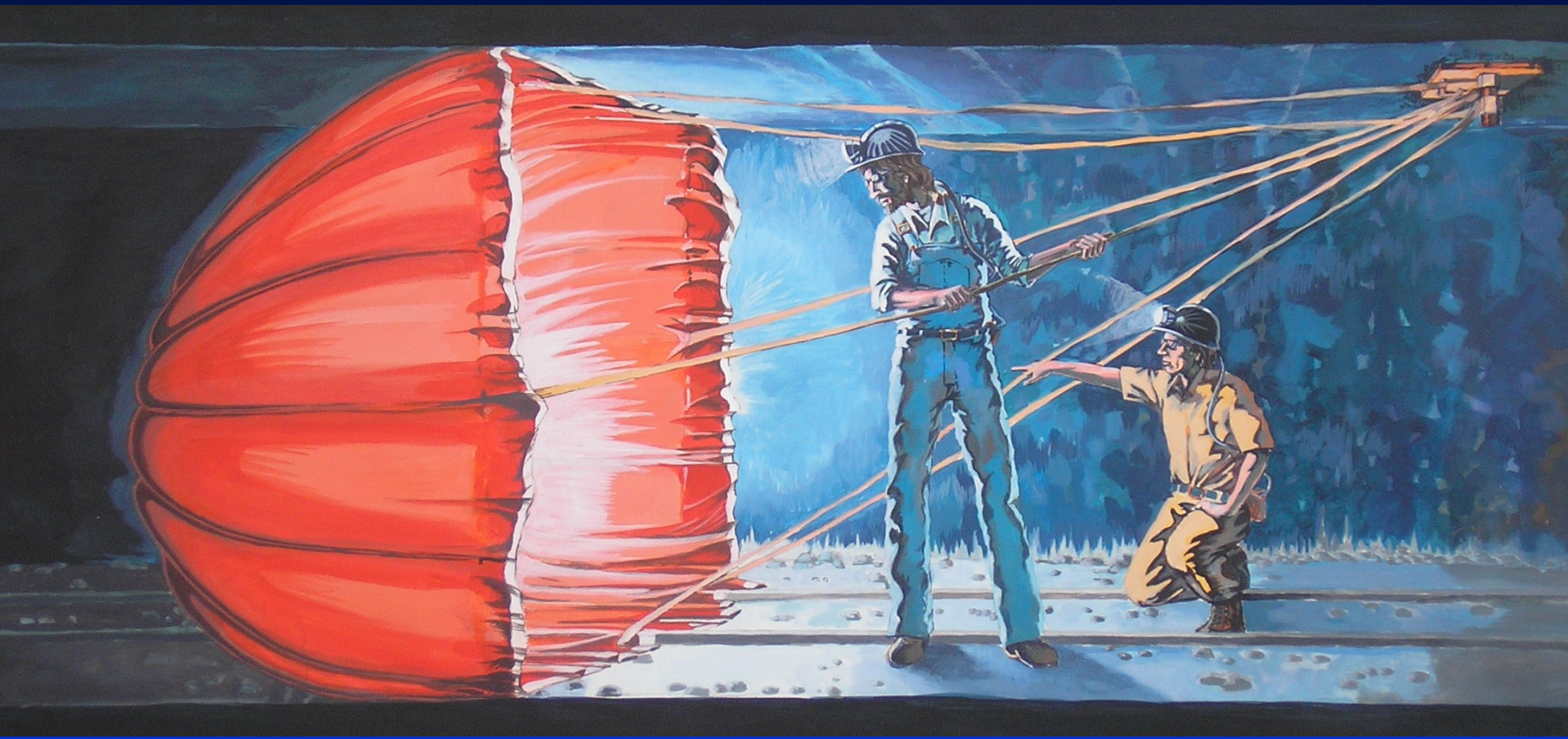
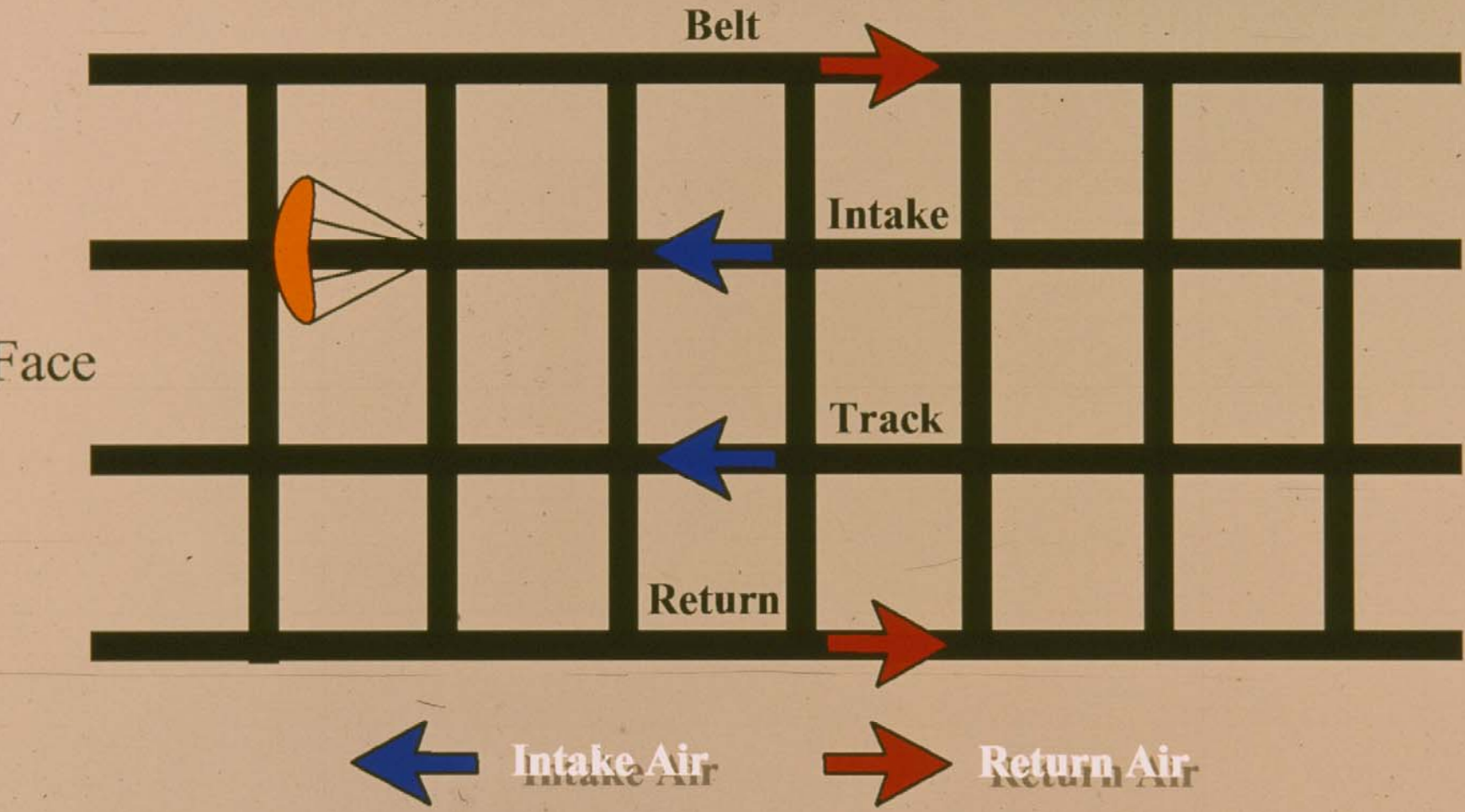
Pressurization of Intake Escapeways with Parachute Stoppings to Reduce Infiltration of Smoke

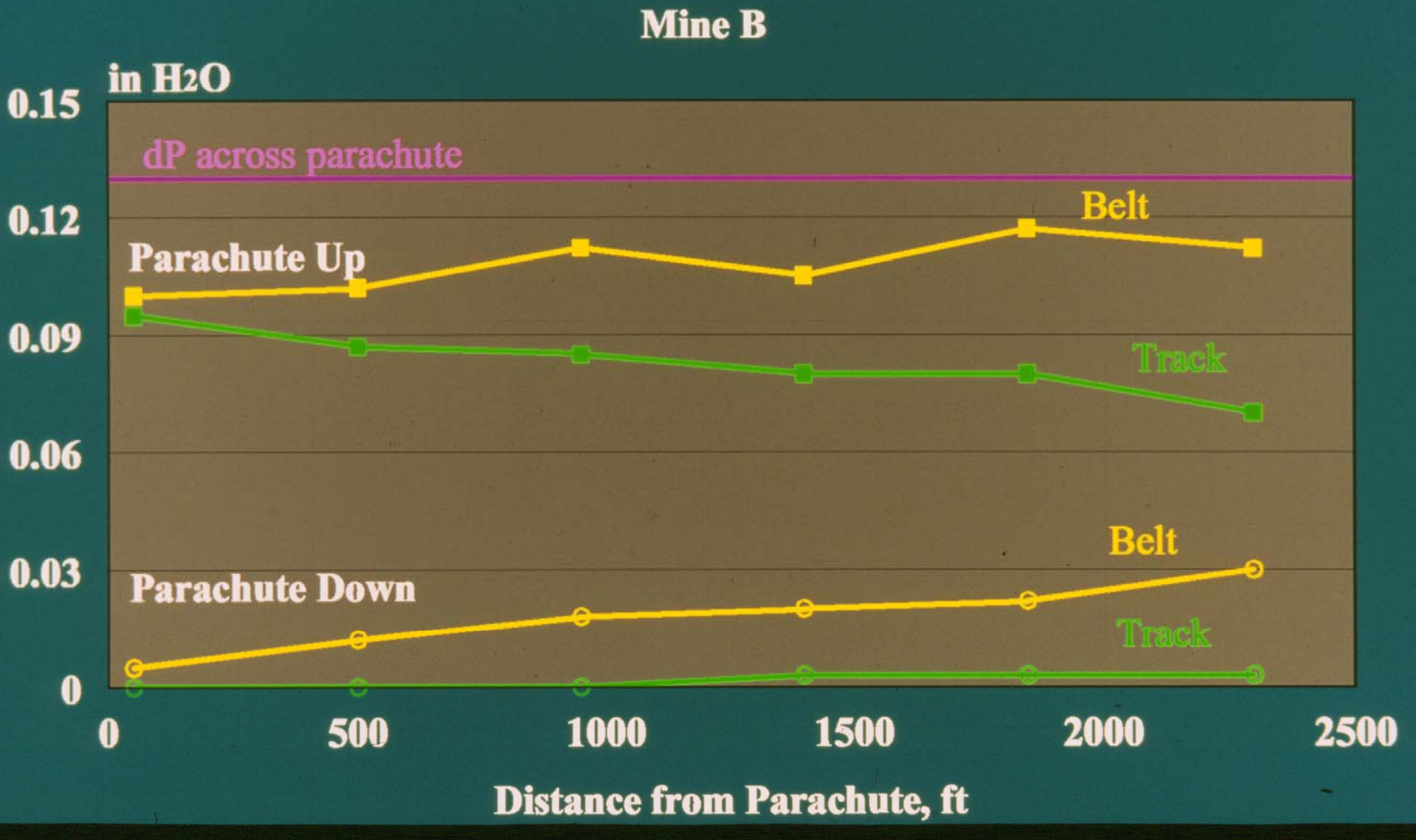


FN Kissell, PhD and RJ Timko
5th US Mine Ventilation Symposium
1991

Mine B



Differential Pressures between Escapeway and Adjacent Entries



Section Airflow

- Escapeway airflow fell by 79%
- Face airflow fell by 6%

CONCLUSIONS……..

- Parachute stopping helps to keep smoke out of escapeway **IF** the fire source is not in the escapeway.

How Smoke Hinders Escape from Coal Mine Fires

FN Kissell, PhD and CD Litton
Mining Engineering
January 1992

Relative CO (ppm) Values at a 0.1/meter OD Smoke Sensor Alarm Level (visibility = 26 ft)

Fuel	CO flaming	CO smoldering
Wood	11.1	7.1
Coal	3.4	1.8
SBR belt	3.7	0.5
PVC belt	8.3	0.6
Neoprene belt	6.3	1.4
PVC brattice	----	2.2

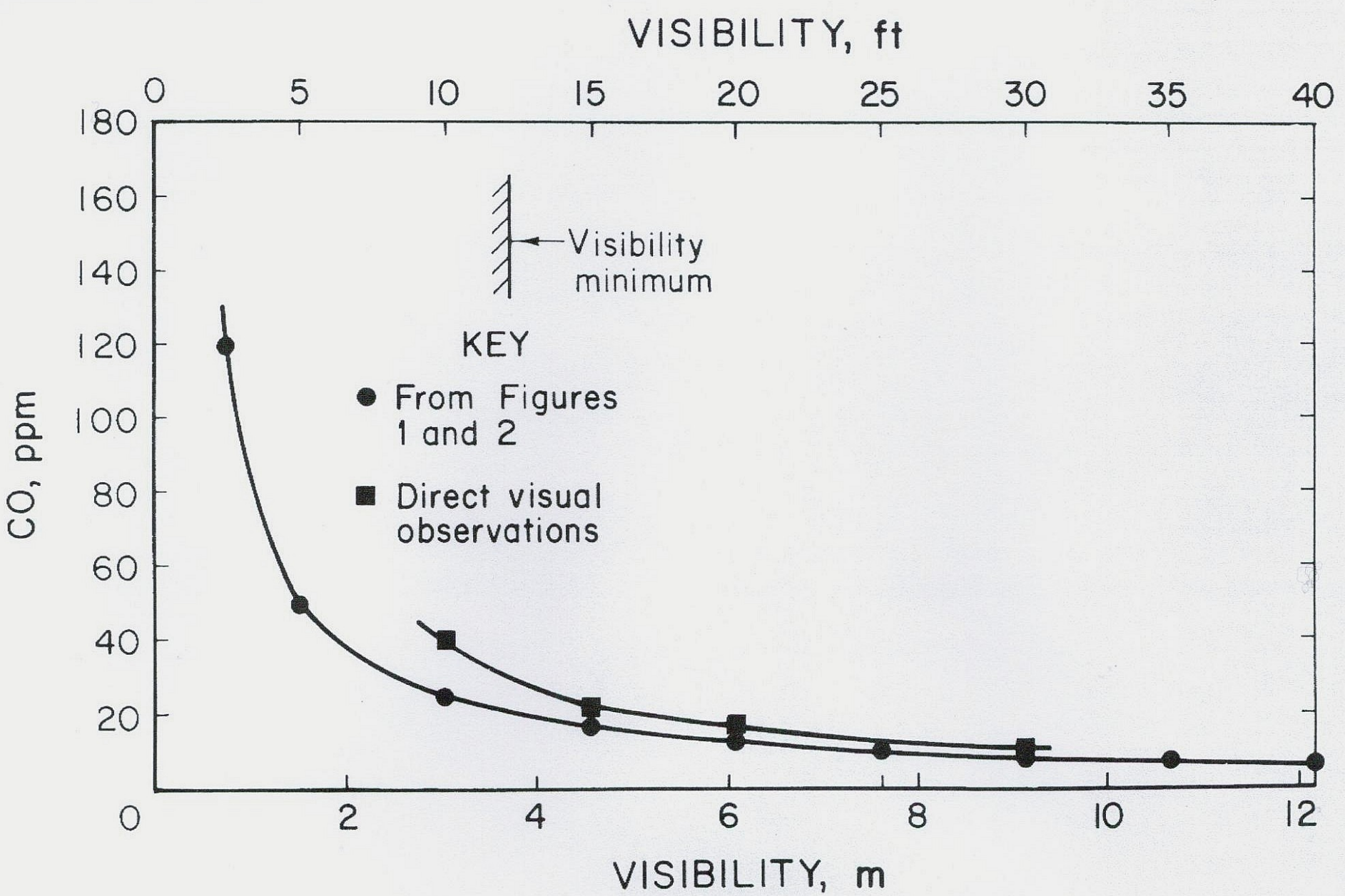
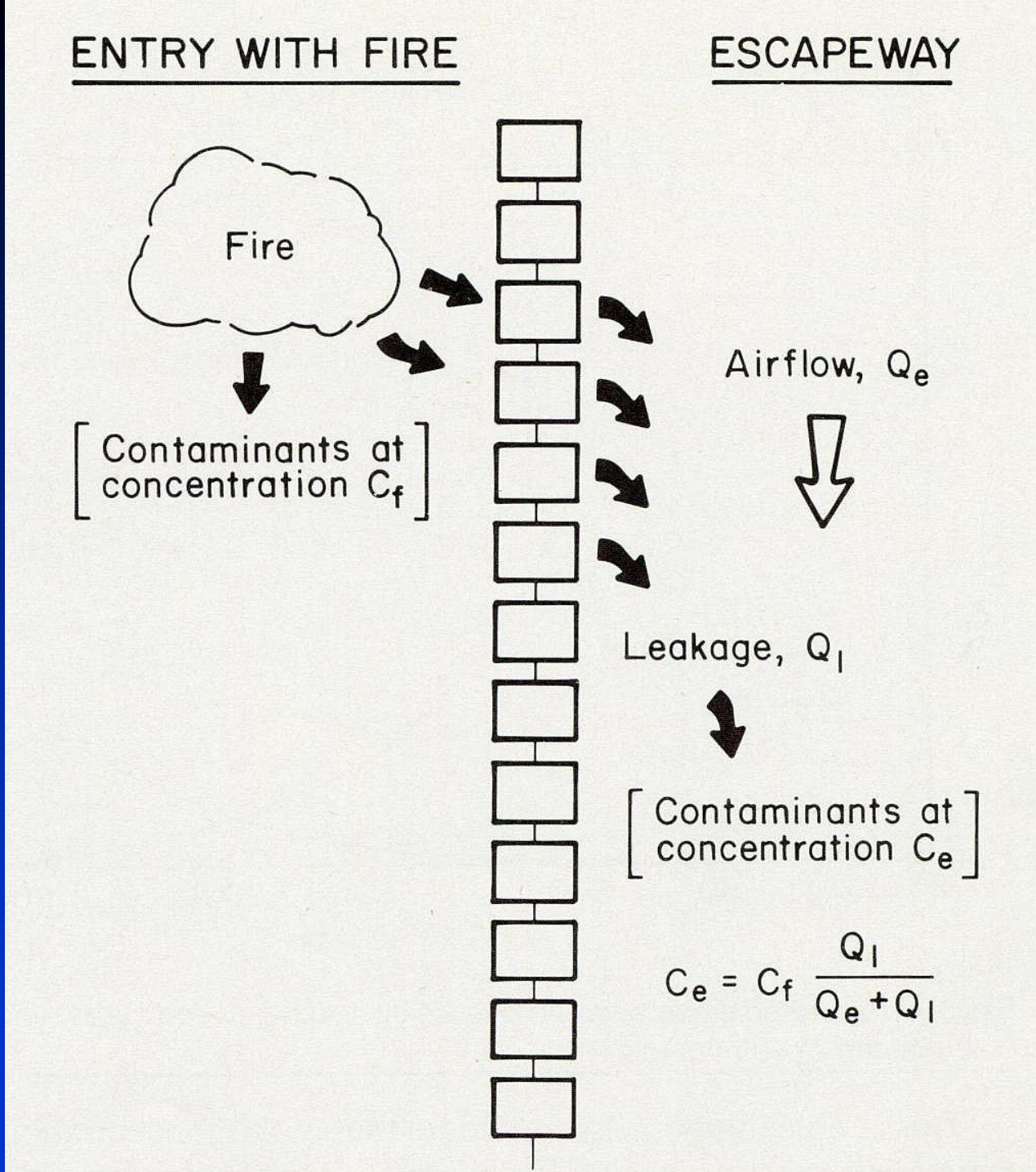


Fig. 3—Downstream smoke visibility and carbon monoxide levels during the growth of a typical SBR belt/coal test fire.


ENTRY WITH FIRE
ESCAPEWAY
Fire
[Contaminants at concentration C_f]
Airflow, Q_e
Leakage, Q_l
[Contaminants at concentration C_e]
$C_e = C_f \frac{Q_l}{Q_e + Q_l}$

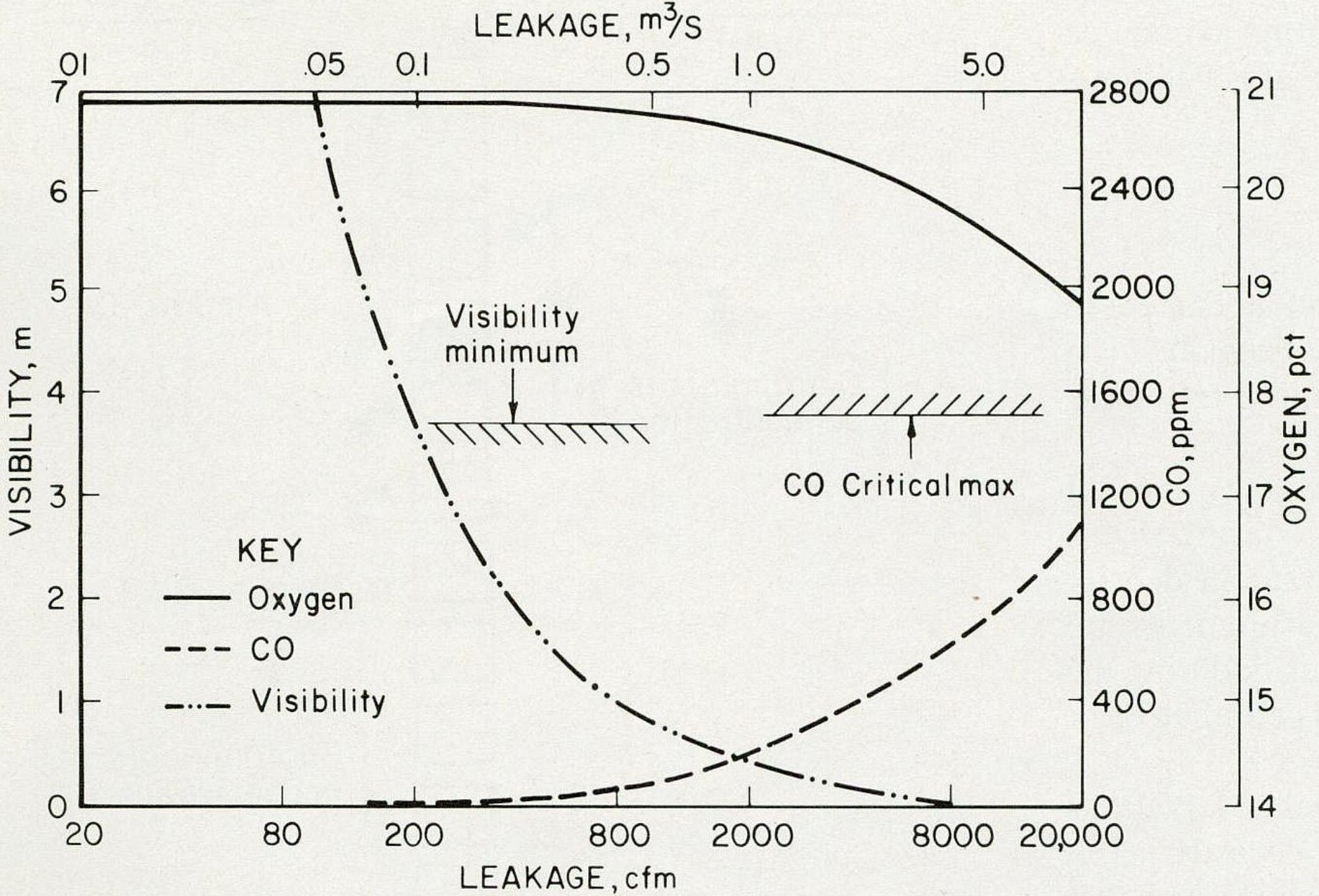


Fig. 5—Calculated escapeway smoke visibility, oxygen and carbon monoxide vs. leakage—SBR belt/coal fire at 60 minutes.

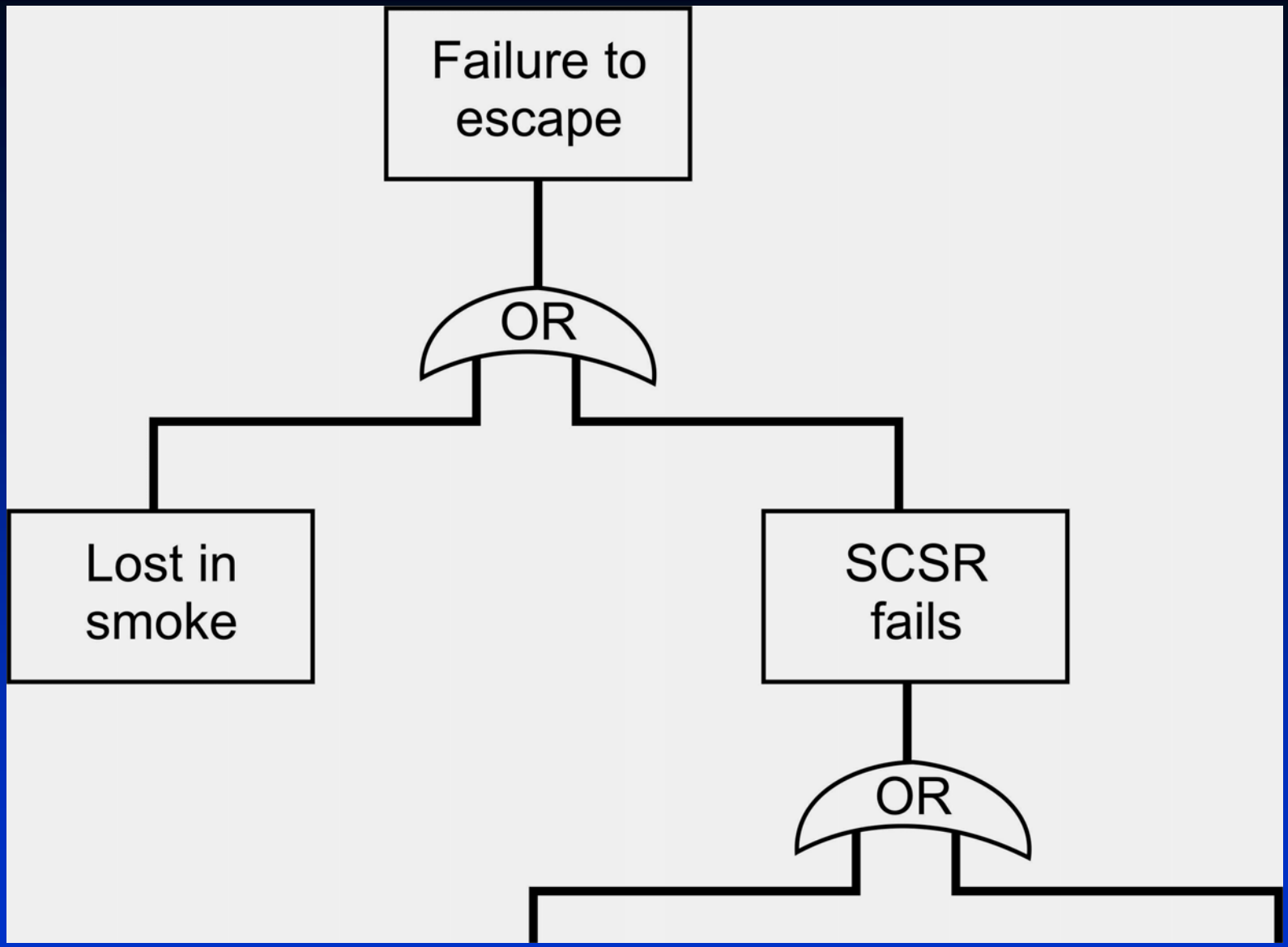
CONCLUSIONS …

- Lack of visibility in smoke and the accompanying fumes are the greatest obstacle to safe escape.

Evaluating Those Factors that Influence Escape from Coal Mine Fires

GVR Goodman, PhD and FN Kissell, PhD

Transactions of the SME
Volume 286, 1989


Failure to escape
OR
Lost in smoke
SCSR fails
OR

Top Event Values for Changes in SCSR Training And Escapeway Knowledge

Probability of finding escapeway	SCSR error .93	.44	.40	.10
.10	.63	.63	.63	.63
.50	.63	.61	.61	.60
.90	.63	.60	.60	.57

Fatality Events Had Common Features

- Delayed evacuation
- Lack of lifelines
- Confusion in locating escapeway
- Malfunction of SCSR

Reducing the Top Event by 75% Requires:

- Minimal delays
- Excellent chance of finding escapeway
- Excellent SCSR training
- Stopping resistance to smoke leakage and fire damage

CONCLUSIONS…

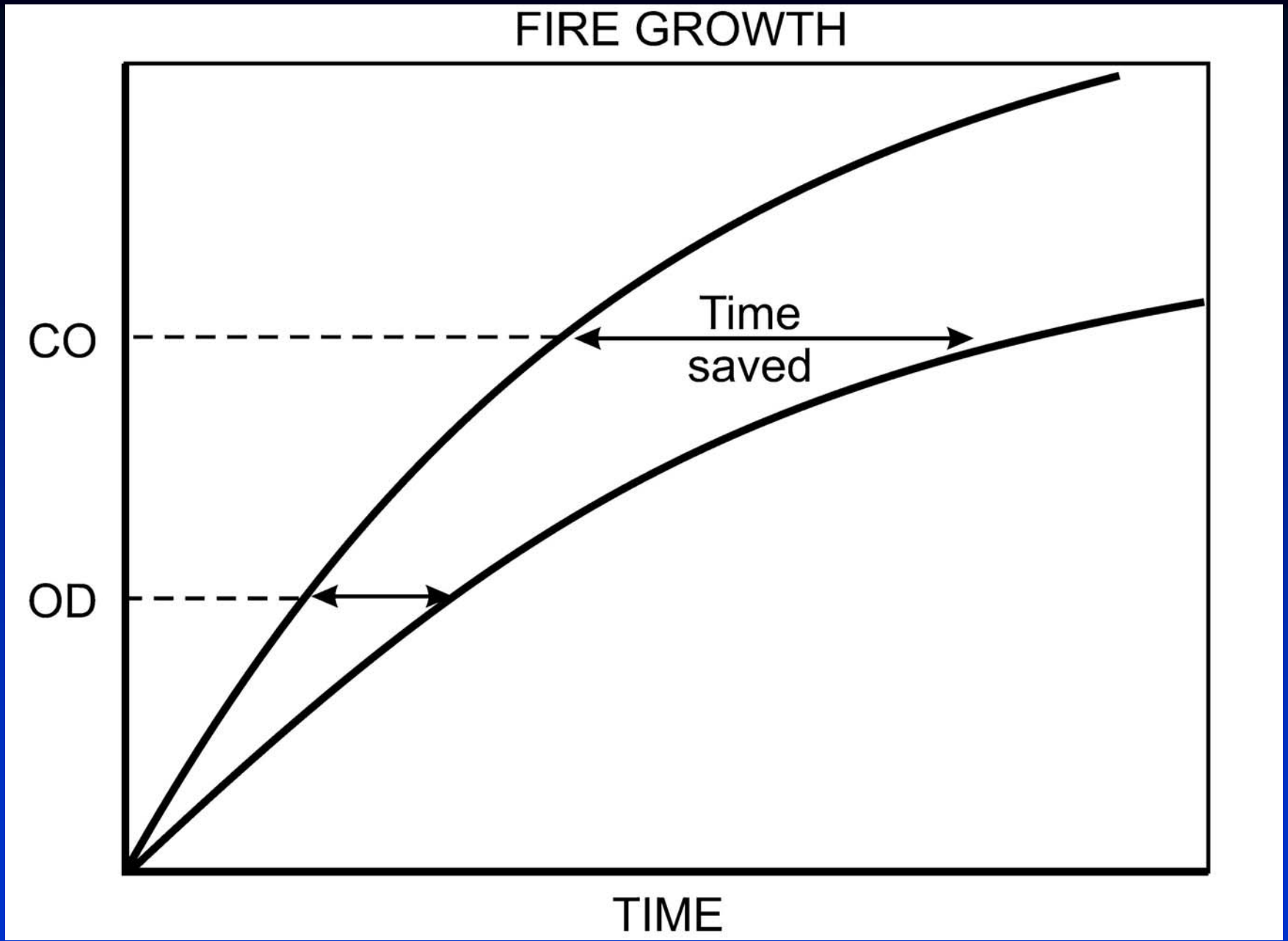
With the exception of delays, single factor changes have minimal impact.

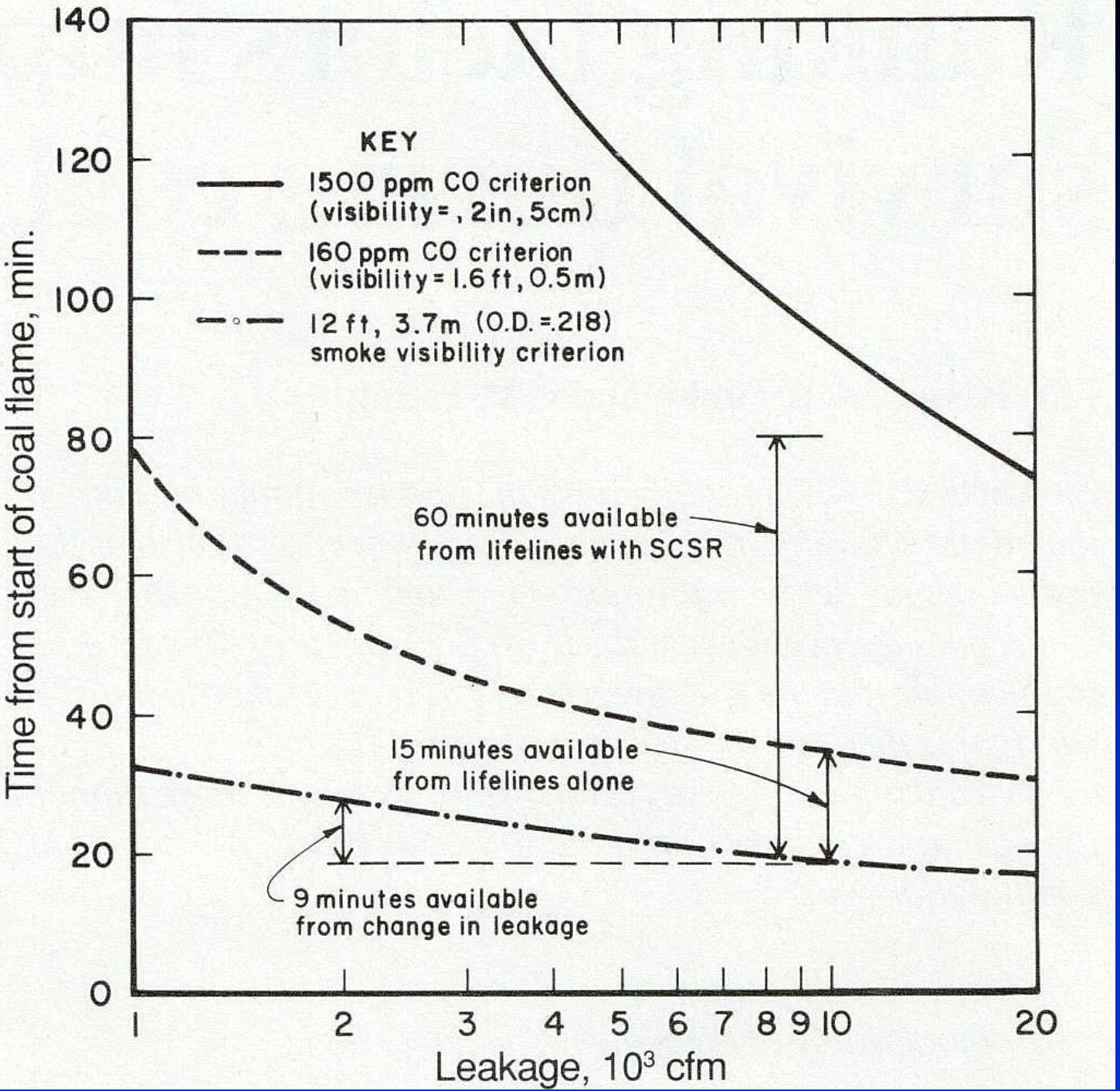
Ranking Factors Impacting Survival during Coal Mine Fires

FN Kissell, PhD, RJ Timko, and CD Litton
Mining Engineering
August, 1993

Roberts, AF [1987]. A systematic strategy for assessing fire protection measures in a mine. First Mine Safety and Health Congress, Johannesburg, South Africa

$$I_{survival} = T_{toxic} - (T_{detection} + T_{decision} + T_{travel})$$


FIRE GROWTH
CO
OD
Time
saved
TIME


KEY
1500 ppm CO criterion
(visibility=, 2in, 5cm)
160 ppm CO criterion
(visibility= 1.6 ft, 0.5m)
12 ft, 3.7m (O.D. =.218)
smoke visibility criterion
60 minutes available
from lifelines with SCSR
15 minutes available
from lifelines alone
9 minutes available
from change in leakage
Time from start of coal flame, min.
Leakage, 10³ cfm
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8
9
10
20

Translated into Time:

Thermocouple→CO	6-10min
CO alarm threshold 15→10 ppm	3 min
Sensor spacing 2000→1000 ft	≤ 5 min
Stopping leakage ↓80%	9 min
Walking vs. riding 5000 ft	10-20 min
Fire growth rate ↓75%	9 min
Lifelines without SCSR	15 min
Lifelines with SCSR	60 min

Fire Growth Rate ↓75% 9 min

- CO alarm threshold 15→10ppm 3 →12 min
- With lifelines and leakage ↓50% 56 min

CONCLUSIONS…

- Multiple factor changes have the most impact
  - Consider non-technical factors such as training and management practices.

RELEVANCE OF THESE RESULTS TO BELT AIR AND BELT FLAMMABILITY

- Belt air: limited, because of other factors
  - Belt flammability: fire growth rate