Emergency Traffic Accommodation

A Guide for First Responders

U.S. Version

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ABSTRACT

This paper presents traffic control guidelines developed for emergency traffic accommodation. The guidelines are based on the principles for temporary traffic control in work zones which have been adapted for emergency situations. It is noted that although there are formal guidelines for work zones (for example: Part 6 Temporary Conditions, U.S. Department of Transportation, Federal Highway Administration Manual on Uniform Traffic Control Devices for Streets and Highways, 2003 Edition), such procedures and guidelines have not been formalized for emergency situations.

Emergency situations are similar to work zones in that they may violate a driver's expectations and compromise their safety in addition to the safety of crash victims, firefighters, police, and EMS personnel attending the scene. These guidelines have recently been developed for the Calgary Fire Department. This department is required to respond to a broad range of incidents including: collisions involving injuries (where the Jaws-of-Life may be required), fatalities, property damage, hazardous materials releases or spills, and vehicle fires. The roadways include the full spectrum of volumes and speeds up to freeways with annual average daily traffic in excess of 200,000 and posted speeds of 60 mph.

The guidelines include: driving to the scene, arrival at the scene, securing the scene and scene roles and responsibilities. The components of an emergency traffic control zone are similar to a work zone and include the advance warning area, transition area, activity area, and termination area. However, some of these components have been modified for emergency situations. For example, the last component of the activity area is the 'fend-off position'. This position allows approaching motorists the best visibility of the emergency vehicle's side while providing them with recognition and direction in regards to the incident. Engine and ladder-truck drivers are instructed to pull as far to the right or left as possible, then to turn back sharply to position the vehicle 20 to 30 degrees to the roadway. The purpose of this positioning may also deflect any high-speed errant vehicle that would otherwise crash into the collision scene. In addition to set-up and takedown procedures, the Emergency Traffic Management guidelines include the rationale for the location of traffic control devices such as barrels and truck-mounted arrow boards.

The Calgary Fire Department's Emergency Traffic Management guidelines are a unique application of the principles of temporary traffic control to work zone safety and represent one of most recent road safety management initiatives in North America.

1.0 INTRODUCTION

Firefighters, police officers, paramedics and other emergency service providers are highly trained professionals who are called upon to stabilize almost any situation imaginable. Upon arrival at an incident, they are required to make decisions that affect lives and/or property and the safety of everyone at the scene. They analyze the situation, identify the critical factors and act or react to them immediately. The severity or technical complexity of the incident increases the number of critical decisions that the 'Incident Commander' is required to resolve. Traditionally, this priority-based system has provided a level of safety at the scene by the operation of optical warning devices and the placement of vehicles. Red, amber, blue or a combination of these colors in rotating, flashing or strobe light patterns were considered sufficient to protect emergency workers and their vehicles parked randomly at the scene.

Unfortunately, the number of "near-miss" and "struck-by vehicle" roadway incidents reported by these emergency responders are increasing along with the deaths of civilians, firefighters, police officers, paramedics and members of other agencies providing a service at the scene of these emergencies. The risks associated with working in or near this moving traffic environment must be reduced, as the current standards used by these responding agencies do not provide adequate protection to emergency workers or the public.

Traffic management has become one of the most common challenges for emergency responders as their vehicles are usually forced to obstruct or encroach into the driving lane(s) of a roadway while they perform their duties. A prime example of this is when the first 'on-scene' emergency service providers (fire, police and medical services) are required to stabilize the scene of a motor vehicle collision. In Canada, not unlike most countries around the world, traffic collisions are a serious problem. In 2003, 2,778 road users were killed in traffic collisions and 222,260 road users (more than 600 per day) suffered some form of physical injury. The number of these unscheduled emergency work zones escalates dramatically when one includes non-injury collisions that involve environmental contamination and/or requests for assistance by the public. Reducing the risk of secondary collisions at these incidents is a priority and all of these personnel, in addition to public and private service agencies (towing, public works, etc.) operating at the scene, the people they serve, and the motoring public need to be protected to the best of our ability.

This paper presents an overview of the Emergency Traffic Management [1] (ETM) program recently developed by the Calgary Fire Department (CFD). It is based on the basic principles of temporary traffic control adapted to the needs of first 'on-scene' emergency responders, and provides them with a guide for Emergency Traffic Accommodation. These guidelines were created to reduce the negative effects of emergency roadway incidents to the public, and to provide an increased level of safety to responders by the organized placement of apparatus and equipment.

1.1 ESTABLISHING A BASELINE

Research Current Standards for Fire Departments - The National Fire Protection Association [2] (NFPA) provides guidelines for the operation of Fire Departments. The current standard issued for the parking of firefighting apparatus is covered under Section 1451, Standard for a Fire Service Vehicle Operations Training Program, Chapter 6 - Accident and Injury Prevention.

6-1.4.1 Fire apparatus shall be utilized as a shield from oncoming traffic wherever possible.

6-1.4.2 Where acting as a shield, fire department apparatus warning lights shall remain on, and fluorescent and retro-reflective warning devices such as traffic cones, illuminated warning devices such as highway flares, or other appropriate warning devices shall be used to warn oncoming traffic of the emergency operations and the hazards to members operating at the incident.

A Survey taken by the Calgary Fire Department in March 2000, among randomly selected fire departments across North America, revealed that there is no "standard parking procedure" for fire apparatus. The interpretation of the NFPA 1451 guideline varied from department to department and pre-planned parking procedures ranged from "creative" to non-existent. In most instances, the criteria used for the placement of fire department apparatus and traffic warning devices was based on the experience of the vehicle operator or Incident Commander.

2.0 DEVELOPING THE GUIDELINES FOR EMERGENCY TRAFFIC ACCOMMODATION

In order to establish guidelines for Emergency Traffic Accommodation, the following critical areas were identified:

- a review of the common practices used for temporary traffic accommodation,
- an awareness of the concepts of geometric road design,
- understanding the basic characteristics of vehicle collisions, and
- establishing the logistics for a practical application by the Fire Department.

2.1 A REVIEW OF COMMON PRACTICES USED FOR TEMPORARY TRAFFIC ACCOMMODATION

A review of the common practices used for temporary traffic accommodation, such as the U.S. Department of Transportation, Federal Highway Administration Manual on Uniform Traffic Control Devices for Streets and Highways, 2003 Edition [3] (MUTCD) Part 6, Temporary Traffic Control, revealed that these principles could be applied to emergency situations. The characteristics of the 'Temporary Traffic Control Zone' would be retained as it provides the fundamental foundation for all traffic set-ups. Emergencies are typically unscheduled, short duration incidents that require a compressed work zone which must be reasonably easy to establish. The Advance Warning, Transition and Termination areas remain the same and the Activity Area is

enhanced at these incidents by adding a Fend-off position and a Staging Area. The major difference between these two procedures is the order of set-up. Temporary traffic accommodation is a pre-determined procedure, provided to secure the area before workers enter the work site. In emergency situations the 'Work Area' or 'Incident Site' is already established therefore the traffic control zone must be built around this location.

Set-up begins with the arrival of the first unit on-scene and is built upon the staging of this apparatus. The emergency traffic control zone is then created by the placement of traffic control devices on the roadway.

The devices and terminology used in the MUTCD must also be adopted to retain consistency and maintain the standards set throughout the industry for temporary traffic control. All of the traffic control equipment used by the CFD must meet or exceed the recommended standards outlined in the MUTCD. Approaching motorists would recognize this equipment and be familiar with the consistent message that it delivers. When emergency situations escalate into long duration temporary traffic incidents and traffic specialists are used to enhance the existing set-up they can consult with fire crews using the same vocabulary. This use of consistent terminology enables the development of the appropriate strategy for each incident and provides an effective level of communication throughout the operation.

Discussions with 'Traffic Operations' supervisors (who have applied years of experience to establish traffic control zones for the City of Calgary) identified that typical traffic set-ups vary with the characteristics of the roadway. Therefore, short-term emergency traffic accommodation must be adaptable to all roadway situations, and have the flexibility to adjust as the conditions dictate. They also recognized that roadways with a posted speed of 45mph or greater required additional equipment to develop a safe and effective traffic set-up. This factor established the 45mph rule, as shown in FIGURE 6, which provides a designated safety support vehicle to any incident on a roadway with a posted maximum speed of 45mph or greater.

2.2 AN AWARENESS OF THE CONCEPTS OF GEOMETRIC ROAD DESIGN

Firefighters are very aware that not all fires are the same; location, fuel, oxygen, temperature and chemical reactions all have an effect on the characteristics of fire. The same can be said for traffic flow and roadway geometrics; classification, cross-section, super-elevation, horizontal and vertical curves, traffic volume, design speed, and changes in design legislation create a multitude of differences in the characteristics of a roadway. Due to the diversity of situations encountered and the complexity of roadway design, each incident must be dealt with on an individual basis.

Upon arrival at the scene, the Incident Commander determines the critical needs of the incident and manpower available, which, in some instances may not allow for the establishment of an adequate traffic set-up. The concepts of geometric road design must be considered in this risk versus benefit evaluation. Once established, traffic set-ups should be monitored in each instance to determine their effectiveness.

2.3 UNDERSTANDING THE BASIC CHARACTERISTICS OF VEHICLE COLLISIONS.

Working with a compressed traffic control zone that includes minimal distances for advanced warning requires an understanding of the basic characteristics of vehicle collisions. Police investigators refer to vehicle “accidents” as **collisions**, due to the fact that each incident has a specific series of events that lead to the impact.

Legal maximum speed, view obstructions, reduced visibility, glare and surface conditions are some of the conditions that must be considered when investigating a collision. An understanding of these principles allows the person establishing the traffic set-up to identify potential problem situations and deviate from standard operating guidelines. This process attempts to prevent secondary incidents from occurring by the application of their good judgement. These items are discussed in Section 4.2 Securing the Scene and provide some of the rationale for the placement of traffic control devices on the roadway.

2.4 ESTABLISHING THE LOGISTICS FOR A PRACTICAL APPLICATION BY THE FIRE DEPARTMENT.

Fire departments have a responsibility to protect their personnel and provide advance warning to the public of their operation. They may also be used to assist other emergency response agencies, as they are one of the few services capable of providing effective Emergency traffic accommodation. Reasons for this include:

- Timely Response – Fire Stations are strategically located to provide optimal response to the community served (most responses are within five minutes of the station in urban municipalities). This response puts a professional incident evaluator on-scene and reduces the risk of secondary collisions by providing advanced warning to the incident.
- Identification – Fire department vehicles are large and easily recognizable as an emergency service provider. Approaching motorists can see these vehicles from a reasonable distance, which allows them more time to initiate defensive driving procedures.
- Apparatus Critical Mass – Most fire apparatus provide an adequate mass for vehicles used to block lanes of traffic or shield workers. Typically, the primary response apparatus (or first arriving unit) is a fire Engine with a mass of approximately 42,500lbs.
- Equipment Capability – Fire departments are usually the only emergency service provider capable of carrying traffic control devices. Arrow boards, drums, and a quantity of traffic cones are some examples.
- Available Manpower – Firefighters arrive in teams. The Incident Commander can assign these teams to a specific function depending on the nature of the incident. Traffic management can be provided as a sector within the organizational structure to secure or stabilize the scene and then monitor the effectiveness of the set-up throughout the event.

- Incident Managers – Firefighters are very diverse as they provide: 'Incident Command', scene stabilization, fire suppression, patient care, extrication and reduce environmental contamination by the monitoring and/or containment of hazardous materials.

3.0 DEVELOPING A STAGING PROCEDURE FOR THE FIRST ARRIVING APPARATUS

Staging of the first arriving, emergency response apparatus is critical to the development of an effective emergency traffic control zone. Since the primary function of this apparatus is firefighting and rescue this position must also compliment the capabilities of the firefighting team. In Temporary Traffic Control, this situation would require the use of an arrow board or arrow panel to close each lane of traffic. Typically, firefighting apparatus does not have traffic control devices like these installed, therefore the staging position should:

- provide a shield to the incident with reference to NFPA 1451,
- remain firefighting and rescue functional,
- provide immediate advanced warning to the incident, and
- establish the foundation for a temporary, emergency traffic control zone.

Apparatus staging involves an angled parking procedure or fend-off position, in addition to establishing a buffer space and lateral buffer.

3.1 FEND-OFF POSITION

To make the best use of fire department vehicles, the "Fend-off" position was developed as shown in Figure 1. To establish the fend-off position, **the driver should pull as far to the right or left as possible, then turn sharply back, to position the vehicle at 20 to 30 degrees to the roadway.** This recommended method of positioning emergency apparatus provides an initial level of safety to the scene for several reasons:

- It follows the NFPA 1451 guideline by providing a shield to emergency personnel working at the scene. This positioning may deflect any high-speed impact that would otherwise crash through the scene.
- The largest surface or side of the truck faces oncoming traffic. Retro-reflective striping is used to outline the vehicles side, which gives the unit dimension at night, when approached by headlights.
- Motorists should identify the unit as an "Emergency Vehicle". Its size, shape, color and overall appearance should be recognizable.
- More of the emergency warning lights are visible when parked at this angle. The combination of upper level optical warning devices (Upper cab and rear mounted rotating lights) and lower level optical warning devices (low level intersection,

mid-ship and rear strobe or flashing lights) combined with rear-mounted amber sequential flashing arrows should attract the motorist's attention.

- Apparatus Mass – Firefighting apparatus out-weights most vehicles on the roadway, which is critical when shielding or blocking closed lanes of traffic. Even if the unit was struck from the rear by a larger vehicle (with greater mass), the front wheels are left in a steering position that should direct the units away from the incident site.

Apparatus not protecting the scene or rescuers should be parked in a safe area (the recommended position is in the Staging Area downstream of the incident site); their location should not create a traffic hazard or obstruction, or impede other emergency services.

3.2 BUFFER SPACE

It is recommended that a **"Buffer Space"**, as shown in Figure 1, be maintained between the incident site and fire apparatus. This creates a clear area or space between the shielding vehicle and the incident site or potentially hazardous area. The suggested distance is double the posted maximum speed limit in feet (a 30 mph posted maximum speed limit requires a 60 ft. buffer space - a 60 mph posted maximum speed limit requires a 120 ft. buffer space). Reasons for the buffer space include:

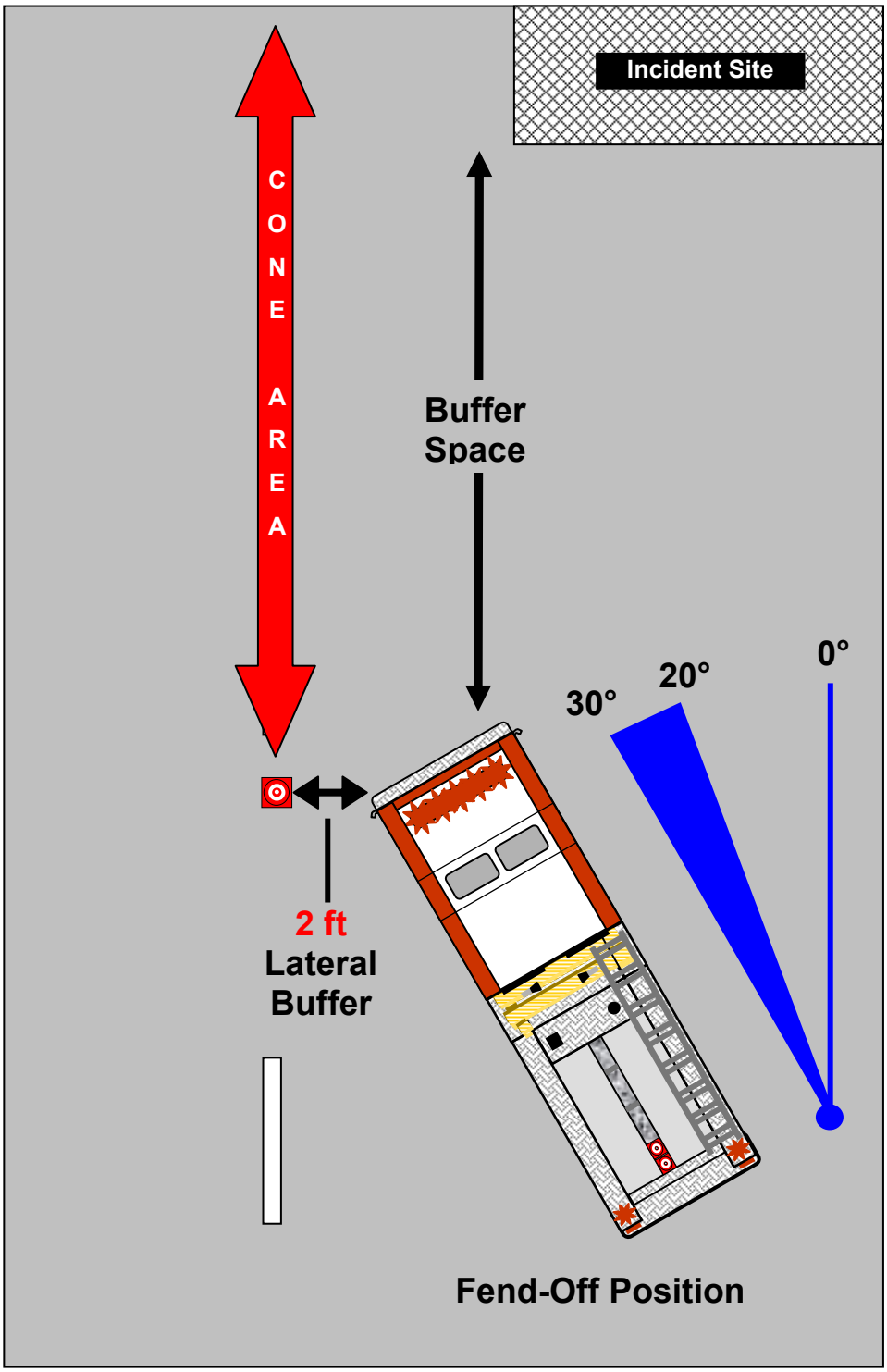
- if the shielding apparatus (usually a Fire Engine) is hit by a vehicle, it should not be pushed into the original incident,
- it creates an escape zone or clear operating area for emergency personnel working at the incident site,
- apparatus remains functional for fire fighting operations, and
- scene evidence preservation (where a collision has occurred, police investigators may require critical evidence that is likely to be contained in this area).

Channelizing devices (traffic cones) can be used to close off the buffer space to vehicle traffic by placing them along the longitudinal pavement marking line.

3.3 LATERAL BUFFER

During the final phases of apparatus staging, while considering the fend-off position and buffer space, the driver should attempt to position the front bumper of the fire truck at least 2 ft from the longitudinal pavement marking line as shown in Figure 1. This lateral buffer is used to reduce encroachment into designated traffic lanes. A traffic cone with a strobe light inserted into the top should also be placed on the longitudinal pavement marking line beside the apparatus to allow personnel safer access around that corner of the vehicle.

FIGURE 1 Apparatus Staging

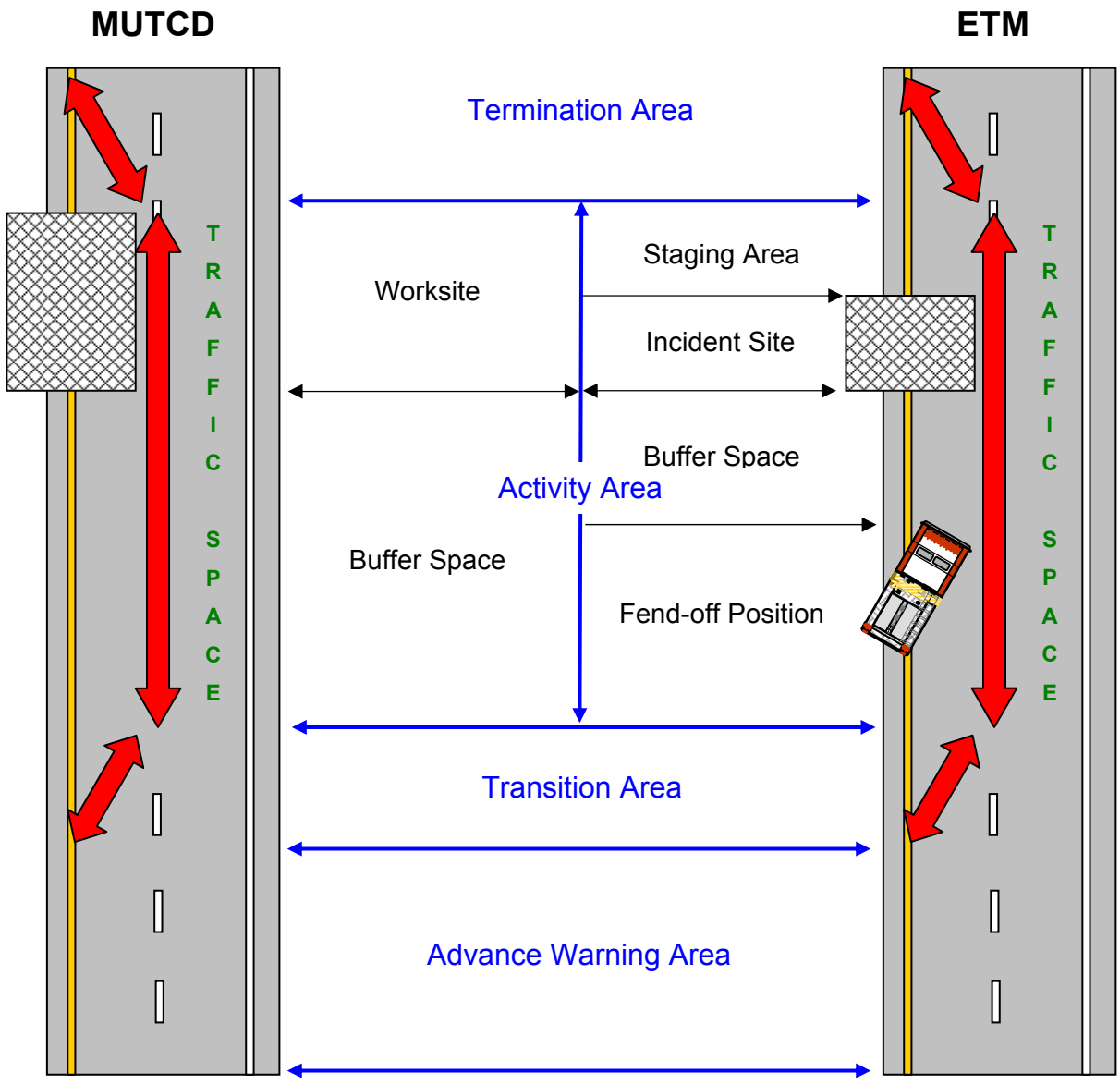


Note: Not drawn to scale. This diagram is a graphical representation of a typical apparatus staging procedure. Red arrow sections indicate areas for the placement of traffic control devices. Actual procedures and placement of devices are situation and condition dependant.

4.0 ESTABLISHING A TRAFFIC CONTROL ZONE

Temporary Traffic Control Zones are designed to allow for the safe passage of motorists through controlled channels while providing a level of safety to personnel in the work area. Emergency situations require a similar work zone that has been adapted into a condensed version of the traditional Temporary Traffic Control Zone. Even though the establishment of these zones differs, the same basic principals apply to each situation.

FIGURE 2 Temporary and Emergency Traffic Control Zones



Note: Not drawn to scale. This diagram is a graphical representation of two traffic control zones. Red arrow sections indicate areas for the placement of traffic control (channelizing) devices.

4.1 COMPONENT AREAS OF AN EMERGENCY TRAFFIC CONTROL ZONE

A well-designed emergency traffic control zone should reflect four distinct component areas. These areas are described below in the order in which drivers would encounter them.

Advance Warning Area

- It should **alert** the motorist that there is a traffic situation or difficulty ahead, which will require some action on his or her part.
- As they approach, it should **identify** the nature of the equipment or vehicle that he or she is about to encounter and allow them to analyse the situation.

Transition Area

- It should provide some indication as to the actions to be taken by the motorist so they can decide a course of action and execute safe driving techniques before entering the activity area.

Activity Area

Recommended components include:

- Fend-Off Position (Fire Apparatus).
- Buffer Space (scene protection area).
- Incident Site (a restricted area for authorized personnel).
- Traffic Space (where traffic is allowed to pass through the activity area, next to the incident).
- Staging Area: Emergency vehicles performing COMMAND functions or not immediately required for shielding or providing direction, that are unable to park in a safe area off of the roadway, may be directed to STAGE in this area, downstream of the Incident Site. Their location should not create a traffic hazard or obstruction, or impede other emergency services.

Termination Area

This area is where traffic returns to its normal path. The termination area extends from the downstream end of the staging area to the point where traffic is able to resume normal driving. Traffic control may be required in this area under emergency conditions when access to off ramps, on ramps and intersections compromises motorist safety.

NOTE: Two or more of the component areas may be combined in emergency situations where traffic volume, speed, visibility and other conditions permit.

Establishing a secure emergency traffic control zone takes time and should be a progressive activity defined by the officer in charge, based on the manpower available and the critical needs of the incident.

4.2 SECURING THE SCENE

The type and location of incident establishes the worksite. The components of a traffic control zone must be understood, and then applied to meet the expectations of approaching motorists. Securing the scene is the placement of traffic control devices on the roadway in a manner that warns and safely guides motorists through controlled channels that are established within the traffic control zone. Since each roadway has a designed speed, curve radius and changes in elevation it is not easy to prepare a plan that will accommodate all of the situations that will be encountered.

Understanding the basic characteristics of vehicle collisions and an awareness of the concepts of geometric road design has identified the conditions listed below. Firefighters must identify these conditions and understand how they may violate a driver's expectations and compromise their safety. They can then apply the appropriate rationale to build an effective traffic control zone for that specific situation.

Legal Maximum Speed

Roadway speed affects warning device placement due to the stopping sight distance. This is the distance a vehicle travels during:

- perception time,
- reaction time, and
- braking distance.

View Obstructions

Obstacles can keep a driver from seeing cones, control devices or hazards.

- Horizontal View Obstructions - embankments, hedges, trees, crops, weeds, buildings, billboards, vehicles.
- Vertical View Obstructions - crests of hills, bridges, overpasses or general lay of the land affects sight distance or the driver's line of sight.

Reduced Visibility

Weather and darkness do not obscure a view the way solid objects do but they do reduce visibility.

- Darkness - Lack of lighting or over-driving headlights.
- Weather - Fog, smoke, rain, snow, or a combination of these plus darkness.

The motorist is usually driving too fast for the conditions present.

Glare

Glare temporarily blinds the motorist's field of vision.

- Headlight Glare – only at night, from oncoming traffic. (This includes emergency vehicle headlights in normal, high beam or wigwag operation).
- Fixed-light Glare - Backlighting, signs, stationary vehicles.

- Sun Glare (sunrise/sunset) sun glare will often make many things invisible. This condition is enhanced when the sun is at a low angle in the fall and winter.

Surface Conditions

- Slipperiness - moisture, ice or snow
- Skid resistance

Other Factors

- Motorist confusion, between existing traffic control devices, signals or pavement markings and emergency traffic control devices.
- Any change in alignment of a straight and level road e.g. elevation, curve or bank, sudden narrowing, on ramps, off ramps or intersections.

The above conditions must be considered when establishing the traffic control zone. When any of these conditions are encountered while placing traffic cones on the roadway or monitoring traffic flow, provisions should be made to augment the motorist's warning of the incident ahead. In most cases this can be accomplished by placing traffic cones farther back from the fire apparatus to enhance the advance warning area. This increase in distance should allow approaching motorists to react appropriately and guide them safely through the traffic control zone.

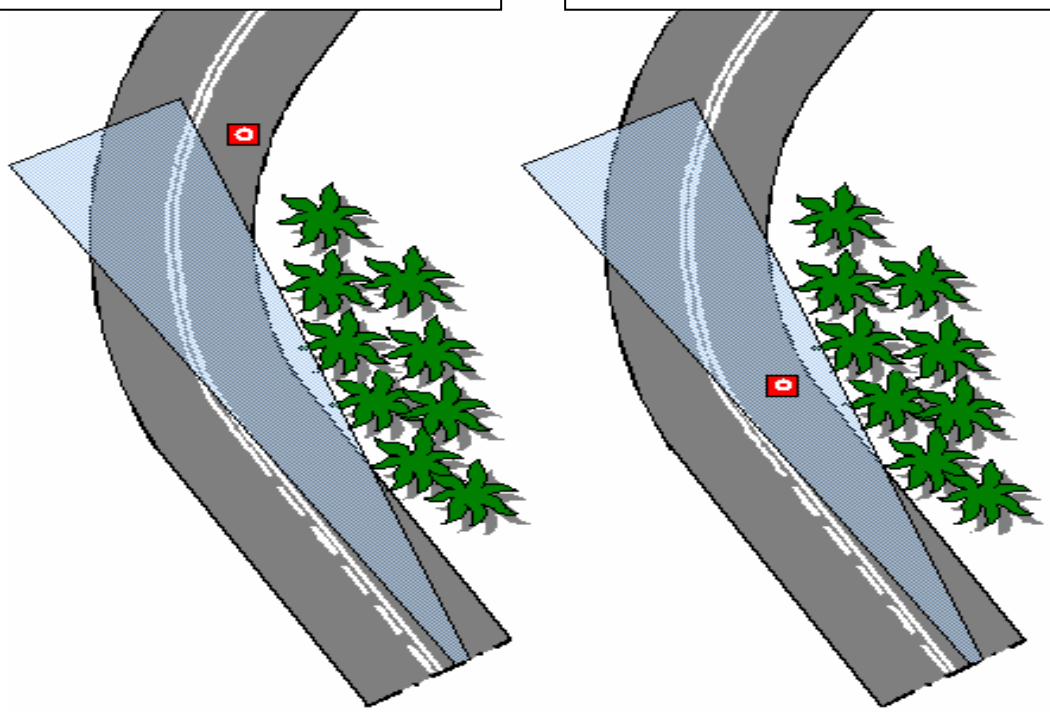
4.3 EXAMPLES OF VIEW OBSTRUCTIONS - HORIZONTAL CURVE

The following Figures 3 and 4 are examples of horizontal view obstructions. The term **Horizontal Curve** is used to describe a level section of curved roadway. This type of situation may have trees (as per example) or buildings on the inside of the curve that affects the **sight distance** of the motorist. Adequate sight distance can be an important factor in these instances as it allows the driver time to perceive that a hazard is present and react accordingly.

FIGURE 3 and 4 Examples of View Obstructions – Horizontal Curve

In **Figure 3** below, the traffic control device is not within the driver's sight distance. The driver is unaware of this device due to the view obstructions (a group of trees on the right hand side are obstructing their view).

In **Figure 4** below, a traffic control device has been moved back prior to the view obstruction. This device is in the driver's "line of sight" and should provide them with sufficient **sight distance** to take corrective action.



Sight Distance **Traffic Control Device**

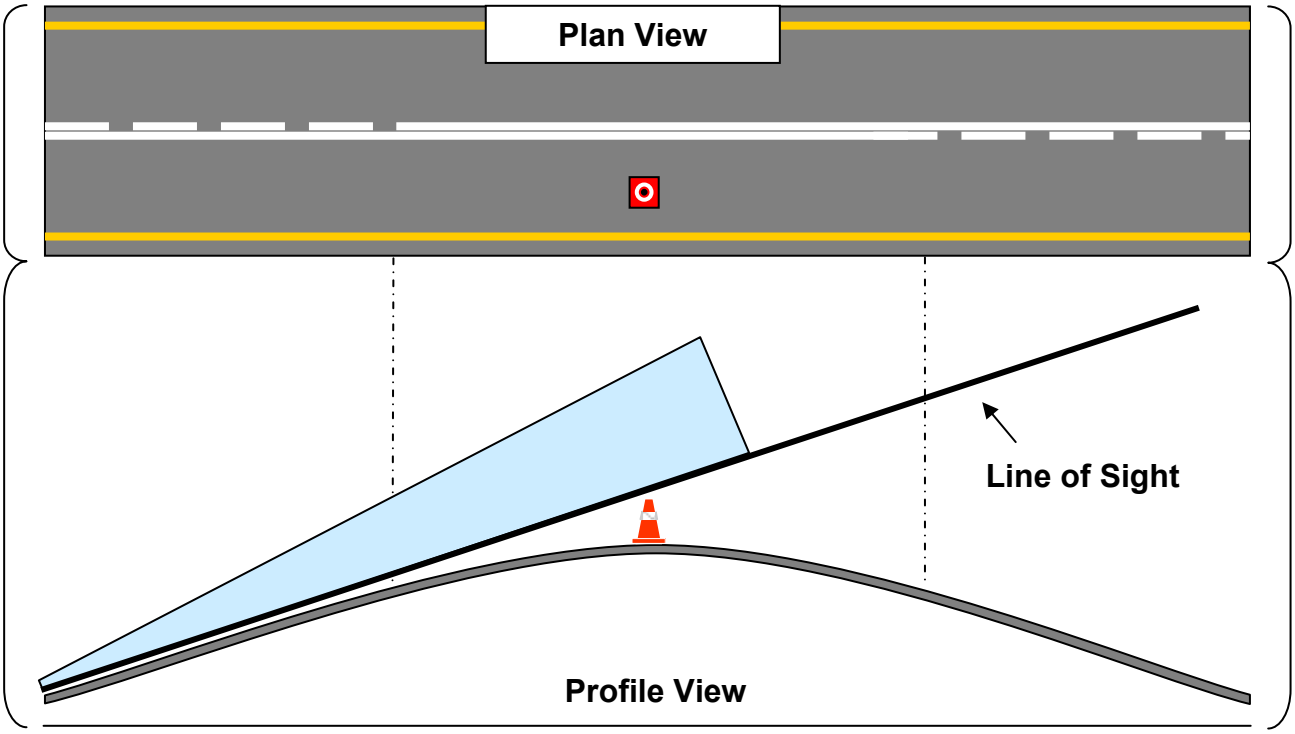
When it is determined that a horizontal view obstruction exists, steps should be taken to move the set-up back to a point that allows the oncoming motorist more perception and reaction time.

NOTE: Substitute vehicle headlight illumination for sight distance and this diagram would provide an example of reduced visibility (darkness). Traffic set-ups at night should consider that the driver's vision might be reduced by a combination of vehicle speed and headlight performance.

4.4 EXAMPLES OF VIEW OBSTRUCTIONS - VERTICAL CREST

The following illustration is an example of a vertical view obstruction. The vertical crest of a hill reduces the motorist's visibility of the roadway as shown below. The sight distance in this situation must be adequate for the driver to perceive that a hazard is present and react accordingly.

FIGURE 5 – View Obstruction – Vertical Crest



LEGEND

Sight Distance

Traffic Cone

Plan View

Profile View

When it is determined that a vertical view obstruction exists, steps should be taken to move the set-up back towards approaching motorists, allowing them more perception and reaction time.

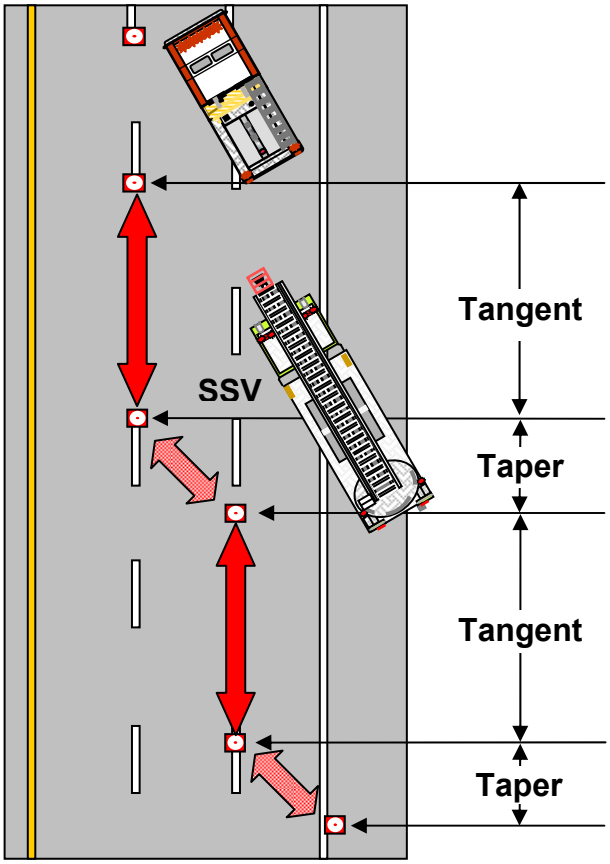
NOTE: Each situation will require individual assessment. Consideration should be given to all of the conditions present at the time of set-up to ensure warning devices are adequate in each instance.

4.5 SETTING UP TAPER AND TANGENT SECTIONS

Tapers and tangents will vary in length as shown in Table 1, 'Recommended Distances for Establishing a Traffic Control Zone'. A freeway with a 55 mph posted maximum speed requires longer tapers and tangents than a street with a 30 mph posted maximum speed. In order to establish a safe and effective traffic control zone, crews must also consider the conditions affecting cone placement as outlined in Section 4.2, 'Securing the Scene'. Longer tapers and tangents allow more time and distance for the motorist to react to a lane closure or change. If the incident affects more than one lane of traffic **each traffic lane should be closed separately.**

Since it has been determined that posted roadway speeds greater than 40 mph required additional equipment to create a traffic control zone, designated safety support vehicles (SSV), as shown below, were established to assist in this process. These units are automatically dispatched to roadway incidents where the posted maximum speed is 45 mph or greater and may be requested at any incident. They are equipped with arrow boards, additional traffic control devices and the crews are well versed in the concepts of emergency traffic accommodation.

FIGURE 6 Taper and Tangent Sections



Recommended Areas for the Placement of Channelizing Devices

Tangent Area

Taper Area

Cone – Start and End Area

LEGEND NOTE: Areas on the diagram represented by the arrows above, indicate areas for channelizing devices. These devices are to be placed within these arrow sections (between the start and end areas).

For illustration purposes, the author has determined that the SSV should take the fend-off position.

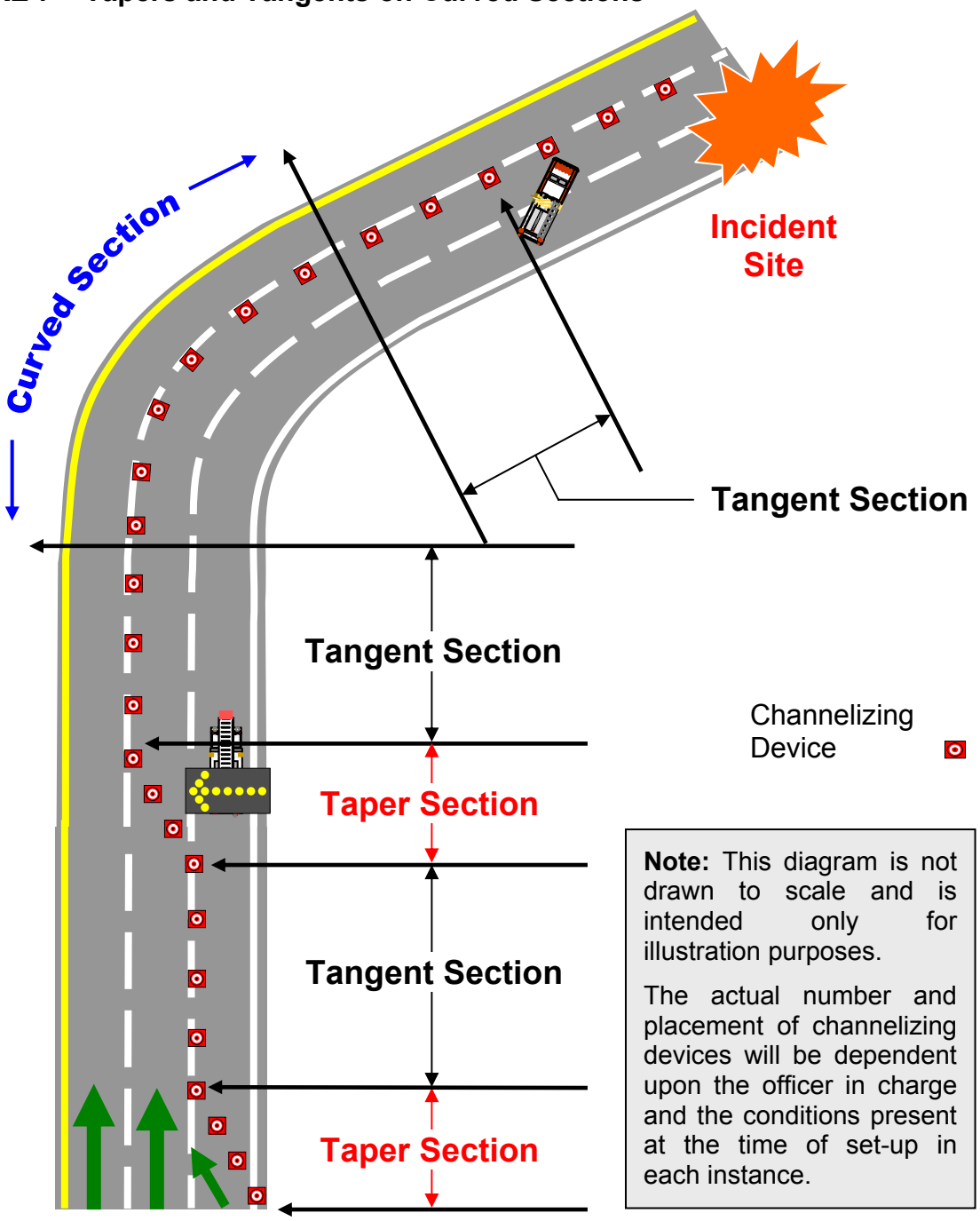
The placement of channelizing devices within the designated taper and tangent sections directs traffic efficiently around the incident. In doing this we have provided a secure well defined traffic control zone.

This diagram is a graphical representation of a traffic control set-up in an emergency situation, where two lanes of traffic have been closed on a three-lane roadway. The placement of apparatus and equipment in an actual emergency is situation and condition dependant.

4.6 TAPERS AND TANGENTS INVOLVING CURVED SECTIONS

In this example, the required tangent length (the minimum distance recommended for the conditions present, at the time of set-up) would extend into a horizontal curve. Since tangents must be straight and parallel to traffic flow, a curved section of channelizing devices has been added between the tangent sections. Adding curved sections of channelizing devices and extending tangent sections improves the motorist's sight-distance of the taper, which should provide them with adequate warning of the lane closure.

FIGURE 7 – Tapers and Tangents on Curved Sections



4.7 DISTANCE TABLE

The following table indicates the recommended distances required (in relation to the posted legal maximum speed) for the buffer space, tapers, device spacing and tangent length. For example, while considering view obstructions, visibility, glare, surface condition and other factors, a posted speed of 60 mph on dry pavement would require a tangent length or the furthest cone to be placed a recommended distance of 300 ft (~10 Engine lengths) from the vehicle. In comparison, the same 60 mph roadway when covered in snow would require a recommended distance of 600 ft (~20 Engine lengths) from the vehicle. The placement of additional cones in between is dependent upon the conditions present, recommended spacing for cones in straight lines and the number of cones available at the time of set-up. The initial traffic control zone may need to be revised or reinforced when additional manpower and equipment arrives.

Fire crews are encouraged to exercise their best judgement; i.e. placement of too many cones is preferable to too few. **As conditions change, so should the traffic set-up**.

TABLE 1 – Recommended Distances for Establishing a Traffic Control Zone

LEGAL MAXIMUM SPEED	30 mph	40 mph	45 mph	50 mph	55 mph	60+ mph
BUFFER SPACE	60 ft	80 ft	90 ft	100 ft	110 ft	120 ft
TAPER LENGTH	60 ft	80 ft	90 ft	100 ft	110 ft	120 ft
RECOMMENDED SPACING FOR CONES IN STRAIGHT LINES	15 ft		30 ft			60 ft
TANGENT LENGTH	NOTE: APPLY TO ROADWAY CONDITIONS BELOW.					
DRY PAVEMENT	150 ft 5.5 E	200 ft 6.5 E	225 ft 7.5 E	250 ft 8.5 E	275 ft 9 E	300 ft 10 E
WET PAVEMENT	225 ft 8 E	300 ft 10 E	337 ft 11 E	375 ft 14 E	412 ft 14 E	450 ft 16 E
SNOW COVERED PAVEMENT	300 ft 10 E	400 ft 13 E	450 ft 16 E	500 ft 18 E	550 ft 18 E	600 ft 20 E

E ---Indicates distance in **ENGINE** lengths 1 Engine length is approximately 30 ft.

NOTE: Another method to use for calculating approximate distance is relating it to surrounding objects or markers when they are visible such as longitudinal pavement marking lines with gaps. Each broken line is a 10 foot segment. This is the specified distance for the line, actual distances may vary.

5.0 SET-UP AND TAKEDOWN OF THE EMERGENCY TRAFFIC CONTROL ZONE

The greatest risk to firefighting personnel occurs during two phases of Traffic Management, set-up and takedown. During the set-up phase, apparatus staging and the placement of equipment establishes an emergency traffic control zone. Until all warning devices are in position, approaching motorists may not be expecting to find firefighters and their equipment on the roadway.

Each step of the takedown phase is performed under non-emergency conditions, yet the removal of manpower and equipment is just as critical as the set-up. Police and Fire Incident Commanders should develop a plan for re-establishing traffic flow patterns and communicate that plan to all personnel working in the control zone. Police vehicles or fire apparatus should also be used to shield firefighters during the removal of equipment from the roadway.

The risks associated with working in this type of moving and constantly changing environment can be reduced through awareness, teamwork and communication. Every situation must be evaluated individually and steps must be taken to perform each task as safely as possible.

5.1 TRAFFIC MANAGEMENT SET-UP CONSIDERATIONS

The following example identifies some of the set-up considerations when closing two lanes of traffic on a high volume, high speed roadway. This scenario may be considered as one of the more complex or as requiring the most apparatus, equipment and manpower to complete. Each situation encountered will require individual assessment and may require periodic re-evaluation to ensure that apparatus position and warning device placement is adequate.

The primary response apparatus is usually the first unit to arrive at an incident, and as Incident Command, should consider the following:

1. Establishing a buffer space between the incident site and the apparatus.
2. Positioning the apparatus to protect the immediate scene by parking in the fend-off position. Units with arrow boards may park parallel to traffic lanes.
3. Maintaining a lateral buffer to reduce apparatus lane encroachment.
4. Designate a fire fighter for cone placement. The fire fighter dons the traffic jacket and when safe to do so, places cones on the roadway in the following areas:
    a) **Lateral Buffer** – They activate a strobe light and insert it into the top of a traffic cone which is used to establish the lateral buffer. The strobe/cone combination is placed on the longitudinal pavement marking line adjacent to the corner of the apparatus, next to the traffic flow.

b) **Advance Warning** - Initial cone placement is initiated on the approach to the emergency vehicle. One of the safest methods for distributing traffic cones is from the shoulder or non-traffic area of the roadway. Cones and strobes are removed from the apparatus and placed on the curb, sidewalk, roadway shoulder, etc. While facing oncoming traffic and **staying in the non-traffic area**, a reasonable number of cones and strobes are carried adjacent to the intended position of the first cone. When safe to do so, the fire fighter steps onto the roadway, positions the cone and returns to the shoulder. They continue to distribute the remaining cones in the same manner as above (with consideration to the conditions affecting cone placement as shown in Section 4.2 'Securing the Scene') until all of the cones dedicated for advanced warning are in position. Strobes may be activated and inserted into the cones before stepping on the roadway to enhance the set-up and increase fire fighter visibility.

c) **Buffer Space** – Delineation devices are placed along the longitudinal pavement marking line between the lateral buffer and the incident to outline the traffic space and secure the incident site.

5. Direct the first arriving safety support vehicle to close a designated lane of traffic and enhance the existing traffic set-up. The officer in charge should consider:

a) Vehicle positioning - with regards to tangent length (conditions affecting cone placement) and directional capability of the unit (i.e. arrow board).

b) A lateral buffer - to reduce apparatus lane encroachment and allow the apparatus operator/driver safer access to and from the cab or operating panel.

c) Designating a fire fighter for cone placement - The fire fighter dons the traffic jacket and when safe to do so, places cones on the roadway in the following areas – as per – **4.**(a) and (b) above, and to reinforce the existing traffic set-up with available warning devices.

6. Direct the second arriving safety support vehicle to park in the shoulder of the roadway to provide the motorist with advanced warning of the situation ahead. The officer in charge should consider:

a) Vehicle Positioning - with regards to tangent length (conditions affecting cone placement) and directional capability of the unit (i.e. arrow board).

b) A lateral buffer - to reduce apparatus lane encroachment and allow the apparatus operator/driver safer access to and from the cab.

c) Designating a fire fighter for cone placement. The fire fighter dons the traffic jacket and when safe to do so, places cones on the roadway in the following areas: – as per **4.**(a) above, and reinforce the existing traffic set-up with available warning devices.

d) Setting up advanced warning signs – The designated "Police Emergency Ahead" or "Emergency Vehicles Ahead" sign can be used to alert the motorist of the incident ahead. These devices should be positioned on the approach to their emergency vehicle (approximately 120 ft upstream).

5.2 TRAFFIC MANAGEMENT TAKE-DOWN CONSIDERATIONS

Taking-down the emergency traffic set-up needs to be well organized and coordinated by the Incident Commander. The removal of apparatus and equipment from the roadway must be a priority of Command in order to provide the required level of safety to each situation. The following recomendations should be considered when preparing to terminate an incident:

1. The Police Service "Officer in Charge" and the Fire Department "Officer in Charge" should liase to develop a joint procedure for take-down and the re-establishment of traffic flow.
2. All apparatus stays in place until the Incident Commander gives the order to start take-down operations. This will ensure that **all personnel** are aware that the incident is terminating and traffic flow will be resuming.
3. Each lane should be opened individually starting with the lane closest to the centre of the roadway.
4. Takedown should follow the same order as the setup with the last traffic control device removed from the roadway in the advance warning area.

NOTE: Due to the non-emergency status of the takedown operation, the Incident Commander (police and/or fire officer in charge), should arrange to have fire apparatus or police vehicles shield fire fighters when they remove equipment from the roadway.

6.0 CONCLUSION

The Calgary Fire Department has provided emergency traffic accommodation to the City of Calgary and its surrounding area for the past four years. During this time they have received numerous commendations for this program, which include letters from the Calgary Police Service, Royal Canadian Mounted Police and Alberta Infrastructure and Transportation. Motorists are also aware of our presence as traffic management providers and are familiar with the layout and equipment used as it parallels existing temporary traffic accommodation.

A recent internal study was conducted by the Calgary Fire Department to provide information about vehicle collisions and the traffic management program. Eight hundred and ninety seven (897) incidents were used to provide the basis for the following results: 27 minutes was the average time on-scene (rapid deployment, set-up and scene stabilization are critical), 34% of these incidents were over 30 minutes (set-ups must be capable of handling long duration emergencies), safety support vehicles attended 41% of the total incidents and provided support at 57% of those (regardless of roadway speed), 158 incidents did not require traffic control (vehicles may have been removed from the roadway) and 1842 members of the public were involved in these incidents (which shows a need for site protection and customer service).

7.0 SUMMARY

This paper has provided a review of the guidelines used by the Calgary Fire Department for Traffic Management at emergency scenes. These guidelines are based on the existing foundation provided by the MUTCD, and recommended requirements for a temporary traffic control zone. Since emergencies are unpredictable in nature, the type of incident, set-up time and duration of time on-scene does not allow for a complete temporary traffic control set-up as outlined in the MUTCD. Therefore, a modified version is established by the first unit on-scene and enhanced by traffic control devices and/or incoming apparatus.

The appropriate set-up is determined by the Incident Commander and/or designated set-up crew based on their understanding of the principals of temporary traffic control, an awareness of the concepts of geometric road design and the basic characteristics of vehicle collisions. This criteria identifies the critical elements in each instance and provides them with the rationale to deviate from normal traffic set-up procedures using their experience and good judgement.

The Calgary Fire Department is pro-actively providing a safe, timely and effective traffic management program. The rapid deployment of manpower and equipment to safely stabilize emergency roadway incidents and reduce their negative effects is in the best interest of the public and all emergency personnel.

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