Designing for Work Zone Incident Management
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Learning Objectives

- Recognize the main differences between Work Zone Traffic Incident Management (WZ-TIM) and TIM in ordinary situations.
- Compare and contrast the WZ-TIM roles and responsibilities of first responders, transportation agency staff, and the contractor.
- Describe several strategies for improving work zone incident prevention and response.
- Become familiar with the advantages and disadvantages of contractor involvement in work zone incident management.
Resources

• Designing for Work Zone Incident Management Guidebook


• *Toward Zero Deaths* national strategy on highway safety.

• OECD *Safe System* approach to highway safety management.
Types of Work Zone Incidents

• Traffic crashes and similar incidents
  • Within work zone
  • In approach to work zone

• Worker medical problems
  • Injury
  • Illness

• Work site mishaps
  • Damage to roadway or other infrastructure
  • Trench collapse
  • Embankment collapse
  • Equipment tip-over
  • Fire, explosion, etc.

• Work Area Intrusions
Incident Response Involves Many Disciplines

Dealing with a crash or other traffic incident occurring in a work zone requires the combined skills of many people/disciplines.

Coordinate to improve work zone incident prevention and response

- EMS
- Fire Dept
- Safety Patrol Team
- Police
- Highway Agency
- Towing Service
- Coroner or Medical Examiner
- Contractor
- Media
WZ-TIM Goals

• Reduce Time
• Expedite Arrival
• Minimize Roadway Capacity Loss
• Facilitate Management
• Reduce Incident Clearance Time
• Rapidly Notify Upstream Travelers
How does work zone design affect work zone incident management?
Unique WZ Challenges

Work Zone Traffic Incident Management (WZ-TIM) differs from TIM on ordinary roadways in several ways:

• **Difficult access** to work zone incidents
• **Limited space**: lane restrictions
• **Traffic congestion**: back-ups / queues
• **Many organizations** to coordinate:
  • First responders (police, fire, EMS, towing)
  • Agency traffic operations center
  • Contractor personnel
  • Agency construction management personnel
The Designer’s Influence

• Allocation of Space
  • When an incident occurs, where can first responders do their jobs?
  • Where can incident management vehicles be staged?
  • Work space → seldom available for first responders
  • Road space → conflicting demands for incident response space and traffic space

• Accessibility
  • Primary and secondary access to traffic lanes and shoulders
  • Primary and secondary access to work areas

• Contractual Relationships
  • Role of contractor in incident management
  • Coordination of first responder agencies and jurisdictional issues
  • Coordination with highway agency Traffic Management Center
Safe System Strategies

• Make the WZ environment as “forgiving” as possible to errors or misjudgments made by workers, first responders, drivers, or others
• If a crash does occur, emergency response personnel—and people already on scene—need to respond quickly and correctly
• Assure victims receive appropriate treatment as promptly as possible
What Happens When An Incident Occurs?
### Working Together: Coordinated Response to a Generic Work Zone Incident

<table>
<thead>
<tr>
<th>Crash or Other Incident Occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call 911 to report incident</td>
</tr>
</tbody>
</table>

- **Move uninjured workers and equipment (except traffic control) to safe locations**
- **Check on victims and give first aid if feasible**
- **Activate signs and messages to warn approaching drivers of incident**

**Assess situation and request additional resources as necessary**

- **Secure and protect the incident scene**
- **Assist in securing and protecting incident scene**
- **Protect back of traffic queue if requested**
- **Postpone deliveries of construction materials**

- **Suppress fires**
- **Give first aid to victims**
- **Manage traffic and bystanders**
- **Provide temporary traffic control devices**

- **Extricate trapped victims**
- **Provide emergency medical care**
- **Assess injuries and provide advanced medical care**
- **Assess hazardous materials**

- **Transport victims to hospital**
- **Examine deceased victims and pronounce death**
- **Contain and stabilize hazardous materials**
- **Coordinate hazmat cleanup with natural resources dept**

- **Supervise scene clearance**
- **Remove vehicles that are blocking traffic lanes**
- **Remove medical waste**
- **Clean up hazardous materials**

- **Collect evidence**
- **Assist people with disabled vehicles**
- **Assist with incident clearance**
- **Remove damaged vehicles**

- **Remove debris from pavement**
- **Restore typical work zone traffic control**
- **Issue citations**

- **Resume typical work zone traffic operations**
- **Resume typical work zone traveler information**
- **Resume typical construction operations**

### Roles and Responsibilities

- **Contractor**
- **Highway Agency**
- **Police**
- **Fire Dept**
- **EMS**
- **Coroner/Med Exmnr**
- **Towing Service**
- **Hazmat Specialist**

Note: Roles and responsibilities shown in this chart are generalized, and could vary based on state and local laws, agreements, and contracts.
Phases of the Incident Management Process

**Response**
- Notify first responders of incident
- Emergency vehicles travel to scene
  - Access to incident site
  - Emergency vehicle staging
- Secure the scene
  - Get workers and equipment out of harm’s way
  - Manage traffic
  - Suppress fire and prevent explosion
  - Protect hazardous materials
- Extricate victims
- Triage victims, medical transport, and on-site treatment
- Pronounce death, if required

**Recovery**
- Collect physical evidence
- Collect involved party and witness statements
- Issue citations
- Clear disabled vehicles
- Clean up spills and debris
- Make lanes driveable
- Restore traffic control
- Resume traffic operations
- Repair damaged infrastructure
Incident Response: Roles for First Responders

- **Secure** and protect the scene
- **Aid** crash victims
- **Coordinate** the response
- **Protect** the back-of-queue to prevent secondary collisions
- **Manage** traffic and re-route if necessary
- **Ask** for contractor equipment and manpower if it will help expedite response and recovery
- **Investigate** the incident, gather evidence, and issue citations as appropriate
Incident Response: Potential Roles for Contractors

• **Report** the incident by calling 911

• **Move** construction personnel and equipment out of the way

• **Give first aid** to crash victims until help arrives (if qualified)

• **Assist** with the response if requested:
  • Traffic control equipment
  • Back-of-queue protection
  • Lifting equipment
  • Spill containment
Incident Complexity Levels

Traffic incident and response levels can be organized into three categories, based on expected duration and complexity:

- **Minor** – Expected duration *less than 30 minutes*
- **Intermediate** – Expected duration *30 minutes to two hours*
- **Major** – Expected duration *more than two hours*
Incident Command System Principles

Modular Organization
- Top-down hierarchy
- First to arrive establishes initial command and control.
- Command is handed over to the agency most deeply involved in response and recovery.
- As response progresses, the leader will change.

Unity of Command
- Everyone on site has one and only one supervisor.
- Every supervisor has 3 to 7 subordinates.

Span of Control
- Supervisors coordinate with one another, but not directly involved in front-line operations
- Supervisors allocate work based on individual skills and abilities.

Management by Objective
- Objectives → Strategy → Tactics → Implementation
Case Study: Truck Rollover
West Des Moines, Iowa – September 2014
Facts & Circumstances

- Rural freeway with 25,800 vehicles per day
- Northbound semi struck, penetrated concrete barrier
- Two southbound passenger cars struck the semi
- All lanes blocked
- Diesel spill

- Traffic re-routed to arterials
- Extended closure due to delayed arrival of HazMat contractor
First Responder Safety

• More on-duty police officers killed in traffic crashes than by bullets.
• More firefighters killed by motor vehicles than by fires and explosions.
• Tow truck operators and EMS personnel also at high risk of being struck by traffic.

Source: Bureau of Labor Statistics
Incident Prevention: What Can Designers Do?

Pre-Construction

- **Prepare** for handling work zone incidents
  - Physical Accommodations
  - Inter-Agency Coordination
  - Contractual Provisions
- **Engage** first responders in Transportation Management Plan (TMP) development and incident management planning.

During Construction

- **Keep responders informed** about lane/ramp closures and “back door” ways to access the work zone.
- **Say something** if you observe a problem.
  - Situations that encourage illegal/risky road user behavior.
  - Missing traffic control devices.
  - Improper work practices.
- **Set a positive example** by complying with work zone traffic laws, on- and off-duty.
Back-Of-Queue Protection
Secondary Crashes

• “Secondary crash” is a second (or subsequent) crash that occurs at the incident scene or in a traffic queue resulting from the original incident.
• About 19% of freeway fatalities are the result of front-to-rear crashes.
• Most common scenario: traffic is backed up and a fast-moving vehicle strikes a slowed or stopped vehicle at the back of the queue.
• Less likely to occur if warning is provided about ¼ mile in advance of the slowed traffic.
Secondary Crashes
Back-of-Queue Protection Methods

Roll-Up Fabric Signs
- Pro: Easy to set up and remove
- Con: Small, may need to reposition as queue changes

Hinged Fixed Signs
- Pro: Bigger and more conspicuous than portable signs
- Con: Cannot move with queue.

Electronic Signs
- Pro: Large, conspicuous, can change the message

Law Enforcement Vehicle
- Pro: Can move as queue grows/shrinks
- Con: Officer not available for other duties
Queue Warning Vehicles

Contractor- or Agency-Supplied Vehicle

- Pro: Can move as queue grows/shrinks
- Con: Requires special contractual provisions, response time possibly slower than law enforcement
Automated Queue Warning Systems

- Series of speed sensors and electronically-actuated signs
- If speeds near sensor fall below pre-determined threshold, the corresponding upstream sign is activated.
- In freeway applications, the distance between the sensor and its upstream sign is typically ½ to 1 mile.
Discussion

• What types of back-of-queue protection have you used?
• Were they sufficient?
Site Access
Primary & Secondary Access/Egress

Fire codes for buildings: every occupied space must have a secondary means of egress.
• Primary egress: doors, hallways, stairs
• Secondary egress: windows, fire escapes

Work Zones
• Not codified, but...
• Same concepts apply

Some Sites are Challenging
• Barrier-separated lanes without shoulders
• Multi-level interchanges

Congestion caused by incidents often hampers response and recovery
Improving Access to Incident Sites

- Gates in temporary barriers
- Temporary access from overpasses or side roads
All-Terrain Emergency Response Vehicles

• All-terrain vehicles can resolve some access issues
• Some fire agencies own all-terrain vehicles
• May need to redeploy from other locations
Gated Secondary Access

• Alternate pathway to access work zone
• Helps avoid driving through traffic back-ups to reach incident site
• Access usually from local road
• Usually locked to deter unauthorized use
• Traversable surface (sometimes unpaved)
• Can be given a name/number and mapped for 911 dispatch systems
Emergency Access Identification

Motivation for the Change
• Freeway-to-freeway interchange reconstruction in Wisconsin
• Multiple access points
• Worker medical emergency
• Delayed treatment because EMS arrives at wrong vertical level

What Was Done
• Support fire and EMS response by developing system for identifying work area access points
• Unique identifier for each access
• Distinct from exit numbers and mile markers
• Also simplifies construction deliveries
Temporary Loss of Access for Emergency Response Stations

- Some projects temporarily cut off access to police, fire, or ambulance stations.
- Sometimes can be resolved administratively (mutual aid)
- Semi-permanent solutions should be proportionate to the project impact
- Response time is the usual measure of effectiveness
Difficult Sites Require Extra Effort

Examples
- Long/high bridges
- Tunnels
- One-side-only access
  - Coastal highways
  - Highways paralleling rivers
  - Highways paralleling rail lines
- Remote sites
- Complex urban sites
  - Mass transit in median
  - Multi-level roadways
- Sites near high-security facilities
  - Airports
  - National defense
Discussion

• What are the challenges of reaching an incident if one occurs in this work zone?
• What design strategies could be used to mitigate them?
Physical Accommodations
Ramp Closure Gates & Signs

Gates reduce police manpower required to:
• Reduce traffic volume approaching incident site
• Prevent vehicles from entering a high-delay situation

Type III barricades can be used temporarily
Flip-up signs reduce unintentional entry to closed ramps

Drops down. Inconspicuous color when not deployed.
Traffic Control Device Caches

- Near-site supply of incident management cones, drums, signs, etc.
- Possibly upstream of work zone
- Some agencies pre-load equipment on a trailer
- Urban areas: possibly include portable fences and other crowd control devices

Orange: Construction
Fluorescent Pink: Incident Management
Allocating Road Space

• Construction activities and traffic compete for road space (especially width) in many work zones.
• Temporary barriers also require space (typically 4 ft)
• Converting shoulders to driving lanes is popular, but without shoulders:
  • Disabled vehicles will block a travel lane.
  • Difficult for first responders to reach the incident scene.
  • No place to stage equipment that will be used during later stages of response and recovery.
Hierarchy of Options
(From the Incident Management Perspective)

- Full Shoulder (8 to 10 ft or more)
- Intermittent Shoulder + Emergency Pull-Outs
- Intermittent Shoulder
- Narrow Shoulder (6 to 8 ft)
- Very Narrow Shoulder (3 to 6 ft)
- Traversable Foreslope
Allocating Available Width

Unequal Lane Width

- 2 ft Shy
- 10 ft Cars Only
- 10 ft Cars Only
- 11 ft All Vehicles

9 ft Shoulder

Equal Lane Width

- 2 ft Shy
- 11 ft All Vehicles
- 11 ft All Vehicles
- 11 ft All Vehicles

7 ft Shoulder

TRUCKS USE RIGHT LANE
Emergency Parking (Pull-offs)

- Safe space for disabled vehicles when work zone has little/no shoulder
- Useful for staging emergency vehicles
- Sometimes used for law enforcement
- Typically placed where terrain is favorable (roughly ½ to 2 mile intervals)
Short vs Long Emergency Parking Areas

Short:
- 100-250 ft plus 75-200 ft of tapers
- Coast in / tow out

Long:
- 750 to 1320 ft plus 300 ft exit taper
- Enter/exit at freeway speeds
- Useful for law enforcement
Emergency Parking Signage

Upstream End of Work Zone

Approaching Parking Area
Signage in Emergency Parking Area

- **Time Limit**: EMERGENCY PARKING ONLY 2 HOUR MAX
- **Milepost for police**: Hwy 999 Westbound Milepost 123.4 Village of Centerville, US
- **GPS for air ambulance**: GPS Coordinates 39.828N 98.579W
Pre-Designated First Responder Staging Areas

Functions

- Rally-point where responders assemble.
- Waiting area for responders and equipment not immediately needed at incident scene.
- Location where responders can take breaks and meals in case of a long-duration incident.
- Safe work area for media reporting on the incident.
Air Ambulance Landing Zones (LZs)

Typical Applications:
- Remote/rugged sites
- High-risk construction operations (e.g. blasting)

LZ Design:
- Usually 100 x 100 ft
- Level ground
- Corners marked by cones and (at night) strobe lights
- Distant from overhead wires, trees, buildings, pedestrians, livestock, etc.
- Paved, sealed, or wetted to reduce flying debris
- GPS coordinates posted at the site
- Floodlighting, if used, directed away from aircraft
Triage Areas

Purpose:
- Sort mass casualty victims based on injury severity
- Allocate ambulances and medical resources sensibly
- Highest treatment priority: severe but survivable injuries

Typical Applications:
- Remote/rugged sites
- High-risk construction operations (e.g. blasting)
Alternate Routes
Alternate Routes

- Review existing alternate route plans if available
- Detour routes for nighttime full closures sometimes double as daytime emergency/overflow routes
- Consider offering different alt routes for cars and heavy trucks:
  - Minimize travel distance for easily-maneuverable vehicles
  - Split up traffic volume
Alternate Route Selection Factors

- Proximity to main roadway.
- Length (Compared to staying on the main route).
- Ease of access to/from alternate route.
- Complexity (Is it confusing for unfamiliar drivers?).
- Land use.
- Existing safety record.
- Height, width, weight, and turning restrictions.
- Pavement and bridge condition.
- Existing traffic volume on the alternate route and capacity to handle additional traffic (especially at intersections).
- Traffic control features (e.g. signals and railroad grade crossing warning systems).
- Existing ITS infrastructure (traffic cameras, traffic flow sensors, and changeable message signs).
  - Gather information about travel conditions on the alternate route.
  - Provide feedback to road users.
- Effect on pedestrians, bicycles, and transit.
- Roadway ownership/jurisdiction.
Contractual Provisions
Tactical Pre-Planning

- Pre-planning incident response tactics help avoid secondary incidents.
  - For example, a plan can be established to close upstream ramps to limit incoming traffic volume.
- Up-front consideration should be given for how tactics will change depending on traffic conditions.
Coordination Meetings

Everyone involved with the project discuss:

- Roles and Responsibilities
- Construction Details
- Procedures & Schedules
- Decisions that must be made
- Questions that have not been answered
Using Contractor’s Traffic Control Devices

- Sometimes, drums and other devices already on site are repositioned to expedite incident traffic management.
- Coordinate with responders to assure that traffic is not directed into impassable areas.
- When incident is cleared, discuss whether traffic control should be put back in its previous location.
Discussion: Should contractors be involved in incident management?

**Pro**
- Typically, the contractor is already on scene
- Some contractor personnel have experience as fire/EMS volunteers
- Contractor assets such as traffic control drums and lifting equipment might be useful for incident response

**Con**
- Contractor could get in the way of first responders
- Contractor personnel might lack relevant training
- Contractors might not understand Integrated Command
- Not a contractual bid item
Measuring Success

Three generally accepted performance measures for gauging TIM effectiveness:

• **Roadway Clearance Time** – Interval between first awareness of an incident by a responding agency (detection, notification, or verification) and first confirmation that all lanes are available for traffic flow

• **Incident Clearance Time** – Interval between first awareness of an incident and time the last responder leaves the scene

• **Secondary Incidents** – Number of additional unplanned incidents that occur at the scene (or in the traffic queue approaching the scene) after the original incident is reported
After Action Reviews

• Post-incident information sharing contributes to long-term improvement in roadway safety.

• Each incident is an opportunity to:
  • **Review** how effectively response was handled.
  • **Inform** roadway agency and contractor about work zone conditions that potentially contributed to the incident.
  • **Consider** what can be done to achieve higher levels of safety and efficiency in the future.

• Works best when the discussion is open and candid.
Case Examples
Collision Sequence
Case Study
Figure 6H-11. Lane Closure on Two-Lane Road with Low Traffic Volumes

Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

(See Section 38.16)
Lessons Learned

• Lack of coordination between the municipality and the signing contractor
• Signing and lighting of the work zone were not in conformity with the MUTCD requirements
• Signs were not properly secured and were moved by high winds which limited their effectiveness
• Signs at the gravel pile were defective and of inferior quality
• Little coordination with law enforcement regarding work zone dynamics and changing conditions
Case Study: Yahara River Bridge Re-Decking
Madison, Wisconsin June 2013
Case Study: Yahara River Bridge Re-Decking
Madison, Wisconsin – June 2013

• Urban freeway with 123,000 vehicles per day
• Causeway over river and wetlands
• Unusual split configuration
Case Study: Complex Urban Work Zone
Video
Lane 1 is Closed by Service Patrol and Local LE
Towing and Recovery
All Lanes Open
Lesson Learned

• All partners participated in pre-construction meetings
• Law enforcement and towing were assigned primary responsibility for the work zone
• Changing work zone conditions were discussed with partners
• Response was coordinated between law enforcement, towing and freeway service patrol, contractors and the traffic operations center
• Back of queue warning and protection strategies were implemented
• After action reviews were conducted to discuss lessons learned
Additional Resources
1. https://search.creativecommons.org/photos/3bc466d1-e547-4a91-a771-b465fd4e055
2. https://search.creativecommons.org/photos/6b86eb6e-0ee7-40e6-a3c9-a612a358f719
3. https://search.creativecommons.org/photos/a7ad5e0-abc4-4304-bce3-601c5365125a
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8. https://search.creativecommons.org/photos/32569ed-6878-45d0-a19e-c08f2084fcb
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43. Steve Fareham/Geograph
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46. https://search.creativecommons.org/photos/eedba646-a4f5-4c8e-a1be-0d8ad9b4d8b6
47. https://search.creativecommons.org/photos/ca2edfe0-022a-44ec-8720-f4d3d3ec514b
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49. https://commons.wikimedia.org/wiki/File:PA_363_shields_on_Egypt_Road.jpg
50. https://search.creativecommons.org/photos/cd300491-00c6-483e-aa6d-1a7fd6178fb8
51. https://search.creativecommons.org/photos/f7a0a413-3a8a-4aad-8c31-227025d70c10
52. https://search.creativecommons.org/photos/a89cad7a-b23d-45d0-ba74-e161470552d1
53. https://search.creativecommons.org/photos/f44467ed-5341-4318-a7f5-8cb6ad18eef2
54. https://www.fema.gov/media-library/assets/images/41446
55. WisDOT Technical Reconstruction Unit
56. Google Earth
57. WisDOT