

Tracking, Safety, and Navigation System for Firefighters

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Summit Safety, Inc.

FDIC Booth 5813

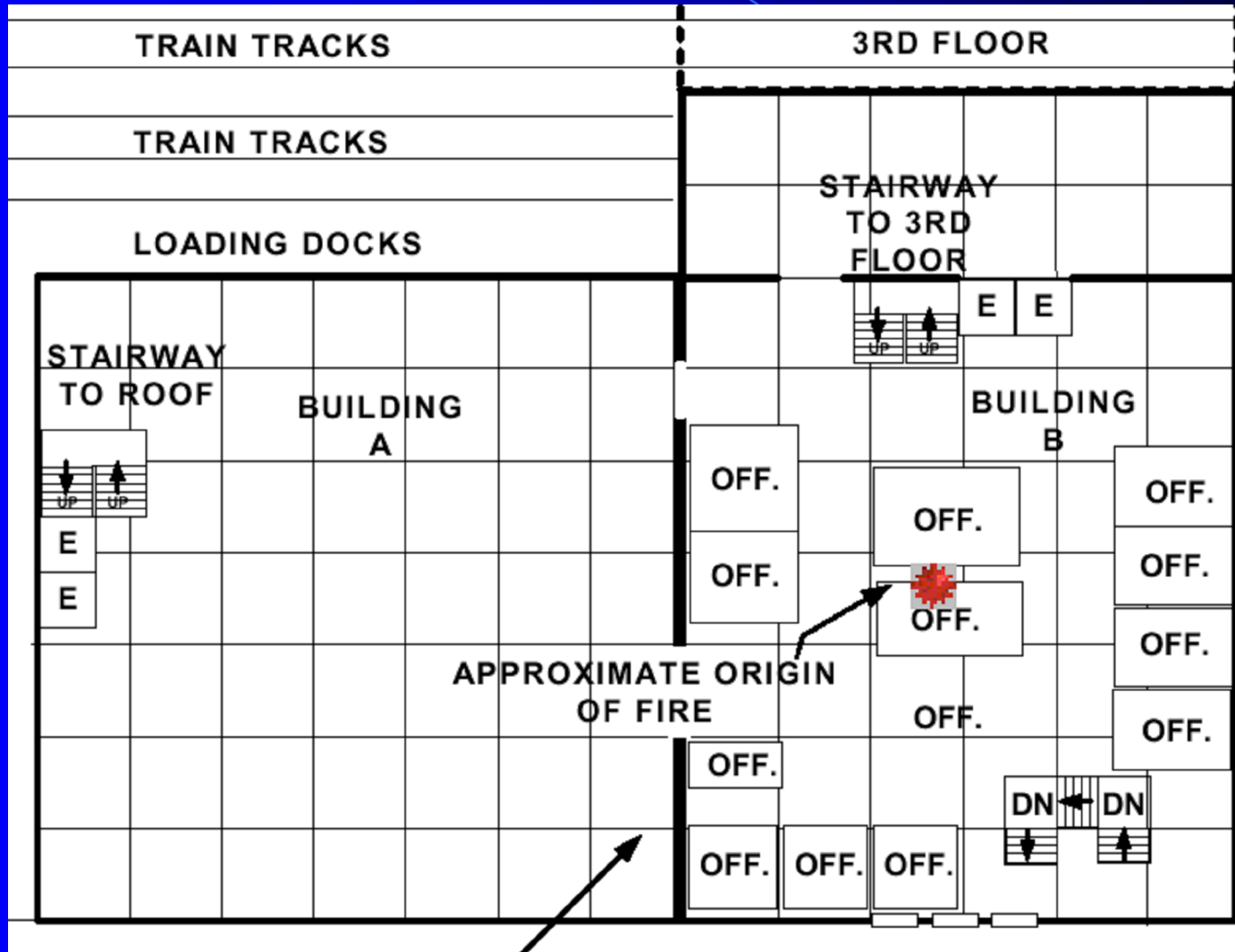
Outline

- Introduction
- Locating/Finding Techniques
- Technology Choices
- Personnel Ultrasonic Locating Safety Equip
- Existing Systems
- Summary & Demo

Introduction

- Background
- Search Techniques
- PASS and TIC
- December 1999 Fire in Worcester, MA

Worcester, MA, Dec 1999



Locating/Finding Techniques

- Location vs Path: Rescue
- Blind Search
- Homing Beacon
- Active Search
- Triangulation

Technology Choices

- Optical: Visible
- Optical: Infrared
- Radio
- Acoustic: Audible
- Acoustic: Ultrasonic

Wavelength

$$c = f \lambda$$

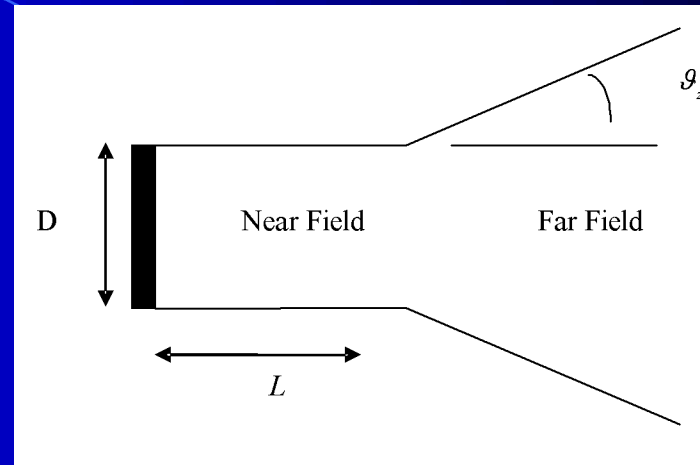
Visible	3×10^8 m/s	4×10^{14} Hz	0.000030 in
Infrared	3×10^8 m/s	3×10^{14} Hz	0.000040 in
Infrared	3×10^8 m/s	2×10^{13} Hz	0.000550 in
Ultrasound	330 m/s	40 KHz	0.325 in
Radio (uw)	3×10^8 m/s	2.4 GHz	4.9 in
Radio (GPS)	3×10^8 m/s	1.575 GHz	7.5 in
Sound	330 m/s	1 KHz	1.1 ft
Radio (FM)	3×10^8 m/s	100 MHz	9.8 ft
Radio (AM)	3×10^8 m/s	1 MHz	984 ft

Acoustic: Audible & Ultrasound

- Longitudinal Pressure Waves
- Reflected by Solid Surfaces
- Penetrate Porous Materials
- No Rayleigh Scattering
- Attenuation at Very High Frequencies
- Acoustic Path
- Interference at Lower Frequencies

Frequency Choice

- Beam Pattern
- $L = D^2/4\lambda$
- $\theta_z = 1.22 \lambda/D$
- All Waves



KHz	D	D/λ	L	θ_z	$2 \theta_z$
40	3 in	9.2	6.9 in	7.6Λ	15Λ
20	3 in	4.6	3.5 in	15Λ	30Λ
4	3 in	0.9	0.7 in	76Λ	151Λ
4	7 in	2.5	3.8 in	32Λ	65Λ
1	7 in	0.5	0.9 in	130Λ	259Λ

Wavelength

$$c = f \lambda$$

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Why Ultrasound?

- Not Affected by Fire Environment
- Small, Directional Receiver
- No Rayleigh Scattering
- Reflected Waves: Locate Behind Obstacles, Behind Doors, and Around Corners
- No Blind Alleys
- Indicates Path

Pulse System

- Personnel Ultrasonic Locating Safety Equip
- Beacon: Omnidirectional Transmitter
- Tracker: Directional Receiver
- Firefighter, Exit, Tot-Finder Beacons
- Range: 150+ feet
- Time: 2-5 minutes (typical)

Beacon

- Ultrasonic Transmitter
- Motion Sensor
- Audible Annunciator
- LED Indicators
- 2 Reset Switches
- Alarm Switch
- Activation Clip
- Monitor/Pre-Alarm/Alarm



Tracker

- Directional U/S Receiver
- LED Bargraph for Signal
- Mode Switch & LEDs
- Audible Annunciator
- LED Bargraph for Battery



Other Systems

- Personal Alert Safety System (PASS)
 - Difficult to Locate w/o Ultrasound
- Thermal Imaging Camera (TIC)
 - Line of Sight
 - Debris
 - Thermal Masking/Overload
 - Could Use Pulse Technology

Summary

- Locating Techniques
 - Location vs Path
- Technologies
 - Optical, Radio, Acoustic
- Pulse System
 - Beacon & Tracker

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- Booth 5813 in Ballroom 500
- Hands-On Demos
- Brochure of Pulse System

Optical: Visible

- E-M Waves
- Line of Sight
- Reflected Only by Mirrors
- No Wall Penetration
- Penetrates Glass
- Rayleigh Scattering

Optical: Infrared (Thermal)

- E-M Waves
- Line of Sight
- Reflected by Gold Mirrors
- No Wall Penetration
- No Glass Penetration
- Limited Rayleigh Scattering
- Image Inversion
- Thermal Overload/Masking

Radio

- E-M Waves
- Wall Penetration at Lower Frequencies
- Dielectric Absorption at Higher Freq (GPS)
- No Rayleigh Scattering
- Blocked by Metals
- “Line of Sight”