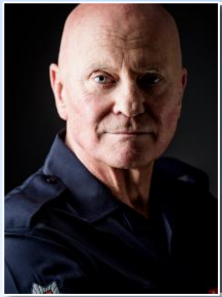
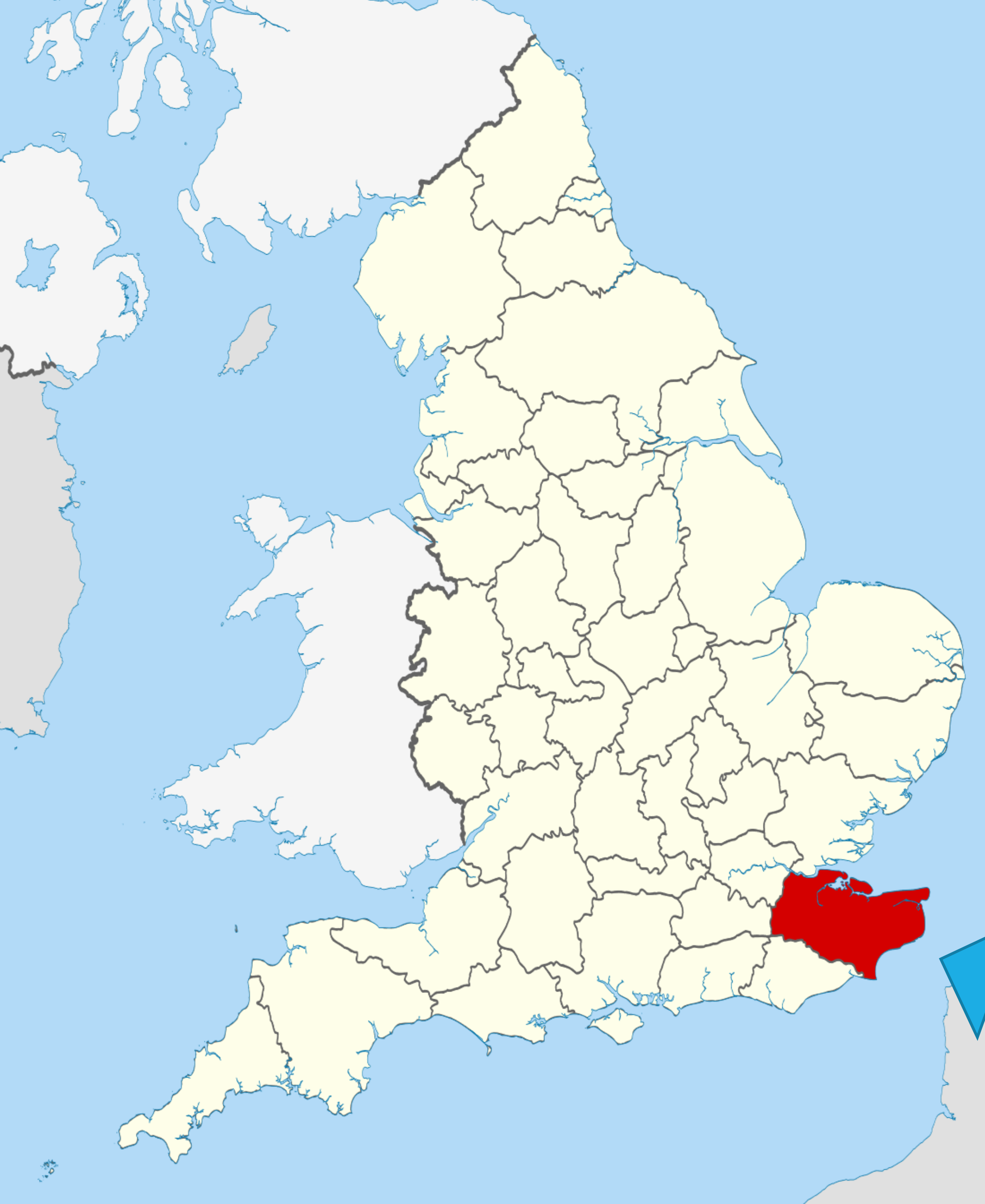


HIGH-RISE FIREFIGHTING

Evidence based Research 1990-2019

Paul Grimwood PhD, FIFireE

Kent Fire and Rescue Service



Kent Fire & Rescue Service

Borders onto **Essex, London, Surrey, Sussex and Calais France**, Fire Service Areas

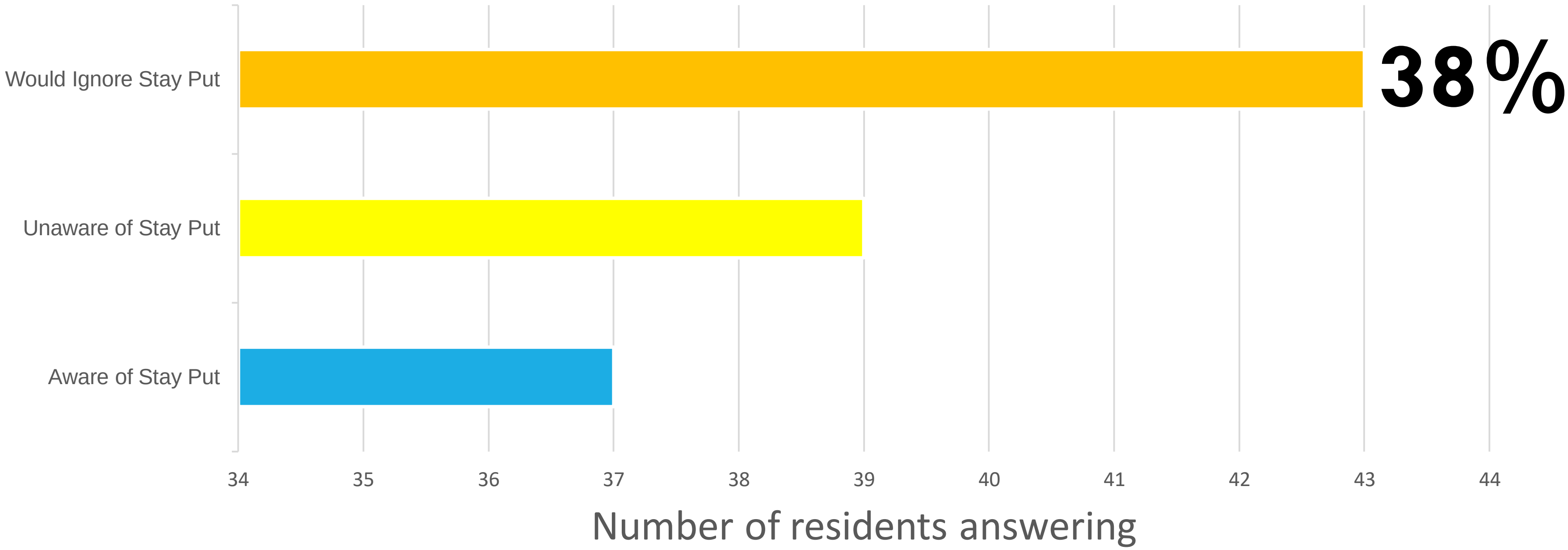

Kent Fire &
Rescue Service
County Area
3,544 km²
23,047 Call Outs in 2018
from 56 Fire Stations
413 people/km²

67 High-rise residential buildings between 10 and 20 storeys

Kent Fire & Rescue Service


A German fire chief once said that the most important room in a fire building is the stairwell!
HE WAS RIGHT!
Stairwell protection is a critical strategy in a successful firefighting operation, in an occupied building involved in fire.

Stay Put Policy - 113 Grenfell Tower residents Gave Evidence
3rd October to 9th November 2018 inclusive



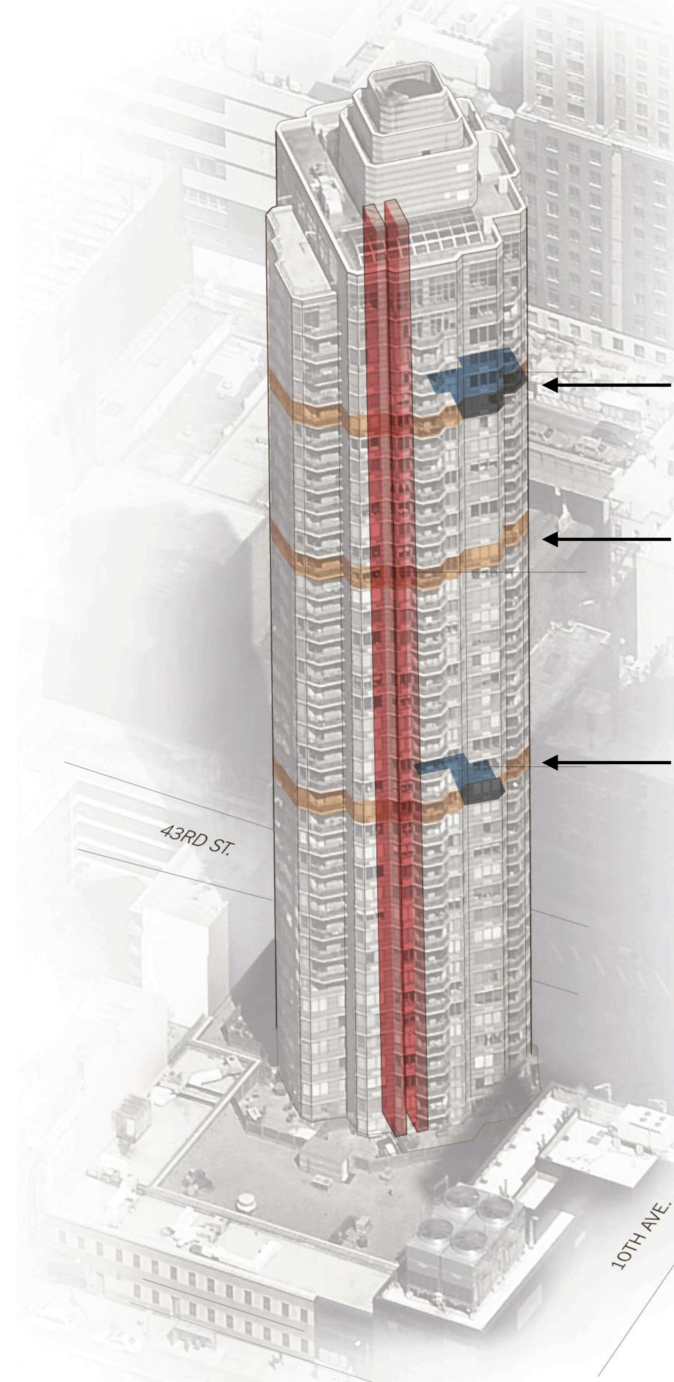
HUMAN BEHAVIOR RELATED TO FIRES IN TALL RESIDENTIAL BUILDINGS

The **attack stair** is the worst place for residents to evacuate into unless it’s kept free of smoke

In **1995**, six people died in the stairway of a burning high-rise apartment building in Ontario, Canada. In **l998**, New York City, four people were killed in a smoke-filled stairway on the 27th floor during a high-rise apartment fire. In Chicago, **2003**, six office workers were killed in a smoke-filled stairwell attempting to escape fire in a high-rise building.

Within eight years, 16 building occupants had died in fires in Chicago, New York City and Toronto; the victims shared one common fate with three primary factors — **they were all found in the attack stair, they were well above the fire floor and all died of carbon monoxide (CO) poisoning.**

Six occupants die in a Chicago fire attack stair overcome by smoke as firefighters take hose-lines from the rising main through the stair door in 2003 – but this was actually an evacuation stair!



10th Avenue Fire New York City 2014

The victims lived on the 38th floor, far above the fire. They decided to evacuate with their two dogs, and started down one of the two stairwells.

They made it as far as the 31st floor, where they were overcome by smoke.

The fire was burning in a small apartment on the 20th floor, but had not spread.

Firefighters, coming up the same stairwell the victims were using, entered the fire floor, and opened the stair doors and the apartment door, sending the smoke up as if through a chimney. One of the men and both dogs died. The residents were evacuating in the firefighting attack stair whilst the evacuation stair remained relatively smoke free.

REVERSING A ‘STAY-PUT’ STRATEGY

It’s true that National Operational Guidance and GRA 3.2 require all FRSs to formulate a plan to reverse a stay put strategy, where necessary. However, there are many factors that serve as a **disconnect** between building design and firefighting procedure, preventing any viable means of doing so.

TWO SERIOUS HIGH-RISE FIRES IN 2001 IN KENT CHANGED HOW WE APPROACH SUCH FIRES


KENT FIRE BRIGADE

Adequate fire protection (**compartments/sprinklers**)	**?**
Adequate **resources, personnel and appliances**	
Adequate fire-fighting **access** and **facilities**	**?**
An effective **pre-plan** (SOP)	**?**
Well **trained** and **prepared** commanders	**?**
Well **trained** and **equipped** firefighters	**?**
To be **familiar** with all building types	**?**
A well developed **situational awareness** in the importance of supporting and protecting access and egress routes for self-evacuation to take place	**?**

WHAT KEY FACTORS ARE NEEDED FOR AN EFFECTIVE HIGH-RISE FIRE-FIGHTING OPERATION?

Adequate fire protection (**compartments/sprinklers**)	?
Adequate **resources, personnel and appliances**	
Adequate fire-fighting **access** and **facilities**	?
An effective **pre-plan** (SOP)	?
Well **trained** and **prepared** commanders	?
Well **trained** and **equipped** firefighters	?
To be **familiar** with all building types	?
A well developed **situational awareness** in the importance of supporting and protecting access and egress routes for self-evacuation to take place	?

2001

WHAT KEY FACTORS ARE NEEDED FOR AN EFFECTIVE HIGH-RISE FIRE-FIGHTING OPERATION?

INVICTA

KENT FRS HIGH-RISE FIREFIGHTING DEVELOPMENTS 2003-2019

1. ATTACK FROM THE FIRE FLOOR 2003
2. TRAINING 97 COMMAND OFFICERS 2010-11
3. R.I.C.E COMMAND DECISION TOOL 2010
4. STAIRWELL SEARCH TEAMS 2010
5. RE-LOCATE RISING MAIN OUTLETS 2010
6. VENTILATION OF EXTENDED CORRIDORS AND STAIRS 2011
7. ADEQUATE FIREFIGHTING WATER 2014
8. 51mm ATTACK HOSE 2014
9. 150mm TWIN-OUTLET RISING MAINS 2015
10. STAIRWELL PROTECTION TEAMS 2019

Adequate fire protection (**compartments/sprinklers**)	?
Adequate **resources, personnel and appliances**	✓
Adequate fire-fighting **access** and **facilities**	✓
An effective **pre-plan** (SOP)	✓
Well **trained** and **prepared** commanders	✓
Well **trained** and **equipped** fire-fighters	✓
To be **familiar** with all building types	✓
A well developed **situational awareness** in the importance of supporting and protecting access and egress routes for self-evacuation to take place	✓

2019

WHAT KEY FACTORS ARE NEEDED FOR AN EFFECTIVE HIGH-RISE FIRE-FIGHTING OPERATION?

KENT FRS HIGH-RISE FIREFIGHTING 2-DAY COMMAND SEMINARS 2010-11

- Nine two-day command seminars over two years
- **97** Level 1 & 2 command officers trained
- Supporting **self-evacuation** was a key learning objective
- Six different **external wall fire types were** discussed at length
- A 90 minute Fire Studio exercise featured an external wall fire across eight storeys

SHANGHAI CHINA 2010

58 LIVES LOST

Potentially 6,000 existing UK buildings with combustible walls

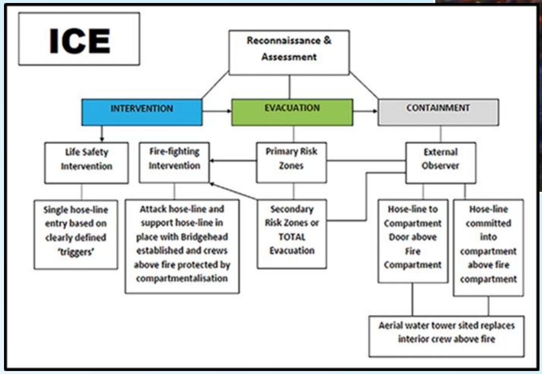
Fire behaviour of modern façade materials – Understanding the Grenfell Tower fire - Journal of Hazardous Materials 368 (2019) 115–123

SIMULATED COMMAND AGAINST EXTERNAL WALL FIRES 2010

The Fire Studio simulation pitched KFRS Command Teams against a fast developing external wall fire. The prime objectives were to **save life and save property.** The teams were split into radio linked sectors including Lobby, Bridgehead, Exterior etc. It was a real-time exercise lasting 90 minutes. **There was a 100% failure rate in the first two seminars**

THE FIRE STUDIO EXERCISE FOR 97 KENT FRS COMMANDERS 2010

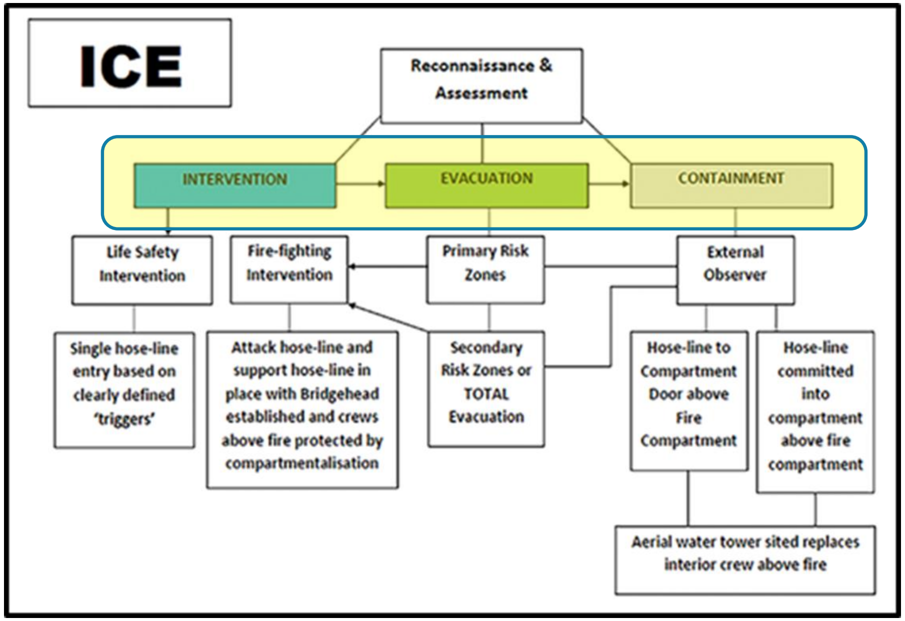
(R).I.C.E COMMAND DECISION TOOL

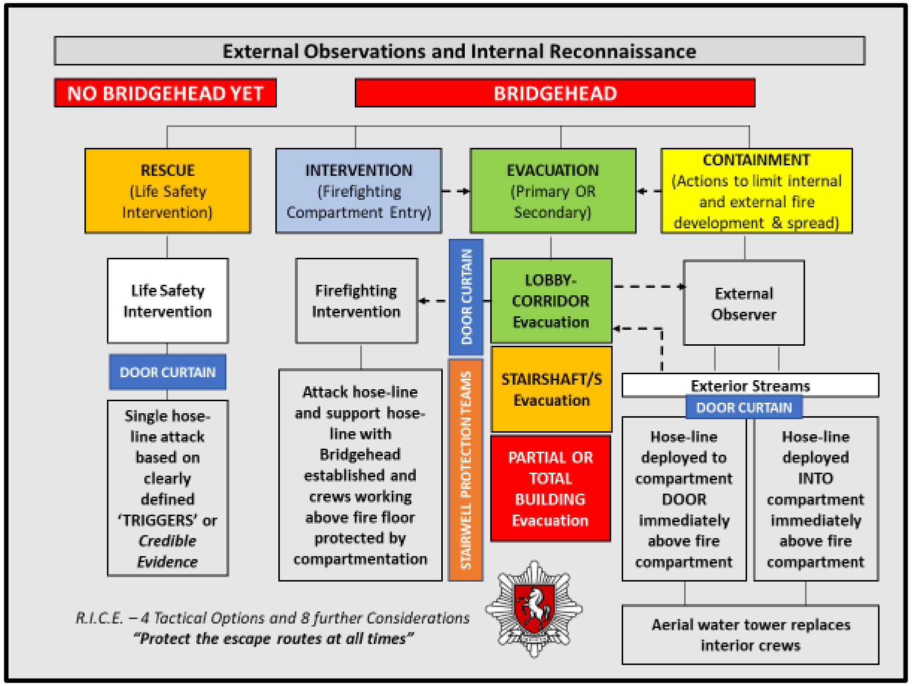


'ICE' was originally developed whilst training high-rise firefighters in the city of Kuala Lumpar in 2008

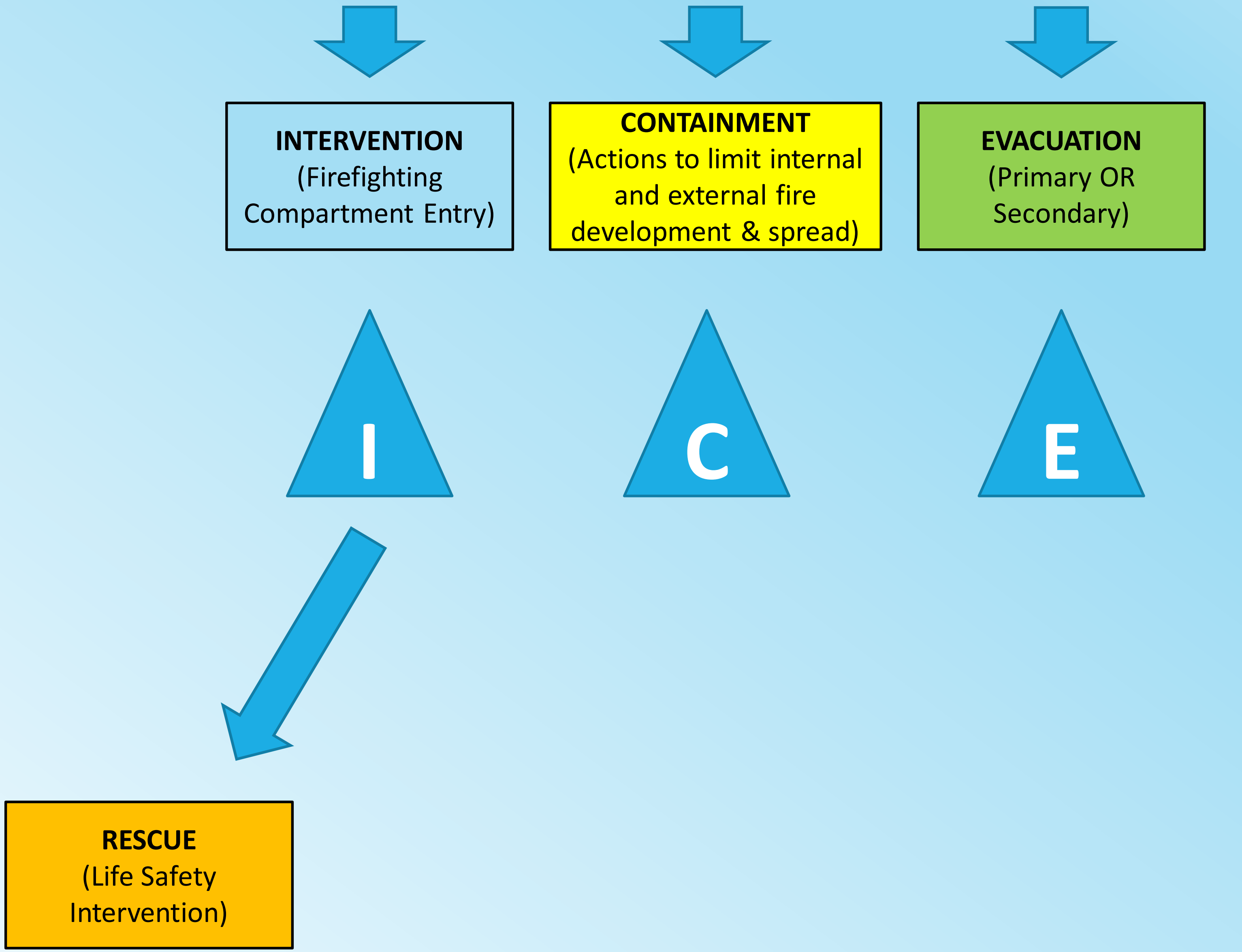
As reported in the Journal - Gulf Fire 12/2015

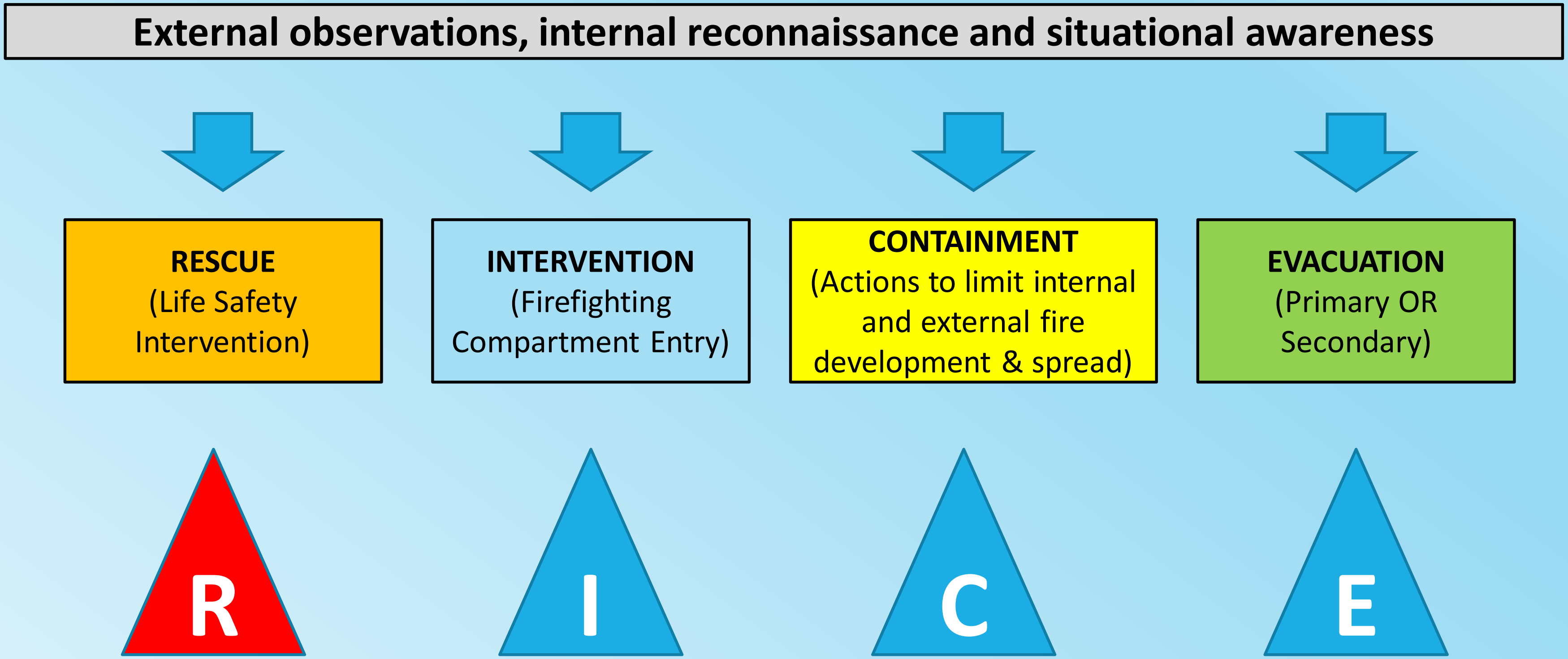
KENT FRS HIGH-RISE COMMAND MNEMONIC ICE (2010) RICE (2013)





Initially called 'ICE' where RESCUE was a branch off the INTERVENTION header



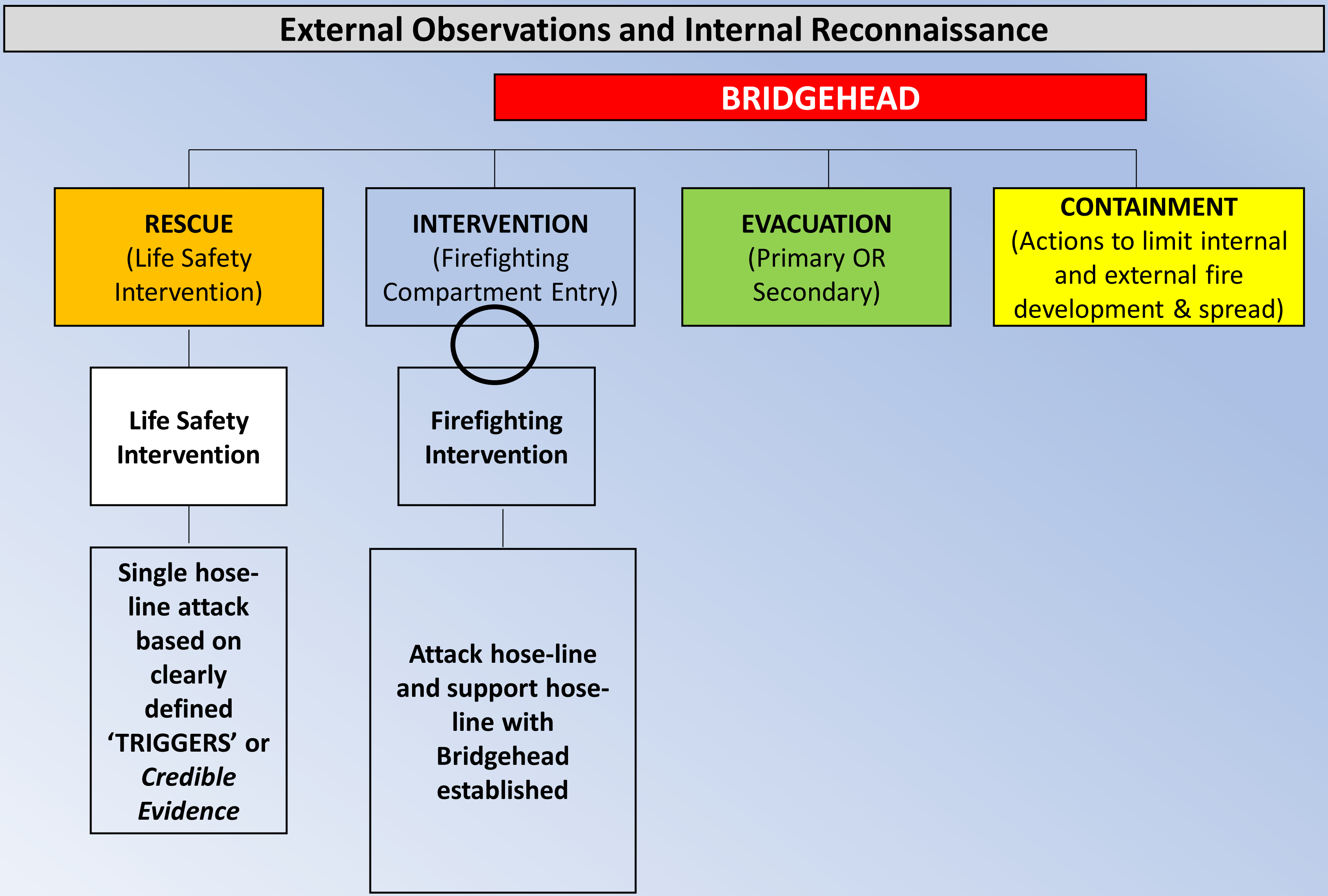


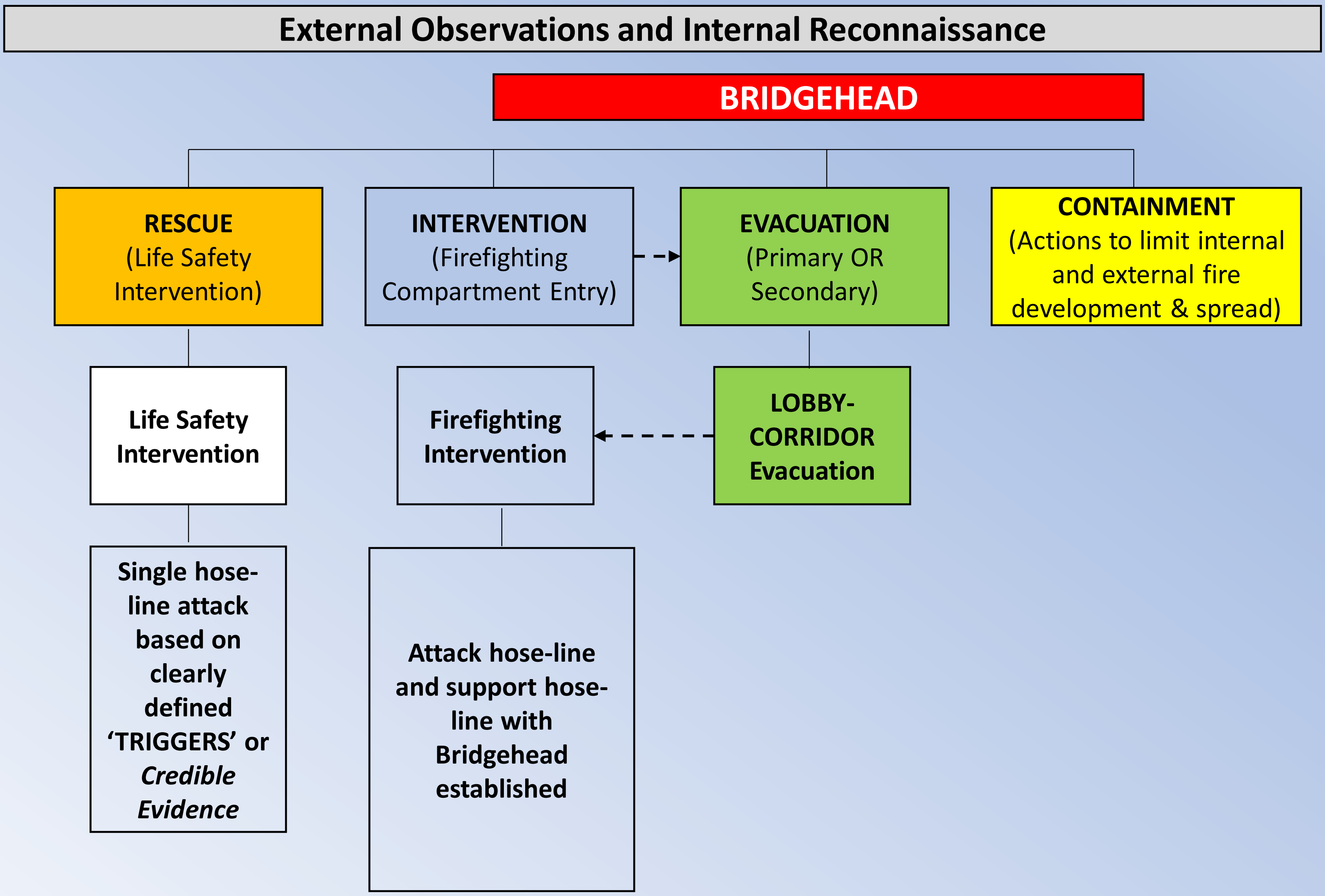
The primary objective of RICE is to simplify initial decision making but also to make EVACUATION and CONTAINMENT part of the critical decision making process, and not just an afterthought.

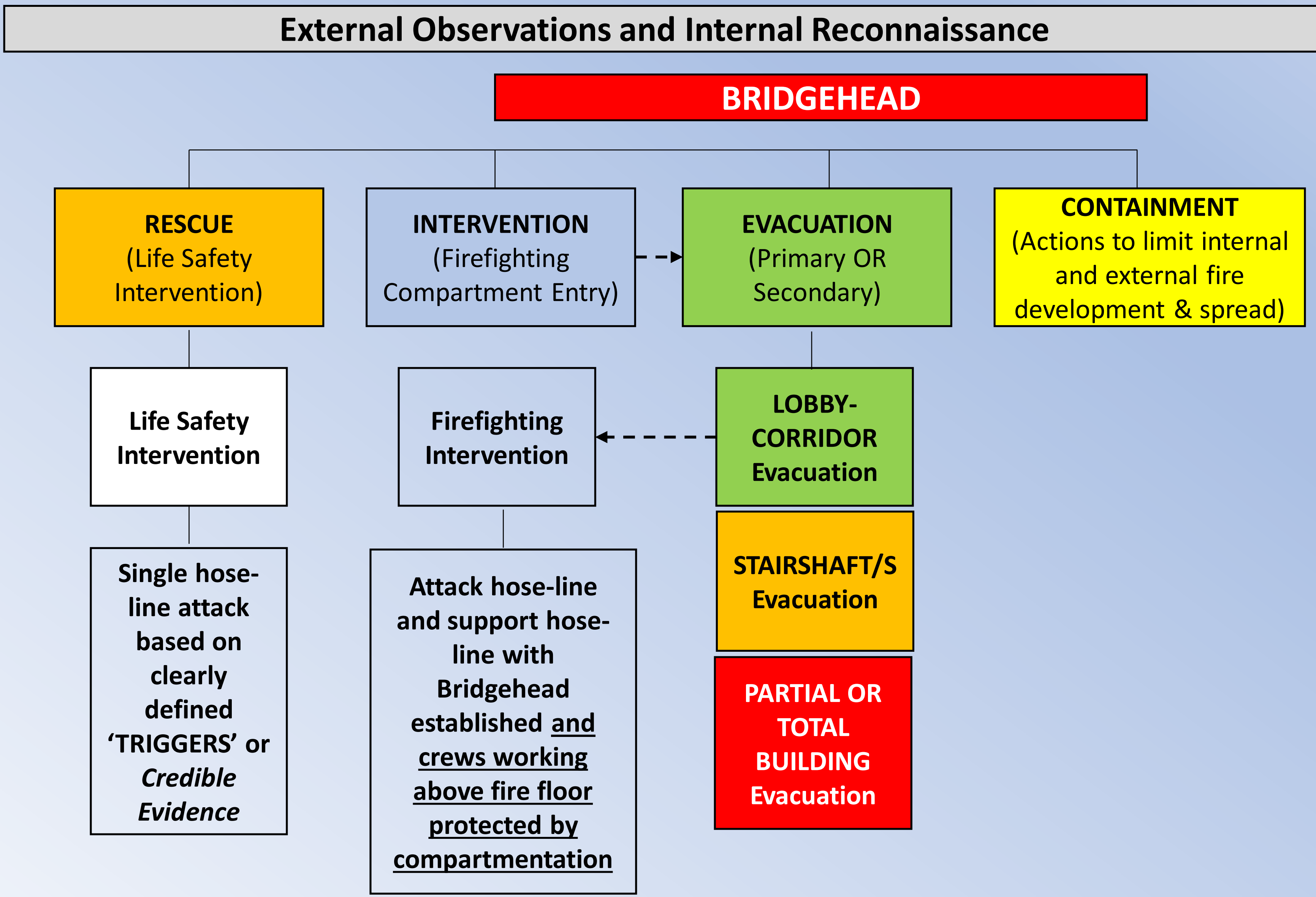
External Observations and Internal Reconnaissance

NO BRIDGEHEAD YET

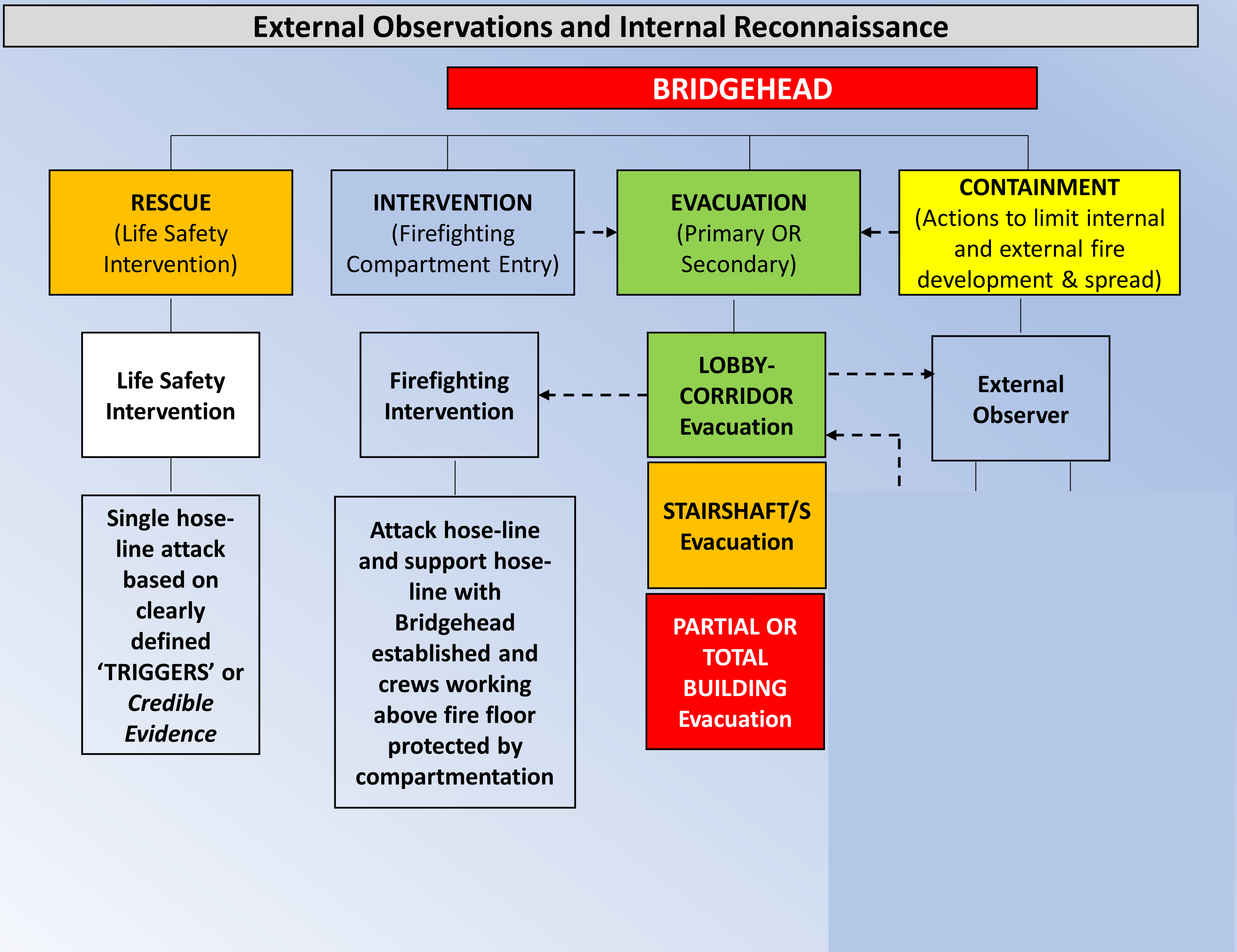
- **RESCUE** (Life Safety Intervention)
  - **Life Safety Intervention**
    - **Single hose-line attack based on clearly defined ‘TRIGGERS’ or *Credible Evidence***
- **INTERVENTION** (Firefighting Compartment Entry)
- **EVACUATION** (Primary OR Secondary)
- **CONTAINMENT** (Actions to limit internal and external fire development & spread)


External Observations and Internal Reconnaissance
BRIDGEHEAD
RESCUE
(Life Safety Intervention)
INTERVENTION
(Firefighting Compartment Entry)
EVACUATION
(Primary OR Secondary)
CONTAINMENT
(Actions to limit internal and external fire development & spread)
Life Safety Intervention
Firefighting Intervention
Single hose-line attack based on clearly defined 'TRIGGERS' or *Credible Evidence*
Attack hose-line and support hose-line with Bridgehead established

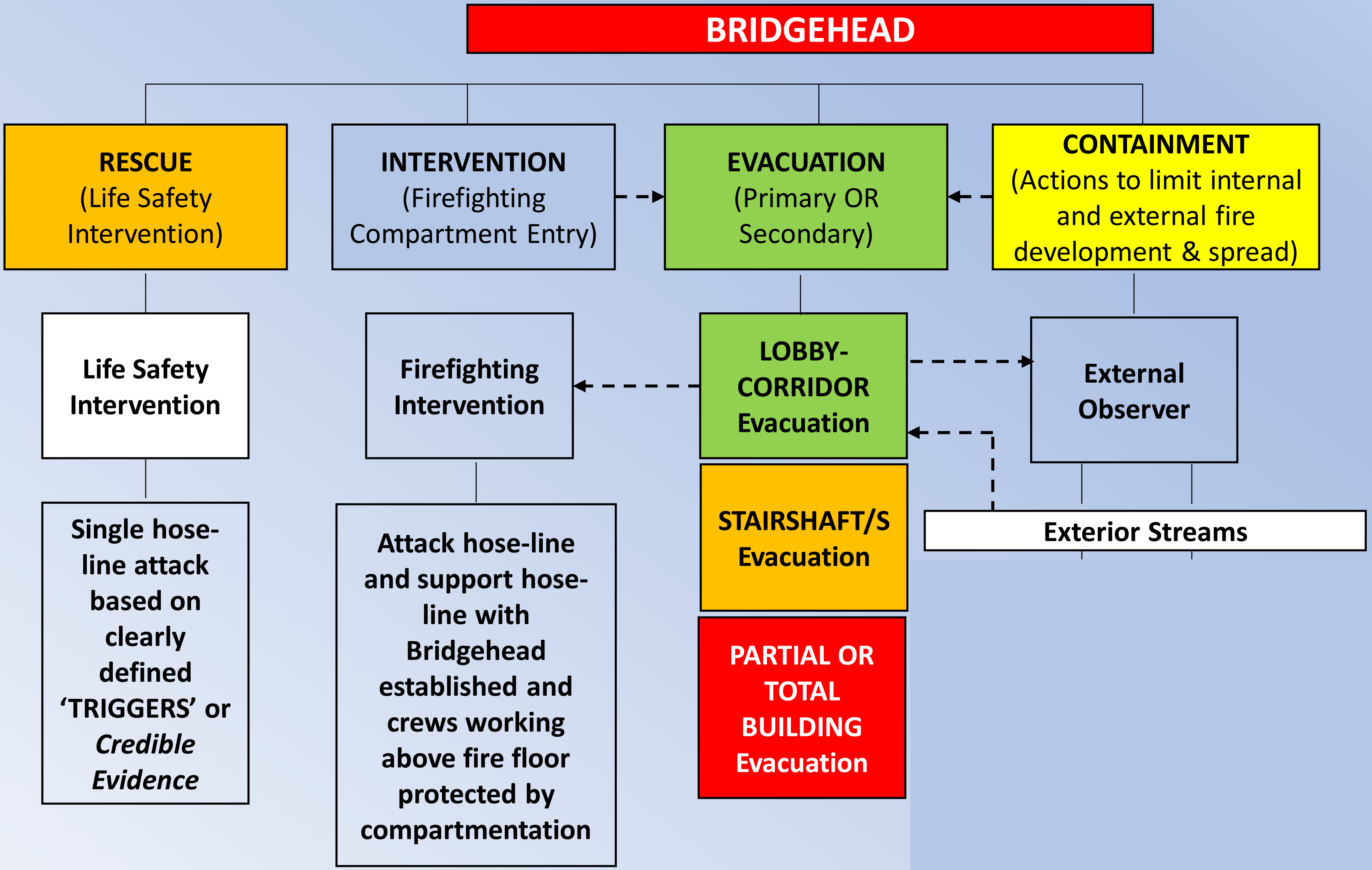

External Observations and Internal Reconnaissance
BRIDGEHEAD
RESCUE (Life Safety Intervention)
INTERVENTION (Firefighting Compartment Entry)
EVACUATION (Primary OR Secondary)
CONTAINMENT (Actions to limit internal and external fire development & spread)
Life Safety Intervention
Firefighting Intervention
LOBBY-CORRIDOR Evacuation
Single hose-line attack based on clearly defined 'TRIGGERS' or *Credible Evidence*
Attack hose-line and support hose-line with Bridgehead established



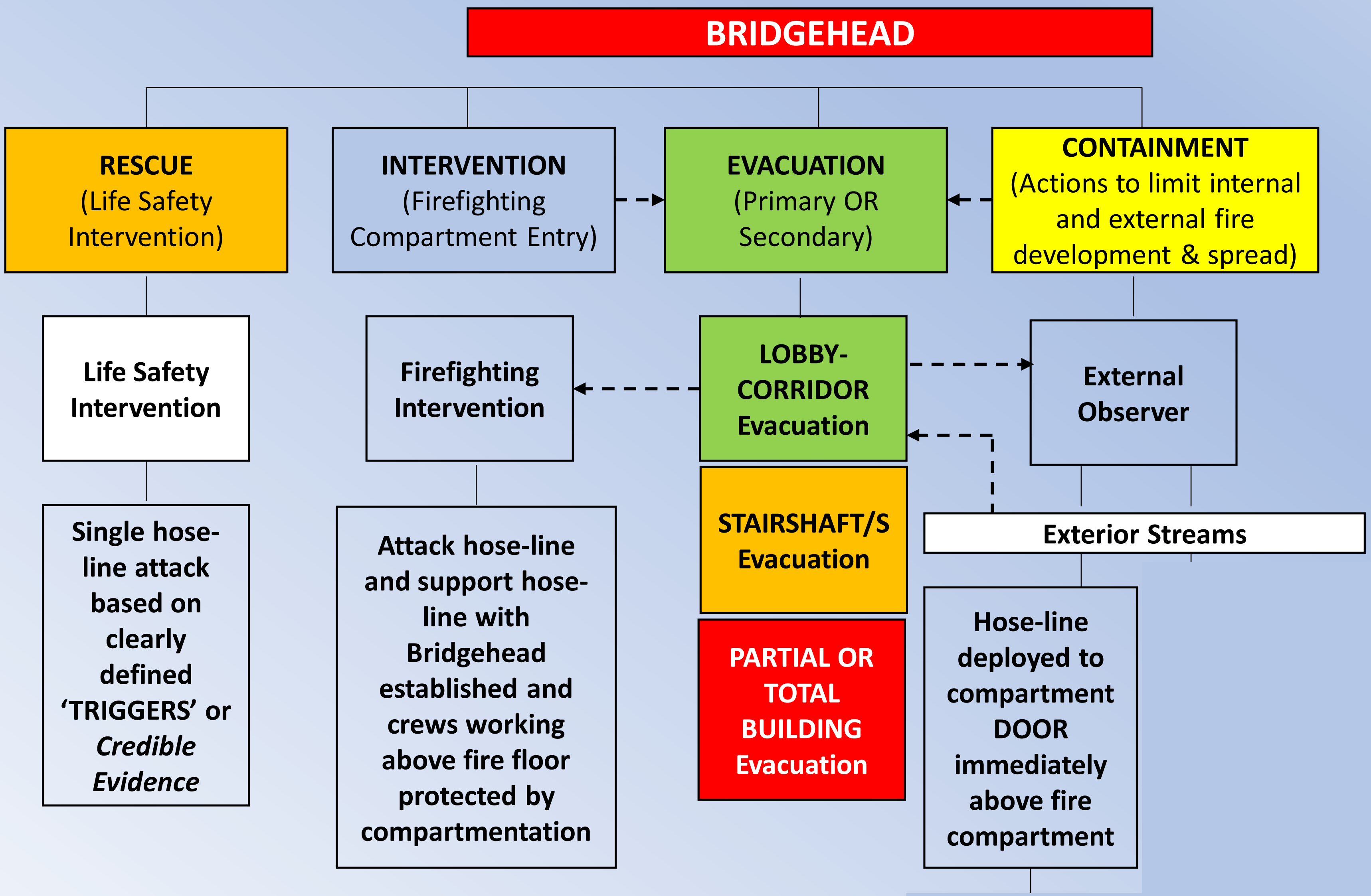
External Observations and Internal Reconnaissance
BRIDGEHEAD
RESCUE (Life Safety Intervention)
INTERVENTION (Firefighting Compartment Entry)
EVACUATION (Primary OR Secondary)
CONTAINMENT (Actions to limit internal and external fire development & spread)
Life Safety Intervention
Firefighting Intervention
LOBBY-CORRIDOR Evacuation
STAIRSHAFT/S Evacuation
PARTIAL OR TOTAL BUILDING Evacuation
Single hose-line attack based on clearly defined 'TRIGGERS' or *Credible Evidence*
Attack hose-line and support hose-line with Bridgehead established and crews working above fire floor protected by compartmentation


External Observations and Internal Reconnaissance
BRIDGEHEAD
RESCUE (Life Safety Intervention)
INTERVENTION (Firefighting Compartment Entry)
EVACUATION (Primary OR Secondary)
CONTAINMENT (Actions to limit internal and external fire development & spread)
Life Safety Intervention
Firefighting Intervention
LOBBY-CORRIDOR Evacuation
External Observer
Single hose-line attack based on clearly defined 'TRIGGERS' or *Credible Evidence*
Attack hose-line and support hose-line with Bridgehead established and crews working above fire floor protected by compartmentation
STAIRSHAFT/S Evacuation
PARTIAL OR TOTAL BUILDING Evacuation

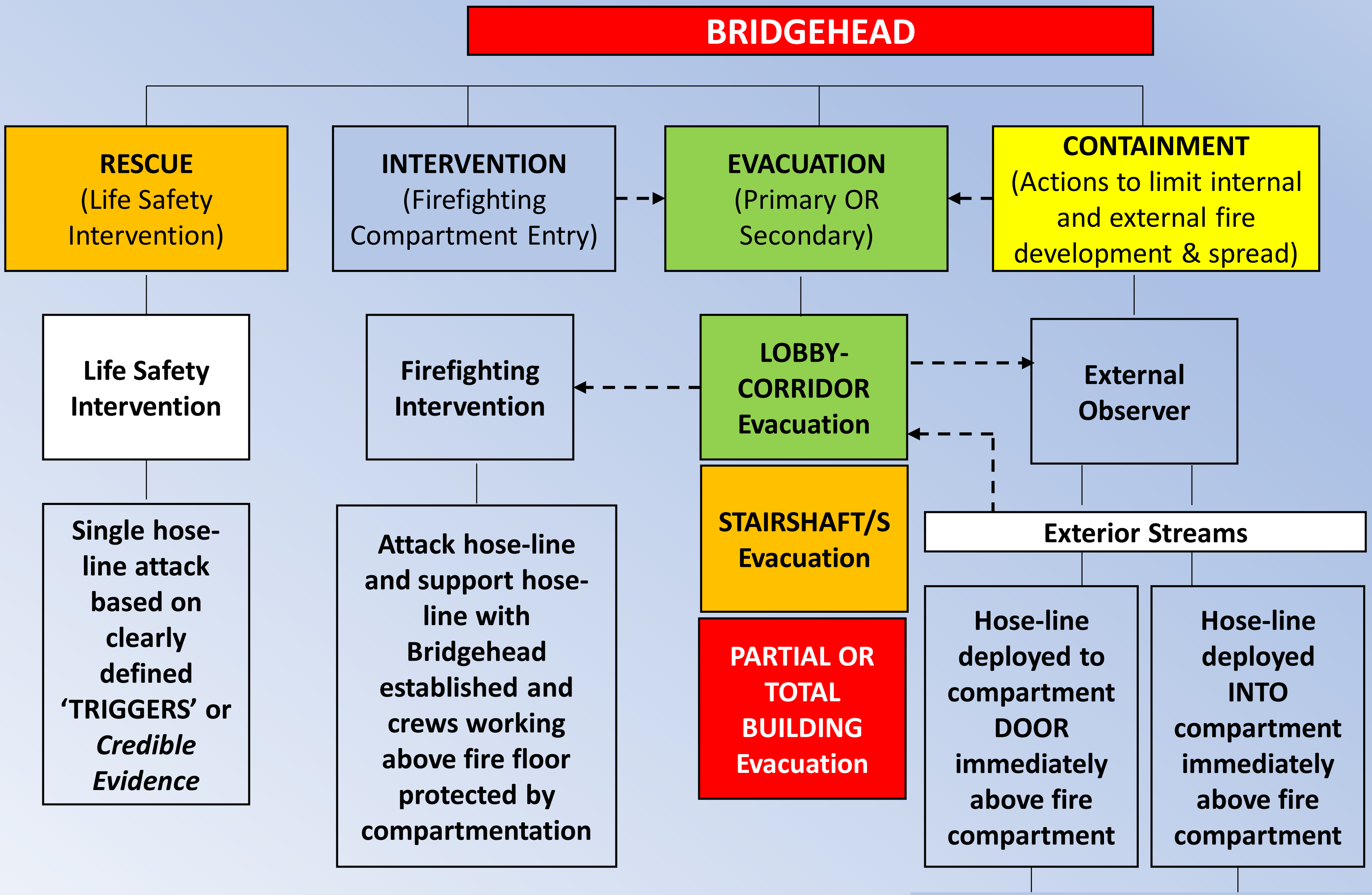
External Observations and Internal Reconnaissance



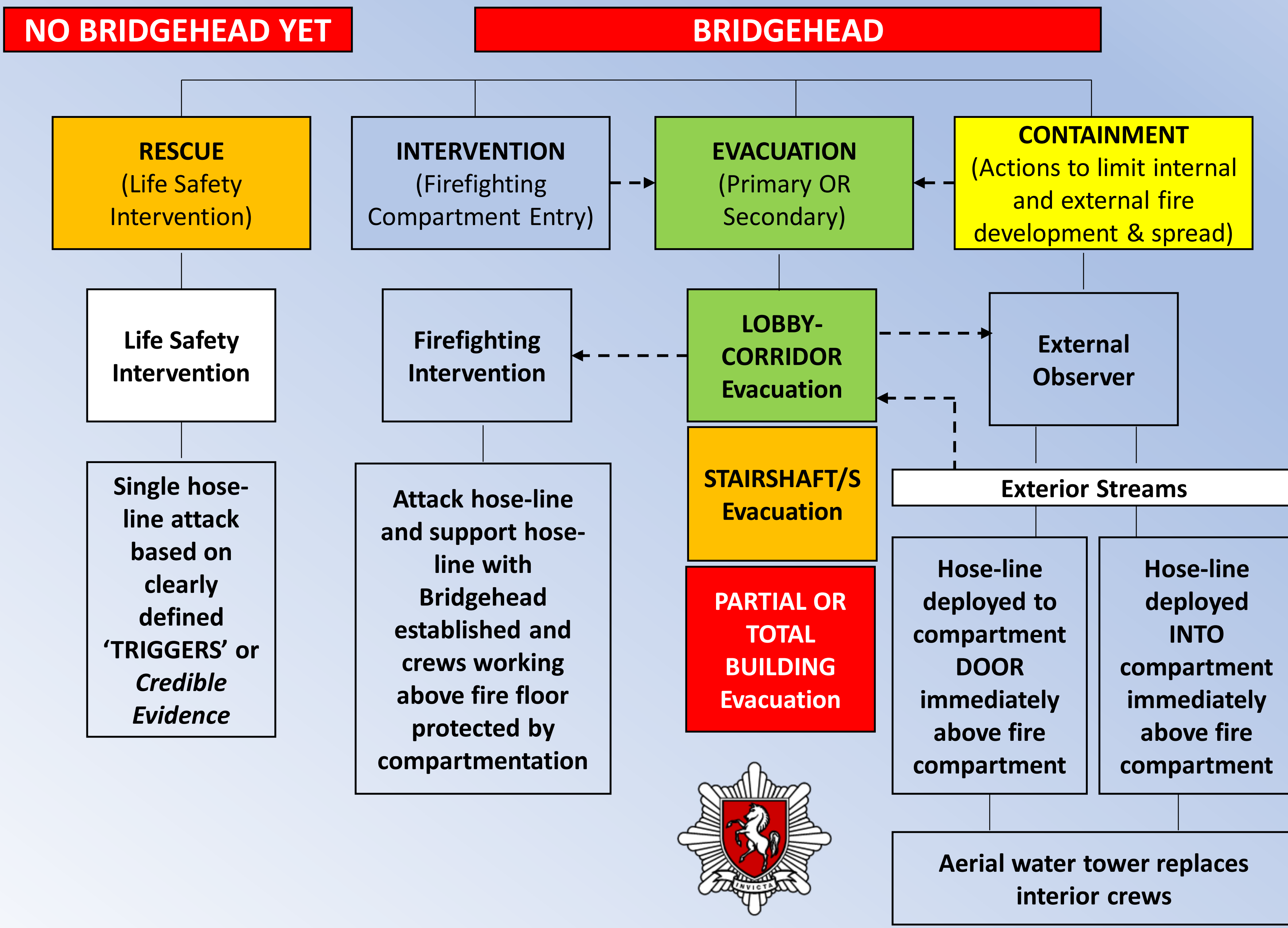
External Observations and Internal Reconnaissance

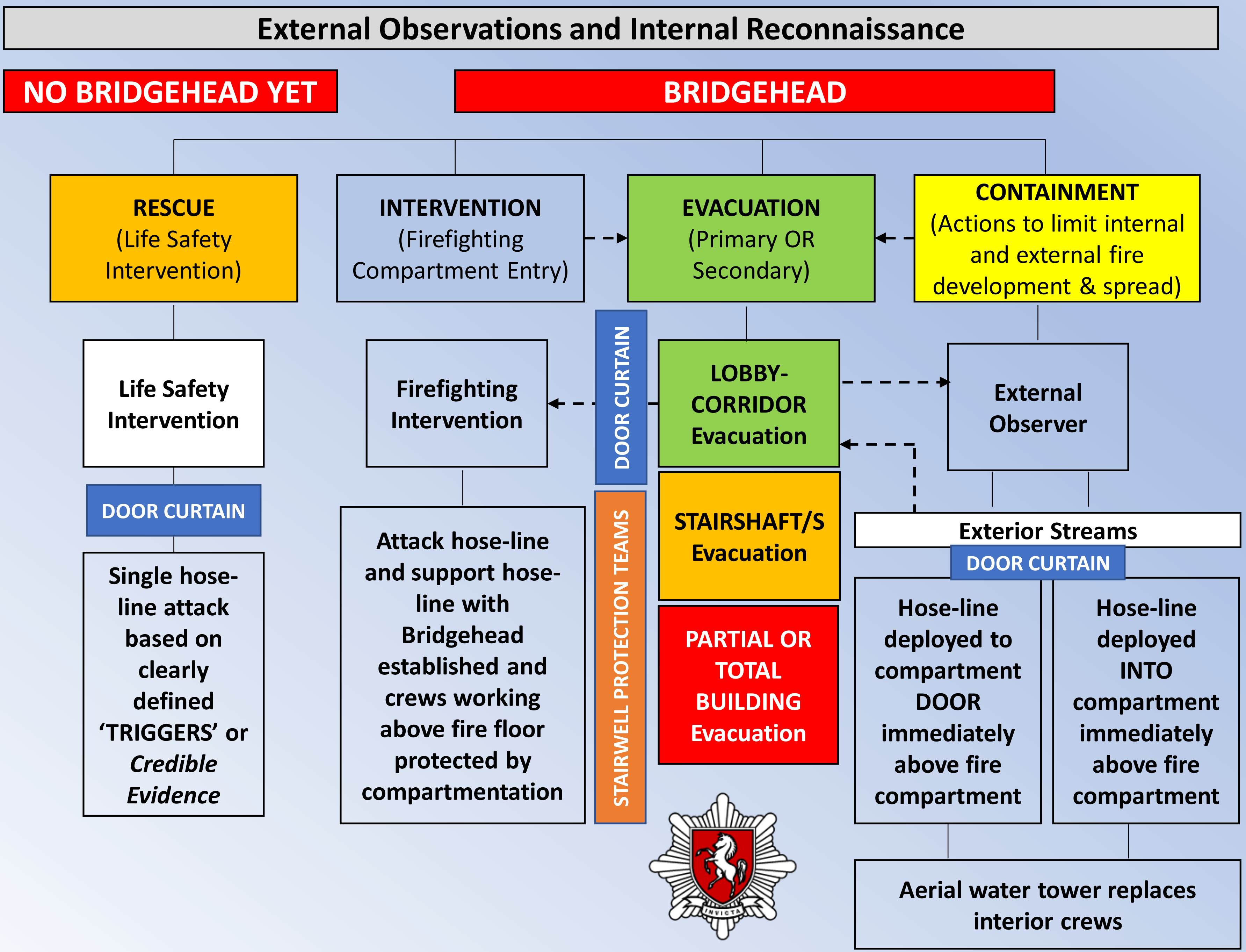


External Observations and Internal Reconnaissance



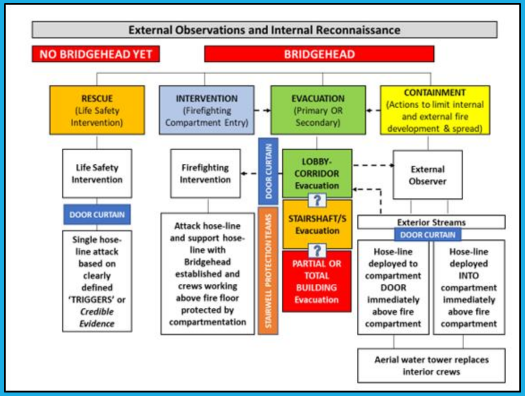
External Observations and Internal Reconnaissance




External Observations and Internal Reconnaissance
NO BRIDGEHEAD YET
BRIDGEHEAD
RESCUE (Life Safety Intervention)
INTERVENTION (Firefighting Compartment Entry)
EVACUATION (Primary OR Secondary)
CONTAINMENT (Actions to limit internal and external fire development & spread)
Life Safety Intervention
DOOR CURTAIN
Single hose-line attack based on clearly defined 'TRIGGERS' or *Credible Evidence*
Firefighting Intervention
Attack hose-line and support hose-line with Bridgehead established and crews working above fire floor protected by compartmentation
DOOR CURTAIN
STAIRWELL PROTECTION TEAMS
LOBBY-CORRIDOR Evacuation
STAIRSHAFT/S Evacuation
PARTIAL OR TOTAL BUILDING Evacuation
External Observer
Exterior Streams
DOOR CURTAIN
Hose-line deployed to compartment DOOR immediately above fire compartment
Hose-line deployed INTO compartment immediately above fire compartment
Aerial water tower replaces interior crews
INVICTA

R.I.C.E Tactical Command Tool

RESCUE
INTERVENTION
CONTAINMENT
EVACUATION



- **Simple mnemonic for primary command**
- **Rapid decision making on-scene**
- **Supports analytical thought process**
- **Assists when in 'Information Overload'**
- **Intervention may not be the first option**

This tool was seen to increase situational awareness amongst 97 KFRS officers by 33% in exercises.

NFCC
National Fire Chiefs Council

R.I.C.E. AS AN ANALYTICAL COMMAND MNEMONIC

STAIRWELL PROTECTION KENT FRS


16

Diagram 52 A proposal to reposition rising main outlets by design to protect stairwells

See para 17.1

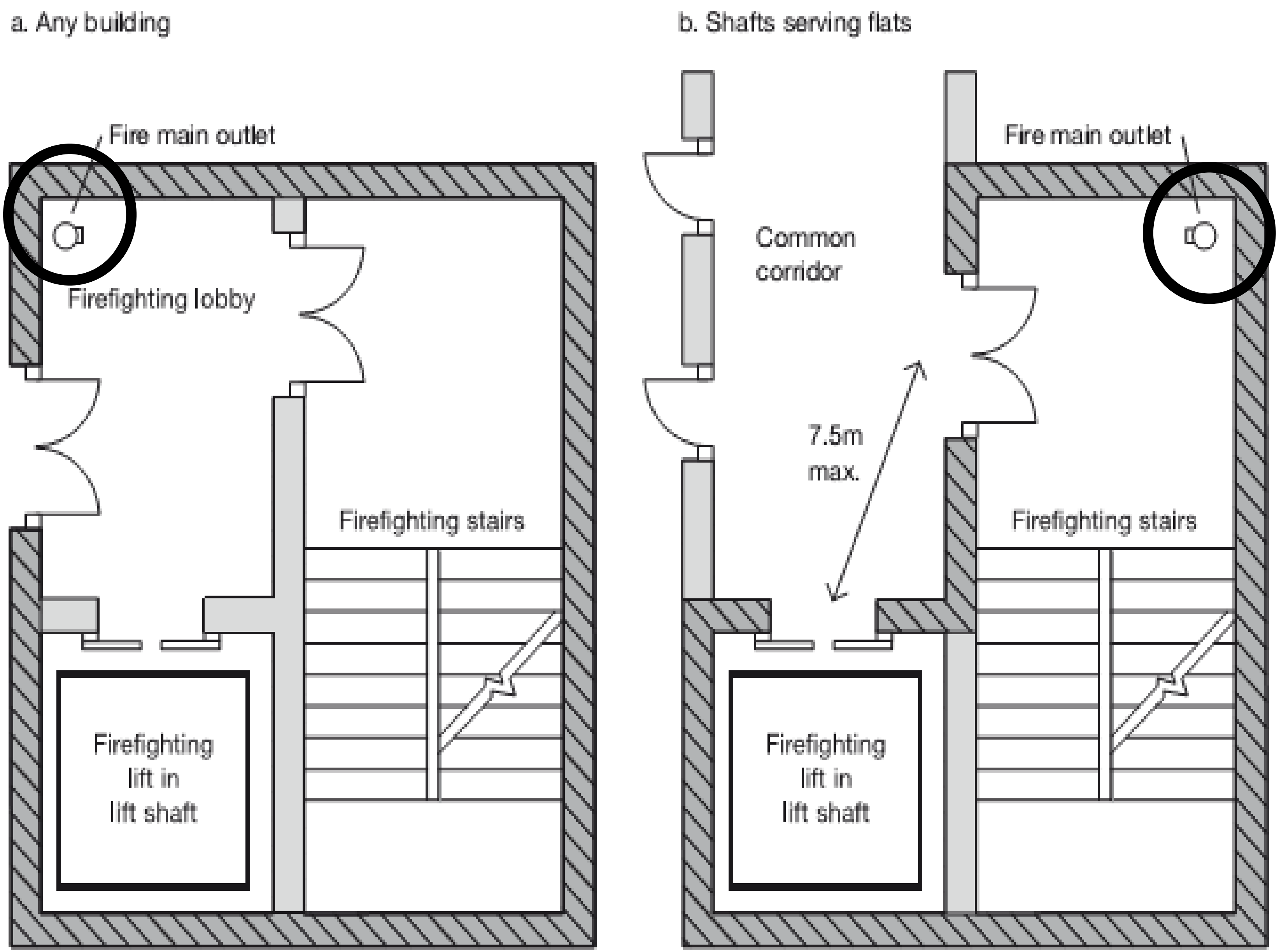
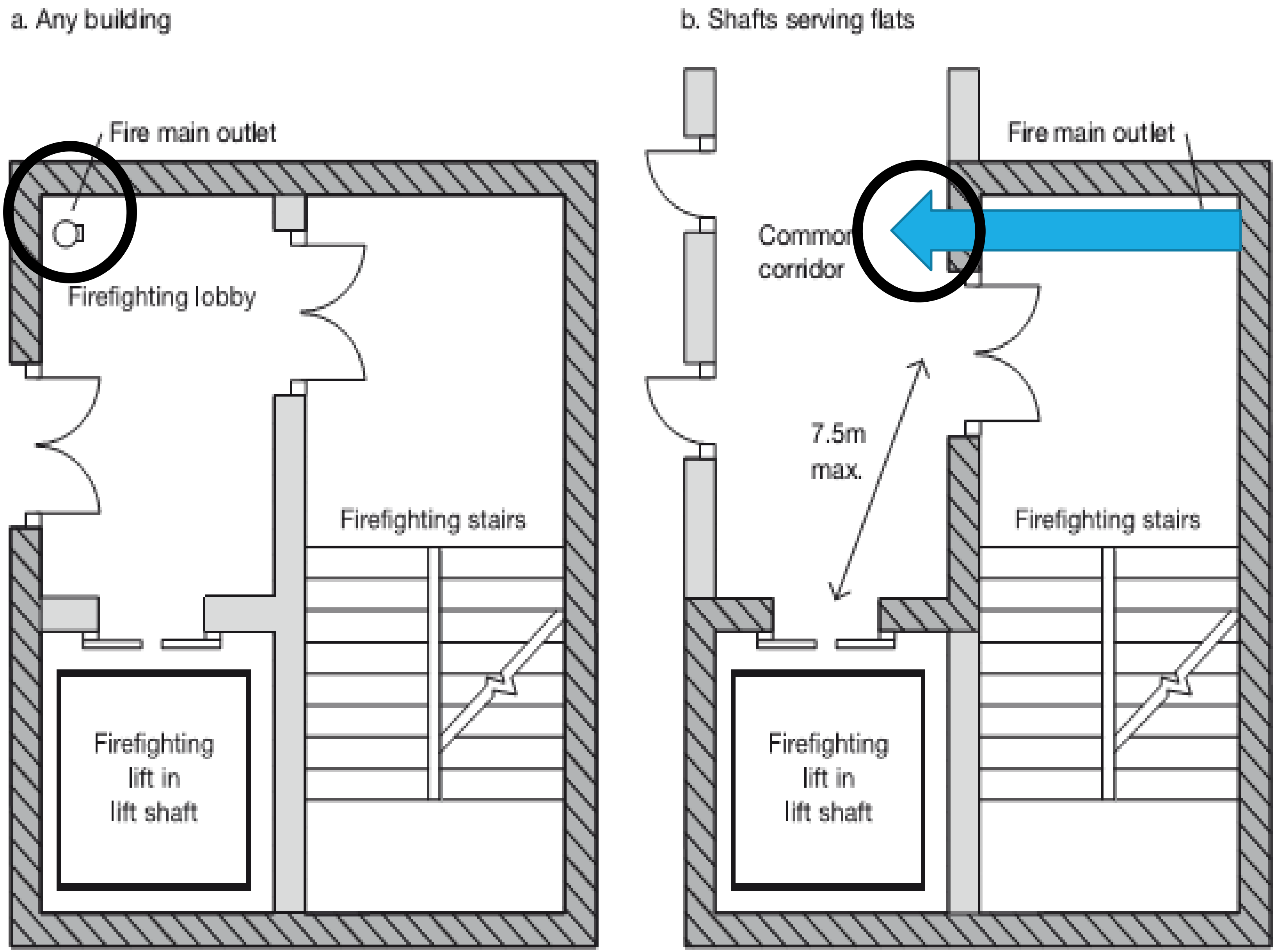


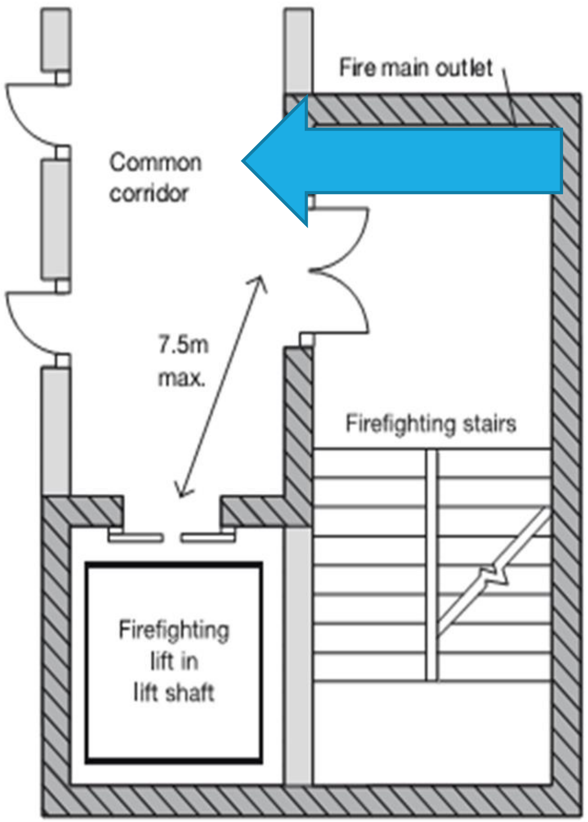
Diagram 52 A proposal to reposition rising main outlets by design to protect stairwells

See para 17.1



150mm Rising mains with twin outlets at each floor level, located away from the stairwell

Within one metre of the stair door



150mm Rising mains with twin outlets at each floor level, located away from the stairwell

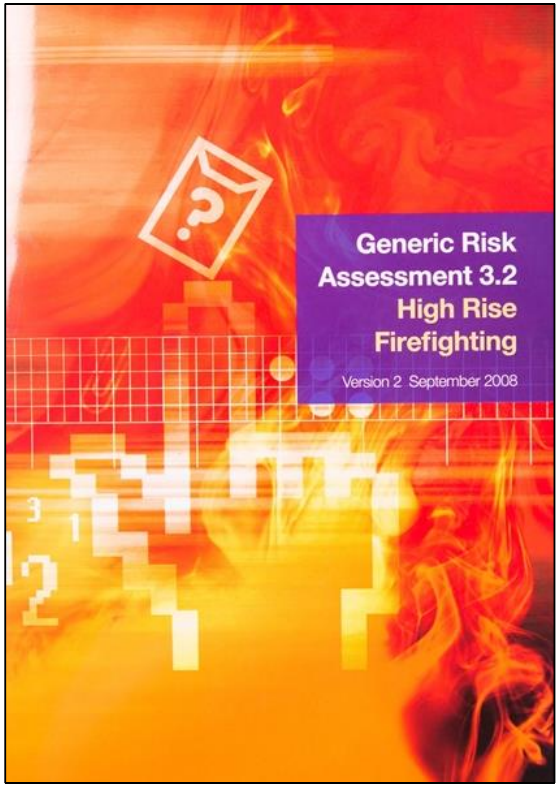
Advantages of Rising Main outlets sited away from the stair -

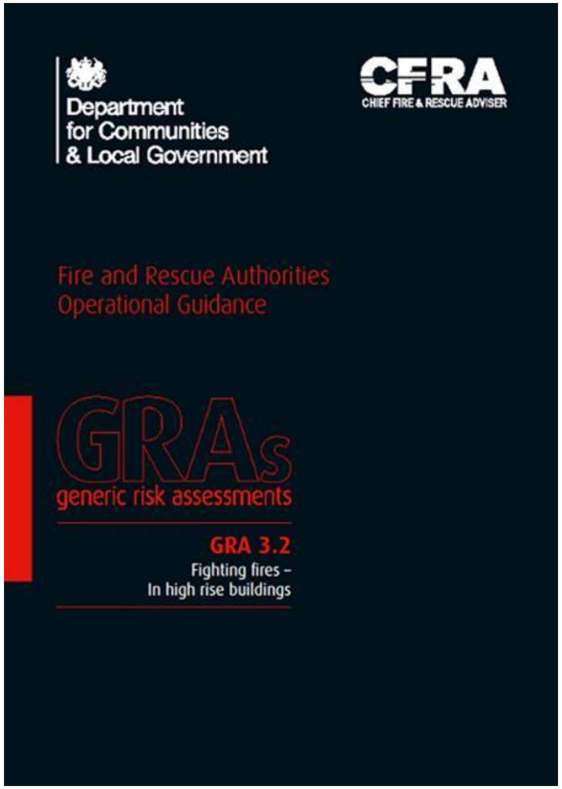
- Hose-lays are reduced in length and are easier to manage.
- Firefighters are exposed to less stress and breathing apparatus will last longer.
- The stair door in residential buildings remains closed and smoke infiltration into the stair is dramatically reduced.
- Where occupants are self-evacuating, particularly but not solely in single stair buildings, the vertical escape routes are relatively clear of smoke and tenable throughout firefighting operations.

DUBLIN FIRE BRIGADE HIGH-RISE OPS


FIRE
DFB
SCOTT
300 BAR

‘Floor below Nozzle’ (Wind Driven Fires)





KFRS STAIR SEARCH TEAMS | 2010

NATIONAL HIGH-RISE FIREFIGHTING GUIDANCE GRA 3.2 2008 (2014)

‘In circumstances where teams need to work in an area above the bridgehead which is not affected by fire or smoke and the Incident Commander has confirmed that the building’s construction and any fire engineered solutions have not been compromised, **teams can be committed without respiratory protective equipment**.

These teams must **maintain communication** and a **Safety Officer** must be deployed in the stairwell and be **in contact** with other Safety Officers and the Incident Commander outside the building’.

STAIRWELL PROTECTION TEAMS 2019 ROLES AND OBJECTIVES

- **Patrol** stairwells continuously from top-to-bottom to ensure that egress routes are safe and free of obstructions; **monitor gas levels**
- **Search** stairwells, corridors, lobbies and lifts for building occupants who may be trapped or are entering an untenable environment
- **Report** information about conditions at each floor to the incident commander
- Ensure the stairs are **clear of smoke**
- **Deploy to FSG calls** where required
- **Manage occupant evacuation** where required

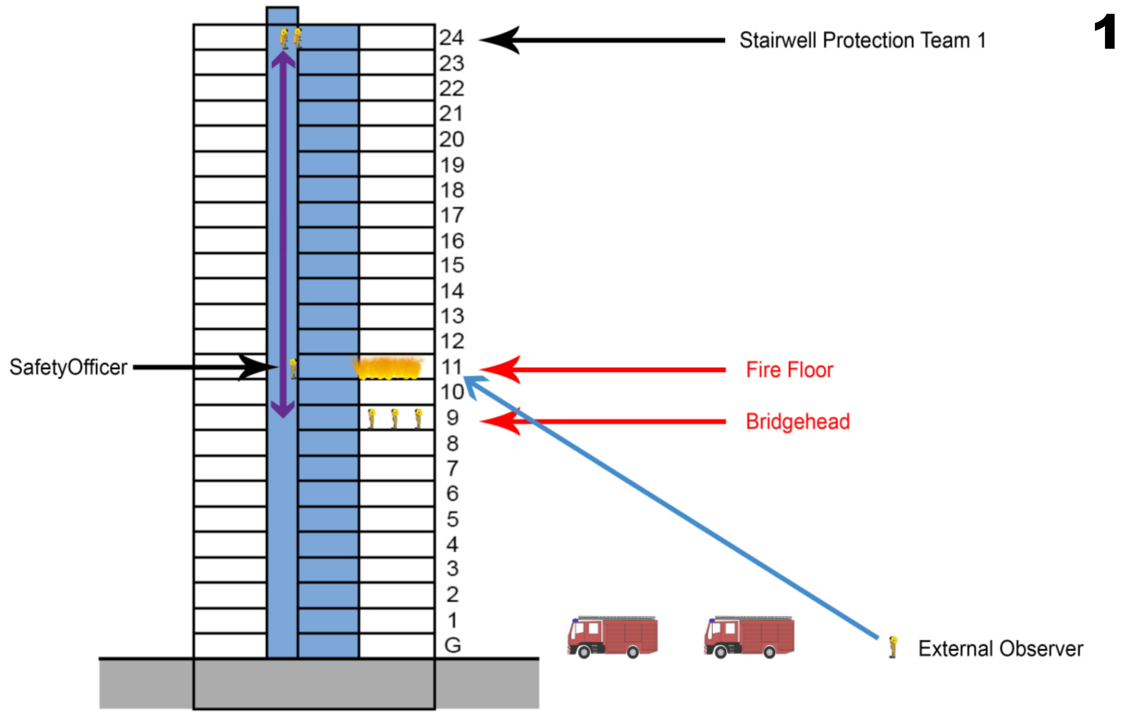
WHERE INTERVENTION BECOMES THE PRIMARY STRATEGY

Prior to taking hose-lines from a rising main located in the stair, a check should be made for occupants **at least five floors** above the fire floor.

As soon as possible, on arrival of the third pump where viable, a **stair protection team** should be deployed above the fire floor where considered safe to do so.

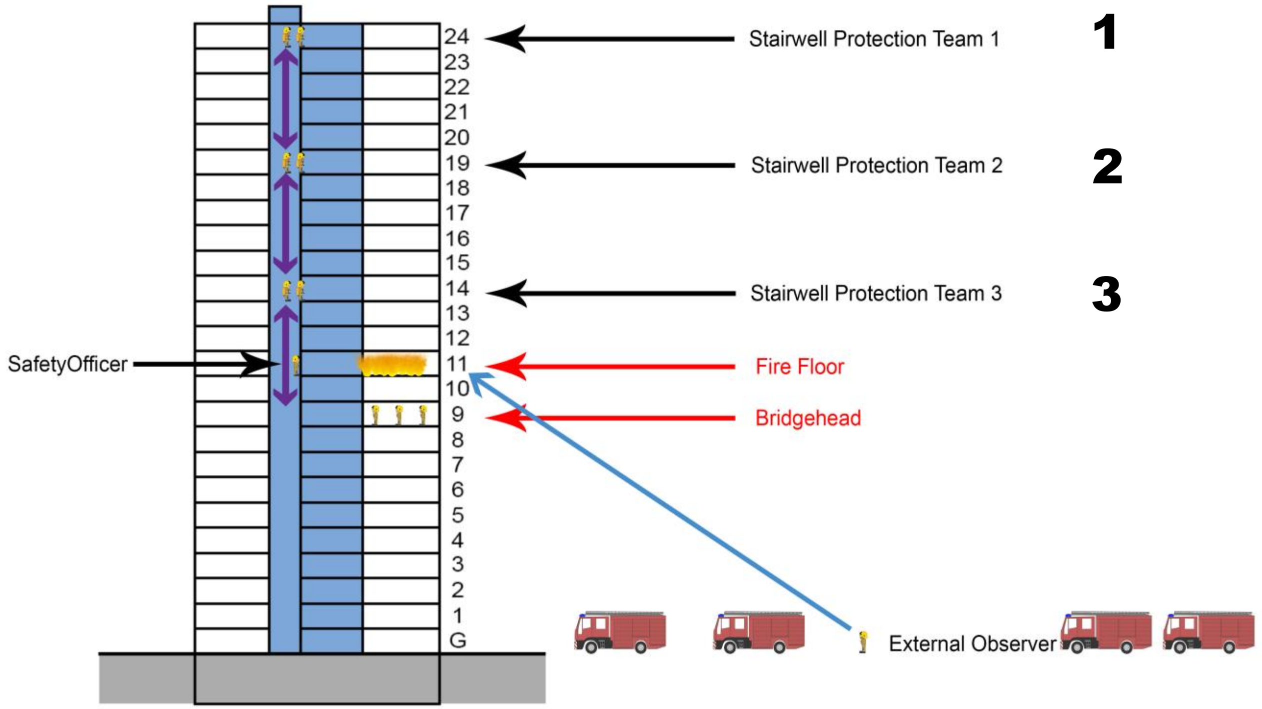
Before allowing smoke to enter the stair, every effort must be made to prevent or reduce this by deploying **door smoke curtains** where possible.

Initial Stairwell Protection Team deployment



KENT FRS STAIRWELL PROTECTION TEAMS 2019

Secondary Stairwell Protection Team deployment



KENT FRS STAIRWELL PROTECTION TEAMS 2019

Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2†	420	150	83	33	27
AEGL-3‡	1,700	600	330	150	130

Carbon Monoxide

Acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	2.5	2.5	2.0	1.3	1.0
AEGL-2†	17	10	7.1	3.5	2.5
AEGL-3‡	27	21	15	8.6	6.6

Hydrogen Cyanide

Star Protection as a strategy – Evacuation .v. Rescue

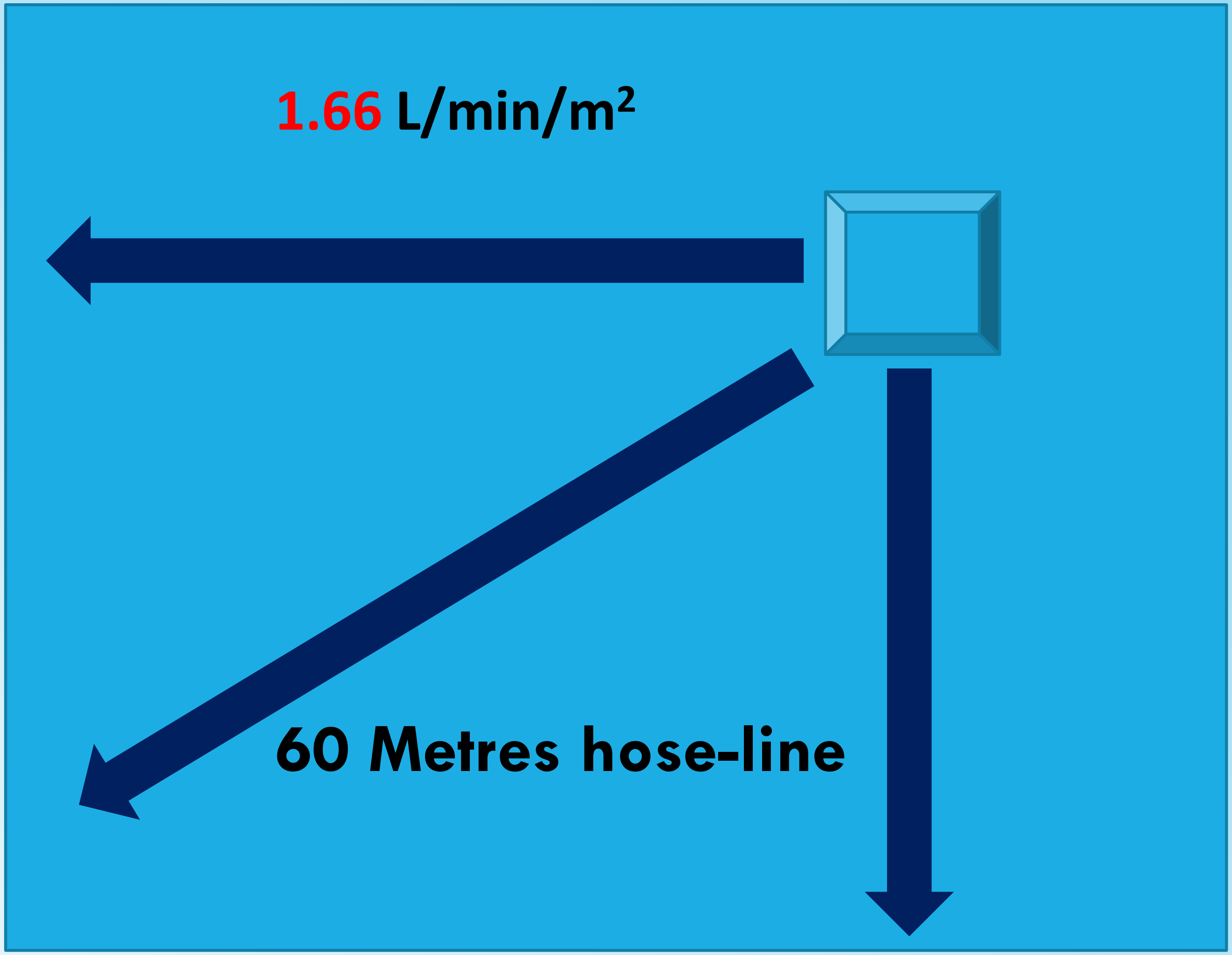
‘An advantage in strategically and tactically supporting any *‘self-evacuation’* that may already be occurring, is to enhance any later decision to reverse a ‘stay-put strategy’, as the natural command and stair deployment structure will already be in place and **less resources will be required**’.

ADEQUATE FIREFIGHTING WATER

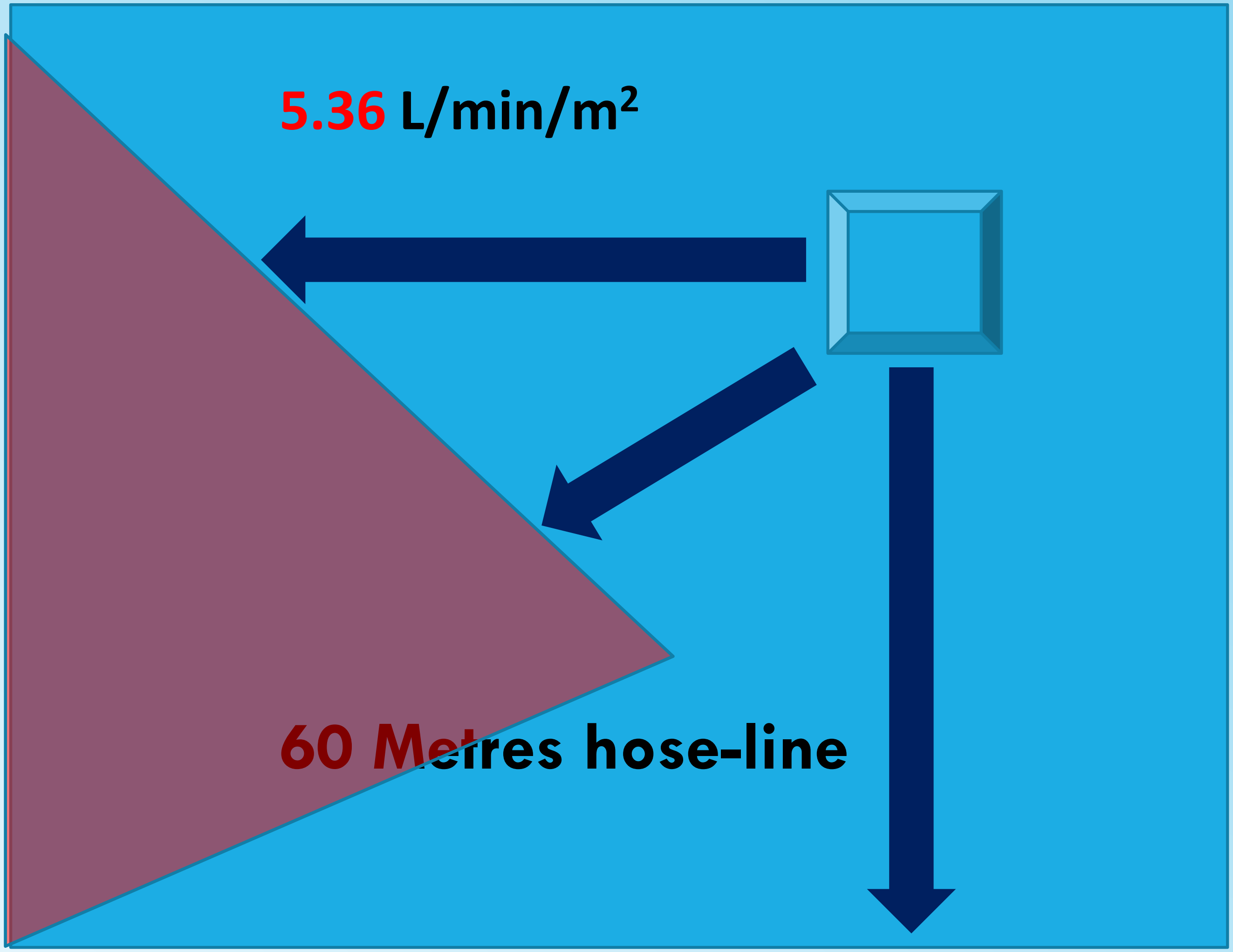
280 Sq. METRES OF FIRE

IS THE MAXIMUM SIZED OFICE FIRE WE CAN DEAL WITH!

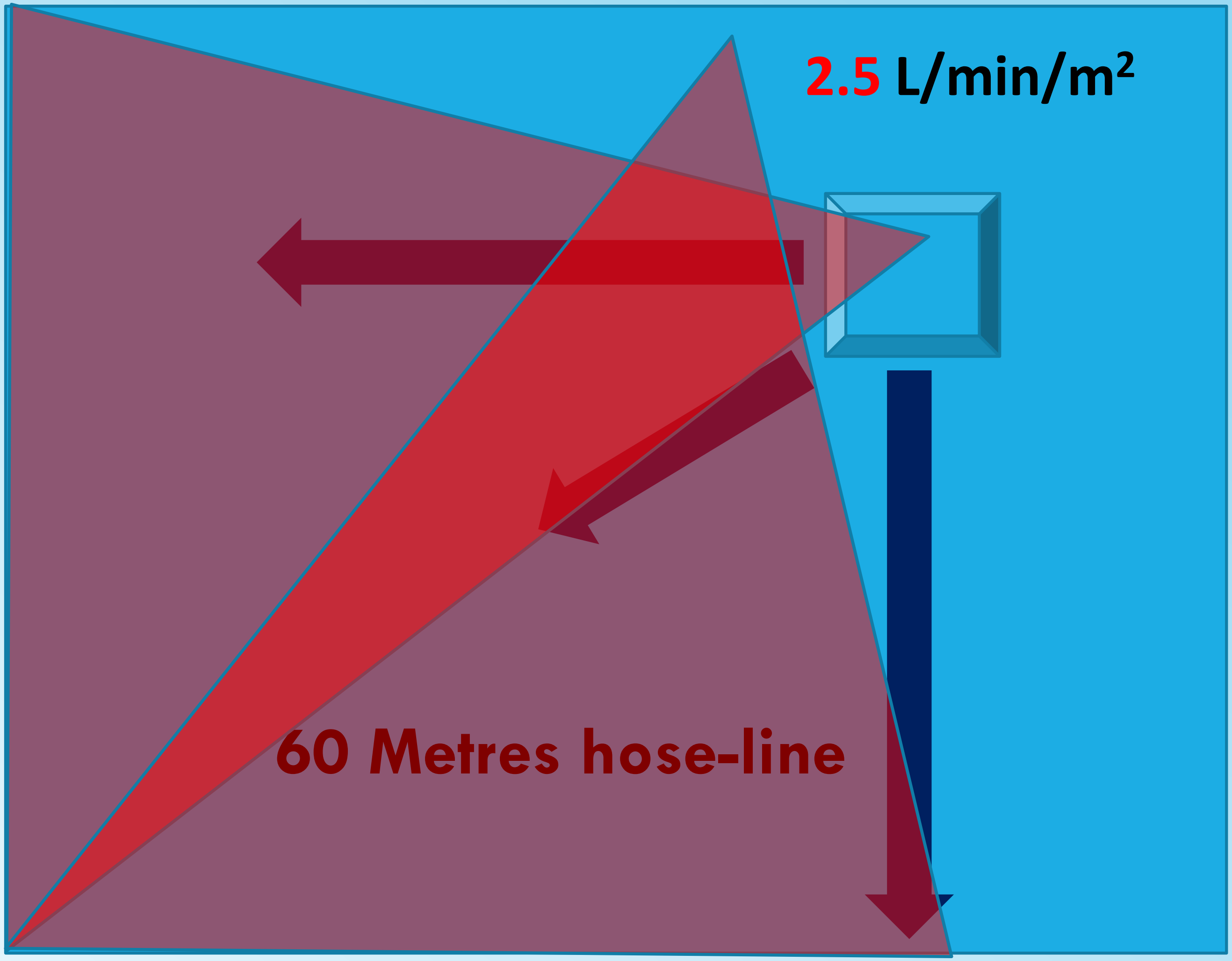
900 Square Metres – 1,500 L/min

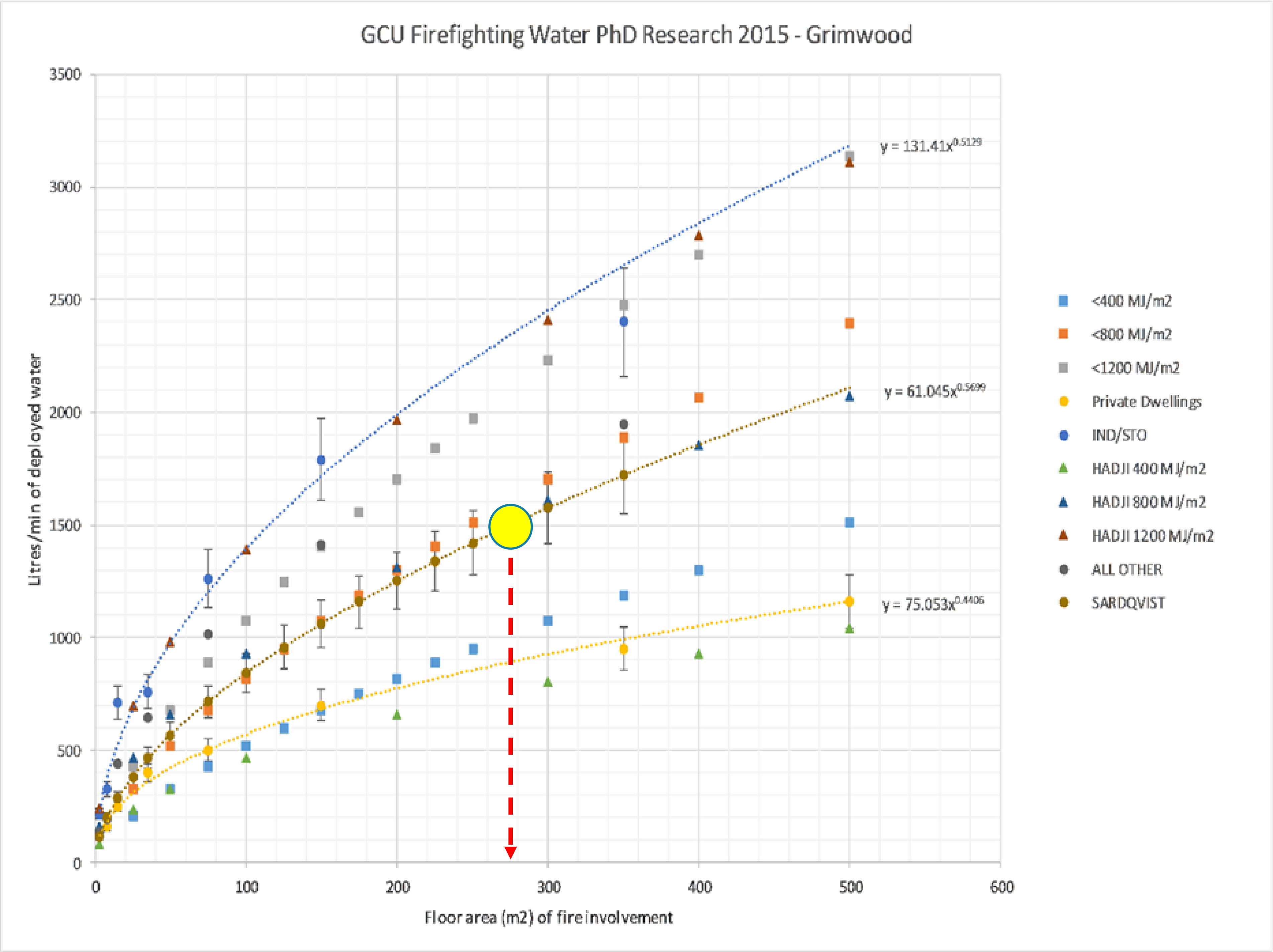


900 Square Metres – 1,500 L/min



900 Square Metres – 1,500 L/min




GCU Firefighting Water PhD Research 2015 - Grimwood
Litres/min of deployed water
Floor area (m2) of fire involvement
0
500
1000
1500
2000
2500
3000
3500
0
100
200
300
400
500
600
y = 131.41x^0.5129
y = 61.045x^0.5699
y = 75.053x^0.4406
<400 MJ/m2
<800 MJ/m2
<1200 MJ/m2
Private Dwellings
IND/STO
HADJI 400 MJ/m2
HADJI 800 MJ/m2
HADJI 1200 MJ/m2
ALL OTHER
SARDQVIST

Open floor space in office fires – Fire Spread Rates – Paul Grimwood IFP (IFE) Journal August 2018

London 2004

- $24\ m^2/min$
- 29 mm/second

Chicago 2003

- $15\ m^2/min$
- 27 mm/second

Los Angeles 1988

- $25\ m^2/min$
- 36 mm/second

All technical perspectives articles and features are sense check reviewed before publication. To submit your articles for IFP Journal publication please email Stephanie.morris@ife.org.uk

Structural fire engineering: realistic 'travelling fires' in large office compartments

Paul Grimwood PhD FIFireE Principal Fire Engineer, Kent Fire and Rescue Service, reports

The speed a fire develops in large open-plan office compartments >150m2 is reasonably well understood by experienced firefighters. Such fires will not conform to typical flashover fire spread rates commonly observed in smaller compartments, but will be seen to travel at a far slower pace across open-plan office floors. It has recently been suggested that this reduced rate of fire spread may have some alternative impacts on structural heat transfer to those provided in the Eurocode and as such, is now beginning to have greater influence on modern design parameters. We already have some very tall buildings on our skylines where fire resistance provisions have been analysed in a way to account for travelling fire methodology, but it is perhaps both prudent and relevant that previous real fire experience is also researched more closely by design engineers in order to establish some wider validation and provide more confidence in such an approach.

Under the expert guidance of Professor Guillermo Rein and Dr Adam Sadowski (Imperial College) and guest speaker Dr Panos Kotsovinos (Arup), I was fortunate enough to take part in the 2018 MSc Module on Structural Fire Engineering based at Imperial College London, where serving fire safety and senior operational officers are more than encouraged to gain some invaluable experience.

The nine-week module begins with an introduction to fire dynamics and fire spread followed by an investigation into the heat transfer mechanisms of conduction, convection and radiation. The mechanical and thermal properties of steel and concrete at elevated temperatures are described, as are the effect of thermal strains on simple structural systems. The MSc module introduces students to both prescriptive and performance-based design according to the Eurocode, concluding with an advanced computational design project using ABAQUS.

The relevance of this teaching is to develop a greater awareness and understanding amongst structural engineers in how fire may spread horizontally in various ways throughout enclosures and by vertical extension to involve multi-floor levels. Then, most importantly, detailing how heat transfer analyses into key structural elements are undertaken across the building frame so that buildings involved in fire can be most effectively protected from disproportionate collapse whilst under fire attack. That is protected for a reasonable period of time to enable occupants to escape and/or firefighters to undertake effective firefighting intervention and rescue. This creates a speciality role for the structural fire engineer, where prescriptive design codes might be considered inapplicable for the design of large, complex or tall structures.

As an introductory 'taster' session to the MSc module, Professor Rein introduced some of the most recent academic research undertaken by Rein and his students[1] (based on their earlier research published in 2011[2]) describing travelling fire spread in large open-plan office buildings. Other research into travelling fires undertaken by the University of Edinburgh has also been recently published[3]. It has long been known by the fire service, but more recently acknowledged by academics, that fires in large office compartments (>150 m^2) take a much longer period of time than an instantaneous fully developed flashover fire before flaming combustion reaches the furthest wall or area. In effect the fire 'travels' across the surfaces of the fuel load at a specific rate of spread, determined by various fuel configurations, compartment geometry/layout and ventilation factors. This specific form of fire development has been noted by Rein's students to form two distinct zones:

(a) the near field and, (b) the far field. The far field model represents smoke temperatures, which decrease with distance from the near field (steady-state fire zone) due to mixing with air. Most importantly from a structural engineer's viewpoint, this has quantitative impacts on the amount and

Estimated Building Fire Spread Rates (Grimwood)
According to on-scene command reports, videos, CCTV and fire timed messages

Interstate Bank fire Los Angeles 1988 12th floor 1,625 m^2 surrounding a 511 m^2 central core 100 per cent fire involvement Fire spread to involve four more upper floors	24.6 m^2/min	36 mm/s Fire took 66 minutes to travel 142.4 metres (average length of fire zone around a central core) Note: if using the external wall of the compartment the spread rate would be close to 48 mm/s, but the average (central line of measure) is taken as above	This rate of fire spread would reach the limits of suppressive capability of a 550 L/min hose-line within 4-5 minutes; or a 750 L/min hose-line within 7-8 minutes of beginning a fire growth-curve.
CCAB 67 West Washington fire Chicago 2004 12th floor – 264 m^2 (230 m^2 fire area) 24 x 11m 87 per cent fire involvement (two end rooms not damaged)	15.3 m^2/min Slower area-based fire spread in comparison, caused by a cellular non-FR office on one side of open-plan area	27 mm/s Fire took 15 minutes to travel 24 metres	This rate of fire spread would reach the limits of suppressive capability of a 550 L/min hose-line within 7-8 minutes; or a 750 L/min hose-line within 10-11 minutes of beginning a fire growth-curve.
Telstar House fire [illegible] [illegible] 1,120 m^2 100 per cent fire involvement Fire spread to involve four more upper floors	24.3 m2/min	29 mm/s Fire took 46 minutes to travel 80 metres	This rate of fire spread would reach the limits of suppressive capability of a 550 L/min hose-line within 4-5 minutes; or a 750 L/min hose-line within 7-8 minutes of beginning a fire growth-curve.
Churchill Plaza fire Basingstoke 1991 8th Floor 1,673 m^2 100 per cent fire involvement Fire spread to involve two more upper floors	Undetermined - Fire was under-ventilated for over an hour prior to self-venting and subsequently being heavily wind driven under a fuel controlled burning regime	Undetermined - Fire was under-ventilated for over an hour prior to self-venting and subsequently being heavily wind driven under a fuel controlled burning regime	N/A

The research demonstrated that commercial office fires and industrial storage fires are likely to spread beyond any practical firefighting capability within the 8-12 minutes, where a fire growth curve is established.

Technical Perspectives

All technical perspectives articles and features are sense check reviewed before publication.
To submit your articles for IFP Journal publication please email Stephanie.morris@ife.org.uk

Structural fire engineering: realistic 'travelling fires' in large office compartments

Paul Grimwood PhD FIFireE Principal Fire Engineer, Kent Fire and Rescue Service, reports

The speed a fire develops in large open-plan office compartments >150m2 is reasonably well understood by experienced firefighters. Such fires will not conform to typical flashover fire spread rates commonly observed in smaller compartments, but will be seen to travel at a far slower pace across open-plan office floors. It has recently been suggested that this reduced rate of fire spread may have some alternative impacts on structural heat transfer to those provided in the Eurocode and as such, is now beginning to have greater influence on modern design parameters. We already have some very tall buildings on our skylines where fire resistance provisions have been analysed in a way to account for travelling fire methodology, but it is perhaps both prudent and relevant that previous real fire experience is also researched more closely by design engineers in order to establish some wider validation and provide more confidence in such an approach.

Under the expert guidance of Professor Guillermo Rein and Dr Adam Sadowski (Imperial College) and guest speaker Dr Panos Kotsovinos (Arup), I was fortunate enough to take part in the 2018 MSc Module on Structural Fire Engineering based at Imperial College London, where serving fire safety and senior operational officers are more than encouraged to gain some invaluable experience.

The nine-week module begins with an introduction to fire dynamics and fire spread followed by an investigation into the heat transfer mechanisms of conduction, convection and radiation. The mechanical and thermal properties of steel and concrete at elevated temperatures are described, as are the effect of thermal strains on simple structural systems. The MSc module introduces students to both prescriptive and performance-based design according to the Eurocode, concluding with an advanced computational design project using ABAQUS.

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40 International Fire Professional August 2018 Issue No 25 www.ife.org.uk

The provision of automatic fire suppression systems or effective compartment size reductions by design in such premises may be critical.

THE HAZARDS OF SMOKE SHAFTS & AUTOMATED VENT OPENINGS TO FIREFIGHTERS

WHERE IS IT OK TO VENTILATE AN ACTIVE FIRE BUILDING?

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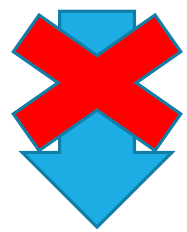

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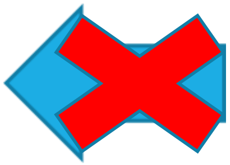


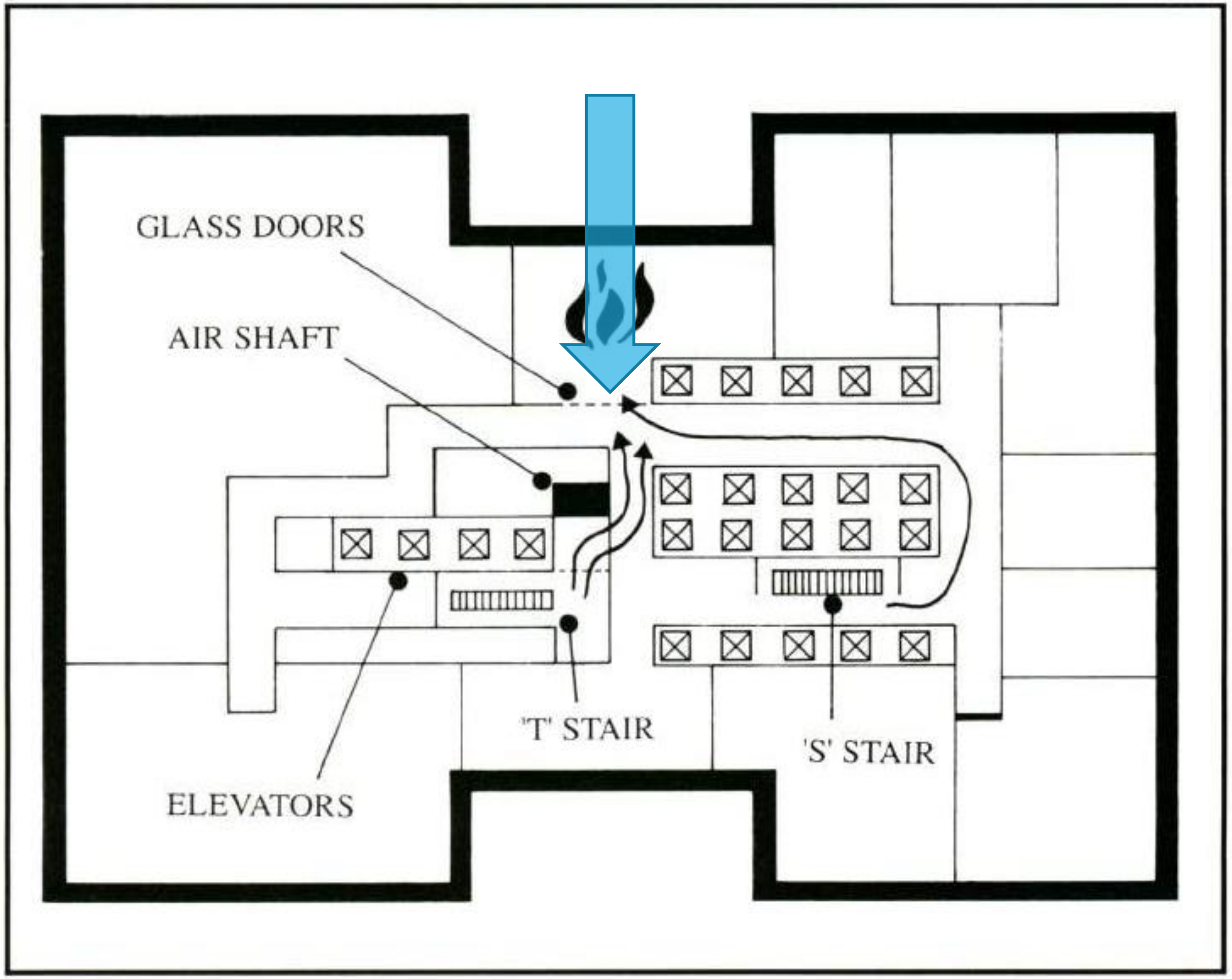
WHERE IS IT OK TO VENTILATE AN ACTIVE FIRE BUILDING?

Advancing a hose-line with a smoke shaft to the rear, NYC EMPIRE STATE BUILDING FIRE 51ST FLOOR 1990

EMPIRE STATE BUILDING FIRE NYC 1990

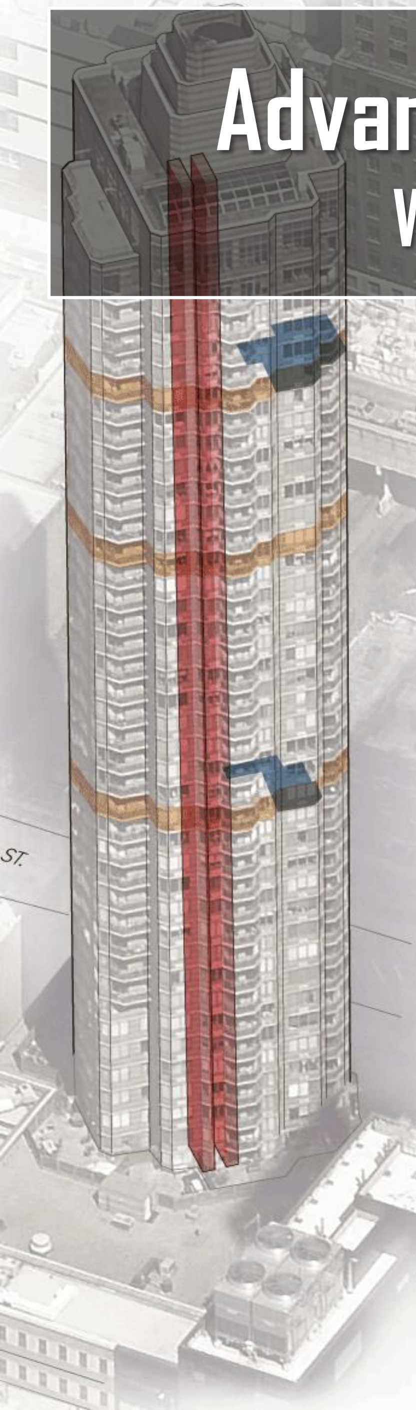
As there was a **smoke shaft located immediately behind** the advancing firefighters protecting an evacuation stairway, the flow path exacerbated the heat and smoke conditions being driven directly at the firefighters. Despite two 65mm hose-lines being advanced towards the fire the firefighters were unable to make little headway against the flames.

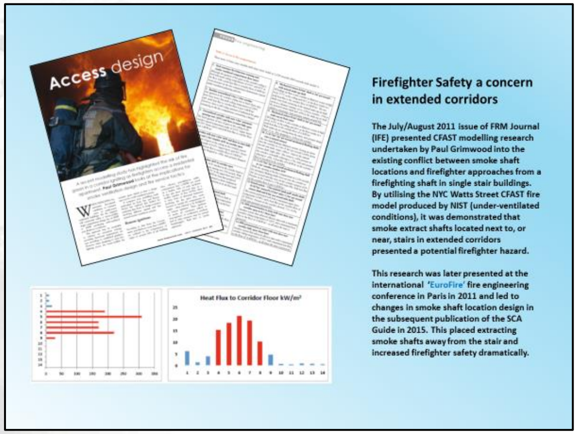
A change in strategy saw firefighters successfully redeploy using an alternative corridor, avoiding the negative flow-path created by a smoke shaft behind their advance.


GLASS DOORS
AIR SHAFT
ELEVATORS
'T' STAIR
'S' STAIR

Advancing a hose-line along the corridor,

WHY does the fire turn right towards you?



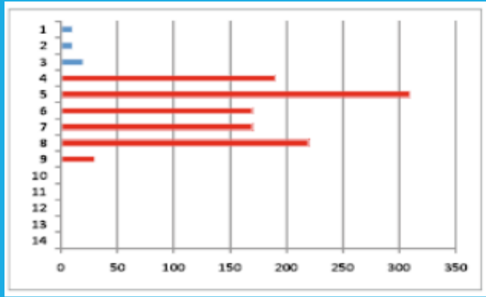


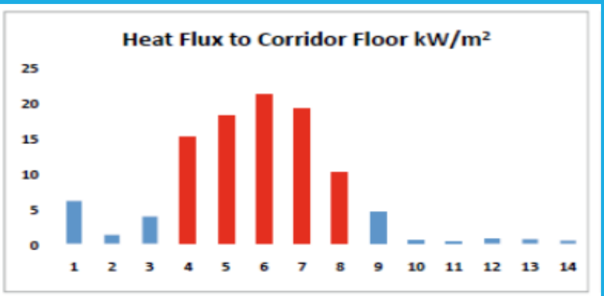
'PRESSURE DIFFERENTIALS'

If the pressure differential is reduced behind the firefighters advance, either through the opening of a smoke shaft or a stair door, the fire will head towards the lowest pressure.

The July/August 2011 issue of FRM Journal (IFE) presented CFAST modelling research undertaken by **Kent Fire and Rescue Service** into the existing conflict between smoke shaft locations and a firefighter's approaches from a firefighting shaft in single stair buildings.

This research was later presented at the international '**EuroFire**' fire engineering conference in Paris in 2011 and led to changes in smoke shaft location design in the subsequent publication of the SCA Guide in 2015. This placed extracting smoke shafts away from the stair and this one change increased firefighter safety dramatically.

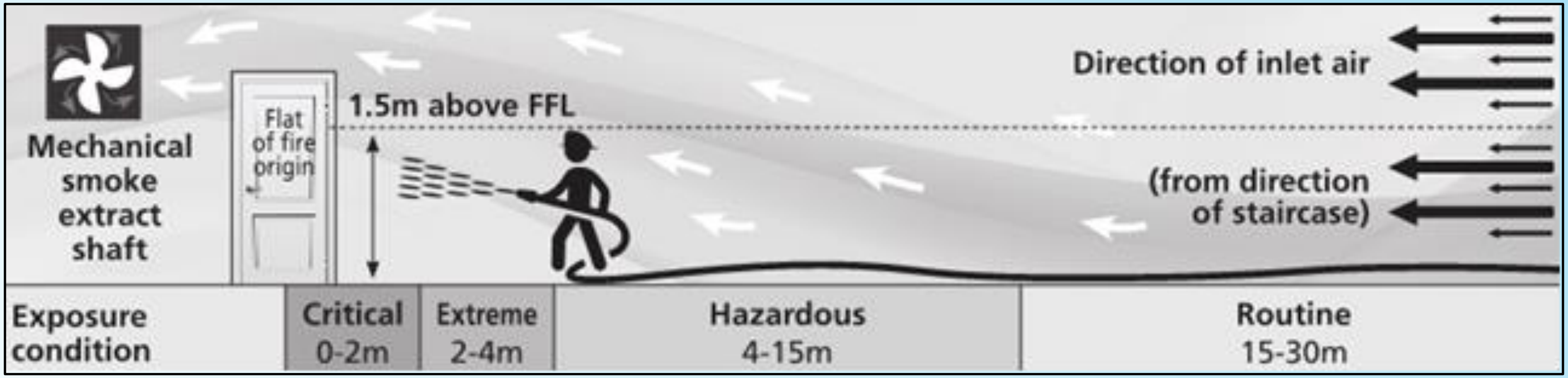




Mechanical Smoke Ventilation Systems (MSVS) (SCA Guidance 2015)

Exposure Condition	Maximum exposure time (minutes)	Maximum air temperature (^{0}C)**	Maximum radiated heat flux (kW/m^2)	Remarks	Recommended distance from apartment door*
Routine	25	100	1	General fire-fighting	15-30m
Hazardous	10	120	3	Short exposure with thermal radiation	4-15m
Extreme	1	160	4 – 4.5	For example, snatch rescue scenario	2-4m
Critical	<1	>235	>10	Considered life threatening	0-2m

The design guidance produced by the Smoke Control Association in 2015 for extended corridor MSVS took into account the 2011 research and demonstrated how placing the extracting shaft away from the stairs will improve firefighter safety and reduce exposure to unnecessary heat and smoke during firefighting.



“Experience is what you get five minutes after you needed it”

‘Don’t let us look back tomorrow and say what we did today, we could have done better’ . . . .

PLAN – PREPARE – EQUIP – TRAIN for it