Next Steps in Implementing HOT ZONE Design
August 30, 2017
Objectives

- Identify the Risk
- Identify the Source
- Respect Hostile Environments
- Understand Exposure Risks
- Hot Zone Design Case Study
- Implement the Strategies
- Lessons Learned
- Recognize Unintended Consequences
- Take Next Steps
The 2016 Station Design Conference, held in Anaheim, CA, brought together nearly 200 fire department officers, municipal leaders, architects and manufacturers to learn about and share trends and innovations for new emergency response facilities. The results were a fantastic exchange of information and ideas.

One of my highlights from the conference was the keynote presentation by Paul Burkhart, principal, Callison Lohrmann Taylor Architects, and Chief Willard Pusateri with Atlantic Fire Protection. This session provided an overview of the industry's current trends and challenges. The session had a strong message about the need to address firefighting infrastructure issues and how new materials and technologies are being introduced.
The Risk
- Firefighters classified by insurance industry as High Hazard
- Demonstrate alarmingly high incidence of:
  - Heart attacks
  - High blood pressure
  - Cancer
- When compared to others firefighters face more risk in developing these cancers:

![Chart: Elevated Risk of Cancer in Firefighters]

**THE RISK**
The Source
CHEMICAL TOXINS AND CARCINOGENS = CONTAMINANTS

- Arsenic
- Formaldehyde
- Benzene
- Nitrogen Dioxide
- Carbon Monoxide
- Nickel
- Butadiene
- Toluene
- Acrylonitrile
- Isocyanates
- Numerous polycyclic aromatic hydrocarbons
INCIDENT RESPONSE

CANCER RISK INCREASES AS CYCLE REPEATS

CONTAMINATION EXPOSURE

RETURN TO STATION

CROSS CONTAMINATION

THE SOURCE
Our Challenge

Isolate, Capture, & Remove Carcinogens

CHEMICALS
Arsenic, Formaldehyde, Benzene, Carbon Monoxide, Nickel, Numerous polycyclic aromatic hydrocarbons

MICROSCOPIC SOOT PARTICLES

NOT VISIBLE TO UNAIDED EYE

EXTREMELY LONG AIRBORNE RESIDENCY

HIGH RISK

Our Challenge ➔ Isolate, Capture, & Remove Carcinogens

THE SOURCE
Hostile Environments
THE WORLD TRADE CENTER

HOSTILE ENVIRONMENTS
STRUCTURE FIRES

HOSTILE ENVIRONMENTS
Comparison of Room Furnishings

Legacy Room

Modern Room

Underwriters Laboratories

03:23
AUTO FIRES

HOSTILE ENVIRONMENTS
FIRES

Dumpster Fires

Stove Fires

HOSTILE ENVIRONMENTS
PPE

HOSTILE ENVIRONMENTS
EQUIPMENT

HOSTILE ENVIRONMENTS
EQUIPMENT

HOSTILE ENVIRONMENTS
Exposure Risks

- Absorption
- Respiratory
- Ingestion
Increase in skin absorption of carcinogens for each 5° elevation in skin temperature

400%
Most Permeable Areas:

- Face
- Neck
- Throat
- Groin

EXPOSURE RISKS
Particle Infiltration Study

- Conducted by IAFF in January, 2015
- Involved Used Turnout Gear with SCBA
- Performed in Particle-Laden Chamber

Results:
- Smoke Easily Penetrates Clothing
- Primarily at Interface Areas
  - Face and Neck
  - Glove to Sleeve
  - Overlap of Boots/Pants
- Serves as Pathways for Contaminants
Face and Neck; Large Amount of Exposure Occurs at Areas Not Protected by SCBA
Particles Enter Garment Through Front Closure and Glove-to-Sleeve Interface to Less Extent
Intense Contamination of Calves Above Boot Line
RESPIRATORY EXPOSURE RISKS

1. Particulate matter enters our respiratory (lung) system through the nose and throat.

2. The larger particulate matter (PM10) is eliminated through coughing, sneezing and swallowing.

3. PM2.5 can penetrate deep into the lungs. It can travel all the way to the alveoli, causing lung and heart problems, and delivering harmful chemicals to the blood system.

Image Courtesy of the U.S. EPA/Boundless.com
RESPIRATORY

- SCBA During Overhaul

- Rehab Away from Off-Gassing of Equipment
  (inhalation of benzene possible)

EXPOSURE RISKS
Effects of Chronic Exposure to Diesel Exhaust:

- Increased Risk of Lung Cancer
- Diesel Particulates 16x Above EPA Standards Inside the Station

Options to Control Exposure:

- Mechanical Evacuation Systems
- Air Filtration Systems
- Direct Capture Systems
- Engine Mounted Diesel Particulate Filters
MECHANICAL EVACUATION

- Oldest Approach to Exhaust Extraction
- Removes Particulates from Diesel Smoke Exhausted into Bays
- Mechanical Exhaust Fans/Louvers in Exterior Walls/Roof Linked to Apparatus Bay Door Controls
- Activates When Apparatus Responds To/Returns From Call
- Drawbacks:
  - Evacuates Heat from Bays Along with Exhaust
  - Need to Override System to Leave Bay Doors Open For Natural Ventilation

EXPOSURE RISKS
AIR FILTRATION

- Provide Single Source Solution
- Removes Particulates, Carbon and Molecular Gases from Diesel Smoke Exhausted into Bays
- Self-Contained Air Circulation/Filtering Units
- Drawbacks:
  - Consistent Reliability and Thoroughness of System
  - Filters Replacement; Particulates Can Spread Within Building
  - Creates Contaminated Surfaces
DIRECT CAPTURE

- Prevents Gases/Particulates from Entering Bays by Venting Directly to Exterior
- Connected Directly To Exhaust of Apparatus
- Drawbacks:
  - Coupling and Decoupling Procedures
    - Requires Personnel to Connect Hose to Exhaust Pipe Prior to Backing in to Bay
    - Reconnection Requires Personnel to Work Directly in Exhaust Stream
    - Fixes Apparatus in One Location

EXPOSURE RISKS
• Diesel Particulate Filters (DPF) Mounted on the Engine Capture/Burn Particulates Before Entering Atmosphere

• Designed to Meet Regulations of Highway Diesel Rule EPA07

• Protects Emergency Personnel When Engine is Idling at Firegrounds or Around Building

• Drawbacks:
  • Fails to Address Noxious Gases
INGESTION

- Particulates Carried by Mucous/Saliva to Digestive System
- Food Consumed at/adjacent to Fireground
- Cross Contamination at the Station
- Ice and Vending Machines in Apparatus Bays
INGESTION

EXPOSURE RISKS
CHANGING OUR CULTURE

IT IS HARD WALKIN' ON THIS STUFF.

YEP, SON, WE HAVE MET THE ENEMY AND HE IS US.

THE SOURCE
CHANGING OUR CULTURE

THE SOURCE
CHANGING OUR CULTURE

THE SOURCE
CHANGING OUR CULTURE

THE SOURCE
HOT ZONE Design Case Study
• **Hot Zone (RED)**
  • Spaces exposed to carcinogens

• **Cold Zone (GREEN)**
  • Living/working spaces intended for extended occupancy

• **Transition Zone (YELLOW)**
  • Allows for movement between Hot/Cold Zones
Strategies
- Contain the Contaminants
- Separate Occupants from Contaminants
- Control or Limit Crossover
- Pay Attention to Transitions
- Enhanced Decontamination
CONTAIN the CONTAMINANTS

- Self Sufficiency
- Hot Zone spaces:
  - Apparatus bays, apparatus equipment storage
    - SCBA, and PPE storage
  - Workshop
  - Decon area w/commercial laundry and extractor
  - Hose storage
  - Training mezzanine
SEPARATE OCCUPANTS from CONTAMINANTS

- Self Sufficiency
- Cold Zone spaces:
  - Administrative Areas
  - Offices and Workrooms
  - Living/Sleeping Spaces
  - Library/Study
  - PT/Work Out Rooms
  - Meeting Rooms
  - Lobbies/Community Rooms/Public Toilets
  - Storage Spaces
CONTROL CROSSOVER

- Self Sufficiency
- Central Accessible Location
- Separate Toilet
- Separate Laundry
- Separate Janitor Closet and Cleaning Supply Storage
- Separate Mechanical/HVAC Systems
PAY ATTENTION to TRANSITIONS

- Think Decon
- Signage
- Sinks or Hand Sanitizer
- Walk Off Mat

HOT ZONE
PAY ATTENTION to TRANSITIONS

- Airlock/Vestibule
- Ice Cooler Clean Up
- Ice Machine
- Toilet / Restroom
- EMS Storage
- Hand Sink / Boot Wash

HOT ZONE
Sale Creek Volunteer Fire Department
Architect: Michael Brady, Inc.

HOT ZONE
ENHANCED DECONTAMINATION

- Decon Rooms
- Gear Laundry
- PPE Storage
- Personal Lockers
- Toilets (Shower w/in an hour)
ENHANCED DECONTAMINATION

Return from Non-Contaminated Call

- Hand Sink/Boot Wash
- Airlock/Vestibule
- Ice Maker
ENHANCED DECONTAMINATION

Return from Contaminated Call

- Decon
  - Central Hub
- Equipment
  - Gear Laundry
  - PPE Storage
- Personnel
  - Uniform Lockers
  - Toilets (Shower w/in an hour)
  - Uniform Laundry

HOT ZONE
Unintended Consequences
• Unintentionally transmitting carcinogens to unsuspecting participants
  • Weddings
  • Bingo
  • Open House/Station Tours
  • Polling Place
  • Equipment Storage
  • Exercise
  • Miscellaneous
FOCUS on the HIGHEST HAZARDS

- PPE
  - Enclosed Room
  - Dedicated Mechanical
  - Direct Exhaust
- Decon
- Hose Drying & Storage
- On-Site Training
- Exhaust Removal Systems
  - Direct Capture
  - Diesel Particulate Filters
Hands, Hands, Hands
Signage
Ice Machines
Vending Machines
Workout Equipment

RENOVATION TRIAGE

NEXT STEPS
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