Designing for Work Zone Incident Management
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
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

**Crash or Other Incident Occurs**

- **Call 911 to report incident**
- **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**

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<th>Primary Focus</th>
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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
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.
WZ-TIM Complexity Varies from Site to Site

Site Conditions
- Terrain
- Accessibility
- Distance from project site to emergency response resources
- Extent of closures and degree of traffic impacts
- Working conditions (e.g. night work)

Administrative
- Working relationships between highway agency and first responders
- Legal issues – who has authority to decide when to divert traffic to alternate routes
- Types of emergency response equipment likely to be available
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 **18%** of freeway fatalities are the result of secondary 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

Equal Lane Width
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

![Diagram of Short vs Long Emergency Parking Areas]
Emergency Parking Signage

No Shoulders
Emergency Parking
Every 1 to 2 Miles

Narrow Shoulders
Emergency Parking
Every 1 to 2 Miles

Upstream End of Work Zone

Approaching Parking Area
Signage in Emergency Parking Area

Time Limit

EMERGENCY PARKING ONLY
2 HOUR MAX

YOUR LOCATION
Hwy 999 Westbound Milepost 123.4
Village of Centerville, US
GPS Coordinates 39.828N 98.579W

Milepost for police
GPS for air ambulance
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.

What went well? What can we improve?
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 3B.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

- Urban freeway with 123,000 vehicles per day
- Causeway over river and wetlands
- Unusual split configuration
Case Study: Complex Urban Work Zone
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
Agency Guideline Examples

• MN: Traffic Incident Management – Recommended Operational Guidelines – 2002 document by the Minnesota Incident Management Coordination Team; incorporates practices agreed upon by Minnesota DOT, Minnesota State Patrol, Minnesota Metro Fire Chiefs, and Minnesota Professional Towing Association
  http://www.dot.state.mn.us/tmc/documents/Freeway%20Incident%20Management.pdf

• WI: Emergency Traffic Control and Scene Management Guidelines – Guidelines established to provide incident responders with a uniform approach to emergency traffic control and scene management, maximize responder safety, and minimize the risk of secondary crashes
Traffic Incident Management—General Publications

- **Guidebook on Incident Management Planning in Work Zones** – Developed in 2005 for the Smart Work Zone Deployment Initiative; provides engineers and construction managers guidance on developing WZ incident management plans.  

- **CO: Guidelines for Developing Traffic Incident Management Plans for Work Zones** – 2008 report from Colorado DOT that discusses best practices, existing TIM programs, and considerations/key components for developing/implementing work zone TIM programs.  