



# High-rise Model SOP

## High-rise Fire-fighting Model Procedure (SOP)

There have been several major fires involving the upper floors of high-rise buildings during the past decades. This global experience is brought together here to produce a model fire-fighting Standard Operating Procedure SOP, based on lessons learned.

This approach to high-rise fire-fighting incorporates many of the major lessons learned at previous fires in tall structures into one document. It is equally applicable to both open-plan office buildings or compartmented residential tower blocks. The tactical approaches are generally the same although office towers generally demand greater resources and more in-depth levels of incident command.

Many of the lessons



learned were at the loss of fire-fighters lives. It would be wrong not to share this experience globally and we owe it to those who have gone before that we will endeavour to prevent similar life losses again.

Many building occupants have also died in high-rise fires and with hind-sight, some of these deaths may

have been preventable if we had had the knowledge and experience then to optimise our tactical approaches to such fires.

This model SOP is flexible and may be adapted to suit local needs. However, it is important to emphasise here that any changes made may not account for past lessons learned.

### A Fire in a High-rise Building Presents Challenges that may be Unfamiliar to Fire Commanders

One of the biggest errors a Fire Commander can make is to believe that a fire on an upper floor of a high-rise building is likely to present the same challenges as one at ground level!

The effects on resource requirements; logistical

demands; staffing arrangements; command system; and physical demands on fire-fighters at a serious working high-rise fire are difficult to imagine and even train for.

The time delay in implementing a plan and the difficulties in communi-

cating a plan means that a successful and safe outcome relies on an effective pre-plan; familiarity with the building; well trained and experienced fire-fighters; adequate resources as well as sufficient staffing levels and equipment from the outset.

#### Learning Outcomes:

1	Effective Command from the outset is Needed
2	An effective SOP Document is Essential
3	Communications are always difficult
4	Contingency plans may be needed
5	Water-flow-rates may be inadequate
6	Incident Command is likely to be fragmented
7	Logistical demands present a real challenge

#### Special points of interest:

- Wind can play havoc on the upper floors, even where it is not considered a problem at ground level!
- Natural air dynamics inside a tall building may cause fires to behave unpredictably
- At least ten fire-fighters are required to fully implement the basic response plan and resources should be tripled as a minimum on any sign of a working fire—eg; 'heavy' or fast moving smoke, or flames seen issuing on arrival
- Ineffective deployments to the upper floors can create problems and cause the IC to play 'catch-up' with Command & Control

	<h1 style="text-align: center;">High-rise Fire-fighting Standard Operating Procedure (SOP)</h1>	<p style="text-align: center;">Draft Model Version 2/2007 Fire2000.com GRIMWOOD.P</p>

**Contents**

1. *Pre-planning*
2. *Information Retrieval*
3. *Risk Assessment*
4. *Critical Control Measures*
5. *On Arrival – Key Tasks*
6. *Primary Incident Command Assignments*
7. *Deployment of the Reconnaissance Team*
8. *Equipment of the Reconnaissance Team*
9. *Establishing a Bridgehead*
10. *Purpose of the Bridgehead*
11. *Search; Rescue & Evacuation*
12. *Rapid Deployment Measures*
13. *Critical Task Assignments on the Secondary Response*
14. *Incident Command System (Secondary Assignments)*
15. *Crew Rotation System at Serious Fires*
16. *Additional equipment needed at the Bridgehead & Staging area*
17. *Training for High-rise Response*
18. *Air dynamics and Wind effects at high-rise fires*
19. *Fire Suppression Flow-rates in High-rise Buildings*
20. *Communications at High-rise Fires*
21. *Aide-Memoiré*

<b>A.</b>	<b>On Arrival -</b>	
	<ul style="list-style-type: none"> <li>• Ten firefighters are needed on-scene to implement the <b>primary response</b> plan fully</li> </ul> <ol style="list-style-type: none"> <li><b>1. Forward Fire Commander</b></li> <li>2. Pump Operator</li> <li>3. Fire Attack</li> <li>4. Fire Attack</li> <li>5. BA Entry Control Officer</li> <li><b>6. Lobby Commander</b></li> <li>7. Primary Search</li> <li>8. Primary Search</li> <li>9. Water Support</li> <li>10. Lift Controller</li> </ol>	

	<ul style="list-style-type: none"> <li>• A Reconnaissance Team should take control of a fire lift and be deployed by the Incident Commander, following briefing, to a location at least four floors below the reported fire floor</li> <li>• The objectives of this reconnaissance team should be to locate the fire; advance the risk assessment and establish a Bridgehead in a smoke free and protected area, at least one floor below the fire</li> <li>• As control measures they should establish a fire attack as a primary action; launch fire-fighting actions from the bridgehead; or from a protected fire-fighting lobby fitted with a rising main outlet; advancing towards the fire compartment behind the protection of a charged hose-line; and utilise effective door entry and compartment fire-fighting techniques</li> <li>• Where the first arriving pump is several minutes ahead of the second arriving pump the reconnaissance team should comprise of the Incident Commander and two firefighters, all equipped with BA and a high-rise equipment pack</li> <li>• Rapid Deployment Procedure is a last resort and should be undertaken with a fire attack hose-line wherever possible</li> </ul>	
<b>B.</b>	<b>Incident Command on Arrival</b>	
	<ul style="list-style-type: none"> <li>• The two primary roles to be undertaken in the Incident Command function are those of –             <ol style="list-style-type: none"> <li>1. Lobby Commander</li> <li>2. Forward Fire Commander</li> </ol> </li> <li>• The Lobby Commander will be the senior officer in a two pump attendance that arrives together, or closely within a minute</li> <li>• Where the second pump is delayed by several minutes, the first officer on scene will undertake the Forward Fire Commander’s role and form part of the initial Reconnaissance Team</li> <li>• The second arriving officer will become the Lobby Commander and will deploy the remaining crew members to make up the six person reconnaissance team and establish control of the fire lifts</li> <li>• Where the Incident Commander has deployed as the Forward Fire Commander then any subsequent handover in incident command must be undertaken at the Bridgehead, where the handing over officer may remain as Forward Fire Commander and the new Incident Commander will return to the ground floor to take over the lobby command post</li> </ul>	

1.	<b>Pre-planning -</b>	
	<ul style="list-style-type: none"> <li>• Fires on the upper floors of high-rise buildings present individual challenges to firefighters not encountered in low-rise structures. Office towers or residential tower blocks each present their own specific challenges and efforts must be made to familiarise with local structures. The layout of buildings; means of access and egress; building security issues; inbuilt fire protection features; local water supplies and occupancy loads are all relevant factors.</li> </ul>	
2.	<b>Information Retrieval –</b>	
	<ul style="list-style-type: none"> <li>• It is essential that a process of information retrieval is begun immediately on, or even prior to, fire service arrival</li> <li>• Locate any fixed sources of information such as building plan boxes; hydrant plates etc</li> <li>• Building occupants and officials must be questioned to gain important information and confirmation of fire location; occupant status; building systems etc</li> <li>• It is important that highly relevant information is immediately shared and communicated to all fire-ground commanders and key operational staff on-scene</li> </ul>	
3.	<b>Risk Assessment –</b>	
	<ul style="list-style-type: none"> <li>• The risk assessment begins on approach, taking in all known information about the structure; observing signs of smoke or fire penetrating the outer skin of the building; taking into account the volume of any such indicators and the velocity of smoke</li> <li>• Ideally, it is important to gain an angled view of a high-rise structure to begin the risk assessment process. It is unlikely that a complete 360° walk-around will be immediately available but a corner position will give a good view of at least two sides of the structure</li> <li>• Where flaming combustion or smoke is observed issuing under pressure, an immediate assistance message should be sent as the resources needed to deal with a working fire in a tall structure are greatly magnified in comparison to a similar fire in a low-rise structure</li> <li>• The Forward Fire Commander should take every opportunity to expand the risk assessment at the fire's location by checking for obvious warning indicators such as fire and smoke behaviour; feeling for heat at various heights on doors serving the suspected fire compartment; checking letter post boxes etc</li> </ul>	

4.	<b>Critical Control Measures –</b>	
	<ul style="list-style-type: none"> <li>• Approach the fire with adequate staffing and equipment, strictly according to procedure</li> <li>• Ensure the procedure is strictly adhered to; any deviation from procedure must be accountable with sound reasoning at a later stage</li> <li>• Keep crews together and under supervision</li> <li>• Establish a confirmed Bridgehead at a safe location, at least one floor below the fire</li> <li>• Launch fire-fighting operations from a protected lobby or area with rising main outlet; attempting to maintain the integrity of the stair-shaft at all times</li> <li>• Advance towards the fire behind the protection of a charged hose-line</li> <li>• Utilise effective door entry and compartment fire-fighting techniques inline with the type of nozzle in use</li> <li>• Rapid Deployment procedure should be avoided unless staffing is limited on the first attendance and there are exceptional circumstances</li> <li>• It should be acknowledged that a prompt fire suppression action may serve to save lives</li> <li>• Stair-shaft integrity should be maintained as far as possible. Whilst it is recognised that building design may, in some situations, place the rising main outlets in a stair-shaft, every effort should be made to keep doors to the stairs closed as much as possible</li> <li>• Prior to opening a door into the stair-shaft from the fire floor, a check should be made for occupants in the stair-shaft for at least five floors above the fire floor</li> <li>• Any stair-shaft contaminated by smoke should be prioritised for secondary searches on arrival of the secondary (assistance) response</li> </ul>	
5.	<b>On Arrival – Key Tasks–</b>	
	<ul style="list-style-type: none"> <li>• Dynamic risk assessment of the exterior of the structure – it is important to gain an angled view from at least one corner of the building to view at least two sides of the structure</li> <li>• Gather information from evacuating occupants or building officials as to the fire’s exact location – communicate this immediately to the assigned Forward Fire Commander; pump operator and brigade control, if different from the initial response call-sheet</li> </ul>	

	<ul style="list-style-type: none"> <li>• Gain control of the fire lift/s</li> <li>• Establish the status of building evacuation and immediately monitor or take control of this function</li> <li>• Deploy a fire reconnaissance team to four floors below the reported fire floor, via the fire lift, to confirm the fire's location and then establish a bridgehead in a smoke free and protected area, at least one floor below the fire floor</li> <li>• It should be the general aim to ensure a water supply is effected to the rising main within <b>three minutes</b> of arrival and further augmented into the fire pump from a hydrant within <b>five minutes</b> of arrival; or within <b>seven minutes</b> of arrival if a second pump is used inline</li> <li>• A particularly high standard of pump operating is required at high-rise fires. With this in mind it is essential that the pump operator is not expected to fulfil other roles or tasks and remains at the pumping panel to observe and adjust flow demands as necessary</li> <li>• A 'water support' firefighter (possibly the second pump operator) will be assigned to augment the water supply and support the pump operator; and primarily to act as command support in sending informative or assistance messages to control</li> <li>• Establish a Lobby Command Post in the ground floor entrance lobby, or suitable area nearby if this is not considered safe or viable</li> <li>• Send an informative and/or assistance message to control within three minutes of arrival</li> <li>• <b>Staffing Assignments on the initial response are as follows –</b> <ol style="list-style-type: none"> <li>11. Forward Fire Commander</li> <li>12. Pump Operator</li> <li>13. Fire Attack</li> <li>14. Fire Attack</li> <li>15. BA Entry Control Officer</li> <li>16. Lobby Commander</li> <li>17. Primary Search</li> <li>18. Primary Search</li> <li>19. Water Support</li> <li>20. Lift Controller</li> </ol> </li> <li>• Therefore, to implement the primary response plan fully, a minimum of ten firefighters are needed on scene</li> <li>• The status and integrity of the rising main outlets should be checked at the earliest opportunity, as resources allow, to ensure pressure and flow is not lost from the main due to previous vandalism</li> </ul>	
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6.	<b>Primary Incident Command Assignments –</b>	
	<ul style="list-style-type: none"> <li>• Lobby Commander (Lobby)</li> <li>• Forward Fire Commander (FFC) (Reconnaissance &amp; Bridgehead)</li> </ul>	<p><i>Dependant on the arrival times of first arriving appliances the Incident Commander may take either role</i></p>
7.	<b>Deployment of the Reconnaissance Team –</b>	
	<ul style="list-style-type: none"> <li>• The reconnaissance team should consist of a minimum of six fire-fighters wherever possible             <ol style="list-style-type: none"> <li>1. Forward Commander</li> <li>2. BA Wearer</li> <li>3. BA Wearer</li> <li>4. BA Wearer</li> <li>5. BA Wearer</li> <li>6. BA Entry Control Officer</li> </ol> </li> <li>• A seventh crew member should immediately be assigned the role of <b>lift controller</b> - They should immediately take control of the fire lift/s – the lift controller will remain in charge of the lift until relieved of this role and return to the ground floor lobby after each transport – This fire-fighter will have fire-ground radio communication at all times</li> <li>• They should take the high-rise pre-packs of equipment and report immediately to the ground floor lift lobby</li> <li>• When ordered to by the Incident Commander the reconnaissance team should ascend via the fire lift, remaining together as a six-person crew where possible, to a position at least four floors below the reported fire floor – all fire-fighters ascending to the upper floors will don but not start SCBA breathing apparatus</li> <li>• Where the fire lift will not accommodate seven fire-fighters together with equipment pre-packs, or where a single fire appliance arrives on-scene some minutes ahead of the next responding appliances, a three-person reconnaissance team will ascend and exit the lift at least four floors below the fire floor.</li> <li>• Three-person Reconnaissance Team – <b>In the case of a single appliance arriving alone</b>, several minutes ahead of further appliances, the IC will become the Forward Fire Commander <b>and</b> lift controller and will exit the lift with at least two fire-fighters at a point four floors or more, below the reported fire floor. The IC will then immediately return the lift to the ground floor on exiting with the crew. Where the remaining reconnaissance team members are waiting to ascend they should do so immediately and communicate to the initial crew that they are closely following.</li> </ul>	

	<ul style="list-style-type: none"> <li>• Each crew of three reconnaissance fire-fighters will be equipped with BA; and carry a high-rise pre-pack containing at least - one nozzle; 30 metres of hose; a breaking in tool; lift/riser keys; Stage One BA board with rapid deployment facility and bolt croppers. They will also be equipped with radio communications.</li> <li>• On arrival of additional fire pumps a further three reconnaissance fire-fighters will immediately make their way to a point at least four floors below the reported fire floor and if staffing will allow; a lift controller should also be assigned. The assignment of lift controller should be a permanent position as soon as ten fire-fighters are on scene.</li> <li>• The crew commander of the second arriving appliance will automatically become the Lobby Commander whilst the Forward Fire Commander will remain with the reconnaissance crew/s on the upper floors.</li> <li>• Where the most senior officer has initially ascended as part of the reconnaissance team he/she will retain the role of Incident Commander (IC) until relieved of such command by a more senior officer arriving on the fire-ground. Handover of command &amp; control should be undertaken by 'face to face' contact. The new IC should then return to the lobby and relieve the lobby commander.</li> <li>• Crews on the fire floor should <b>always</b> remain under the direct supervision and control of a Forward Command Officer sited at the Bridgehead, or a Fire Attack Commander working in SCBA beyond the Bridgehead, once assigned.</li> <li>• The first arriving members of the reconnaissance team should then ascend via a protected stairway to the reported fire floor whilst under the Forward Fire Commander's control, briefly checking each floor for smoke as they go</li> </ul>	
8.	<p><b>Equipment of the Reconnaissance Team</b>  <b>High-rise Pre-packs</b></p>	
	<ul style="list-style-type: none"> <li>• All members of the reconnaissance team, including the team commander and the lift controller, should be rigged in BA, donned but not started</li> <li>• <b>Hose &amp; Equipment pre-packs</b> (may be split across two packs) should carry the following items -</li> <li>• 60m of 51mm hose (or a mix of 70mm and 45mm) in 15 metre lengths</li> <li>• A suitable fog/jet combination nozzle with flow control handle and pistol grip, providing a minimum flow-rate of 500 LPM at a branch inlet pressure of 4 bars</li> </ul>	

	<ul style="list-style-type: none"> <li>• A suitable solid stream smooth-bore nozzle with flow control handle and pistol grip, providing a minimum flow of 470 LPM at a branch pressure of 2 bars</li> <li>• BA Entry Control Board with rapid deployment facility</li> <li>• Breaking in tool</li> <li>• Lift/Riser keys</li> <li>• Bolt Cutters</li> <li>• Thermal Imaging Camera</li> </ul>	
9.	<b>Establishing a Bridgehead</b>	
	<ul style="list-style-type: none"> <li>• As soon as the fire's exact location has been confirmed and communicated to the Lobby Commander the reconnaissance team should return to the relative safety of a <b>protected area</b> to set up a bridgehead, taking any opportunity to evacuate occupants in the immediate area as they go</li> <li>• At no time should the reconnaissance team split apart from each other. There should always be a minimum of two or five firefighters under the direct supervision of, and in visible contact with, the Forward Commander, until they begin their advance towards the fire compartment behind the protection of a charged hose-line.</li> <li>• At this point the Forward Fire Commander should meet up with the remaining members of the reconnaissance team, selecting a suitable location for setting up the bridgehead. This should be in a protected smoke free area <b>at least one floor below the fire floor</b>. This location should immediately be communicated to the Lobby Commander</li> <li>• On the Bridgehead being established, the reconnaissance team is immediately disbanded and re-organised into (a) Fire Attack; (b) Primary Search; and (c) BA Entry Control assignments, under the direct supervision of the Forward Fire Commander</li> <li>• Fire-fighting operations should then be launched from the bridgehead where BA Control will be sited</li> <li>• The <b>Fire Attack team</b>, consisting of two fire-fighters donned in BA under air, will advance from the bridgehead; or a protected fire-fighting lobby fitted with rising main outlet; behind the protection of a charged hose-line. The integrity of the stair-shaft must be maintained smoke free as far as possible</li> </ul>	

	<ul style="list-style-type: none"> <li>• A Further two fire-fighters donned in BA under air will accompany them to assist in advancing the hose-line; forcing entry to the fire compartment and then initiating a <b>primary search</b> of the immediate fire area</li> <li>• The Forward Commander will take a position adjacent to the BA Control Officer and relay important communications to the Lobby Commander</li> </ul>	
10.	<b>Purpose of the Bridgehead</b>	
	<ul style="list-style-type: none"> <li>• The Bridgehead provides a safe working 'platform' from which to launch fire-fighting and rescue operations using a controlled approach to the fire floor</li> <li>• The Bridgehead serves as a sector command post in the Incident Command System where the Forward Fire Commander is located</li> <li>• The Bridgehead serves as a safe location near the fire floor from where BA Control may be implemented. The BA Entry Control Officer is able to carry out entry control procedures from this position in a safe and effective manner</li> </ul>	
11.	<b>Search; Rescue &amp; Evacuation</b>	
	<ul style="list-style-type: none"> <li>• Primary Search is undertaken by two members of the initial reconnaissance team under the direct instructions of the Forward Fire Commander. They will also assist the Fire Attack team with advancing the primary attack hose-line and forcing entry to the fire compartment</li> <li>• The primary search zone is defined as those areas on the fire floor closest to the fire; or mostly affected by smoke and heat.</li> <li>• The primary search team will work in close coordination with the fire attack team and not work ahead of the hose-line without their agreement</li> <li>• Efforts must be made to either to control, suppress or isolate the fire, prior to the primary search team advancing into areas ahead of, or beyond the safety of the hose-line</li> <li>• Areas such as corridors and lobbies leading to the fire compartment may also become heavily contaminated by heat and smoke and should form part of the primary search zone at the earliest opportunity</li> </ul>	

	<ul style="list-style-type: none"> <li>• Search &amp; evacuation of areas adjacent to the fire floor should be considered as 'secondary' search zones. These areas should include (a) stair-shafts; (b) floors above the fire; (c) roof area; etc. These areas are primarily and generally the responsibility of secondary response units</li> <li>• In some buildings an evacuation system may be in place that utilizes a building or zoned alarm or Public Address system. This system should be immediately monitored at source by the Lobby Commander on arrival for operation and effectiveness, in accordance with tactical approaches being made. For example, one stair-shaft may be in use as a fire attack stairway leaving the other as an evacuation stairway. Such information is relevant to any message be sent around the building. The responsibility of building evacuation is handed over to a senior officer on the secondary response.</li> <li>• It is essential that immediate and urgent attention is given to all secondary search areas as soon as resources allow and it is the responsibility of the Lobby Commander to ensure this role is assigned and supervised at the earliest opportunity</li> <li>• Some buildings may have security features that prevent access to floors from the stair-shaft. These self locking doors may serve to hinder the fire-fighting efforts and may even trap building occupants in stair-shafts that later become heavily contaminated by smoke and heat. This is the type of hazard that should be pointed out during building familiarisation visits.</li> </ul>	
<b>12.</b>	<b>Rapid Deployment Measures</b>	
	<ul style="list-style-type: none"> <li>• TB 1/97 deals with Rapid Deployments under BA control procedure where persons are known to be in urgent need of assistance inside a building</li> <li>• Such an deployment is only undertaken in exceptional circumstances where resources and staffing on the initial attendance are limited and normal approaches under Stage One BA procedure cannot be effectively implemented</li> <li>• Any such deployment should be closely monitored and supervised by an outside commander who is in radio contact with the crew prior to, and during, the entry</li> <li>• Rapid deployments are generally the result of firefighters being placed into positions where they may face the 'moral dilemma' of seeing, hearing or knowing there are confirmed occupants trapped within</li> <li>• The primary consideration should be to assess the occupants viability as a live victim, prior to any such deployment</li> </ul>	

	<ul style="list-style-type: none"> <li>• To prevent firefighters being placed into such a position in the first place, every opportunity should be taken to (a) keep crews together whilst under direct supervision; (b) launch fire-fighting operations from a protected area; (c) advance towards the fire behind the protection of a charged hose-line; (d) encourage firefighters that a fire suppression action or a simple fire isolation action might serve to save lives on their own</li> <li>• Where a rapid deployment becomes necessary, correct procedure should be followed, using the rapid deployment BA control board facility</li> <li>• Consideration should be given to the <i>three-person rapid deployment procedure</i>* utilising a door control assignment in an effort to control and monitor the fire development</li> </ul>	
13.	<b>Critical Tasking on the Secondary Response –</b>	
	<ul style="list-style-type: none"> <li>• This procedure requires at least ten firefighters to be on-scene in order to be able to implement the primary functions of reconnaissance; lift control; bridgehead formation; fire attack; primary search; water supply and basic incident command</li> <li>• The secondary response is defined as additional resources and staffing called in to assist the primary response</li> <li>• Critical roles and tasks of the secondary response include the following –             <ol style="list-style-type: none"> <li>1. Secondary support (back-up) hose-line on the fire floor</li> <li>2. Additional attack hose-line/s from alternative strategic positions</li> <li>3. BA Emergency Team (RIT)</li> <li>4. Secondary Search &amp; Evacuation of stair-shafts, unaccounted lift cars and all floors and areas above the fire, including the roof</li> <li>5. BA Relief Support (3-crew rotation system)</li> <li>6. Logistics – transporting BA cylinders and equipment to the upper floors and setting up a staging post</li> <li>7. Tactical Ventilation Support</li> <li>8. Evacuation of building occupants according to strategic needs and self evacuation that may already be in progress</li> <li>9. Medical Triage Post</li> </ol> </li> </ul>	

14.	<b>Incident Command System – Secondary Assignments –</b>	
	<ul style="list-style-type: none"> <li>• Fire Attack Commander (FAC)</li> <li>• Further Fire Attack Sector Commanders as needed</li> <li>• Search &amp; Rescue Commander (SARC)</li> <li>• Safety or Sector Officer (Exterior of Building)</li> <li>• Evacuation Commander</li> <li>• Staging Commander</li> <li>• BA Control Commander</li> <li>• Salvage Commander</li> <li>• Command Support</li> </ul>	
15.	<b>Crew Rotation System at serious working Fires</b>	
	<ul style="list-style-type: none"> <li>• The three-crew rotation system recognises the need for prompt relief of crews working on the fire floor and elsewhere under arduous working conditions</li> <li>• In high-rise fires, firefighter heart rates can soar in excess of 200 BPM and BA cylinder contents may be depleted rapidly</li> <li>• It has been estimated at previous working high-rise fires that a fresh 30 minute cylinder is needed every 33 seconds and a fresh 45 minute cylinder is needed every 80 seconds.</li> <li>• It was also estimated at fires in the US and the UK that a firefighter was needed for every 25m<sup>2</sup> of fire involvement to ensure strategic objectives were achieved effectively and safely</li> <li>• The three-crew rotation system of relieving firefighters on the nozzle places one team on the nozzle; one team at the bridgehead and one crew in rehabilitation at staging</li> <li>• The three-crew rotation system is needed for each crew working in BA. Therefore forty additional firefighters are needed to provide direct cover for twenty firefighters working in BA</li> </ul>	
16.	<b>Additional Equipment Required at the Bridgehead &amp; Staging Area</b>	
	<ul style="list-style-type: none"> <li>• As already noted, at a serious working high-rise fire, there is a high demand on BA cylinders due to the shorter working durations caused through arduous working conditions</li> </ul>	

	<ul style="list-style-type: none"> <li>• If a fire progresses through several floors of an office tower then anything from 100-300 cylinders may be required</li> <li>• 51mm hose stocks ready and waiting at staging</li> <li>• Interior lighting working from portable generators or building electrical mains supply</li> <li>• Nozzles and hand controlled branches of both fog and smooth-bore design with the ability to provide high-flows; effective throw and fully filled fog patterns at low pressures</li> <li>• Breaking in and forcible entry tools</li> <li>• Thermal Image Cameras</li> <li>• BA Control Support</li> <li>• Oxygen Resuscitators &amp; Triage Support</li> </ul>	
17.	<b>Training –</b>	
	<ul style="list-style-type: none"> <li>• Training firefighters in high-rise fire-fighting should be a practical 'hands-on' process</li> <li>• The Standard Operating Procedure must be regularly covered in a class-room setting and firefighters should be fully familiar with their roles in the tactical plan</li> <li>• Familiarisation visits and frequent exercises in local buildings are essential if firefighters are to develop and maintain an efficient and confident approach to high-rise fire-fighting and rescue operations</li> </ul>	
18.	<b>Air Dynamics &amp; Wind Effects at High-rise Fires</b>	
	<ul style="list-style-type: none"> <li>• The influences of natural air dynamics; stack effects and exterior wind forces have often created havoc in previous fires in tall buildings</li> <li>• It is certain that firefighters will most likely be unfamiliar with such effects and therefore find it almost impossible to anticipate how fires are likely to behave or how smoke is likely to spread in tall structures</li> <li>• The effects of exterior winds are greatly magnified at height and what is a seemingly light wind at ground floor level may create high velocities on upper floors. Many firefighters have been tragically killed or badly burned by such effects</li> </ul>	

	<ul style="list-style-type: none"> <li>The effect of opening internal doors and creating openings in windows, or at roof level in stair-shafts, can completely change the air dynamics associated with fire and smoke movements. Therefore, from a tactical standpoint it is essential that firefighters receive at least some training in the basics of air dynamics in high-rise structures</li> </ul>	
19.	<p><b>Fire Suppression Flow-rates in High-rise Buildings</b></p>	
	<ul style="list-style-type: none"> <li>It has been demonstrated that in glass-fronted high-rise structures with fire involvement in excess of 200m<sup>2</sup>, that some auto-exposure with fire spreading upwards on the building facade is almost inevitable.</li> <li>In many situations, the only way this exterior spread of fire, from floor to floor, can be curtailed is through the application of exterior fire streams.</li> <li>The problems associated with loss of head pressure in rising mains and frictional loss in delivery hose-lines means that pressures available at the nozzle are generally much lower than in low-rise structural fire-fighting.</li> <li>Rising mains are generally designed to provide attack hose-lines with a flow-rate of 500 LPM but due to the problems mentioned above the actual flow-rate may only be around 100-250 LPM. This means attack hose-lines are generally only around 20-50% as effective as routinely expected</li> <li>British Standard rising mains are generally designed to operate at a maximum pressure of 10 bars and BS fire hoses to a maximum of 15 bars</li> <li>Flow-rates based on the average UK residential fire loading have been estimated at around 450-500 LPM (LGA for example). This means a flat (65m<sup>2</sup>) or house (76m<sup>2</sup>) would require this flow-rate to suppress at full involvement in fire</li> <li>A well-involved open-plan office floor may need higher flow-rates as the compartments are larger and the fire loading is greater. However, 500 LPM remains the ideal attack hose-line flow-rate as it offers a perfectly manageable nozzle reaction for interior fire-fighting</li> <li>Where exterior winds are spreading the fire, heat release rate and associated compartment temperatures are likely to be higher and therefore greater flow-rate will be needed to suppress fire during the growth stages of development</li> <li>Working at 10 bars supply pressures a twin fed 100mm dry rising main will provide outlet pressures of 7.3 bars at the 10<sup>th</sup> floor and just 5 bars at the 19<sup>th</sup> floor</li> </ul>	

	<ul style="list-style-type: none"> <li>• If 15m hose-lines are used there will be 0.8 bar friction loss per length at 500 LPM flow</li> <li>• Therefore, a 45m run of hose (3x15m) will lose 2.4bar in friction loss from the rising mains outlet pressure</li> <li>• Automatic nozzles should be avoided as they lose anything between 1-4 bars more at 500 LPM as the flow passes through the nozzle!</li> <li>• Wet rising mains are designed to provide similarly low outlet pressures of 4-5 bar in the UK</li> <li>• Therefore, nozzles providing 450-500 LPM with effective throws at low nozzle pressures are required</li> <li>• Compartment fire-fighting and door entry techniques should be adjusted depending on the type of nozzle in use</li> </ul>	
20.	<b>Communications at High-rise Fires</b>	
	<ul style="list-style-type: none"> <li>• Radio communications may be severely affected in high-rise situations due to (a) the height and design of the building, causing 'dead' spots; and (b) the amount of radio traffic</li> <li>• Pre-planning and research testing during live exercises may demonstrate some of the problem areas</li> <li>• Strict radio protocol should be used at all times and messages should be acknowledged and important content repeated as confirmation of receipt</li> <li>• In some situations it may be necessary to utilise fire-fighter 'runners' to despatch urgent messages that do not appear to be getting through or are not receiving confirmation</li> <li>• Additional use should be made of all communication systems such as internal phones or mobile phones where normal channels are unable to transmit</li> </ul>	
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