Ventilation Methods and Techniques
Acknowledgements

The following presentation was developed from the review, practice, and emergency ground experience utilizing principles and techniques which have been documented in “Ventilation Methods and Techniques” written by John Mittendorf.

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Objectives

Increase Knowledge of Building Construction
Understand the Principles of Ventilation
Review Ventilation Rules
Review Pressurized Ventilation Techniques
Discuss the Anatomy of a Ventilation Opening
Review Conventional Ventilation Methods
Review Lightweight Ventilation Methods
Introduction

Definitions:

Ventilation:

Procedures necessary to effect the planned and systematic direction and removal of smoke, heat, and fire gases from a structure.

Size Up:

A mental evaluation that assists in determining a course of action and the methods necessary to accomplish a desired goal.
Introduction

Size Up

1) Analyze the situation
   Ventilation Yes/No
   Offensive vs. Defensive
   Time factor

2) Decide on a plan
   2 Man vs. 4 Man Teams
   Vertical vs. Horizontal
   Natural vs. Mechanical

3) Put the plan into operation
   Ladder placement
   Tool assignments
   Type of opening
Introduction

Visually “size up” construction methods and styles.

Undress the building in your mind!

Look past the exterior of the building and visualize what is inside.
Table of Contents

1. Building Construction
2. Ventilation Principles
3. Ventilation Rules
4. Pressurized Ventilation
5. Ventilation: Anatomy 101
6. Conventional Ventilation
7. Lightweight Ventilation
Chapter 1 Building Construction

Chapter Contents:

Construction Styles
Roof Styles
Construction Methods
Age of the Building
Chapter 1 Building Construction

Construction Styles

Conventional
size = strength
depends on the structural members size to be strong.
the greater the span, the larger the material.
characteristics; 8x8, 2x6, mill timber.

Lightweight
compression and tension = strength
depends on multiple members.
length does not change the size.
characteristics; 2x4, 2x3, mgp
Chapter 1 Building Construction

Roof Styles

- Gable
- Hip
- Bridge Truss
- Arch
- Saw Tooth
- Corrugated
- Flat
Chapter 1 Building Construction

**Roof Styles**

**Flat**

- conventional
- wooden I-beam
- open web
- open web bar joist
- metal gusset plate
- panelized
- lightweight concrete
Chapter 1 Building Construction

Construction Methods

- Metal
- Concrete
- Masonry
- Frame/Stucco
- Frame/Wood
- Curtain
Chapter 1 Building Construction

Age of the Building

Pre - 1933
1933 - 1950’s
1950’s - 1970’s
1970’s - Today
Chapter 2  Ventilation Principles

Chapter Contents:

Key Terms
Ventilation as a Tool
Structural Considerations
Chapter 2 Ventilation Principles

**Key Terms**

**Ventilation**

Procedures necessary to effect the planned and systematic direction and removal of smoke, heat, and fire gases from a structure.

**Backdraft**

The introduction of oxygen to a confined area that is pressurized with heated flammable gases, that are deficient in oxygen, that results in an explosive force of significant intensity.

**Flashover**

The sudden ignition of exposed combustible surfaces and/or combustible gases in an involved area that results in a sudden and intense rise in temperature.

Note: Vertical Ventilation prevents Backdraft and Flashover!!!
Chapter 2 Ventilation Principles

Ventilation as a Tool

Rescue
Exposure Protection
Confinement
Extinguishment
Overhaul and Salvage
Chapter 2 Ventilation Principles

**Structural Considerations**

- Basements
- Habitation
- Commercial
- High Rise
Chapter 3  Ventilation Rules

Chapter Contents:

Efficient and timely ventilation operations should be governed by a set of characteristic standard operational procedures whose values will determine the behavior of a ventilation operation.

The following ventilation rules should be an integral part of each ventilation team members standard operating procedures.
Chapter 3  Ventilation Rules

Standard Operating Procedures

Pre-Plan Standard Operations
Size Up
Minimum of 2 Team Members
Minimum of 2 Ladders
Basic Equipment
Ladder the Strong Areas of the Roof
Uninvolved to the Involved
Chapter 3  Ventilation Rules

Standard Operating Procedures

Priorities
Read the roof
Location and extension of the fire
Sound your path of travel
Keep the wind at your back
Utilize natural ventilation aids
Chapter 3  Ventilation Rules

Standard Operating Procedures

Use construction to your advantage
Work towards the means of egress
Only cut as deep as necessary
Size of the opening
Coordination
Communication
Power tool safety
Chapter 4  Pressurized Ventilation

Chapter Contents:

Key Terms
Negative Pressure
Positive Pressure
Operational Considerations
Structural Considerations
Chapter 4  Pressurized Ventilation

**Key Terms**

2 Basic Methods of Ventilation

**Natural Ventilation**

natural currents directing flow of air through buildings openings
positive pressure

**Pressurized Ventilation**

mechanically forcing the flow of air through buildings openings
negative pressure
positive pressure
Chapter 4  Pressurized Ventilation

Negative Pressure

Requires personnel to be exposed to contaminants
Contaminates the blowers
May require special equipment to hang blowers
Added noise and confusion inside structure

Implementation

Blower is placed inside of opening and started
Must have another opening to draw fresh air from
Contaminated air is drawn to and through the blower and outside
Chapter 4  Pressurized Ventilation

*Positive Pressure*

Personnel are not exposed to contaminants
Contaminants are not drawn through the blower
Doorways and hallways are not blocked
No additional noise inside the structure
Efficient at removing contaminants from all parts of room/building
Twice as efficient as negative pressure

**Implementation**

Entrance opening – “the cone”
Control the travel of air through the building – “compartmentalize”
Exhaust opening – $\frac{3}{4}$ to $1 \frac{3}{4}$ the size of the entrance
Chapter 4  Pressurized Ventilation

Operational Considerations

Blower exhaust odor in building

Exhaust opening is too small

Multiple blowers

Maximum efficiency = in-line
#1 blower directed into opening
#2 blower covers the opening (“the cone”)
Large entrance opening = side by side
Chapter 4  Pressurized Ventilation

*Structural Considerations*

**Basements**
- #1 blower into lower portion of opening
- #2 blower blowing from the side, and above the #1

**High Rise**
- HVAC/Stairwell
- Pressurized systems
- Cross ventilation
- Exhaust features
Chapter 5  Anatomy of an Opening

Chapter Contents:

Key Terms
Types of Openings
Size of Openings
Chapter 5  Anatomy of an Opening

Key Terms

Ventilation Opening
Specific openings that are utilized to reduce and/or remove concentration of heat, smoke, and fire gases from a structure, and/or to channel and redirect the travel of fire.

Center Rafter
A section of roof decking that has been cut for ventilation purposes of the section to be removed is nailed to a single rafter.

Decking
Made up of a base (lightweight concrete, wood sheathing, plywood, corrugated metal), and a covering (tile, shingles, comp).

Dicing
A series of cuts between and parallel to rafters. Ventilation is then accomplished by “J” hooking roof material off of its structural members.
Chapter 5  Anatomy of an Opening

**Key Terms**

**Head cut**
A cut through the decking that is perpendicular to the direction of the rafters and involves rolling the rafters.

**“J” Hook**
Removal of sheathing enhanced by using a “J” Hook motion which brings the tool under and up to the decking to be removed.

**Louvering**
A cut section of roof decking that is hinged vertically on a single rafter to open a ventilation opening.

**Parallel Cut**
Cuts through the decking that are parallel to the direction of the rafters. Utilized when dicing.

**Pull Back**
A cut section of roof that is removed from its structural support by pulling up and back with an appropriate tool to open the ventilation opening.
Chapter 5  Anatomy of an Opening

**Key Terms**

**Rolling Rafters**
When cutting through roof decking with a power saw and a rafter is encountered, the saw is lifted over the rafter and the cut is resumed. (Note: mark the rafters).

**Score Cut**
A light cut of the decking covering (usually composition) only.

**Strip**
A long and narrow section of roof decking that is removed ahead of a horizontally extending fire to minimize extension of the fire. A defensive cut.

**Inspection Cut**
A cut through the roof decking only and at 45 degrees to any exterior wall. When contact is made with a structural member, roll the member and continue the cut for approximately one foot. Complete the cut by making two small cuts over the structure which will allow the removal of a small triangular portion of decking directly over the rafter. This will assist in determining the type of roof, decking, and rafter direction.
Chapter 5  Anatomy of an Opening

Key Terms

Indicator Hole

A small hole which indicates the conditions of smoke or fire within a structure.

Heat Hole

Heat openings are opened over (or in close proximity to) a fire and are specifically designed to vertically vent the fire, heat, and smoke.
Chapter 5  Anatomy of an Opening

Types of Openings

Natural Openings – utilized/created by a fire to “self ventilate”
- Fire burning through the roof
- Ventilators
- Skylights that fail/burn through
- Automatic smoke vents

Heat Openings
- Opened over a fire
- Designed to vertically vent the fire

Directional Openings
- Cut ahead of the fire
- Directs horizontal/extension travel
Chapter 5  Anatomy of an Opening

Size of Openings

Type of Opening
- Heat Hole vs. Strip Cut

Ease of Removal
- Louvering vs. Dicing
- Multiple rafter sections

Location of Opening
- Type of construction
- Style of opening (heat vs. strip)
- Strength of work area (conventional vs. lightweight)

Note:
- As long as contaminants are venting under pressure, keep enlarging the opening!
Chapter 6  Conventional Ventilation

Chapter Contents:

Identification
Teamwork
Ladder Placement
Location of Fire
Structural Integrity
Method of Travel
Ventilation Openings
Chapter 6 Conventional Ventilation

Identification

Objective: “Identify the type of roof”

Dwellings
   Older styles
   Wood sided
   Pre-1970’s
   2x6 rafter tails
   True shake roof material

Commercial
   Earthquake retro
   Pre-1950’s
   Un-reinforced masonry
Chapter 6 Conventional Ventilation

Teamwork

2 Man Team
Verbal communication
Non-verbal communication
1 Saw man
1 Sounder/Safety

4 Man Team
Verbal communication
Non-verbal communication
2 Saw men
1 Sounder/Lead
1 Sounder/Safety
Chapter 6  Conventional Ventilation

Ladder Placement

Ladder and approach the involved area from the uninvolved
Minimum of 2 ladders
Determine the location and extension of the fire
Windward side of objective
Ladder the strong areas of the building
   Beams, Ridges, Valleys, Hips, Corners
Avoid windows and doors
Extend far enough to be readily visible
Once climbed – DO NOT MOVE!
Chapter 6  Conventional Ventilation

*Location of Fire*

What is the location and extent of the fire?

**Read the Roof**
- Smoke Indicators
- Indicator holes
- Radio traffic
- Windows
- Ventilators
- Vent Pipes
Chapter 6  Conventional Ventilation

**Structural Integrity**

What is the structural integrity of the area to be ventilated?

**Dwellings**
- Perimeter
- Ridges
- Valleys
- Rafters

**Commercial**
- Perimeter
- Beams
- Perlins
- Rafters
Chapter 6 Conventional Ventilation

Method of Travel

Dwellings
- Perimeter
- Ridges
- Valleys
- Rafters

Commercial
- Perimeter
- Beams
- Rafters
Chapter 6  Conventional Ventilation

Ventilation Openings

Dicing
Not possible with plywood decking

Louvering
Mandatory with plywood decking

Strip
Time consuming
18-24 inch width
Louver – sheathing, plywood, metal decking (4-6 ft)
“J” Hook – sheathing (not plywood)
Chapter 7  Lightweight Ventilation

Chapter Contents:

- Identification
- Teamwork
- Ladder Placement
- Location of Fire
- Structural Integrity
- Method of Travel
- Ventilation Openings
Chapter 7 Lightweight Ventilation

Identification

Objective: “Identify the type of roof”

Dwellings

Newer styles
Last 20-30 years
2x4 rafter tails

Commercial

Concrete “tilt-up” walls
Newer style with fascias
Flat roofs
Last 20-30 years
Chapter 7  Lightweight Ventilation

**Teamwork**

2 Man Team
- Verbal communication
- Non-verbal communication
- 1 Saw man
- 1 Sounder/Safety

4 Man Team
- Verbal communication
- Non-verbal communication
- 2 Saw men
- 1 Sounder/Lead
- 1 Sounder/Safety
Chapter 7  Lightweight Ventilation

**Ladder Placement**

Ladder and approach the involved area from the uninvolved
Minimum of 2 ladders
Determine the location and extension of the fire
Windward side of objective
Ladder the strong areas of the building
   Beams, Pilasters, Corners
Avoid windows and doors
Extend far enough to be readily visible
Once climbed – DO NOT MOVE!
Chapter 7 Lightweight Ventilation

*Location of Fire*

What is the location and extent of the fire?

**Read the Roof**

- Smoke Indicators
- Indicator holes
- Radio traffic
- Windows
- Ventilators
- Vent Pipes
- Sky lights (4x8)
Chapter 7  Lightweight Ventilation

Structural Integrity

What is the structural integrity of the area to be ventilated?

**Dwellings**
- Perimeter
- Trusses
- Valleys

**Commercial**
- Perimeter
- Beams
- Trusses
- Perlins

**Note:**
Do not ventilate over the fire - Go as close as possible on an uninvolved part of the roof!
Chapter 7  Lightweight Ventilation

Method of Travel

Dwellings
Perimeter
Ridges
Hips

Commercial
Perimeter
Trusses
Beams
Perlins
Chapter 7  Lightweight Ventilation

Ventilation Openings

Louvering
  Plywood decking
  Panelized
  Open Web
  Metal Gusset Plate
  Wooden I-Beam
  Open Web Bar Joist

Removing Skylights
  Panelized
  4x8 = roof structure

Drop Panel
  Panelized
  Dangerous for those below
Chapter 7  Lightweight Ventilation

Ventilation Openings

Strip
- Time consuming
- 18-24 inch width
- Louver - plywood, metal decking (4-6 ft)

Pull Back
- Panelized
- Demands timing and teamwork