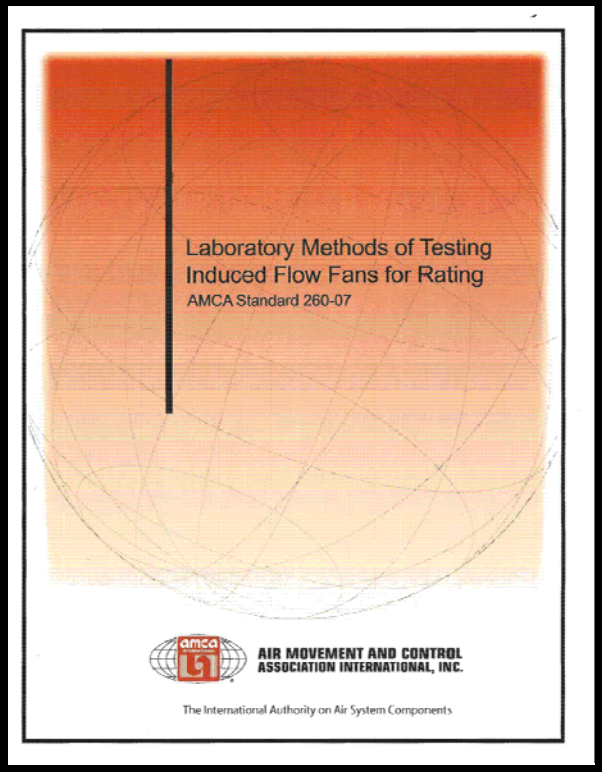

LOREN COOK COMPANY

Lab Exhaust Design Guidelines

AMCA STANDARD 260-07



"Laboratory Methods of Testing Induced Flow Fans for Rating"

Why Lab Exhaust Fans ?

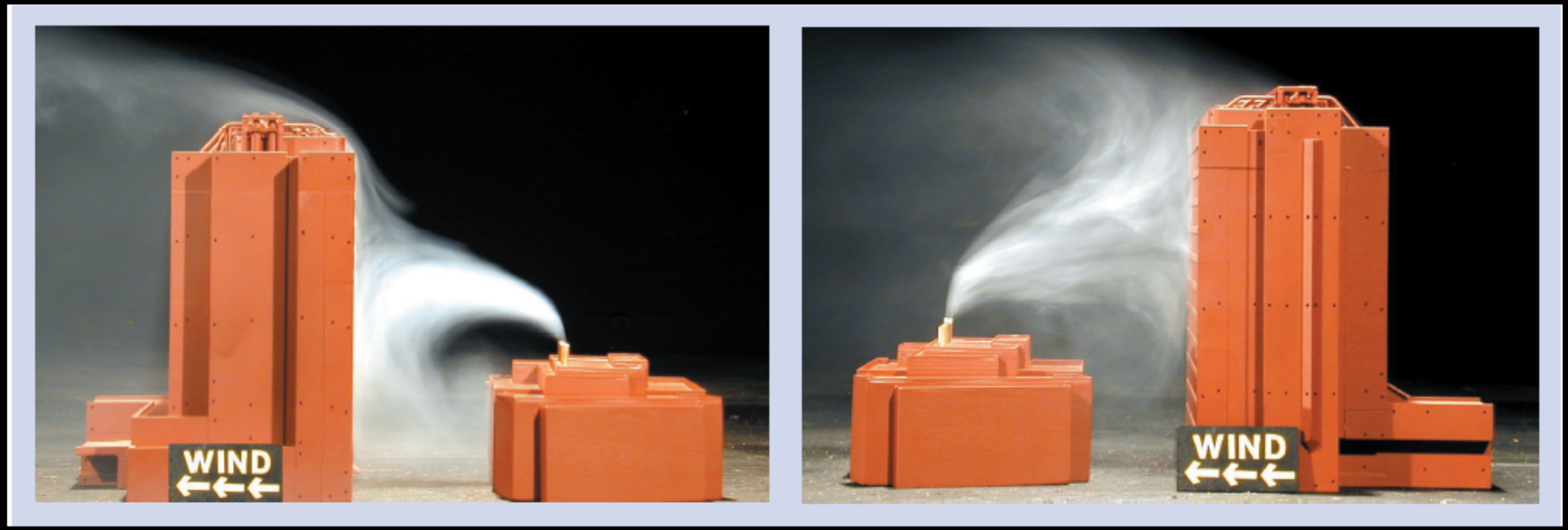


Photo Courtesy of CPP, Ft. Collins, CO

Prevents Re-entrainment of the Hazardous or Noxious Exhaust

Lab Exhaust Design Guidelines

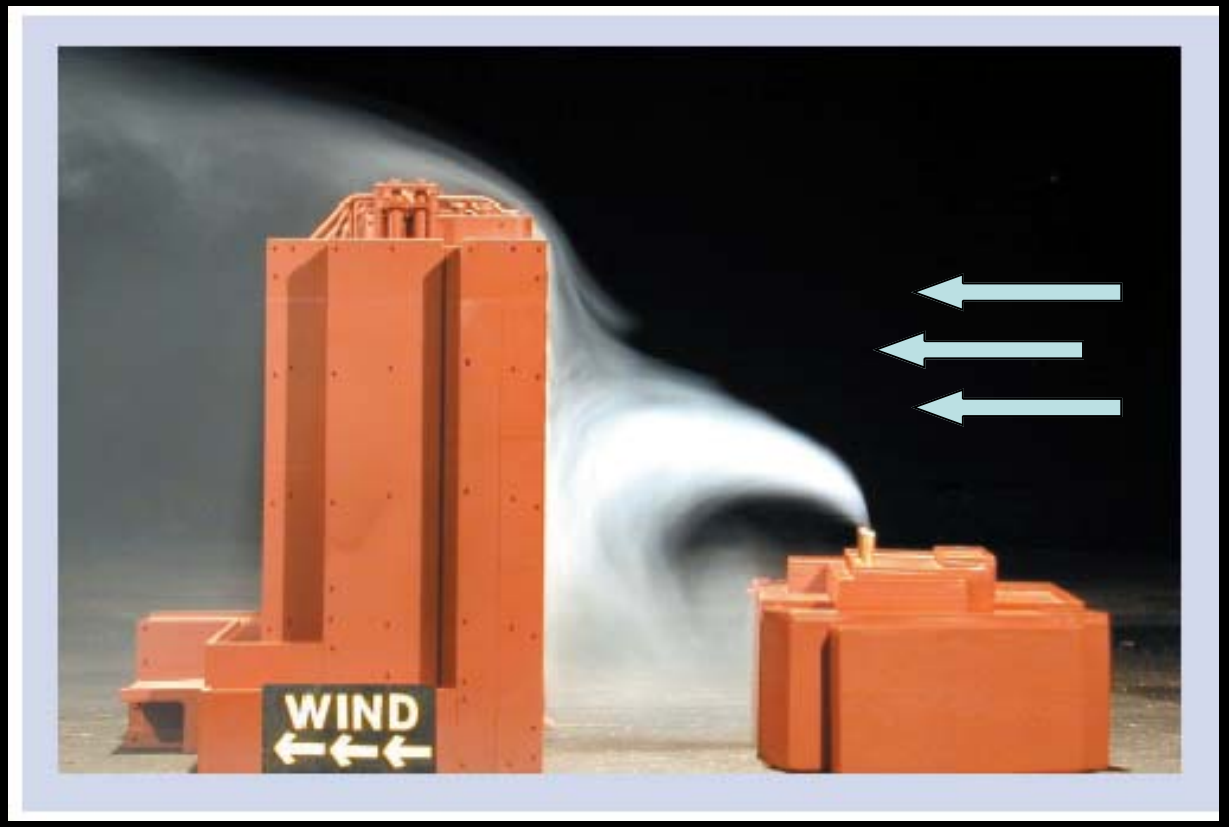


Photo Courtesy of CPP, Ft. Collins, CO

Lab Exhaust Design Guidelines

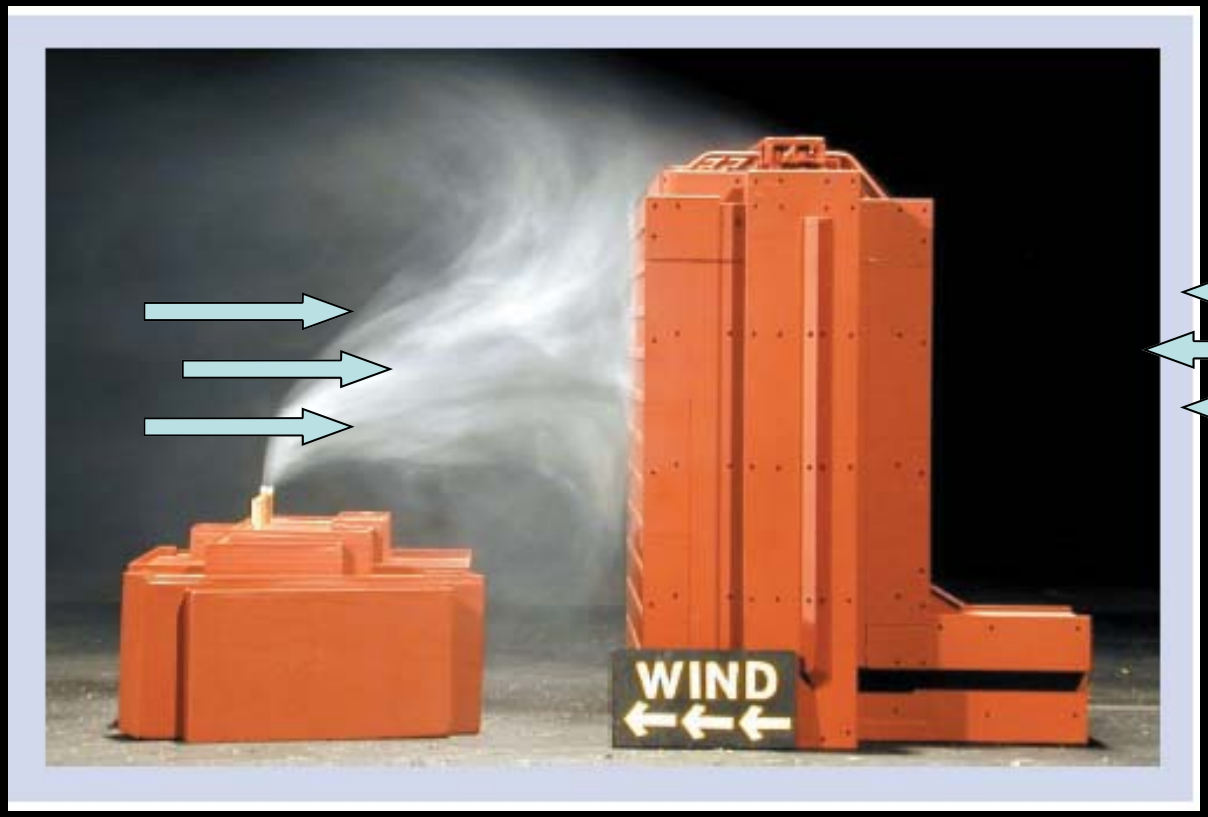


Photo Courtesy of CPP, Ft. Collins, CO

Lab Exhaust Fan Systems

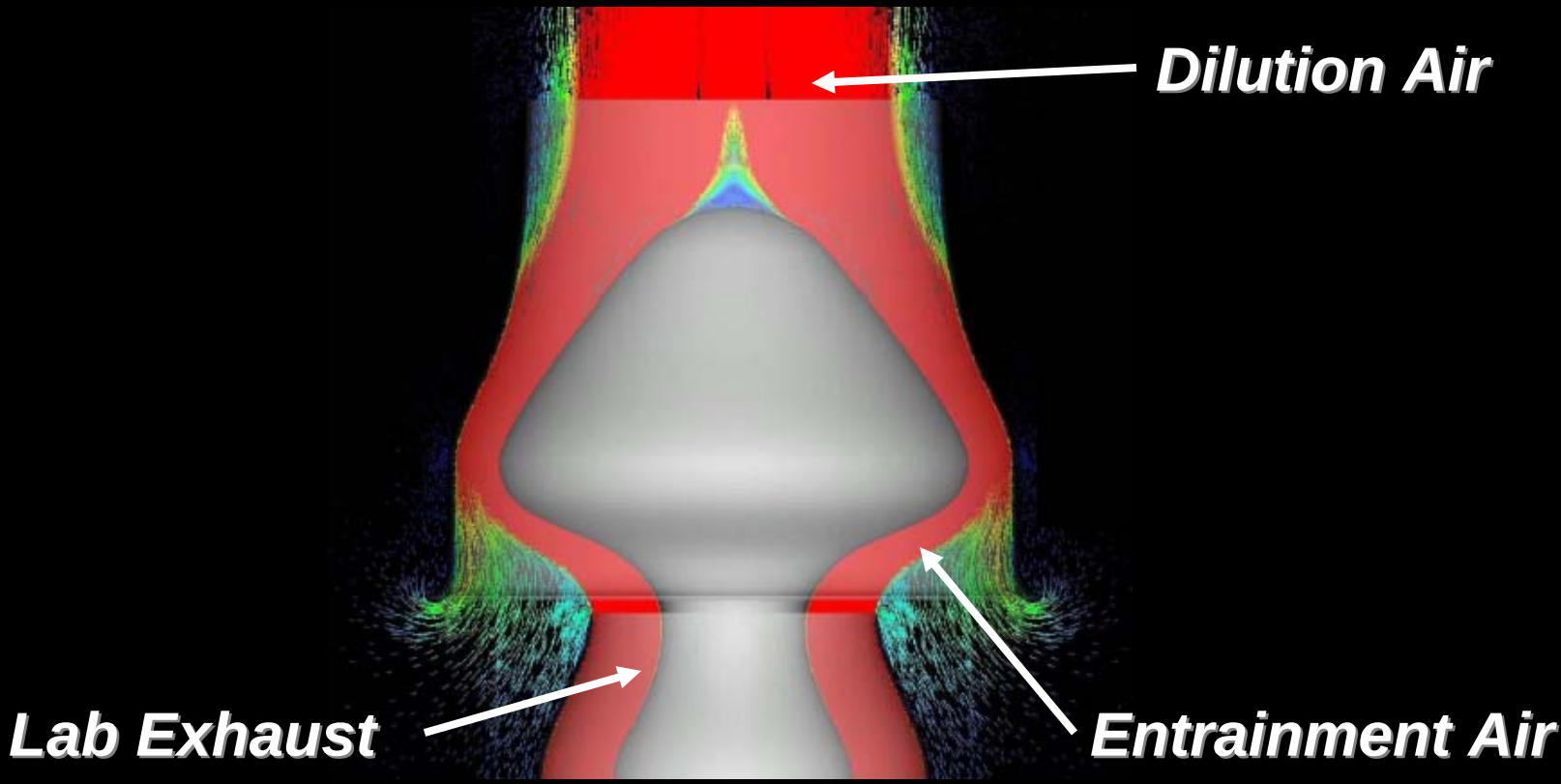
High Plume Induced / Dilution

Mixed Flow

Centrifugal Blowers

Cook Vari-Plume

Entrainment Characteristics



Lab Exhaust Fan Systems

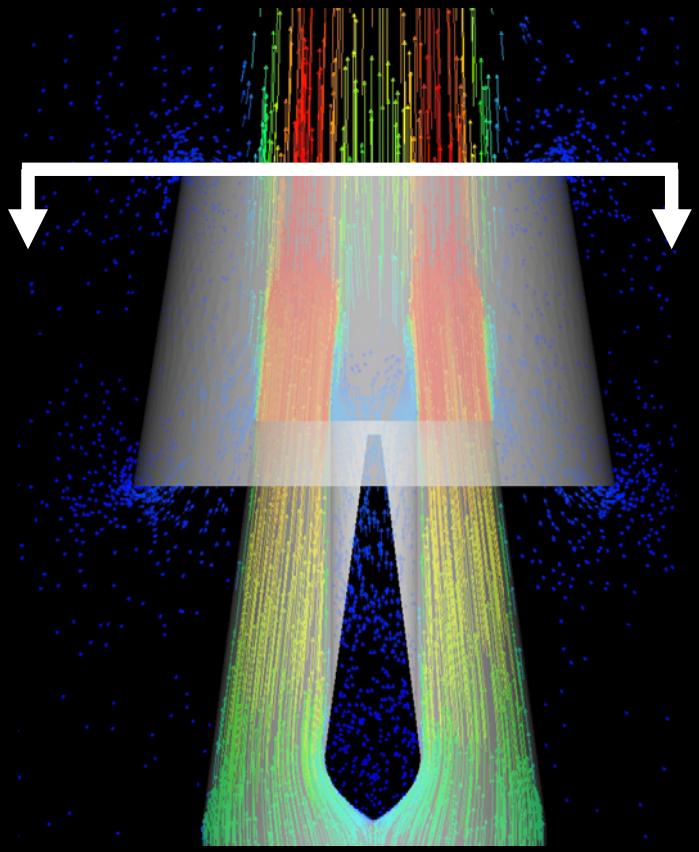
- Bifurcated Nozzles
- Bifurcated Housing
- Concentric Nozzles

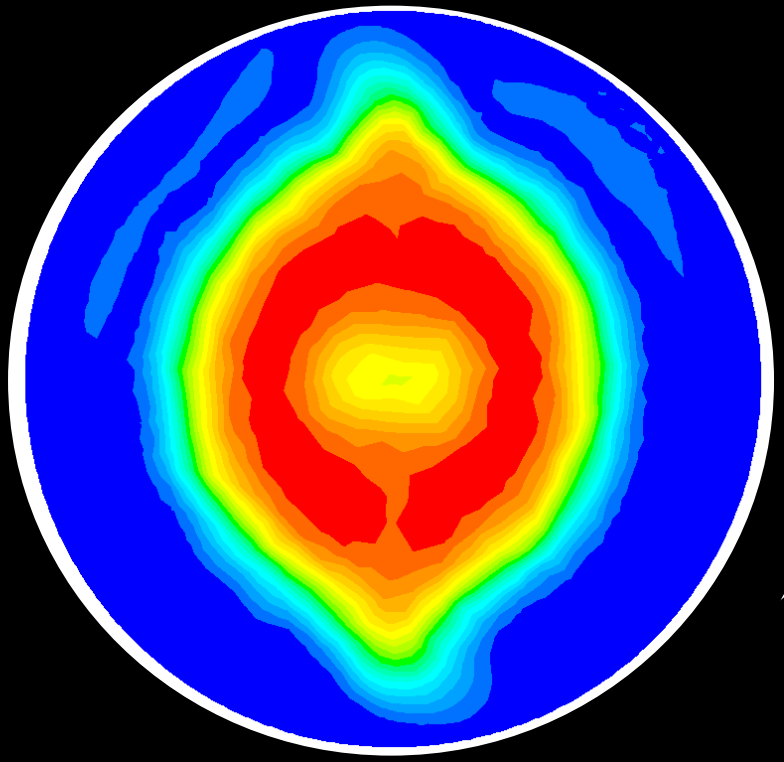
Bifurcated Nozzle Study

Dividing the Air Stream into Two Branches

Bifurcated

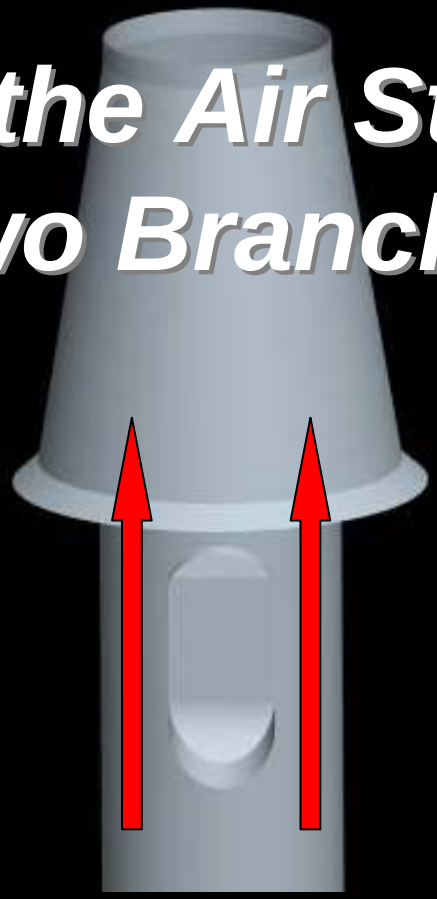
Bifurcated Nozzle Study





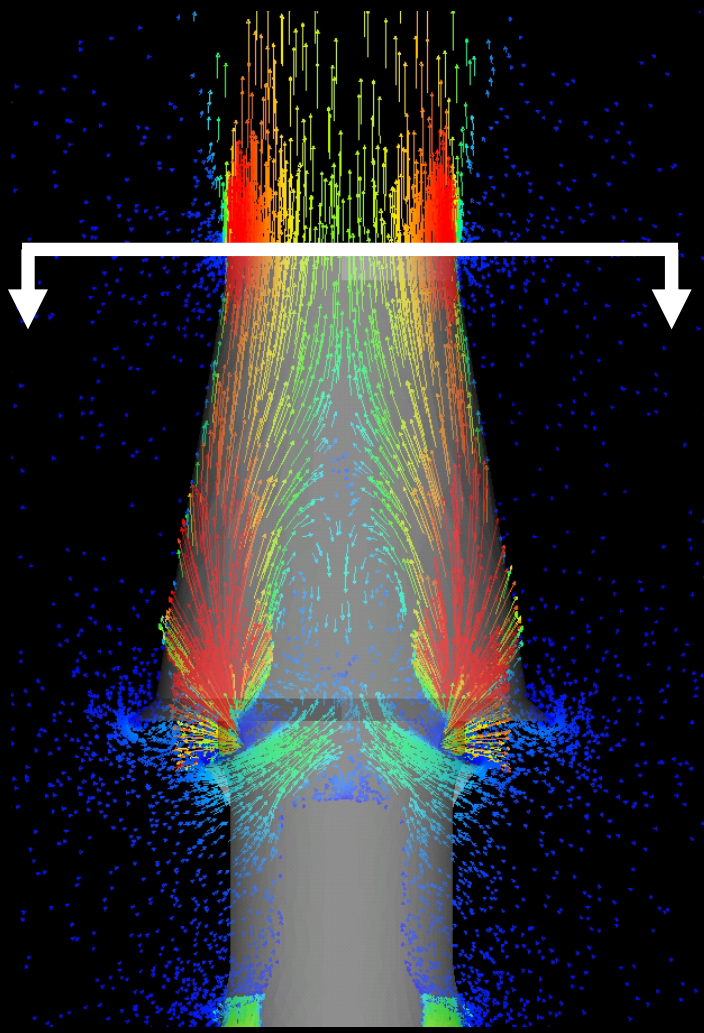
Bifurcated Housing Study

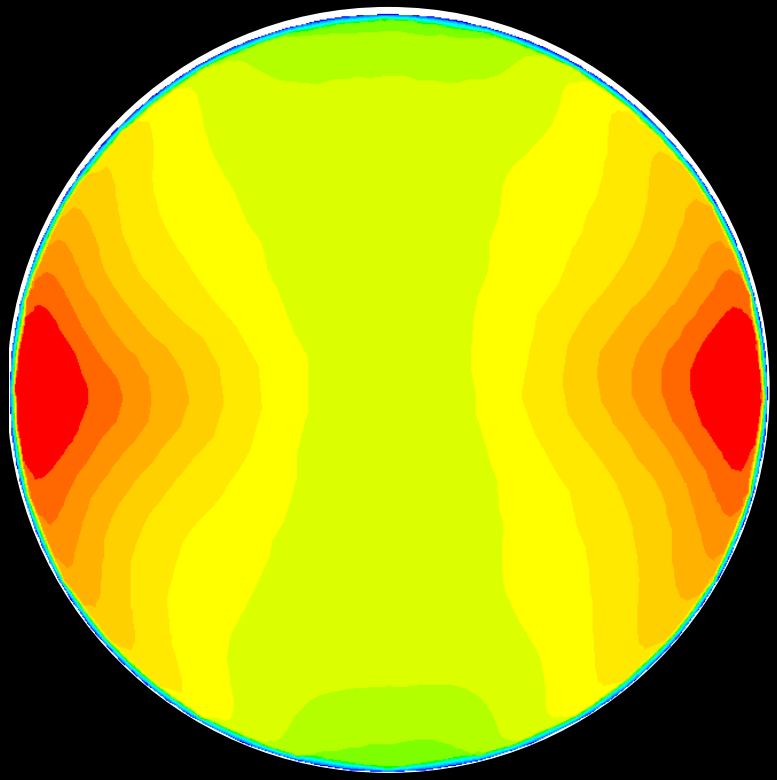
Dividing the Air Stream into Two Branches



Bifurcated

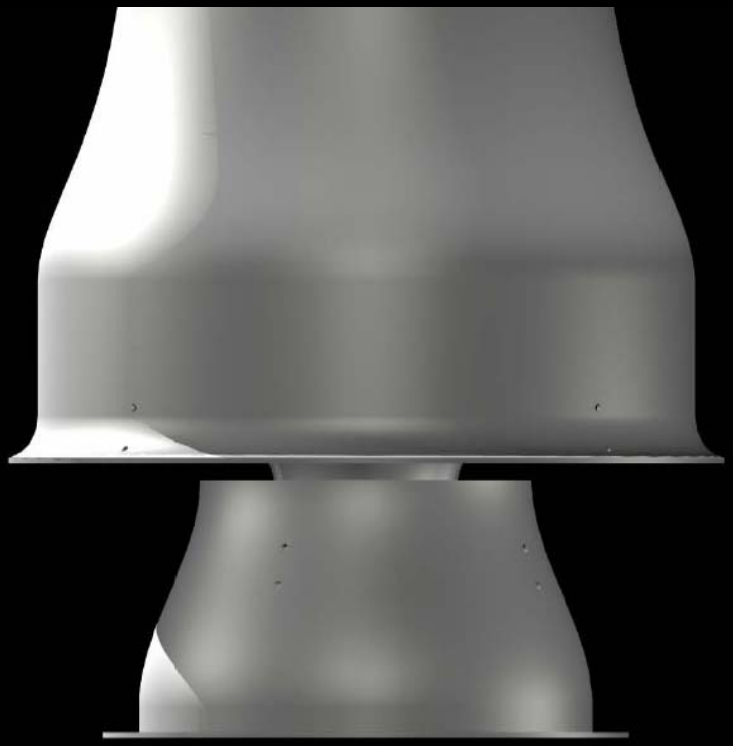
Bifurcated Housing Study



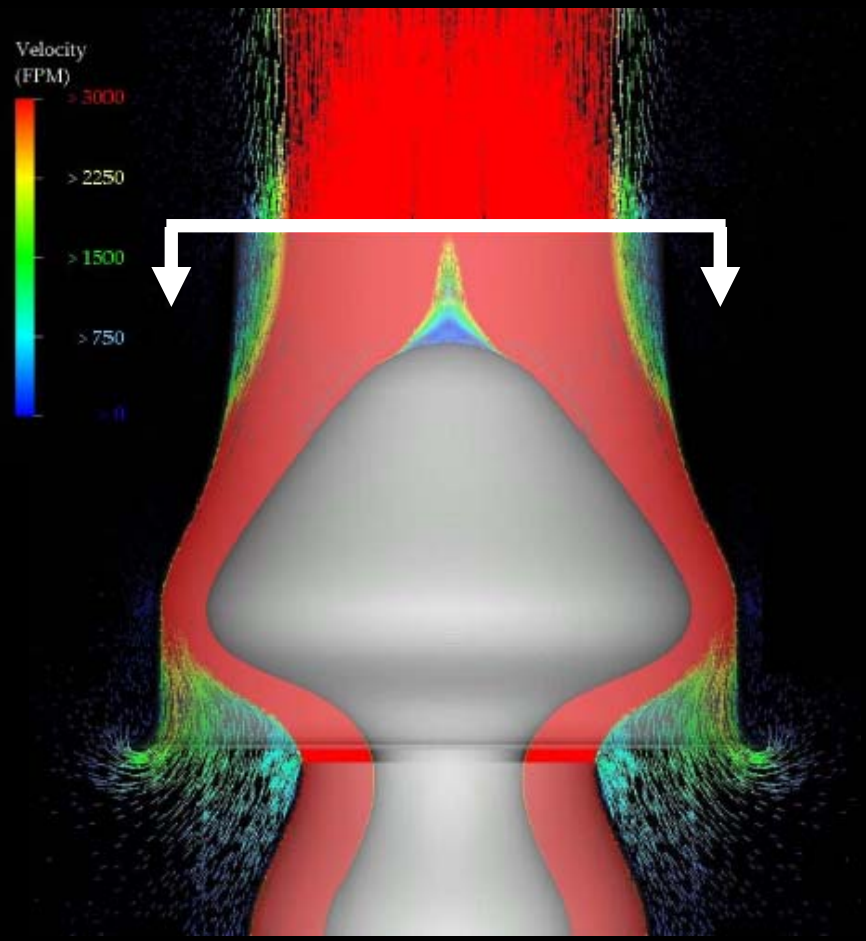


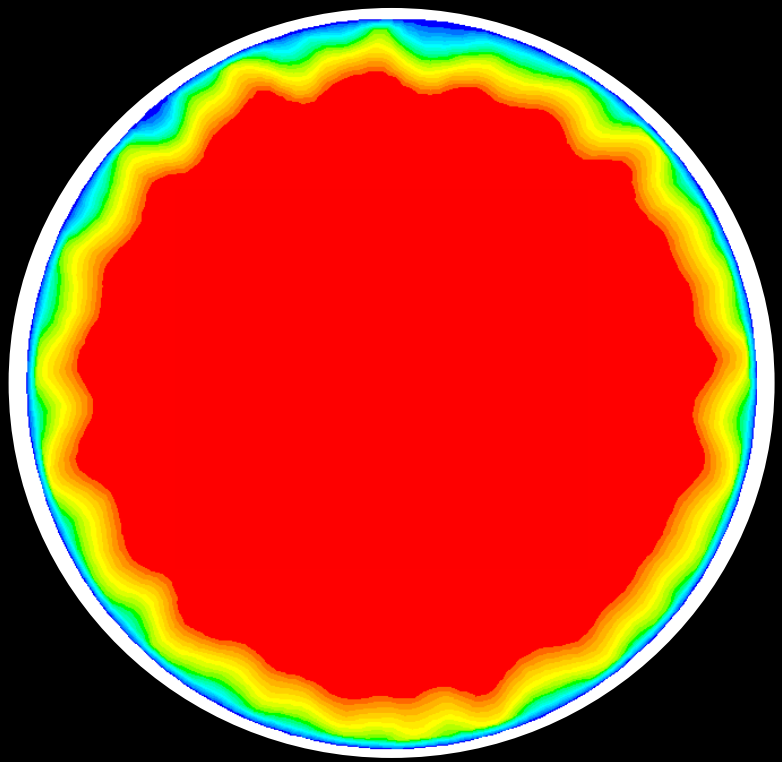
Cook Vari-Plume

Concentric Nozzle Design



Vari-Plume – MP

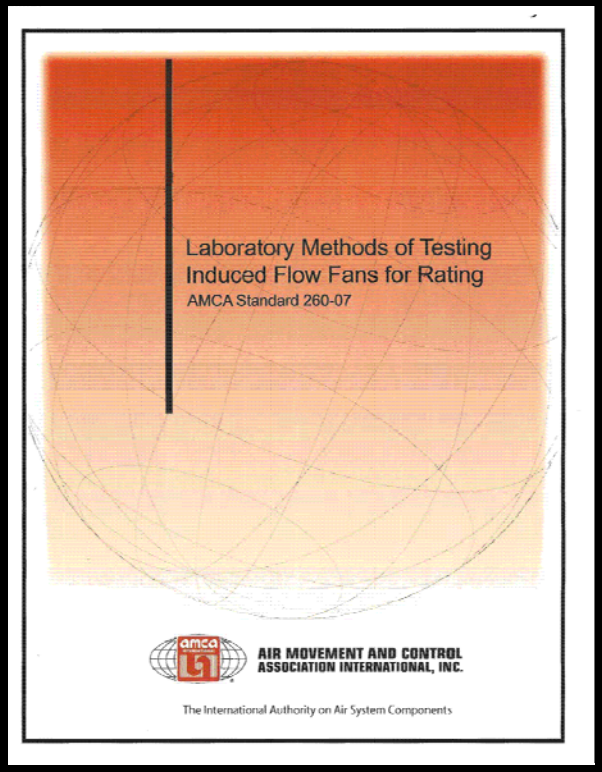




Discharge Profile

Lab Exhaust Design Guidelines

AMCA STANDARD 260-07



"Laboratory Methods of Testing Induced Flow Fans for Rating"

Induced Flow Certification

AMCA Review Committee

Bob Valbracht, Chair	Loren Cook Company
Brad Cochran	CPP, Inc.
Doug Gifford, Jr.	DF Fan Services, Inc.
Tim Mathson	Greenheck Fan Corportation
Mike Seliger	Greenheck Fan Corportation
Mel Cooper	M.K. Plastics Corporation
Keith Lins	M.K. Plastics Corporation
Tung Nguyen	PennBarry
Paul Sixsmith	Plasticair, Inc.
Alex Zhang	Shanghai Nautilus General Equipment Manufacturing
Paul Tetley	Strobic Air Corporation
Dick Williamson	Twin City Fan Companies, Ltd.
Joe Brooks	AMCA International

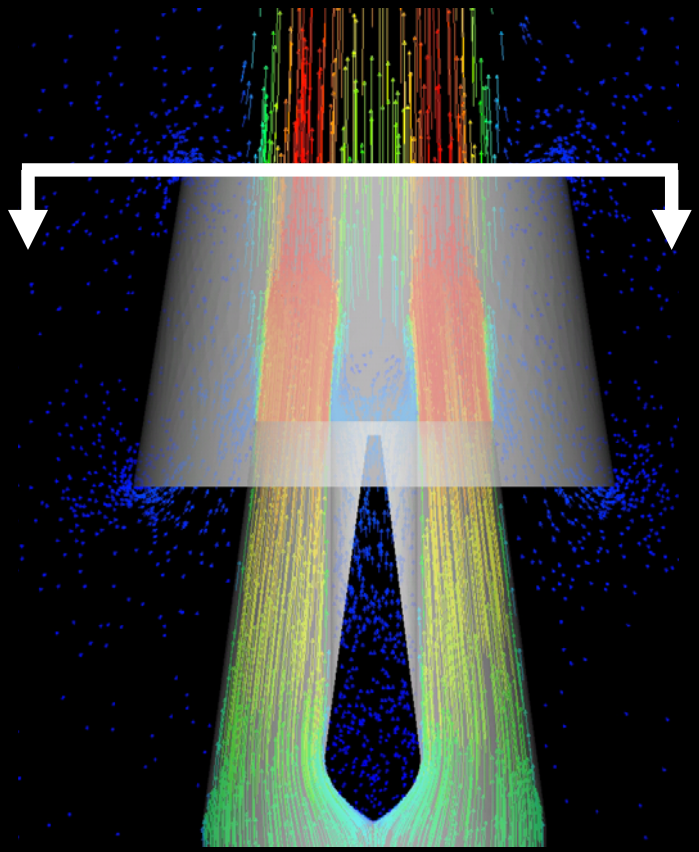
Induced Flow Certification

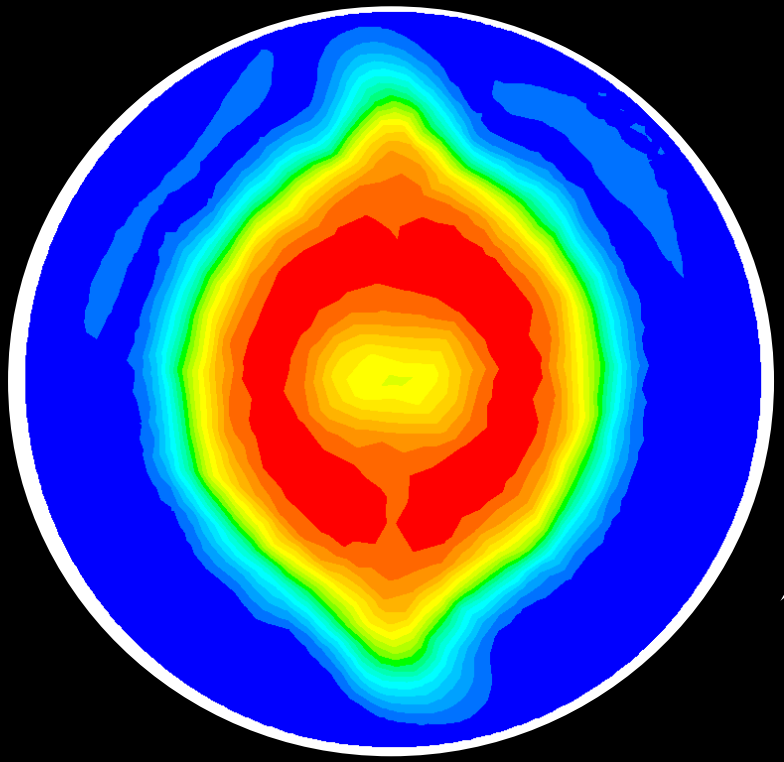
Certification of…

- Discharge Wind Band Velocity
- Dilution / Entrainment
- Total Fan Performance

Induced Flow Certification

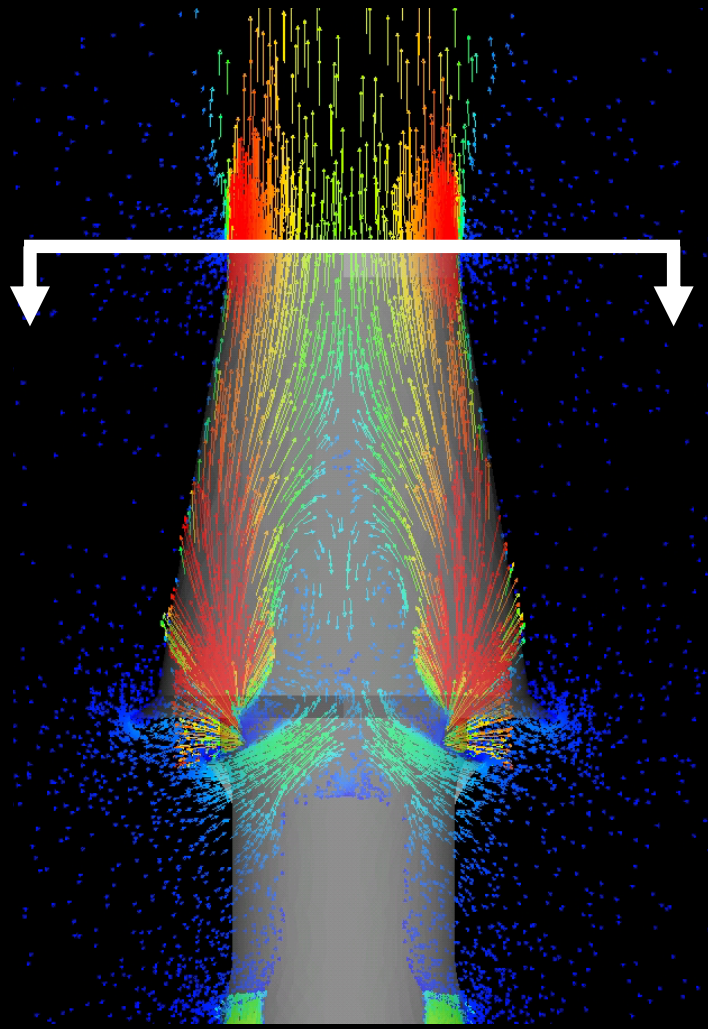
Discharge velocities vary…..

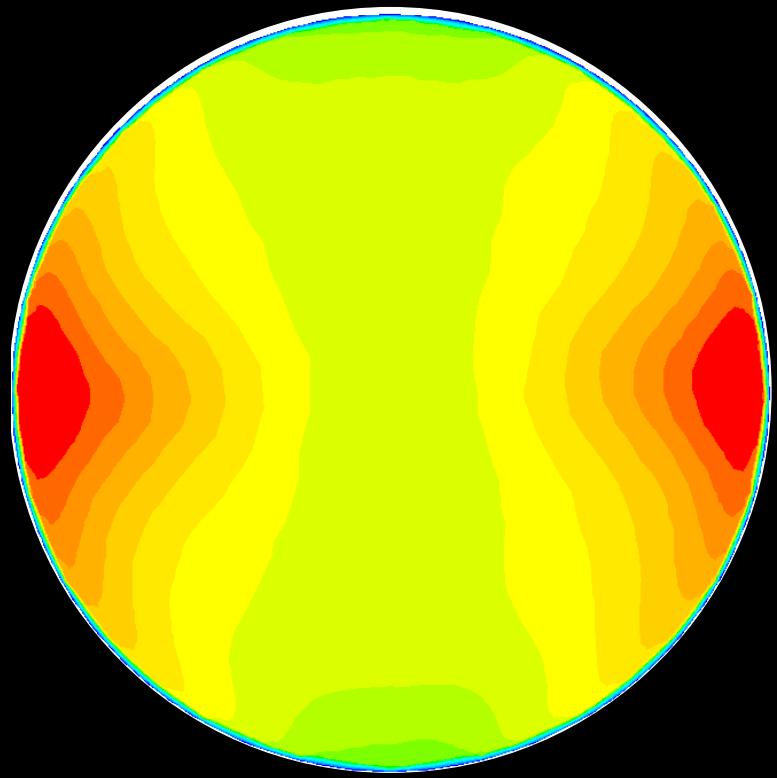




Bifurcated Housing Study

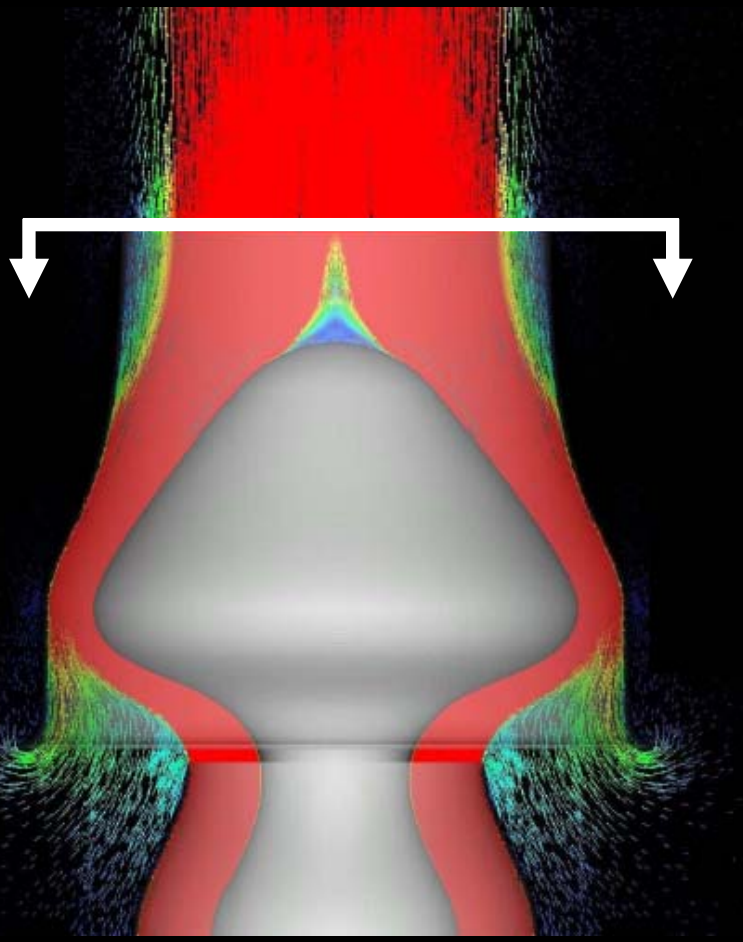
Discharge velocities vary…..

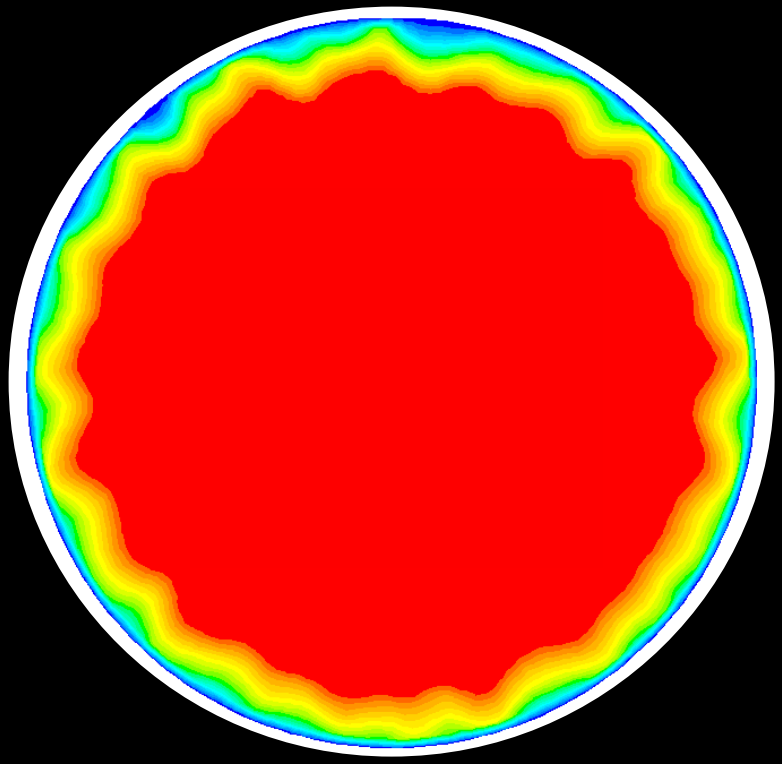




Induced Flow Certification

Discharge velocities vary…..





Discharge Profile

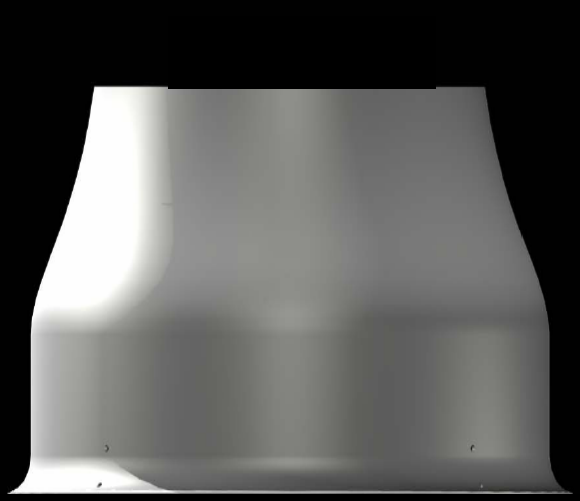
Induced Flow Certification

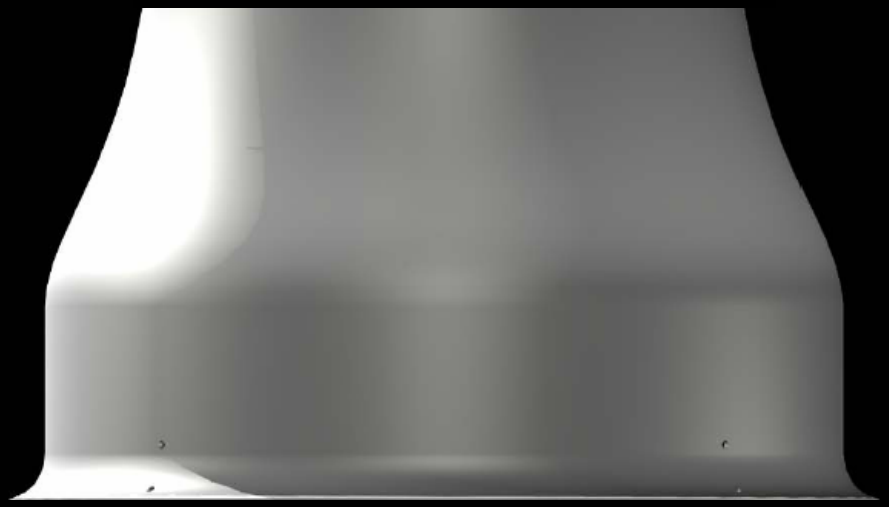
Certification of…

- Dilution / Entrainment

Induced Flow Certification

Outlet Area

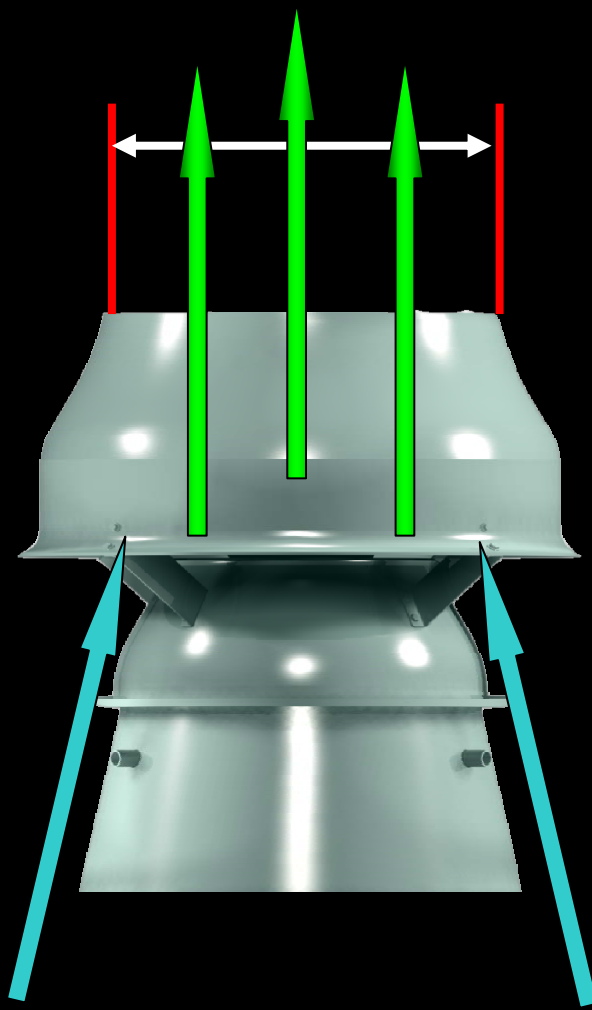




- Determines Outlet Velocity
- Entrainment Ratio

Induced Flow Certification

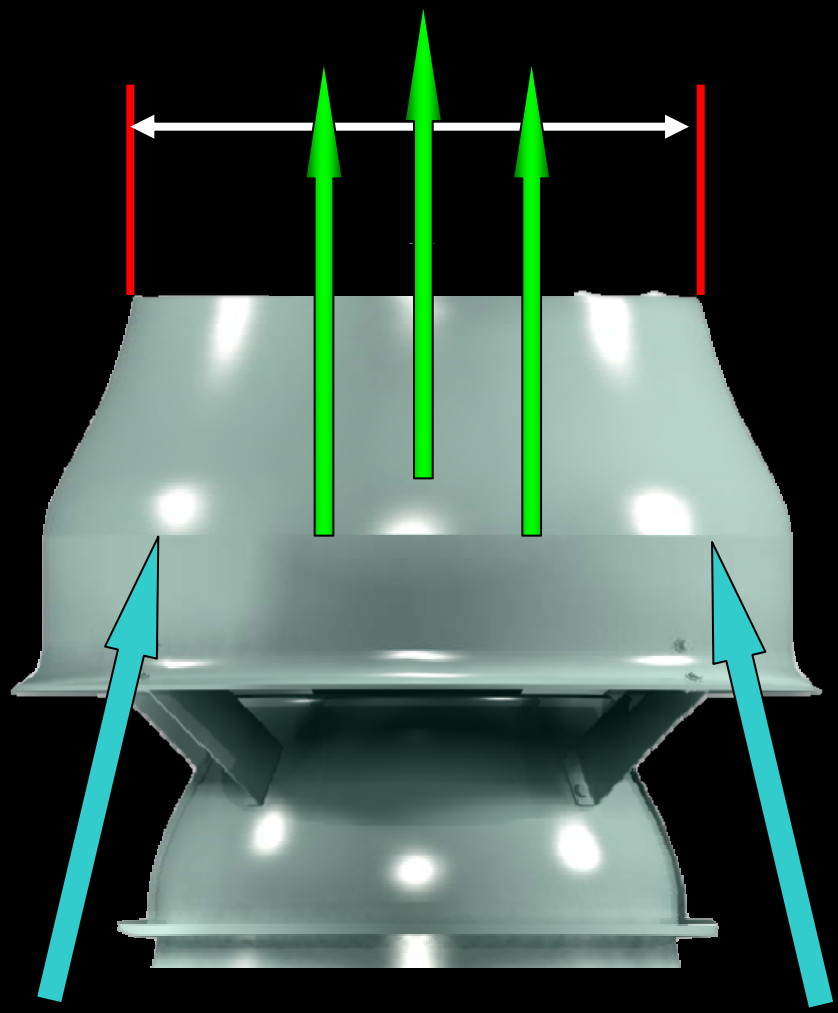
Discharge Outlet Characteristics



- Reduced Area
- 70 Foot Plume
- 1.7 Entrainment

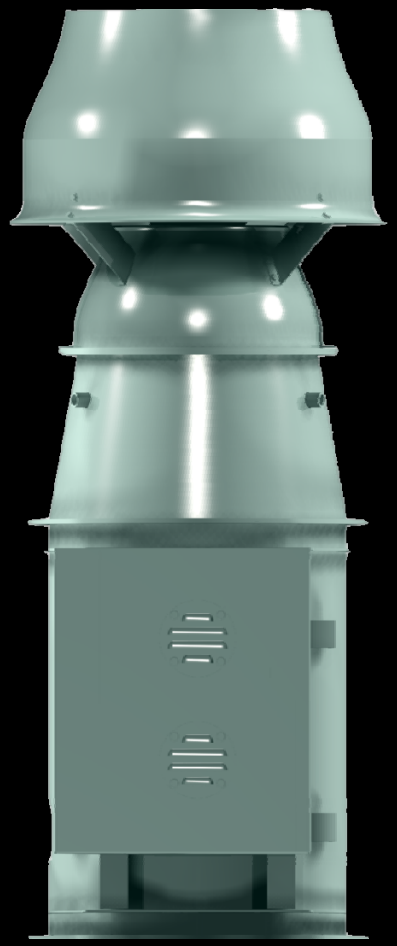
Induced Flow Certification

Discharge Outlet Characteristics



- Increased Area
- 45 Foot Plume
- 3.0 Entrainment

Induced Flow Certification

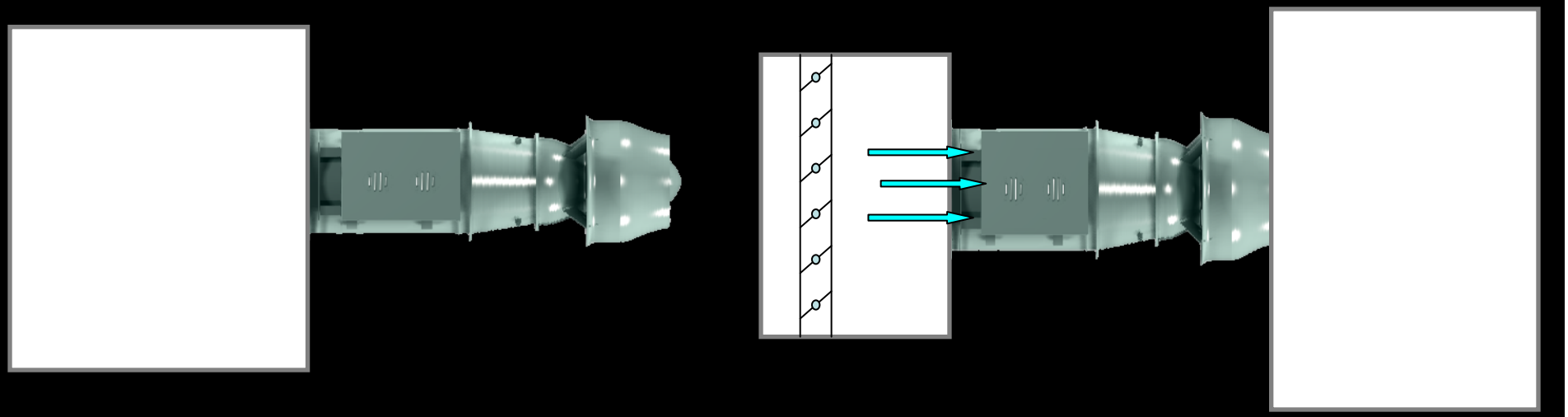


Certification of…

- Total Fan Performance with the Nozzle

Induced Flow Certification

- Two Part Test

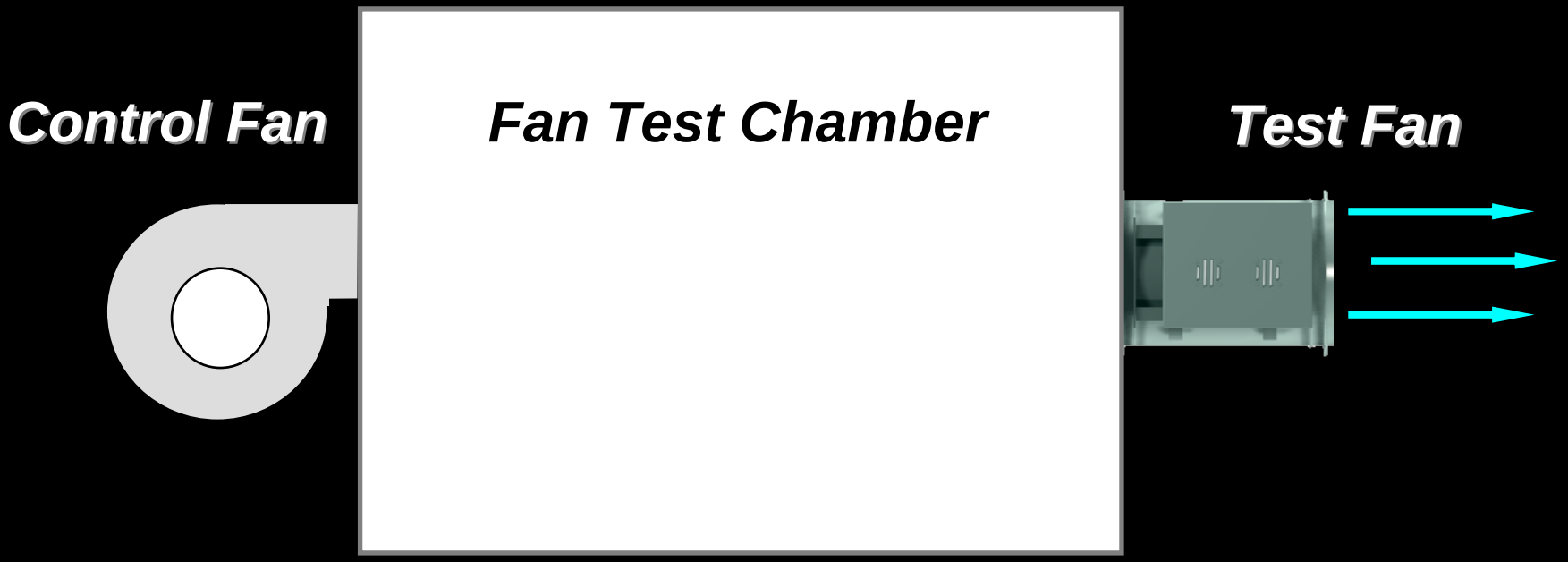


Inlet CFM Test

Wind Band Entrainment

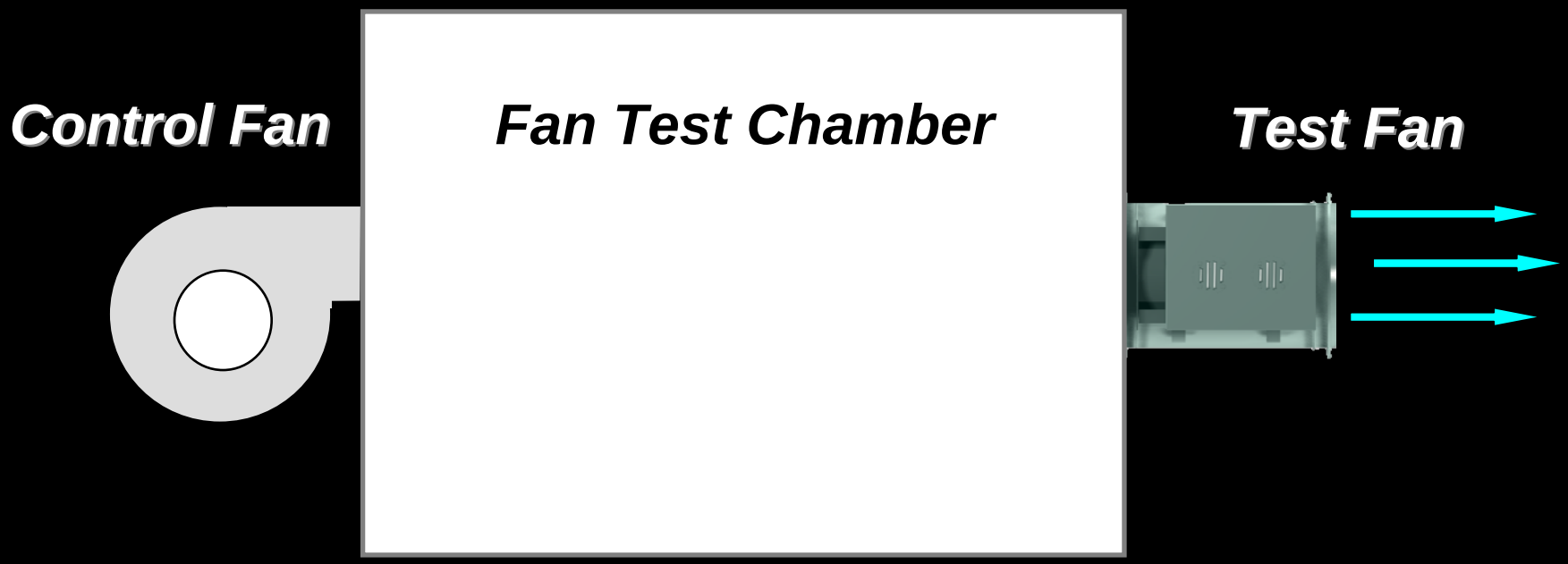
Induced Flow Certification

- Understanding the Fan Test



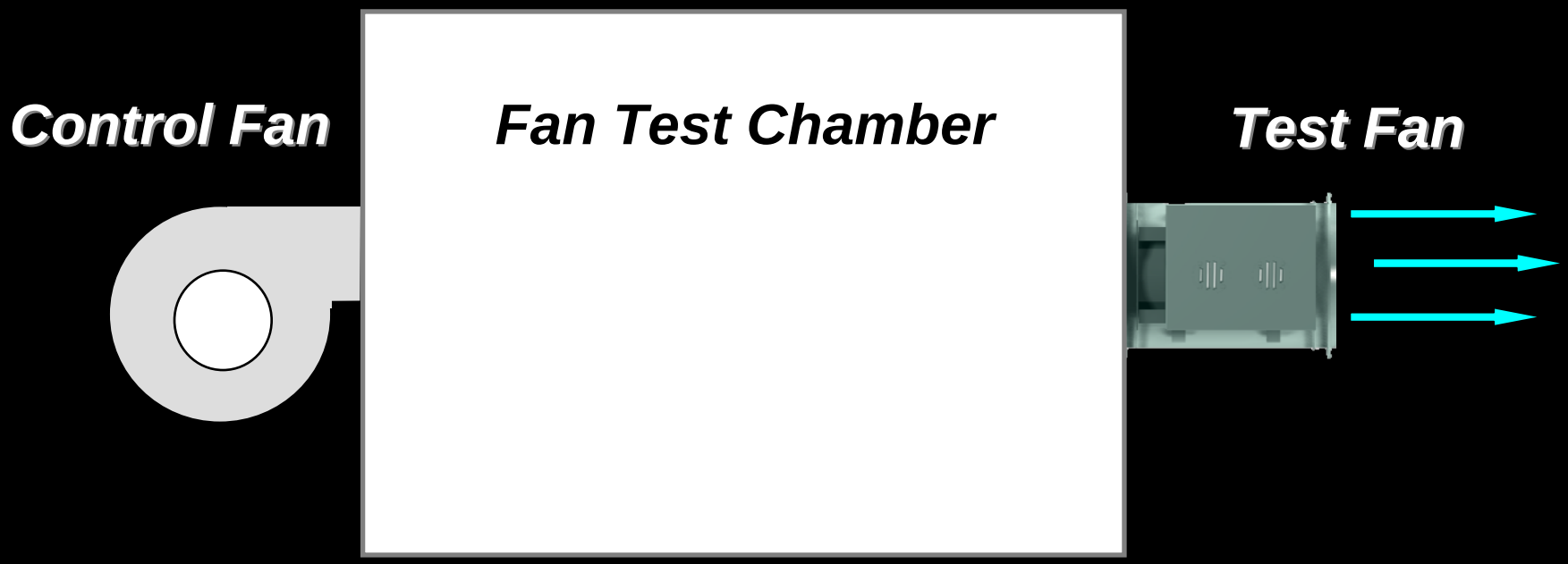
Induced Flow Certification

- Fans Are Tested on Either Side of Test Chamber



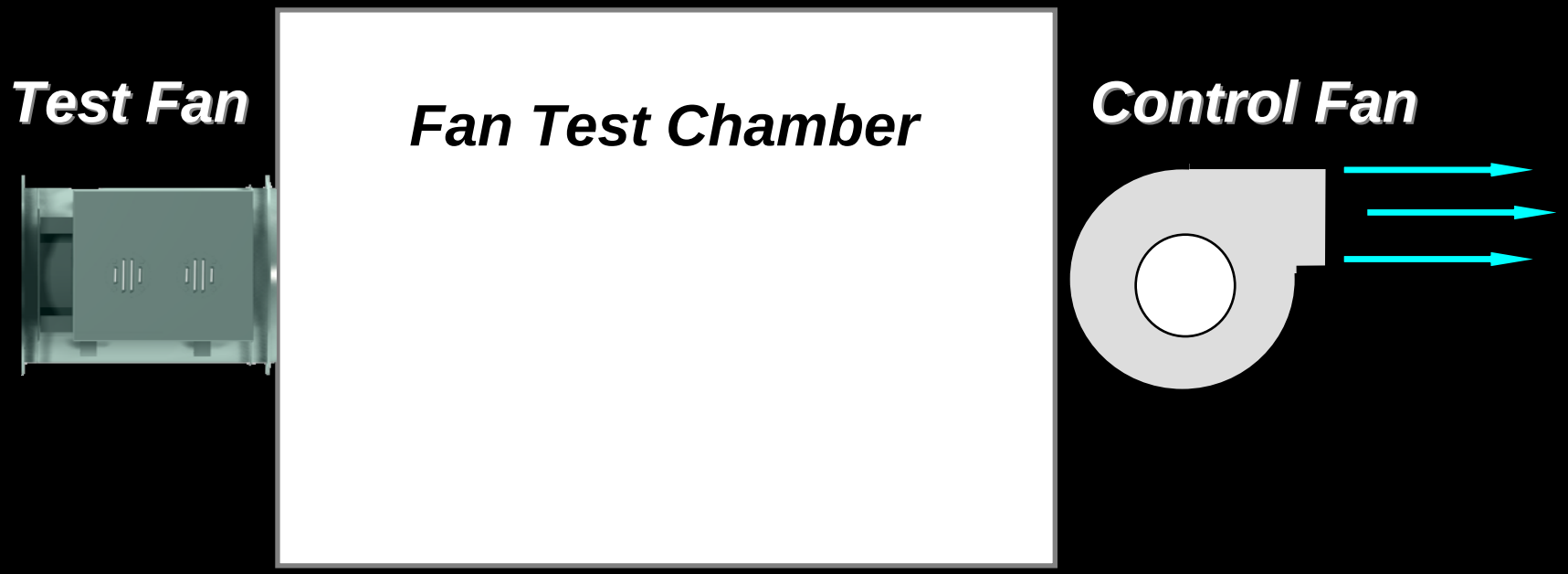
Induced Flow Certification

- Fan Inlet CFM / SP Test



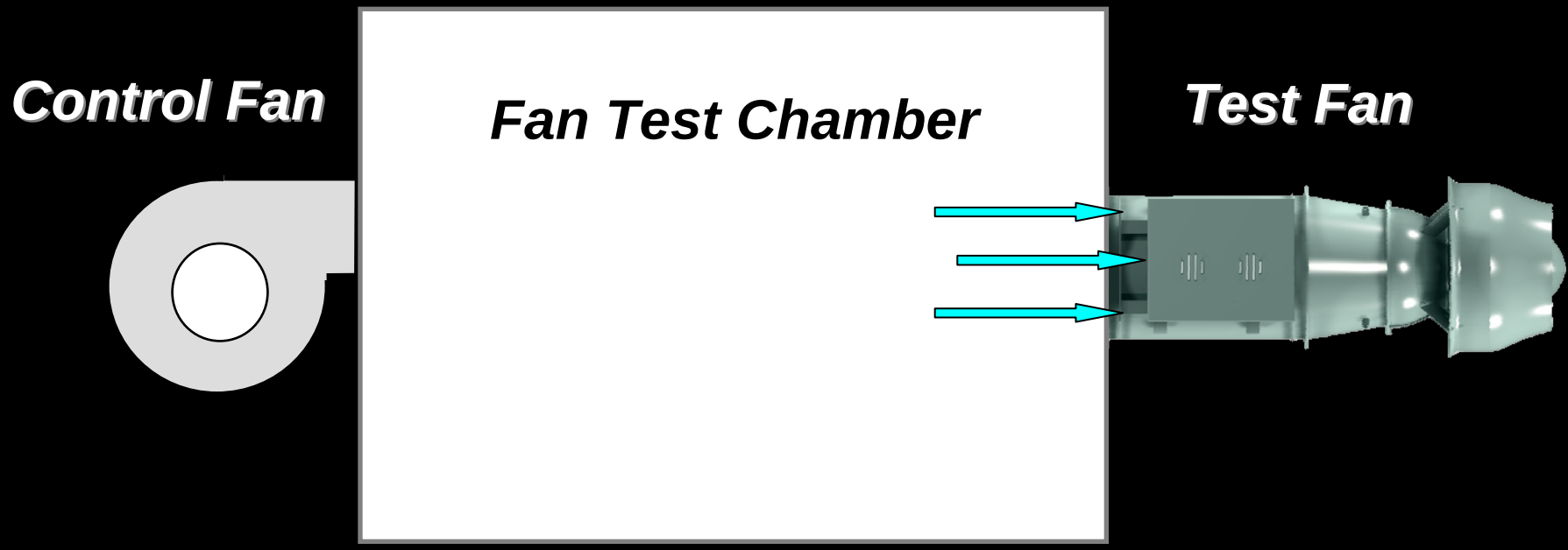
Induced Flow Certification

- Fan Outlet CFM / SP Test



Induced Flow Certification

- Test 1) Total Lab Fan Performance



Induced Flow Certification

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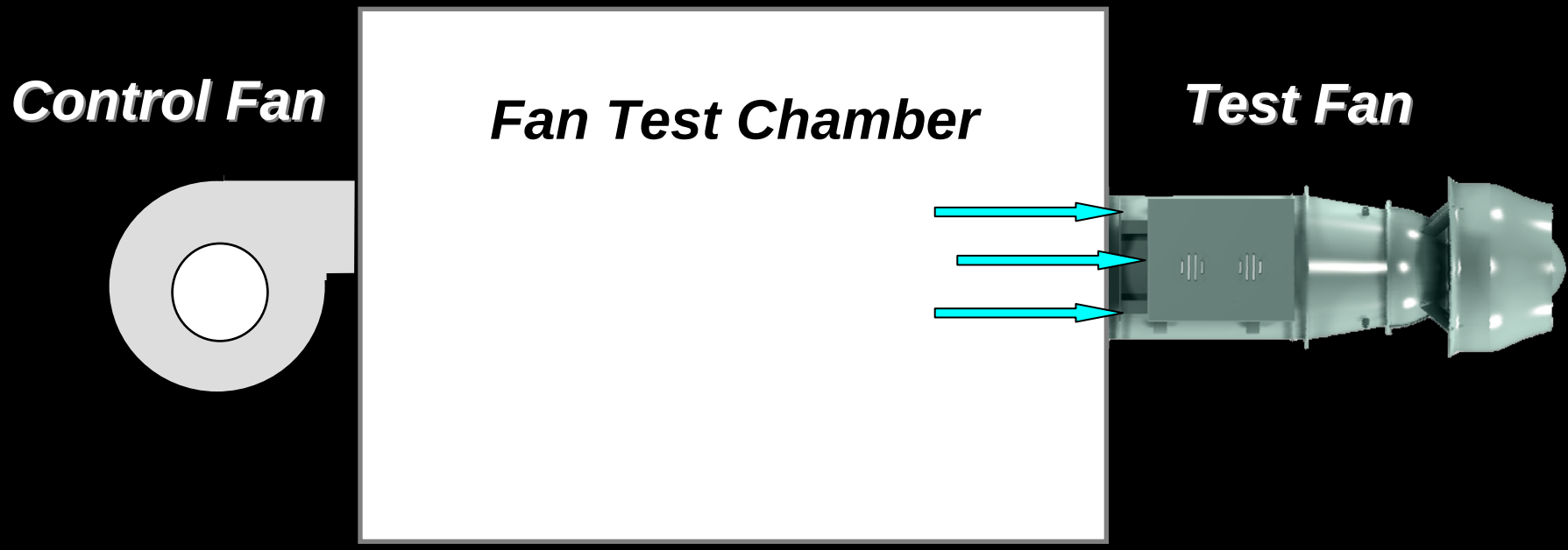
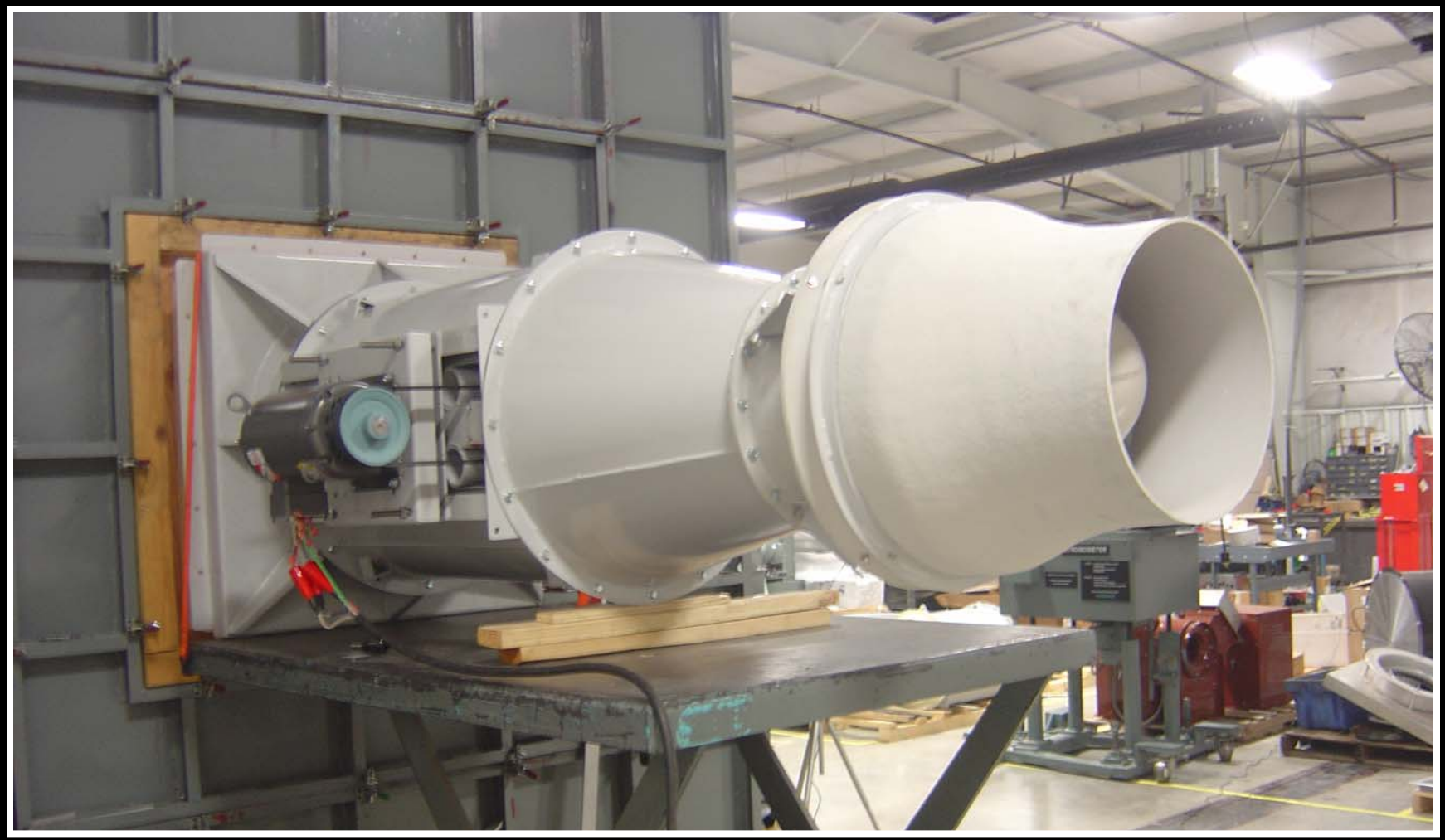


Measure Inlet Performance

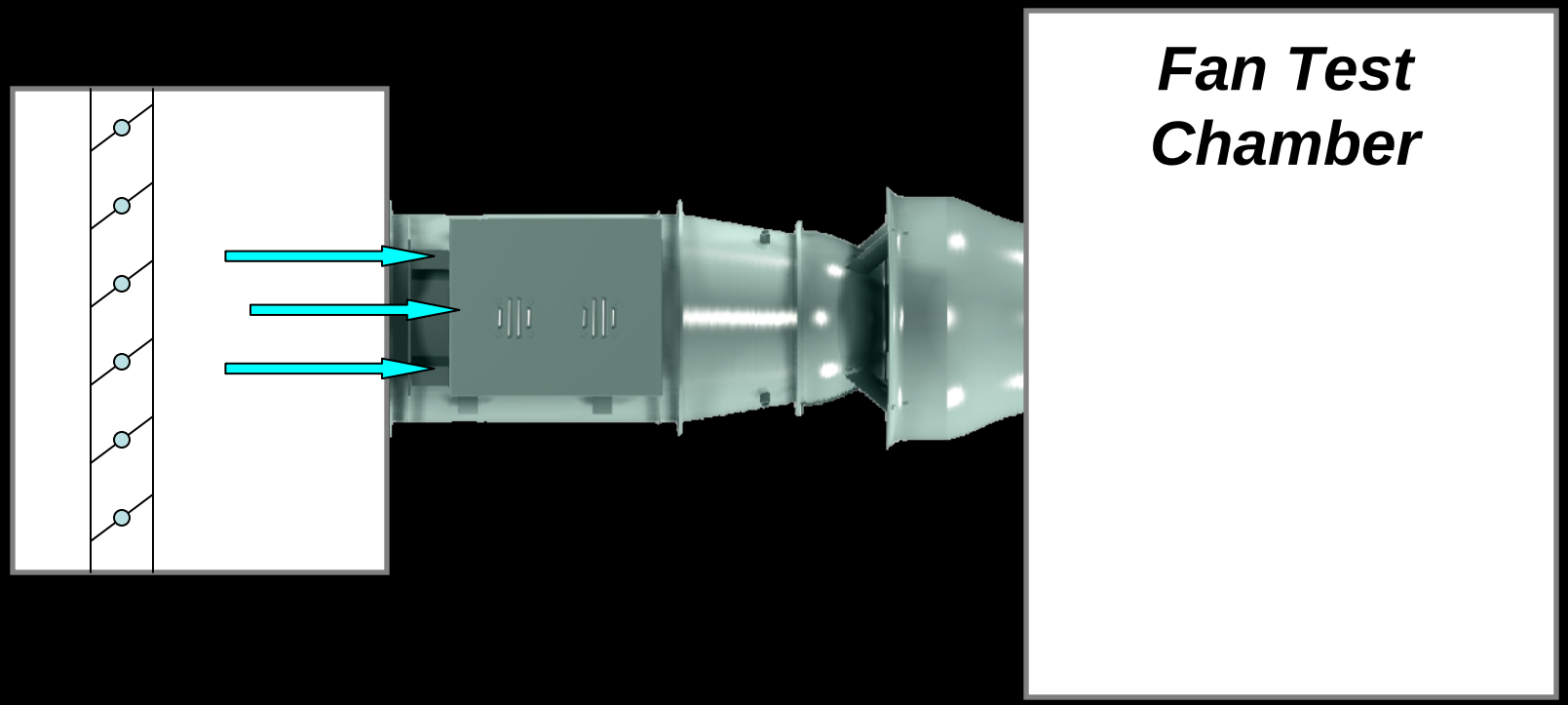
Induced Flow Certification

- Test 1) Total Fan Performance



Induced Flow Certification

- Test 2) Measure Fan Entrainment



Induced Flow Certification

- Test 2) Measure Fan Entrainment

Induced Flow Certification

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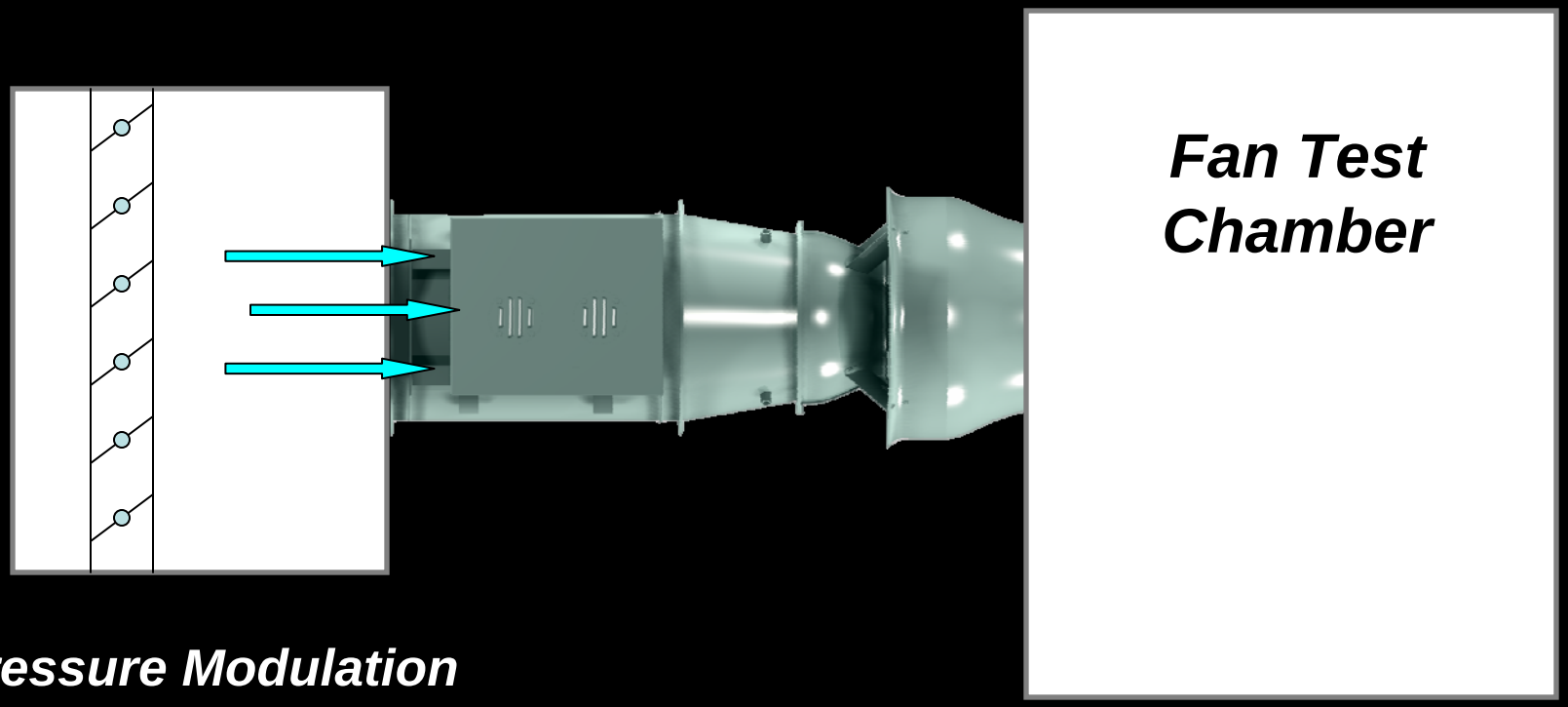
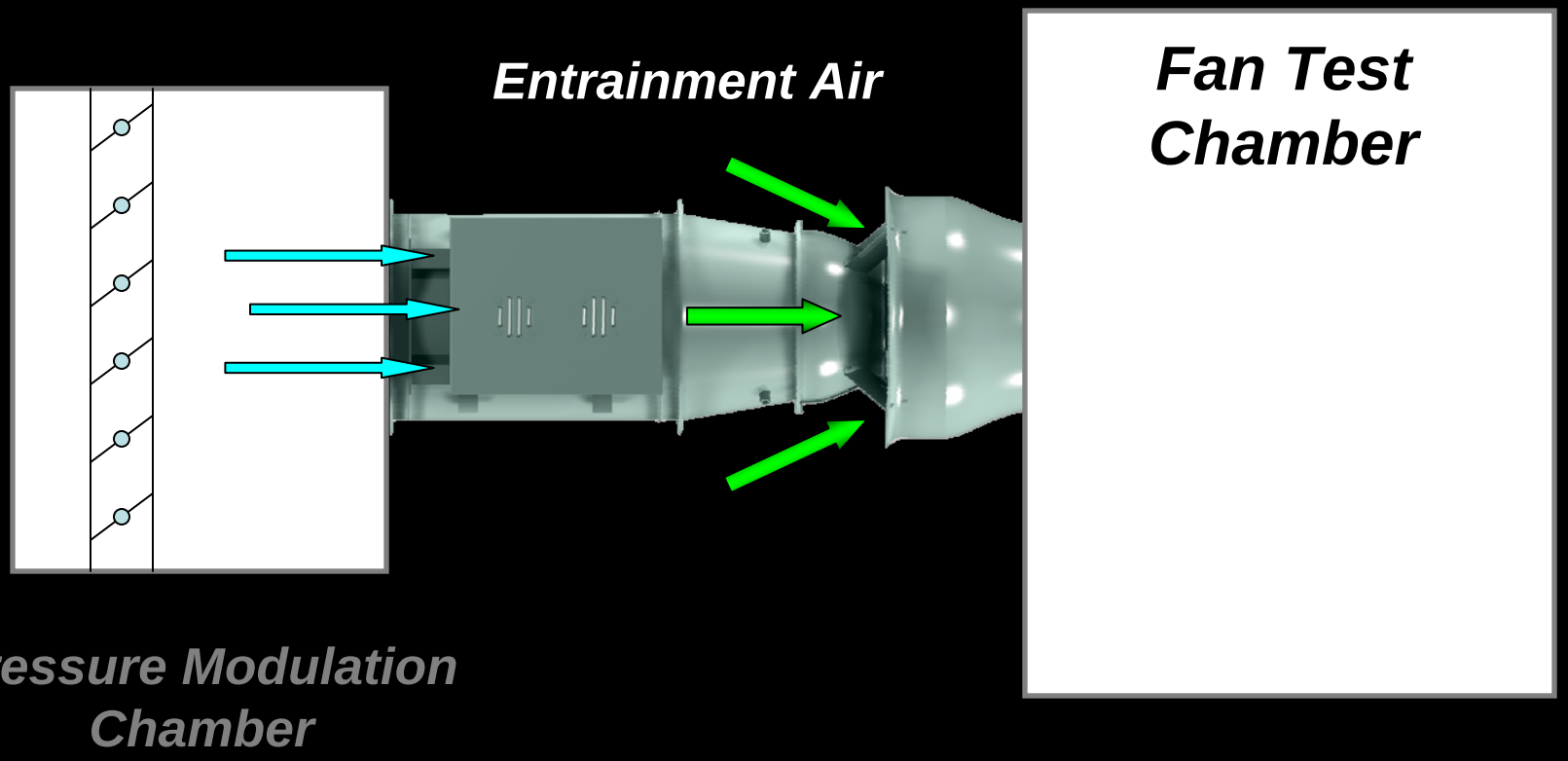


Induced Flow Certification

- Test 2) Measure Fan Entrainment



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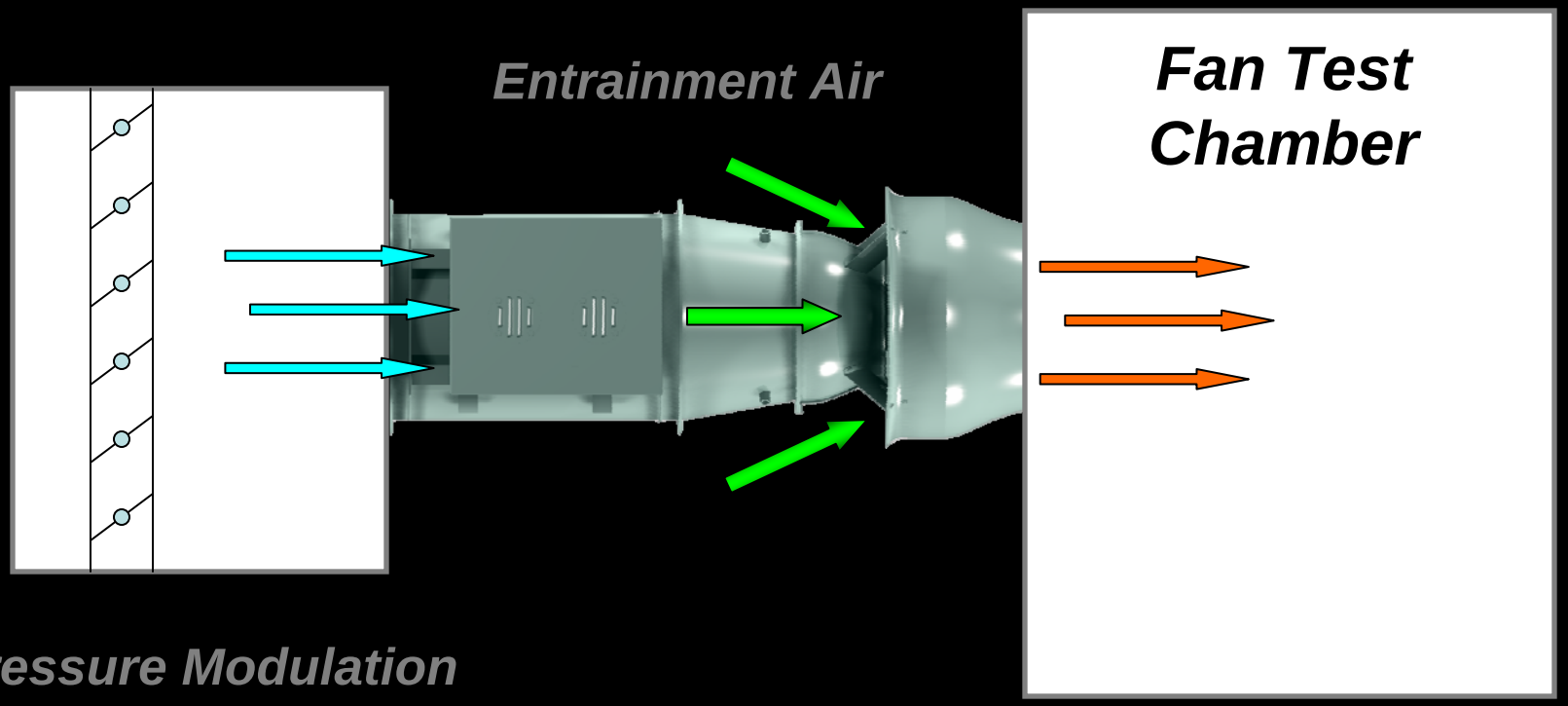

Induced Flow Certification

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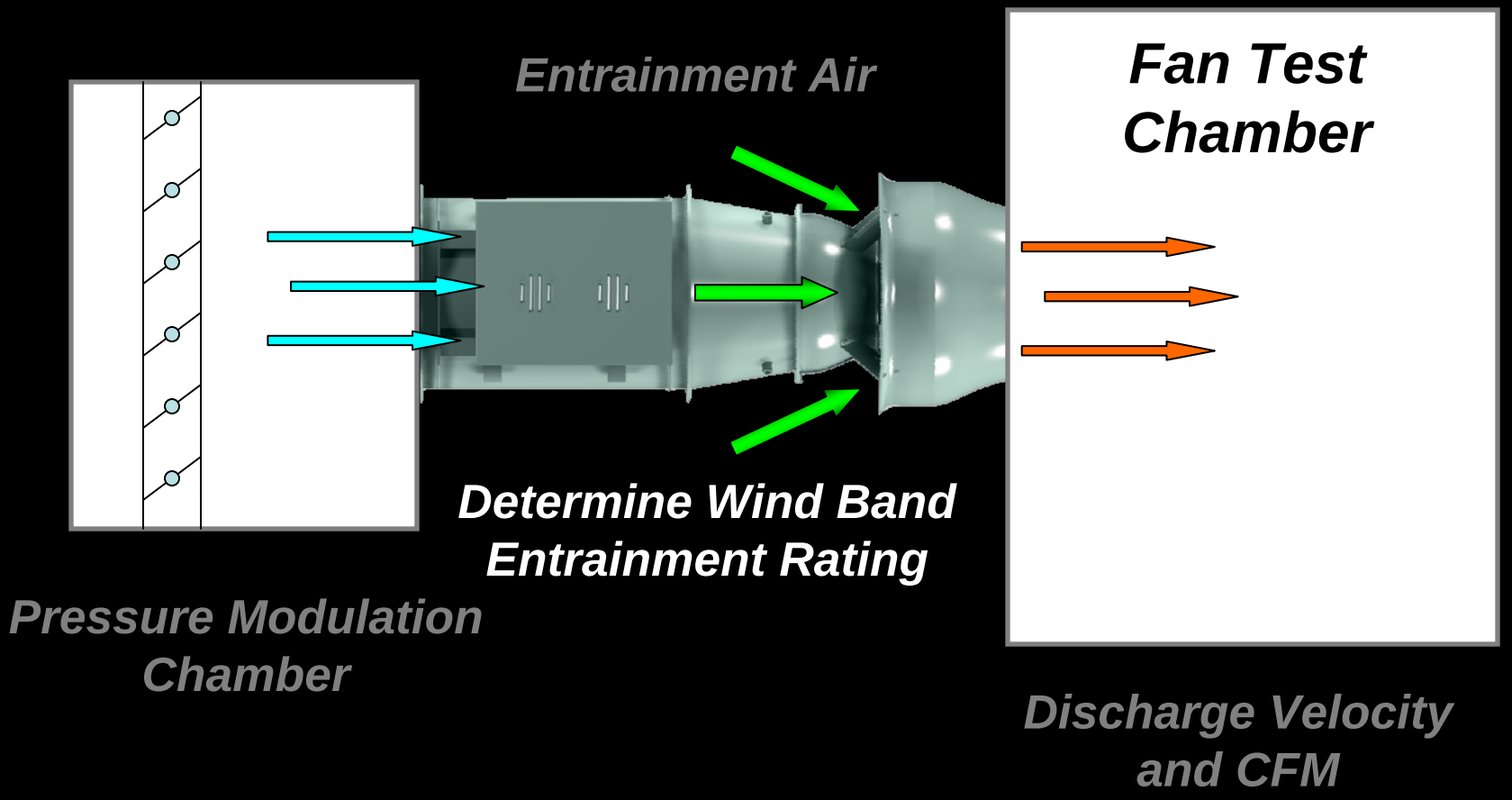
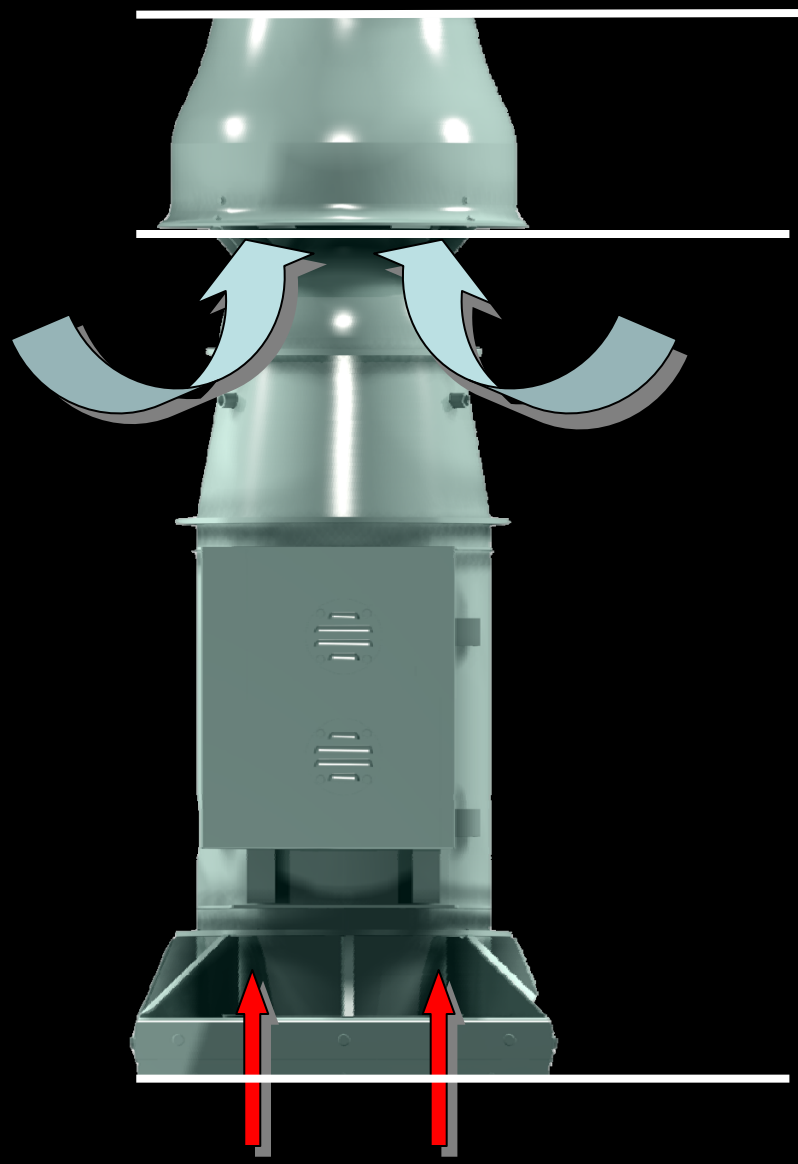


Induced Flow Certification



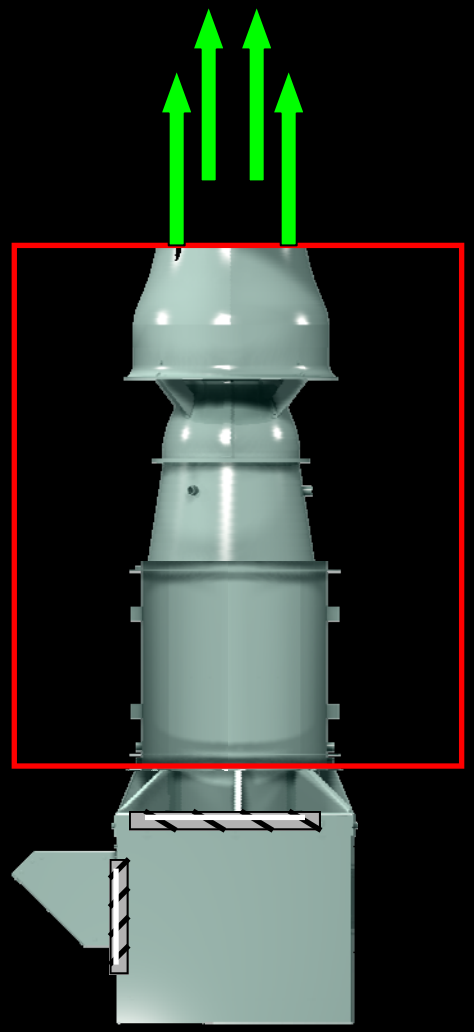
Exhaust Air = 5,000 CFM

Entrainment = 1.66 Ratio

(2,000 CFM)

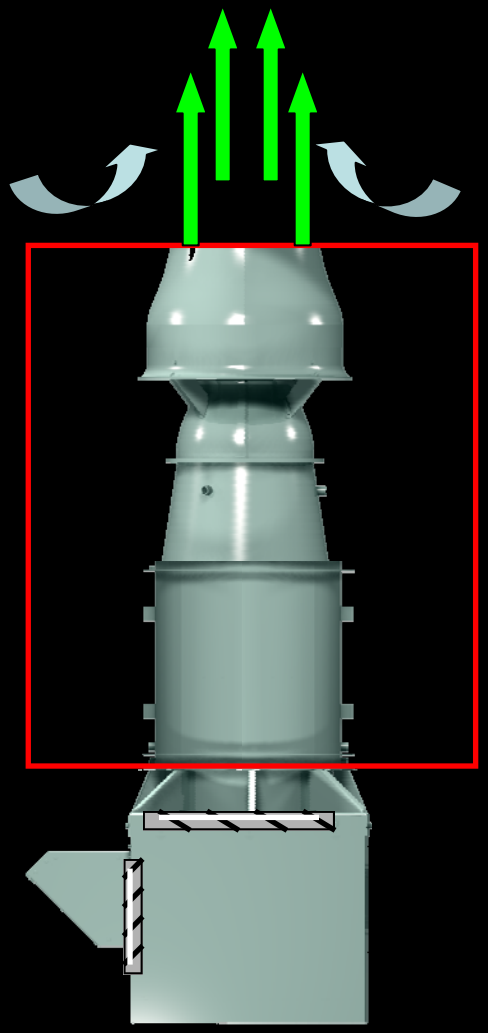
Primary Air = 3,000 CFM

Induced Flow Certification



Induce Flow Certification

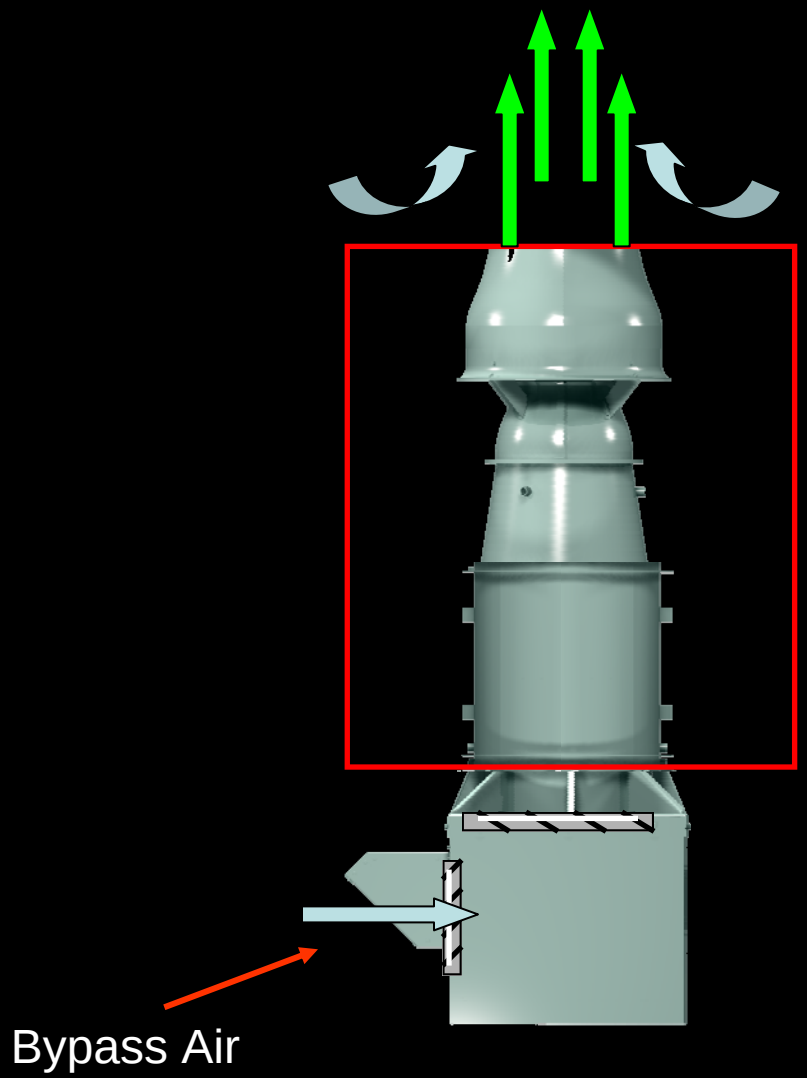
Induced Flow Certification



Disregarding induce flow above the fan.

Induce Flow Certification

Induced Flow Certification



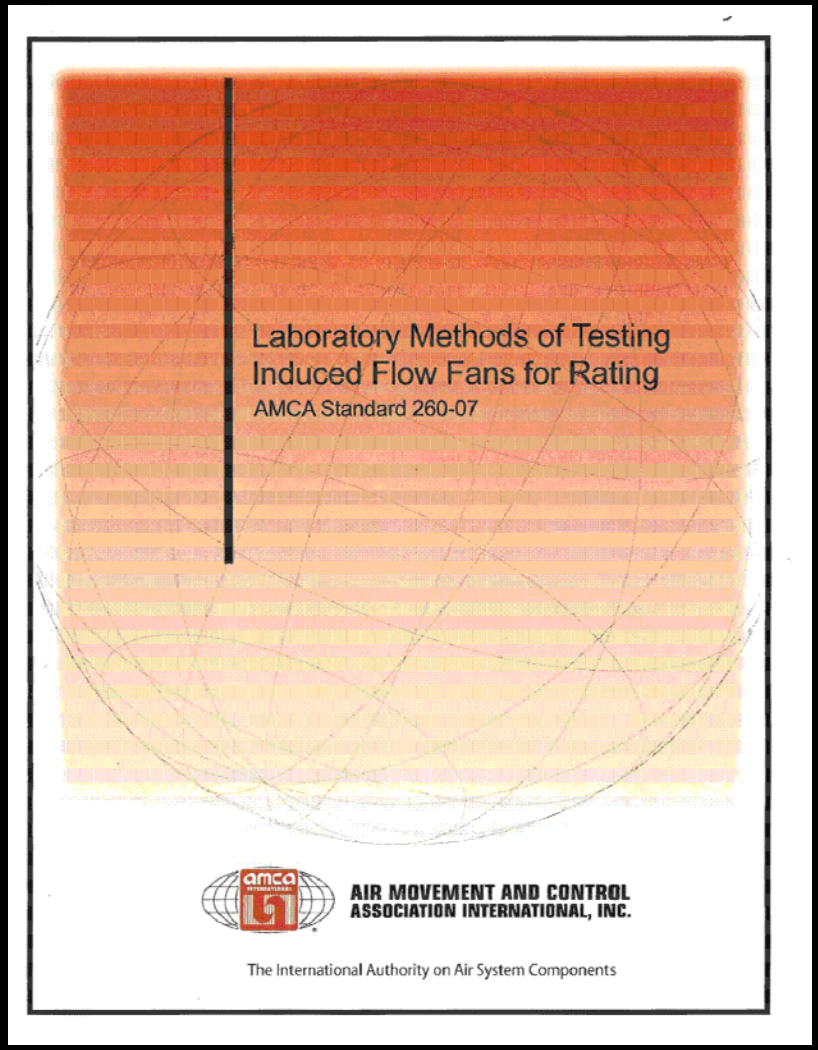
Disregarding induce flow above the fan.

Induce Flow Certification

Disregarding Bypass

Lab Exhaust Design Guidelines

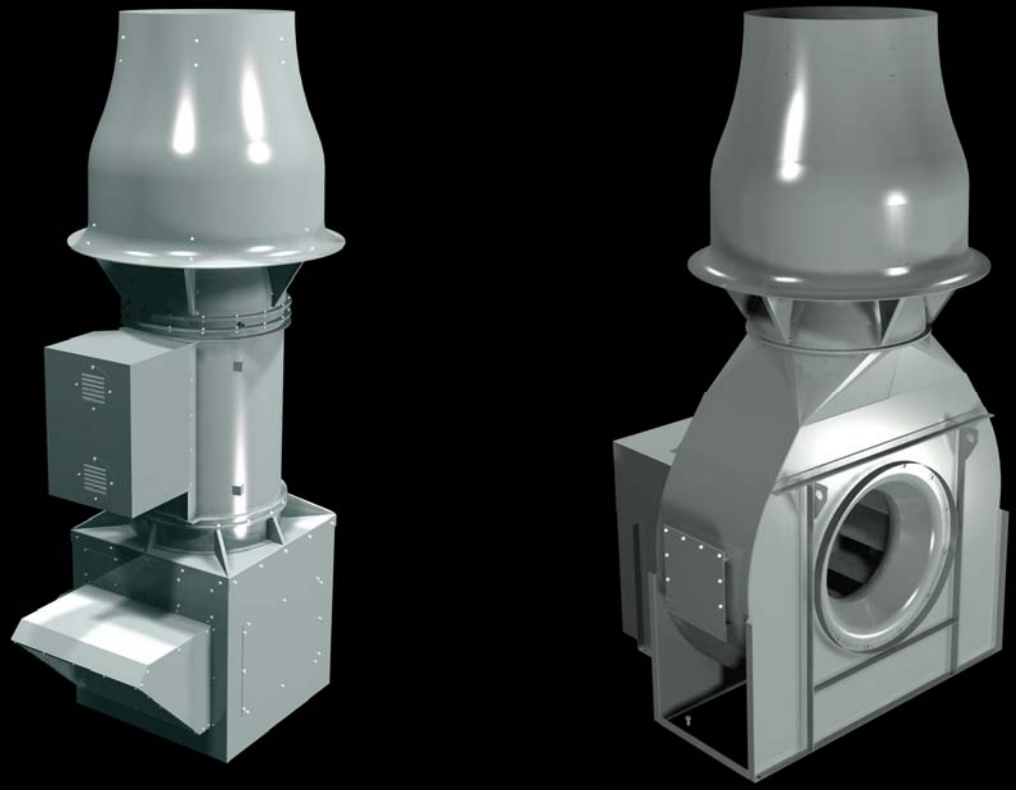
AMCA STANDARD 260-07



Lab Exhaust Design Guidelines

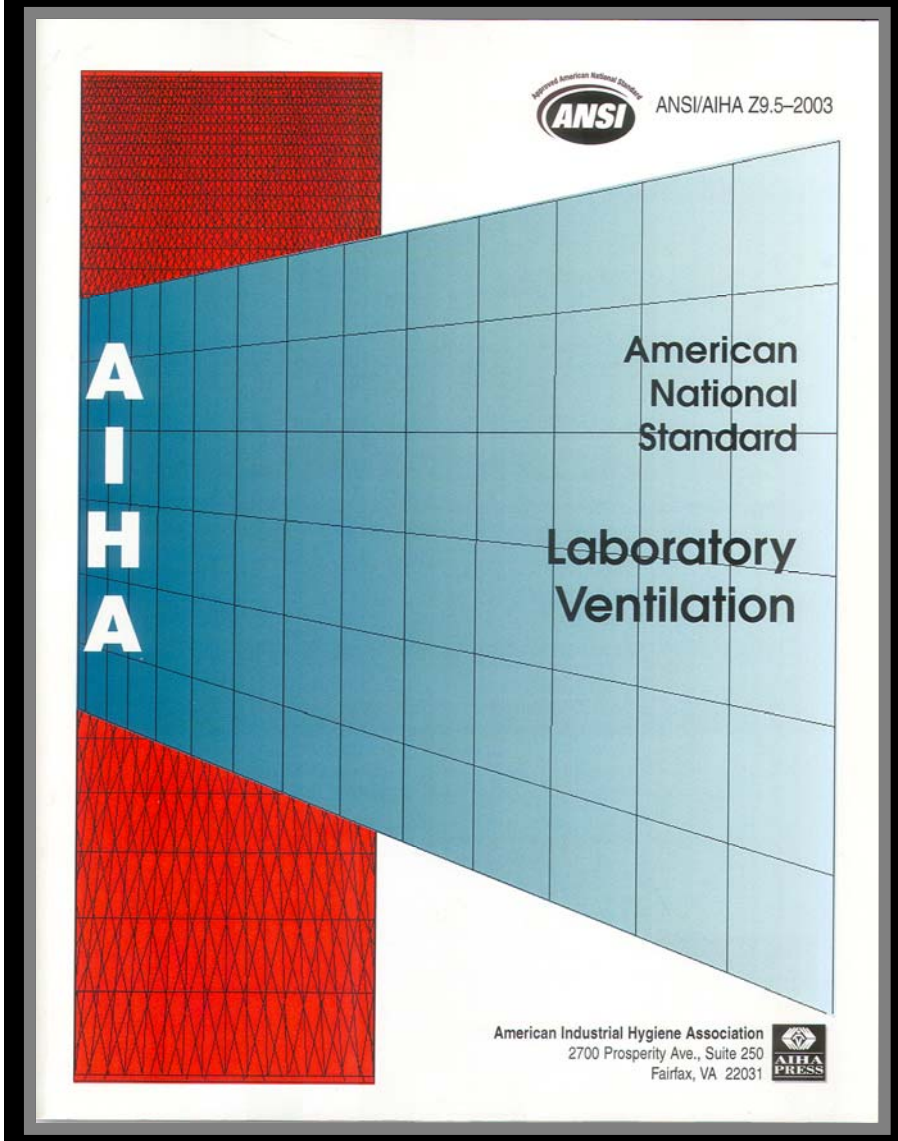
Some Common Guidelines to Know…

Induced Flow Fans



History, Codes, Standards and Guidelines

Lab Exhaust Design Guidelines



ANSI / AIHA Z9.5

Covers:

- Exhaust System Reliability
- Exhaust Fan Location
- Exhaust Stack Discharge

Lab Exhaust Design Guidelines

NFPA

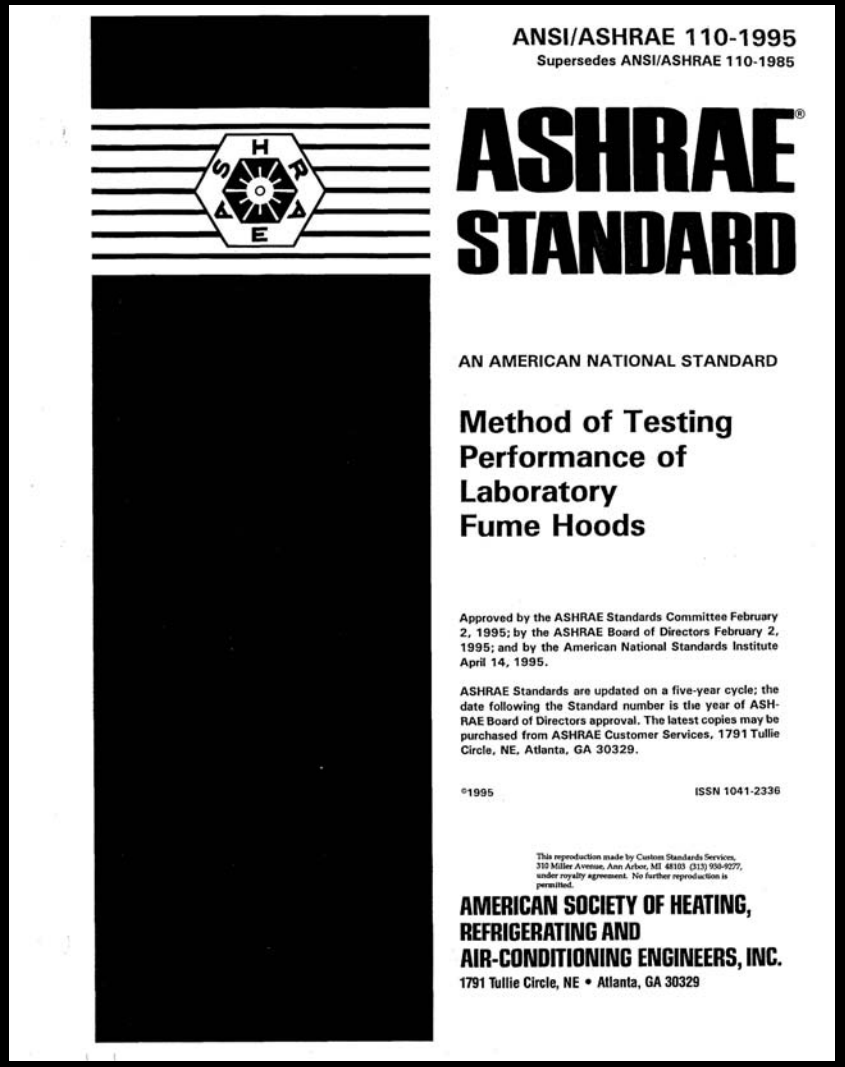
OSHA

Title 29 CFR Section 1910

Occupational Exposure to Hazardous Chemicals in Laboratories

Lab Exhaust Design Guidelines

ASHRAE Standard 110



ANSI/ASHRAE 110-1995
Supersedes ANSI/ASHRAE 110-1985

ASHRAE® STANDARD

AN AMERICAN NATIONAL STANDARD

Method of Testing Performance of Laboratory Fume Hoods

Approved by the ASHRAE Standards Committee February 2, 1995; by the ASHRAE Board of Directors February 2, 1995; and by the American National Standards Institute April 14, 1995.

ASHRAE Standards are updated on a five-year cycle; the date following the Standard number is the year of ASHRAE Board of Directors approval. The latest copies may be purchased from ASHRAE Customer Services, 1791 Tullie Circle, NE, Atlanta, GA 30329.

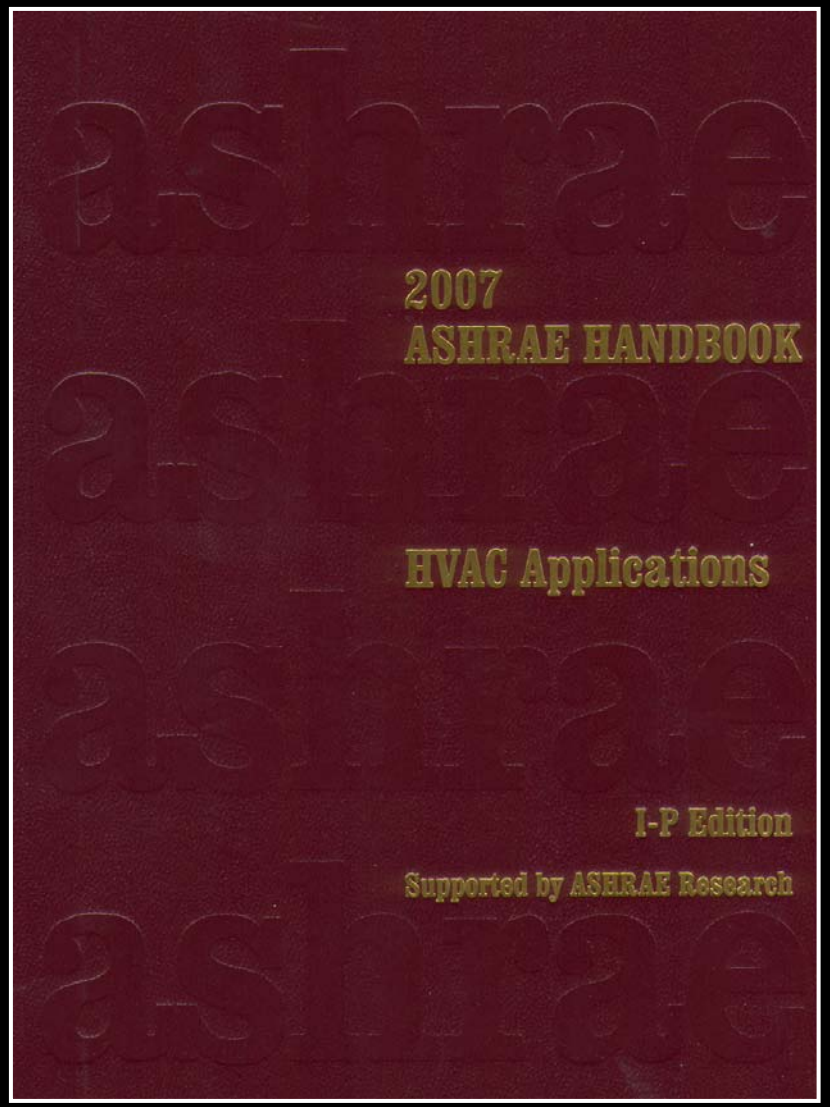
ISSN 1041-2336

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE • Atlanta, GA 30329

Lab Exhaust Design Guidelines

ASHRAE

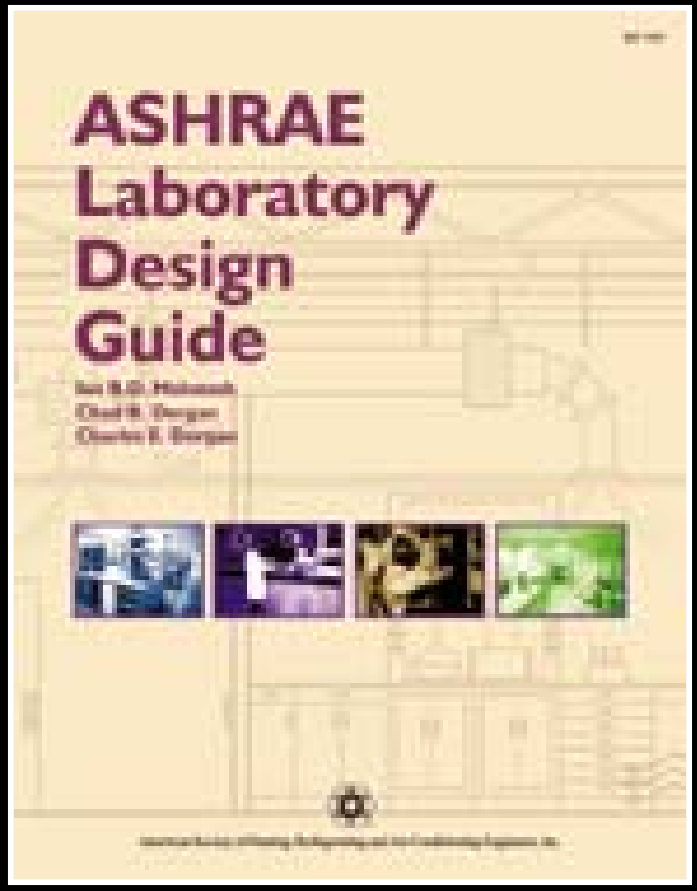
- HVAC Applications (Handbook Series)
- Laboratory Exhaust
- Design Calculations
- Multiple Standards



Lab Exhaust Design Guidelines

ASHRAE

Laboratory Design Guide



Wind Consultants

Effective Stack Height

ASHRAE Journal

Figure 1a (left): Plume impact on taller downwind building. Figure 1b (right): Plume impact on taller upwind building.

Specifying Exhaust and Intake Systems

By Ronald L. Petersen, Ph.D., Member ASHRAE, Brad C. Cochran, Member ASHRAE, and John J. Carter, Member ASHRAE

The design of exhaust stacks and air intakes needs careful consideration. Public concern has increased regarding air pollution in general. In addition, adverse exposure to air pollutants in the workplace can affect employee health and productivity. In some cases, releases of toxic pollutants may lead to litigation. The following newspaper article excerpts illustrate some of these issues.

Business Weekly (May 2, 1988): "Local residents were frightened. New pharmacology laboratories at the University of California at San Francisco were investigating everything from AIDS to parasitic diseases. Could disease organisms or toxic chemicals from those labs escape and harm citizens?"

San Francisco Chronicle (September 5, 1996): "A barrage of letters and concerns about toxic chemicals have forced a circuit board manufacturer to drop, at least temporarily, plans to move next door to a peninsula high school."

Chicago Daily Herald (April 17, 1998): "Suspicions confirmed. Public health officials say brain tumors at Amoco center more than coincidence.... A study of Building 503 at the Amoco Research Center in Naperville indicates a rash of malignant brain cancers.... Eighteen Amoco Research Center employees have developed brain tumors in the last 28 years."

Some challenges to specifying a good stack design include the existing building environment, aesthetics, building design issues, chemical use, source types, local meteorology and topography. For example, if a new laboratory building that is being designed is shorter than surrounding buildings, it is difficult to design a stack so the exhaust will not impact neighboring buildings.

The effect of a taller downwind or upwind building is illustrated in *Figure 1*. The figure shows how the plume hits the face of the taller building when it is downwind and how, when it is upwind, the wake cavity region of the taller building traps the exhaust from the shorter building. In either case, the plume impacts the face of the taller building.

Figure 2 further illustrates problems that can be created by poor stack design. Fumes from the exhaust may reenter the building, enter adjacent buildings, or

About the Authors

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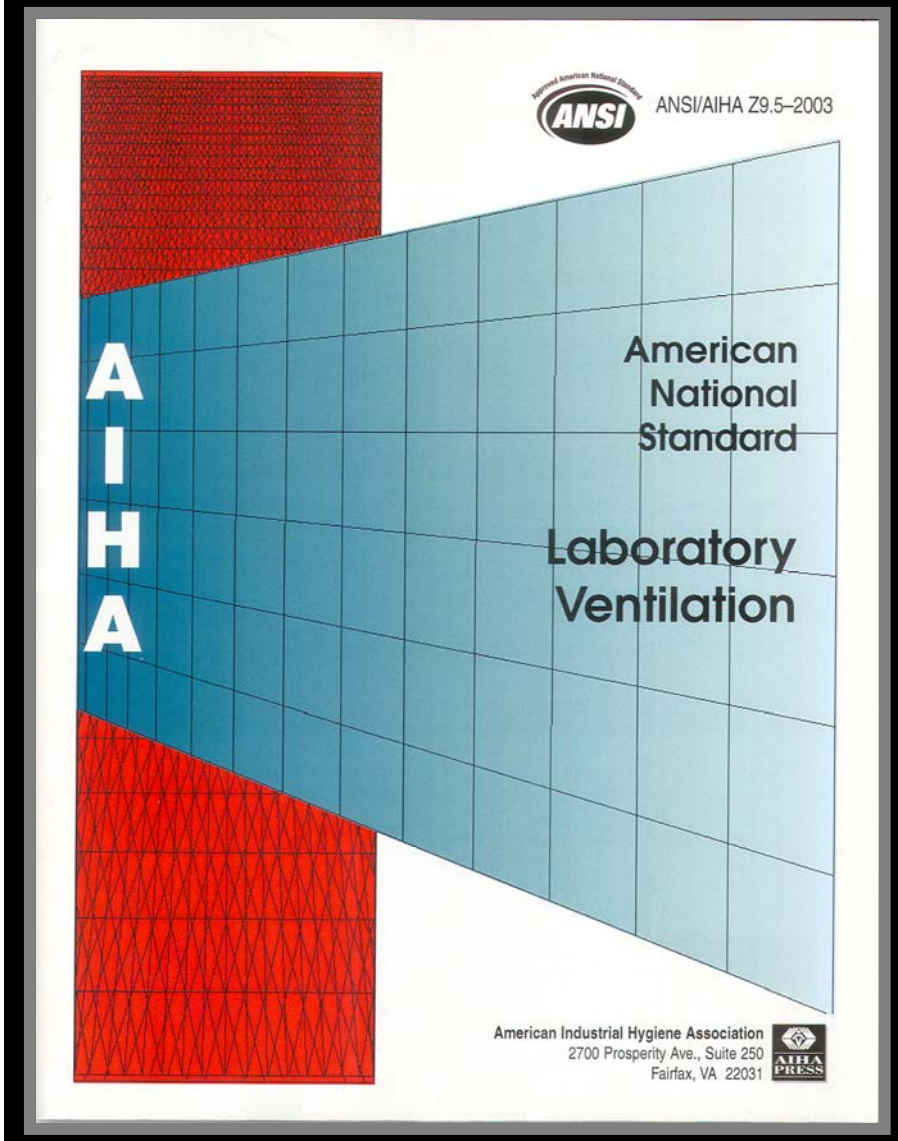
Lab Exhaust Design Guidelines

Some Common Guidelines to Know…

Lab Exhaust Design Guidelines

- 3000 FPM Discharge
- 10 Foot System Height
- Dilution Rates
- Effective Stack Height

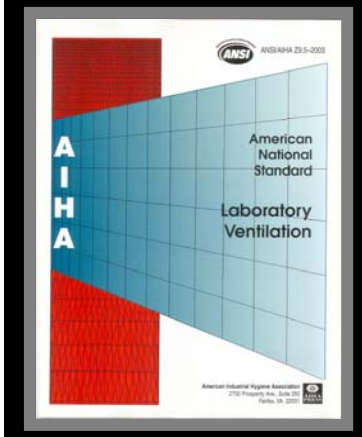
Lab Exhaust Design Guidelines



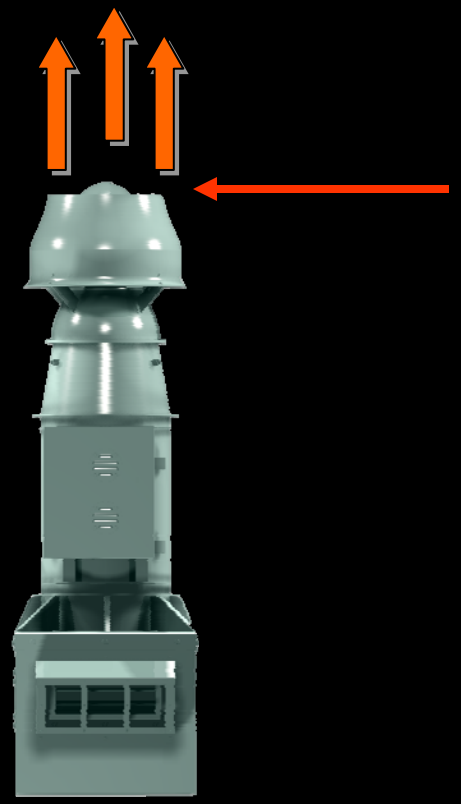
American Industrial Hygiene Association

ANSI / AIHA Z9.5-2003

Lab Exhaust Design Guidelines



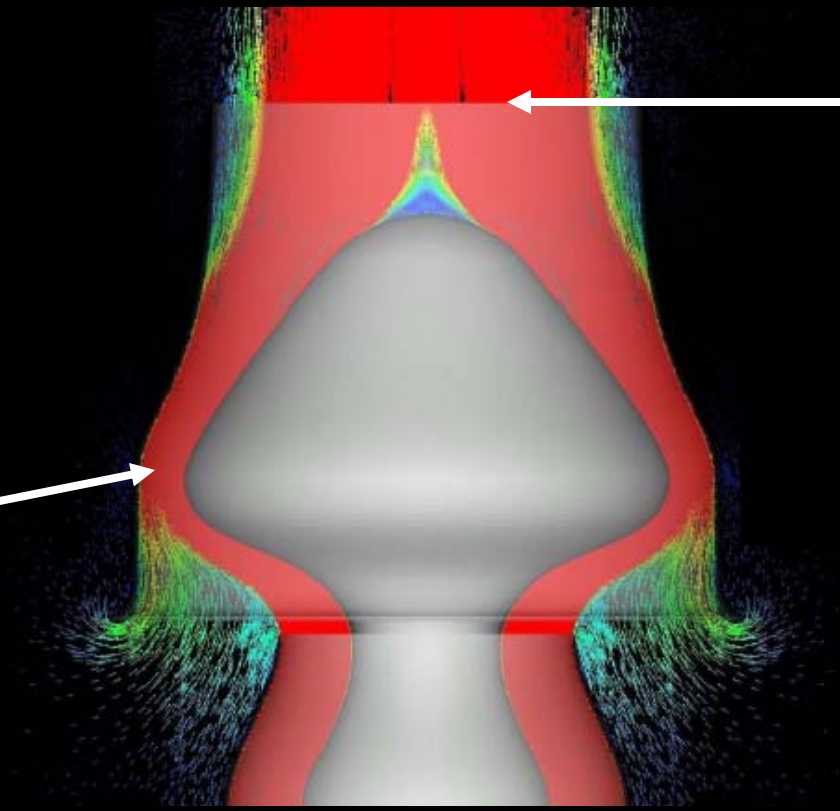
ANSI / AIHA Z9.5-2003



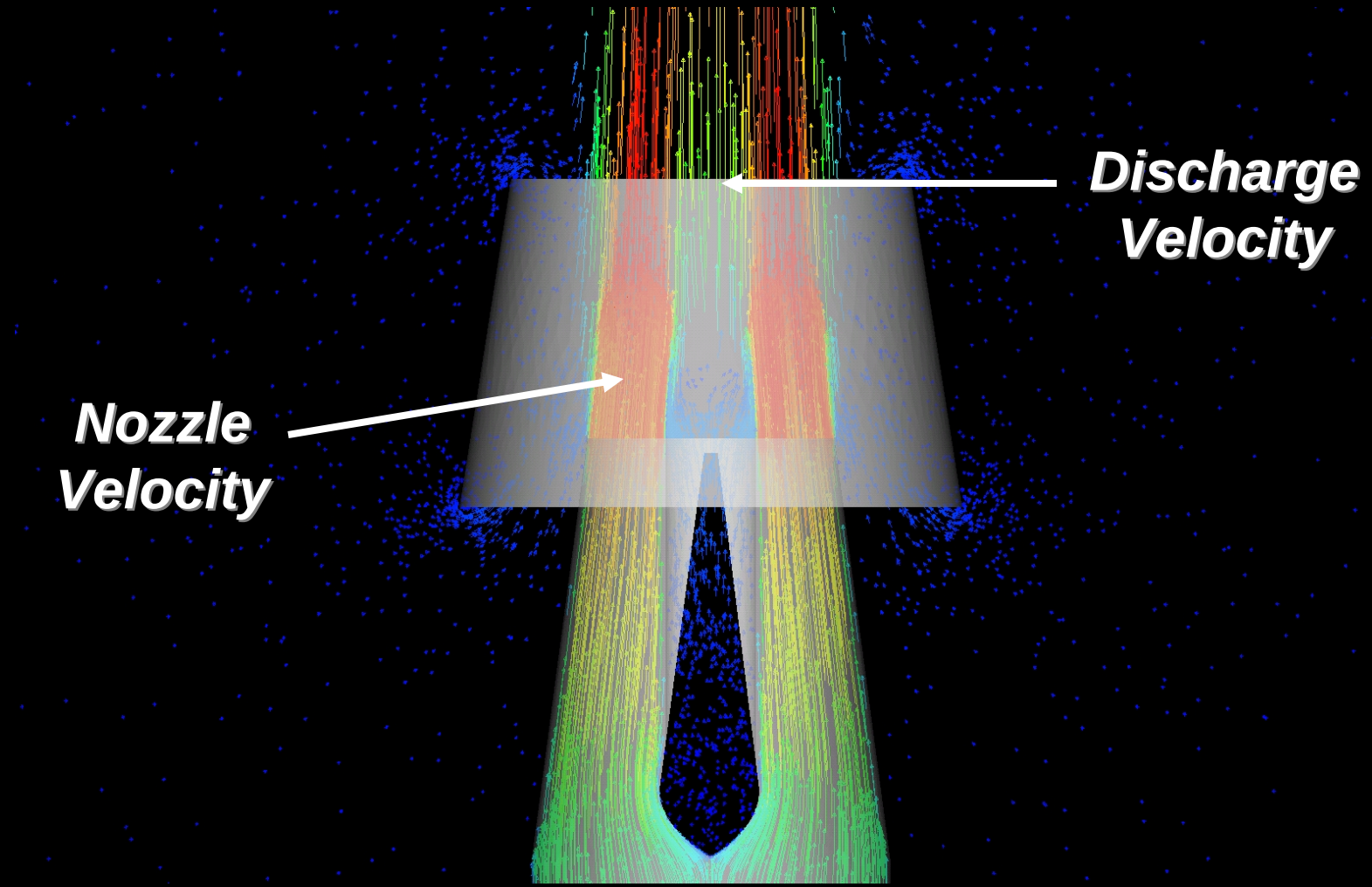
3000 FRM Discharge

Concentric Nozzle

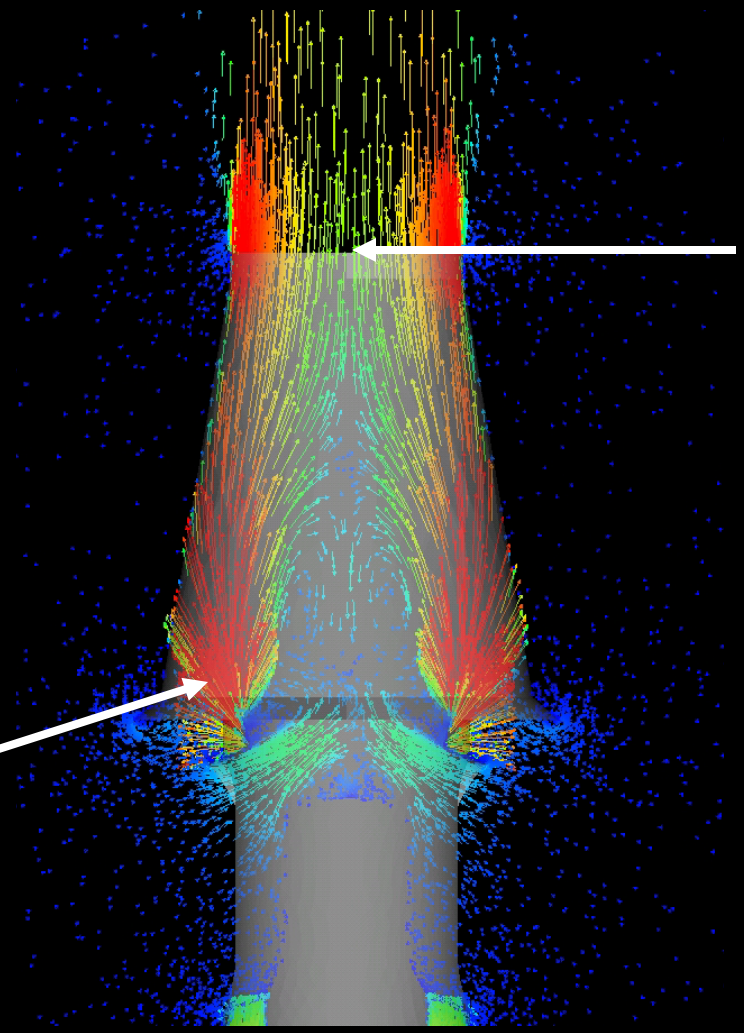
Entrainment Characteristics



Bifurcated Nozzle Study



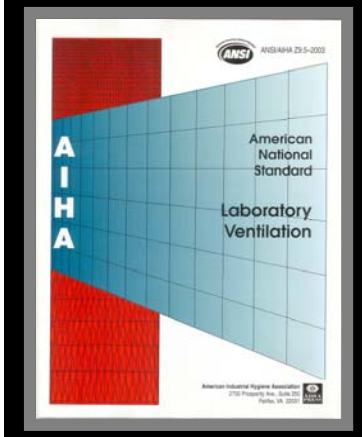
Bifurcated Housing Study



Discharge Velocity

Nozzle Velocity

Lab Exhaust Design Guidelines



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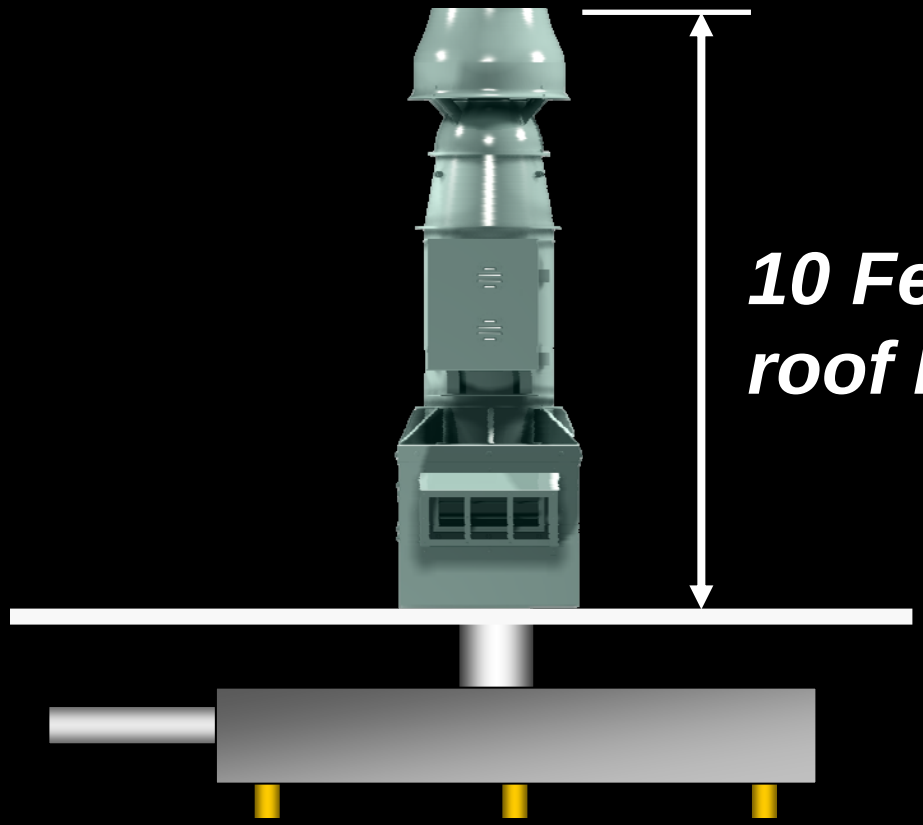
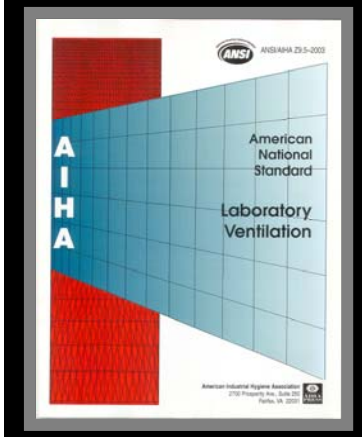


10 Feet above roof line.

Lab Exhaust Design Guidelines



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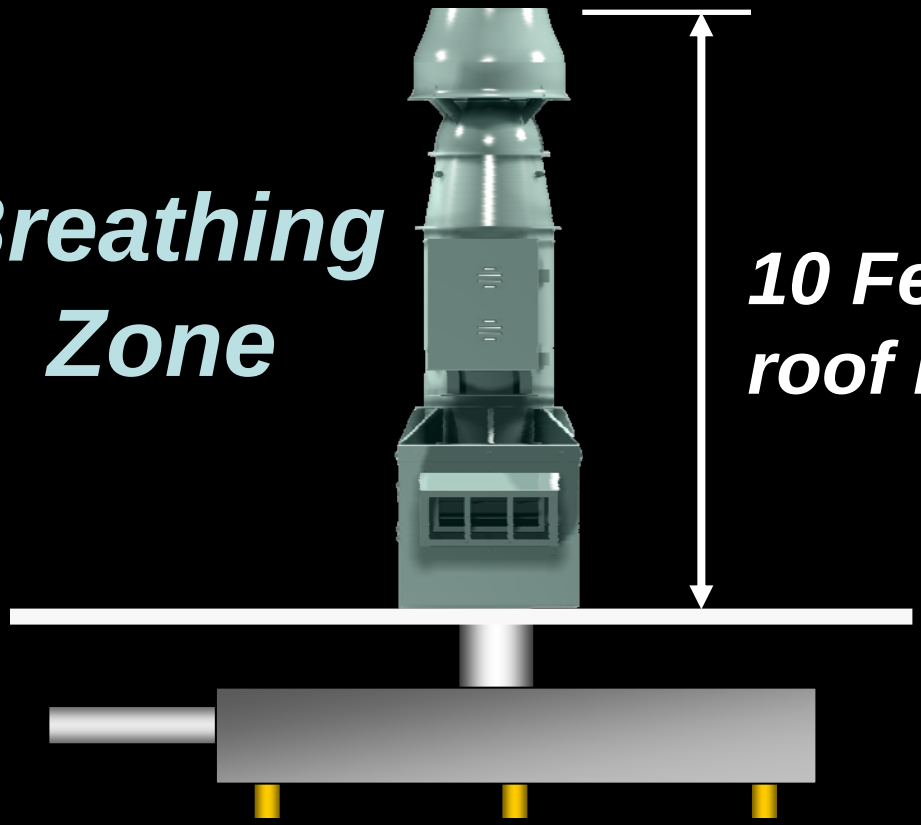
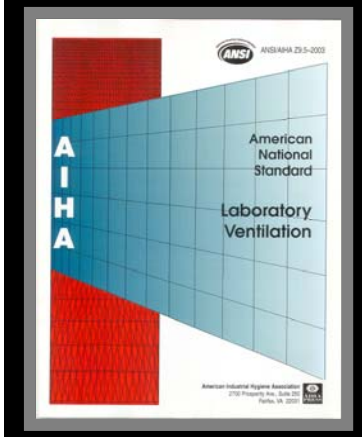


Breathing Zone

10 Feet above roof line.

Lab Exhaust Design Guidelines



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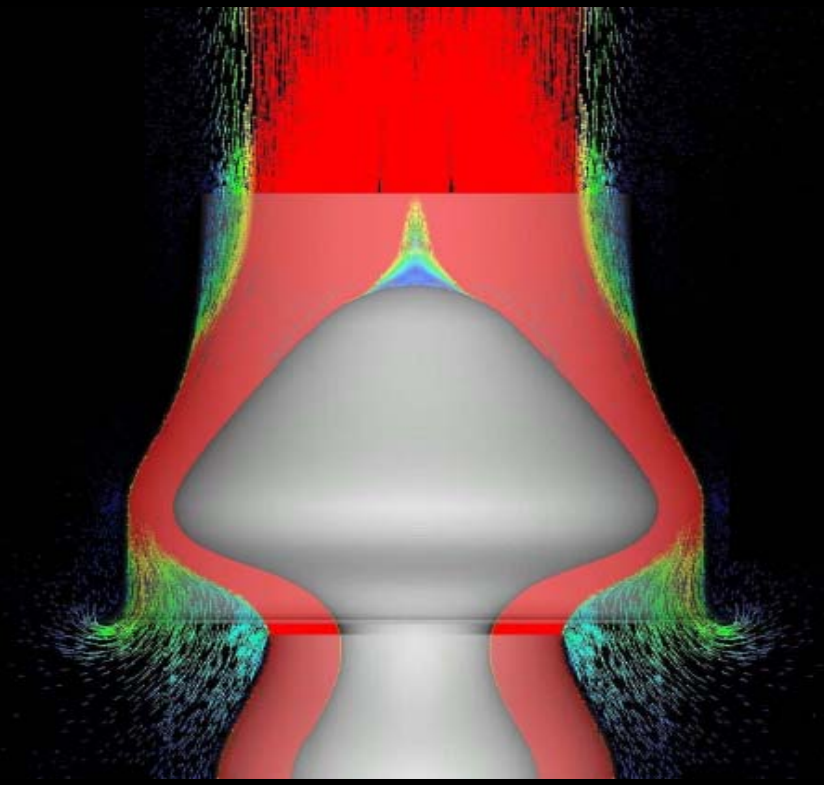
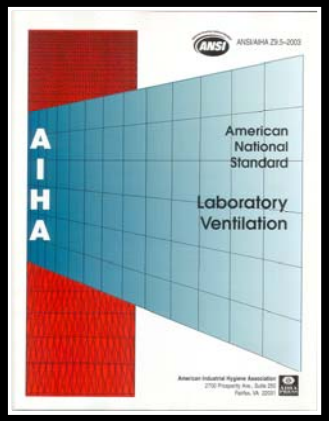
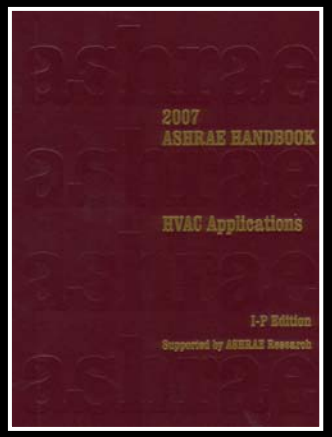


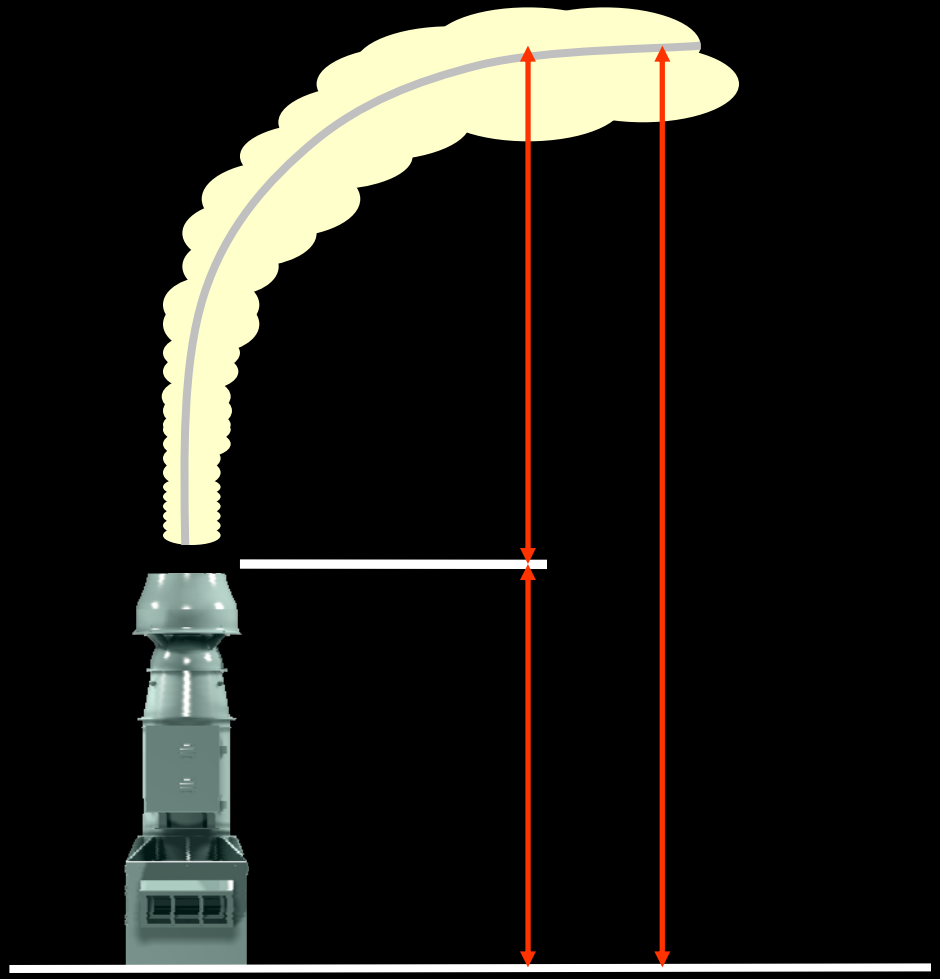
Dilution Rates

Lab Exhaust Design Guidelines



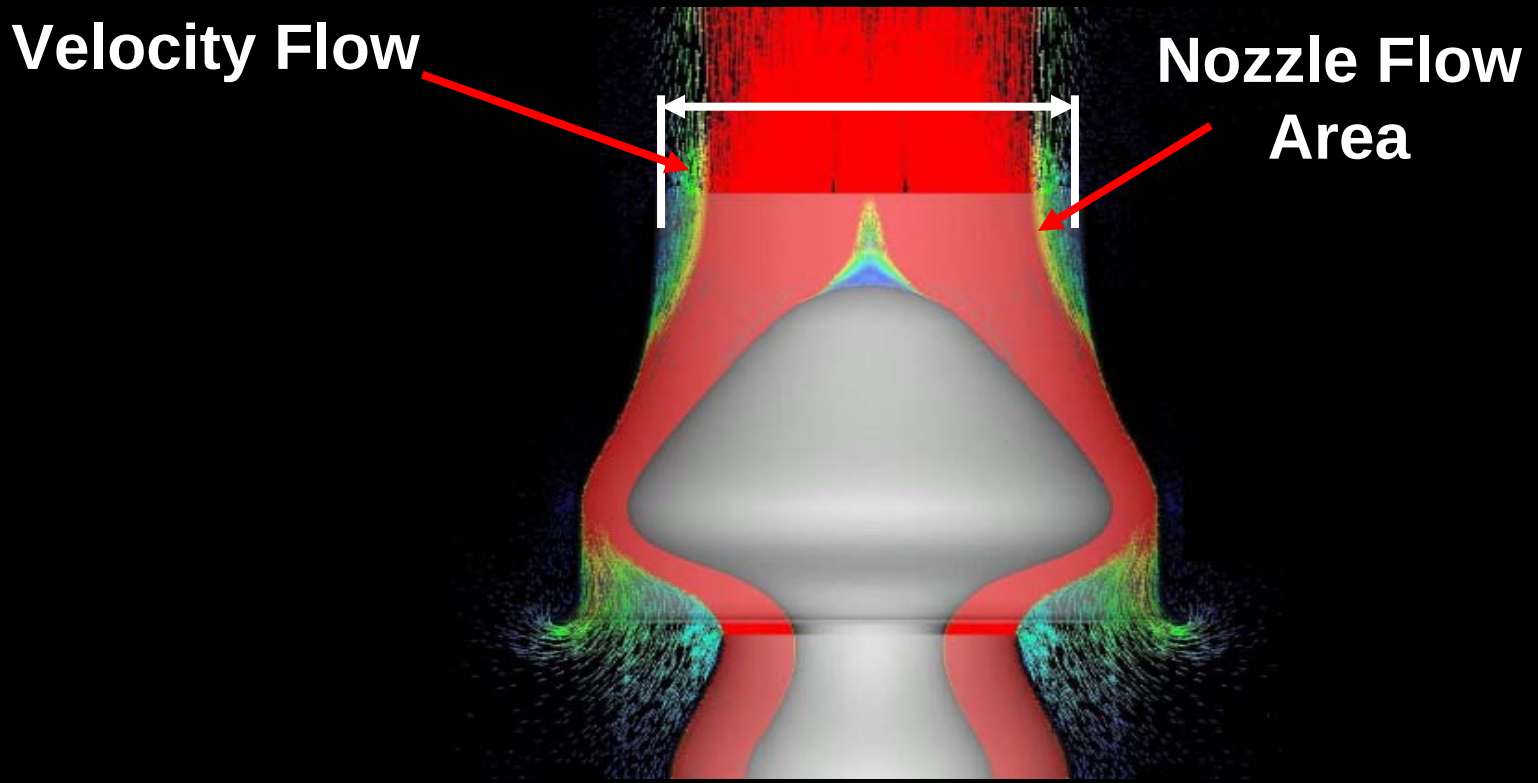


Stack Height and Plume Rise



Lab Exhaust Design Guidelines

Calculating Plume Rise



Lab Exhaust Design Guidelines

(Briggs) Plume Rise , h_r equation

$$h_r = \frac{3Vd}{U}$$

h_r = plume rise, feet

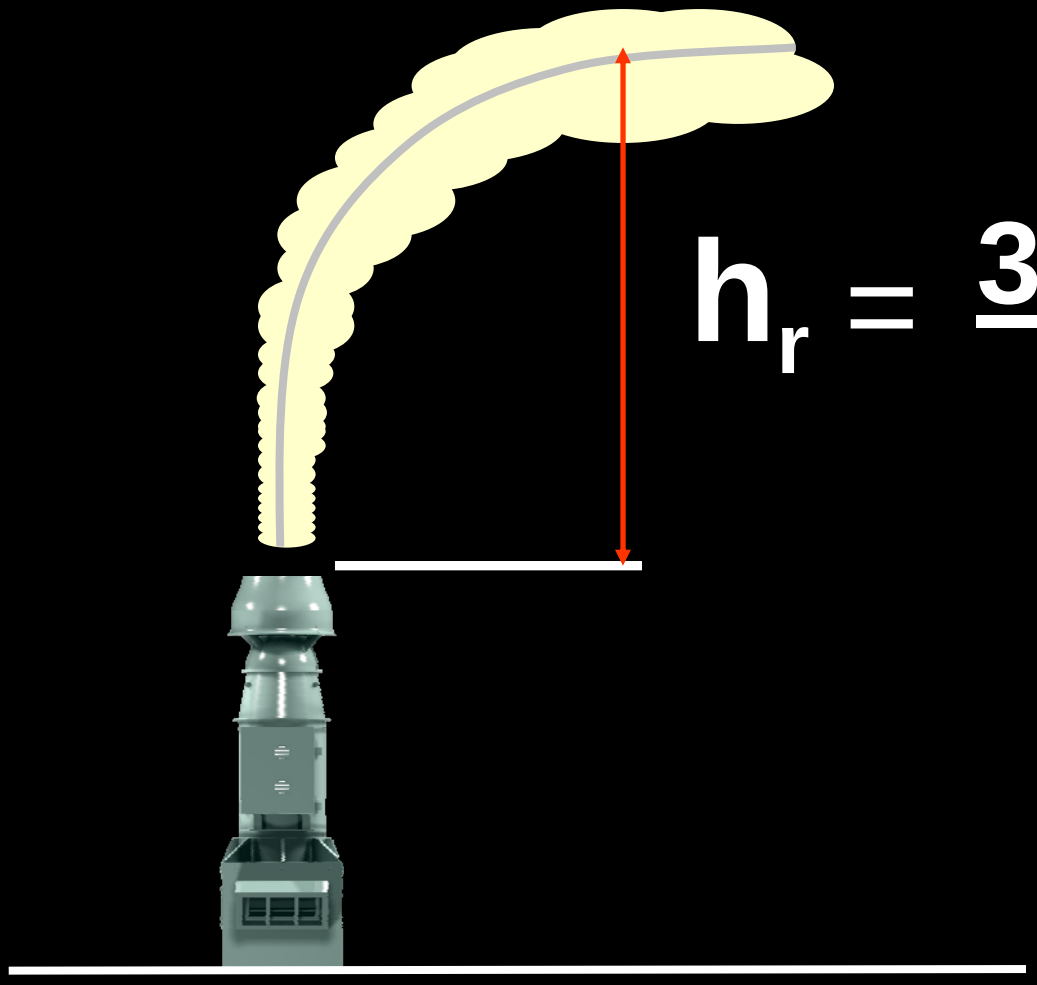
V = discharge velocity, fpm

d = nozzle diameter, feet

U = wind speed, ft/min

Lab Exhaust Design Guidelines

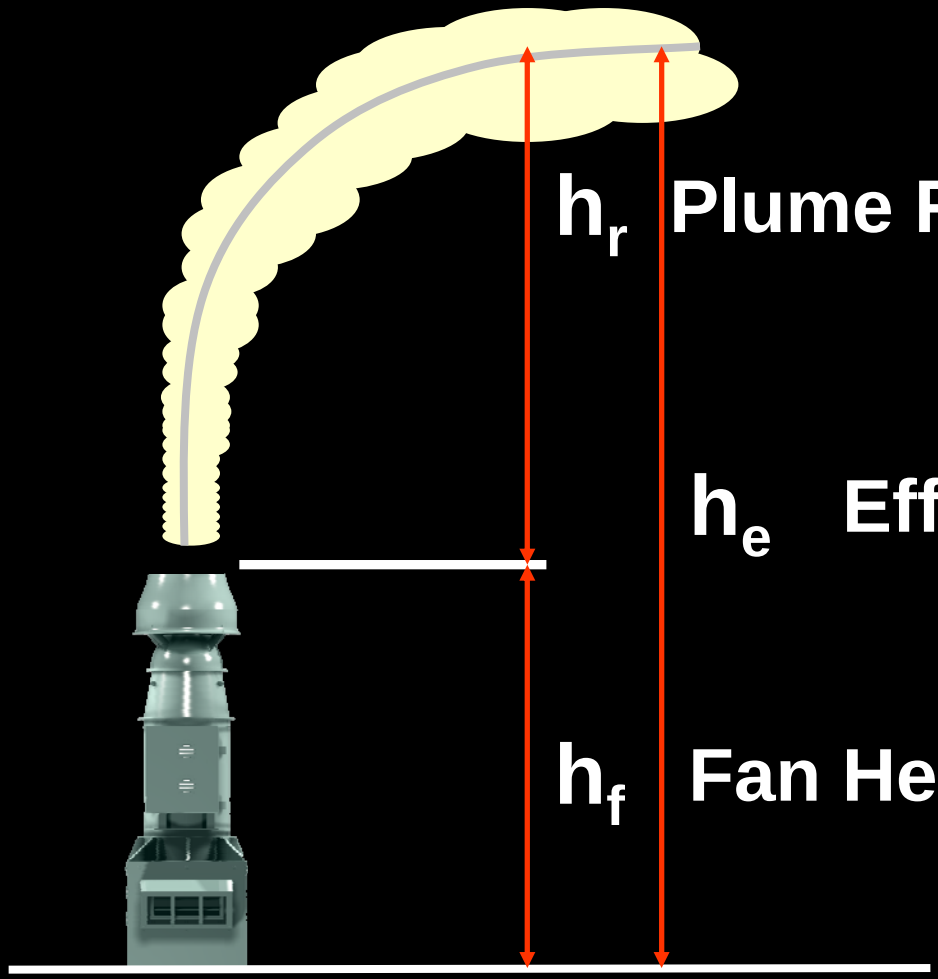
(Briggs) Plume Rise , h_r equation



$$h_r = \frac{3Vd}{U}$$

Lab Exhaust Design Guidelines

Effective Stack Height



h_r Plume Rise

h_e Effective Stack Height

($h_e = h_r + h_f$)

h_f Fan Height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