IMPROVING SAFETY IN THE WORK ZONE
Design, Training, and Implementation
IMPROVING SAFETY IN THE WORK ZONE

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Work Zone Fatalities

Fatalities in Work Zones
2000–2010

- 2000: 1026
- 2001: 989
- 2002: 1186
- 2003: 1095
- 2004: 1063
- 2005: 1058
- 2006: 1004
- 2007: 831
- 2008: 716
- 2009: 680
- 2010: 576
23 CFR 630 Subpart K v. MAP 21

- 23 CFR 630 - At a minimum, positive protection devices shall be considered in work zone situations that place workers at increased risk from motorized traffic.....such as:
  1) Work Zones that offer workers no means of escape....

- MAP 21 - At a minimum, positive protective measures are used to separate workers on highway construction projects from motorized traffic in all work zones conducted under traffic in areas that offer workers no means of escape (such as tunnels and bridges), unless an engineering study determines otherwise.
23 CFR 630 - At a minimum, positive protection devices shall be considered in work zone situations that place workers at increased risk from motorized traffic.....such as: (2) Long duration work zones (e.g., two weeks or more) resulting in substantial worker exposure to live traffic.

Map-21 - Temporary longitudinal traffic barriers are used to protect workers on highway construction projects in long-duration stationary work zones when the project design speed is anticipates to be high and the nature of the work requires workers to be within 1 lane –width from the edge of a live travel lane, unless...
Why the Survey?

- Does my state’s policy comply with the Rule 23 CFR 630 Subpart K and MAP 21 concerning positive protection?
- Does the way my state’s policy is written, implemented, and enforced lead to safer work zones?
- What are other states doing that would improve the safety work zones?
Why the Survey?

- Could the process of work zone safety design be improved?
- Is the contractor or construction division involved in the work zone design? Does the contractor have the flexibility to make modifications?
- How is positive protection considered in work zone design?
- What type of training is required for workers in work zones?
What did the Survey Find?

Positive Protection

- 29 Responses to the Survey
- Work zone design is performed during Design in all but 2 responses
- Survey: Who is responsible for work zone safety design? (Designer, Contractor, and Construction Inspection [all of the above 38.5%])
  - “I would say the contractor primarily, but inspection staff have responsibility to address unsafe conditions.”
What did the Survey Find?

Positive Protection

- Of those providing policy/guidance on positive protection: 3 had the guidance in design manuals; 8 had specific Work zone Safety or specific positive protection manuals; the remainder other types of guidance
- Several states had a specific person charged with work zone safety statewide
- 8 Responses that positive protection was not required by the DOT
What did the Survey Find?

Positive Protection

- Who makes the decision to use Positive Protection on a project?
  - Design 7 responses
  - Design and Construction 14 responses
  - Design, Construction, Contractor 6 responses
  - Depends on the project and type of work and is a joint decision between design and construction. Contractor can suggest a change to the method.
  - All of the above may institute positive separation.
What did the Survey Find?

Positive Protection

- Bidding of Traffic Control and Positive Separation
  - Bid as individual items – 13 responses
  - Bid as Lump Sum – 2 responses
  - Bid as either depending on item – 9 responses
Positive Protection

- Alabama Positive Protection warrant guide
  - Motorist and Worker protection considered
  - Gives other types of PP, not just barrier when barrier is impractical

- Colorado Guidelines for the use of Positive Protection in Work zone (Rare to have Manual)
  - Exposure Control Measures
  - Warrants
  - Detailed Engineering Study Guidance

- Virginia Work Area Protection Manual
  - 7 step process for analyzing need for positive protection
  - Worker Safety is considered in process
## Portable Concrete Barrier

<table>
<thead>
<tr>
<th>Location</th>
<th>Drop off</th>
<th>TCP Offset¹</th>
<th>Worker Exposure Concentration</th>
<th>Barrier Warranted</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge/Tunnel</td>
<td>Any</td>
<td>Any</td>
<td>Any</td>
<td>Yes</td>
<td>Applies to work zones with no means of escape from a vehicle entering the work area. Also applies to any removal of the railing for a drop off hazard.</td>
</tr>
<tr>
<td>Stationary Work</td>
<td>Any</td>
<td>Less than 20'²</td>
<td>High</td>
<td>Yes</td>
<td>Applies to work operations that are labor intensive (such as tying steel, formwork, etc...) and stationary³</td>
</tr>
<tr>
<td>(Culvert Extension, etc...)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overnight Concrete</td>
<td>Any</td>
<td>2' or Greater</td>
<td>Any</td>
<td>No</td>
<td>Applies to overnight operations that make the placement of barrier impractical. Provide shadow vehicle protection as practical</td>
</tr>
<tr>
<td>Slab Repair</td>
<td>Less than 1.5'</td>
<td>8' or Greater</td>
<td>Any</td>
<td>No</td>
<td>Requires use of Vertical Panels. Include Incentive/Disincentive clause (based on RSAP analysis) in the Contract as an exposure mitigation technique. Limit to 2 lanes maximum in each direction with a maximum total Average Daily Traffic (ADT) of 50,000. Barrier required for more than 2 lanes per direction or ADT &gt; 50,000.</td>
</tr>
<tr>
<td>Interstate Lane</td>
<td>4.5&quot; - 8&quot;</td>
<td>0'</td>
<td>Any</td>
<td>Yes</td>
<td>Barrier not warranted if a 4:1 wedge is provided</td>
</tr>
<tr>
<td>Addition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Duration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement Drop off</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pavement Drop off 4.5&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 8&quot;</td>
<td>0'</td>
<td>Any</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>4.5&quot; - 8&quot;</td>
<td>3'</td>
<td>Any</td>
<td></td>
<td>No</td>
<td>Use 3:1 Wedge or barrier without wedge</td>
</tr>
<tr>
<td>8&quot; - 1.5&quot;</td>
<td>3'</td>
<td>Any</td>
<td></td>
<td>No</td>
<td>Use 4:1 Wedge or barrier without wedge</td>
</tr>
<tr>
<td>&gt; 1.5&quot;</td>
<td>10'</td>
<td>Any</td>
<td></td>
<td>No</td>
<td>Use 4:1 Wedge or barrier without wedge</td>
</tr>
<tr>
<td>Separation of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposing Traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ The nearest TCP Phase to the drop off. Barrier may be warranted in one phase and not another.
² For slopes flatter than 3:1. Slopes steeper than 3:1 should have barrier regardless of TCP offset distance.
³ Stationary for worker exposure is 2 weeks.

Table 1
Colorado DOT Positive Protection Manual

CDOT
Guidelines for the Use of Positive Protection in Work Zones

- Exposure Control Measures
- Warrants
- Engineering Study Analysis
EXPOSURE CONTROL MEASURES

- Remove the hazard from the clear zone
- Full road closure/ramp closure with traffic detoured
- Road closure with diversion (i.e., onsite detour, median crossover, temporary pavement)
- Performing work during off-peak periods when traffic volumes are lower
- Accelerated construction techniques
- Directional detours or alternate route detours
- Rolling road blocks
Positive protection in work zones is warranted whenever an engineering study clearly indicates any of the following:

- Positive protection will reduce the severity of potential crashes
- Consequences of striking a fixed object or running off the road are likely to be more serious than striking the positive protection
- Consequences of striking a worker or pedestrian are likely to be more serious than striking the positive protection
ENGINEERING STUDY AND ANALYSIS

- Primary Factors
  - Clear Zone Distances
  - Roadside Geometry
  - Anticipated Traffic Volumes
  - Work Zone Speeds
  - Roadway Geometry
  - Duration

- Special Factors
  - Worker’s Safety
  - Pedestrian Safety
  - Separating Opposing Traffic
  - Law Enforcement
ENGINEERING STUDY AND ANALYSIS

Secondary Factors to Consider:

- Crash History
- Impacts on Project Cost and Duration
- Impacts on Available Lane Widths
- Roadway Classification
- Work Area Restrictions
- Bridge Construction- (Extra Weight on Structures)
7 Step Process

1. Determine Variables
   - Preconstruction Speed, Traffic Volume, Construction Time, Roadway Type, Run off Road Crash frequency, Length of Work Area

2. Clear Zone and drop off check

3. If hazard exists, remove or consider other mitigation

4. Determine Expected Accident Factor
7 Step Process (continued)

5. If expected accident frequency factor $p < 0.5$, select channelizing device

6. If expected accident frequency factor $> 0.5$, or CZ or DO violations, complete checklist to see if Barrier is warranted, if not channelizing devices

7. Design Barrier
1. Determine Variables

2. Check Clear Zone and Drop-off Guide
   - not violated
   - violated

3. Remove Hazard
   - yes
   - no

3a. Consider Alternatives
   - yes
   - no

4. Determine Expected Accident Factor, \( p \)
   - \( p \leq 0.5 \)
   - \( p > 0.5 \)

5. Select Channelizing Devices
   - no

6. Complete Checklist. Is barrier needed?
   - yes
   - no

7. Design Barrier
CLEAR ZONE TO A FIXED OBJECT & DROP-OFF REQUIREMENTS

TEMPORARY PAVEMENT MARKINGS SHALL MATCH THE EXISTING PERMANENT PAVEMENT MARKINGS AND SHALL BE INSTALLED ON PAVED DIVERSIONS (MARKINGS TO BE IN FRONT OF BARRIER OR CHANNELIZING DEVICE.)

FIXED OBJECT

CLEAR ZONE (CZ) GUIDE TO FIXED OBJECTS

LIMITED ACCESS HIGHWAY
42' @ 70 MPH
37' @ 65 MPH
32' @ 60 MPH
27' @ 55 MPH
25' @ 50 MPH

ALL OTHER ROADWAYS
33' @ GREATER THAN 55 MPH
25' @ 55 MPH
20' @ 46-54 MPH
15' @ 36-45 MPH
8' @ 26-35 MPH
4' @ 0-25 MPH

CZ = CLEAR ZONE
DO = DROP-OFF DEPTH

LOW SHOULDER

LOW SHOULDER (W8-6) SIGN

SHOULDER DROP-OFF

SHOULDER DROP-OFF (W8-9a) SIGN

1 FOOT MIN.

AND 6:1 WEDGE DESIRED 4:1 WEDGE MINIMUM

1 FOOT MIN.

AND 6:1 WEDGE DESIRED 4:1 WEDGE MINIMUM

4 - 5 FT ADDITIONAL SHOULDER REQUIRED FOR GROUP 2 CHANNELIZING DEVICES
WEDGES STEEPER THAN 4:1 (3:5:1, 3:1, 2:1, etc.) ARE NON TRAVERSABLE AND ARE A FIXED OBJECT.

4 - 5 FT ADDITIONAL SHOULDER REQUIRED FOR GROUP 2 CHANNELIZING DEVICES OR TEMPORARY BARRIER

GROUP 2

AND 6:1 WEDGE DESIRED 4:1 WEDGE MINIMUM

OR

OR

TYPE A

TYPE B

DO = LESS THAN 2" MAY USE

DO = 2" TO 5"

SHALL USE

IF A 8:1 WEDGE DESIRED OR 4:1 WEDGE MINIMUM IS USED NO SIGN(S) REQUIRED

OR

DO = 2" TO 5"

IF 8:1 WEDGE DESIRED OR 4:1 WEDGE MINIMUM IS USED NO SIGN(S) REQUIRED
What did the Survey Find?

Training and Enforcement

- What type of training must Contractor Employees attend prior to working in work zone?
  - Basic OSHA training – 7
  - Work zone specific training provided by DOT – 2
  - Contractor to Provide Training – 11
  - Third Party Training – 5
  - None – 4
What did the Survey Find?

Training and Enforcement

- What type of training must Department Employees attend prior to working in a work zone?
  - Work Zone Specific DOT Training – 16
  - OSHA training – 10
  - Third Party such as ATTSA – 5
  - None – 4
What did the Survey Find?

Training and Enforcement

- How is safety enforcement/verification done in work zones?
  - Department Construction Inspector – 13
  - Department Safety Inspector – 3
  - State or Federal OSHA – 6
  - 3rd Party Inspector OCIP – 1
  - Contractor Safety Manager – 3
  - A combination of the above – 3
  - If by "safety" you are referring to work zone issues, our Project Manager and his inspectors enforce the specifications. Or if by "safety" you are referring to things like trench safety, fall protection, etc., the enforcement of these issues is left to the Contractor's own safety officer.
What did the Survey Find?

Training and Enforcement

- What type of Traffic Control Verification is required?
  - Logs of TC setups at certain intervals – 13
  - None – 7
  - Video – 1
  - Others: Inspection Forms and Checklists, Daily Diaries
Best Practices

Training and Enforcement

- Virginia’s Work Zone Safety Checklist
  - Looks at all aspects of WZ traffic control
  - Performed Daily
  - If urgent fix immediately, otherwise 3 working days
### WORK ZONE SAFETY CHECKLIST

**RESIDENCY:** CONTRACTOR / AREA HEADQUARTERS:  
**CITY / COUNTY:**  
**PERSON IN CHARGE:**  
**WEATHER CONDITION:**  
**TYPE OF OPERATION:**  

<table>
<thead>
<tr>
<th>DAY / DATE</th>
<th>TIME</th>
<th>POSTED SPEED</th>
<th>MPH</th>
</tr>
</thead>
</table>

| DAY OR NIGHT WORK | IN | NOT IN PROGRESS |

#### A. DRIVE THRU:
- Are maneuvers difficult or unexpected?  
- Adequate warning of hazards?  
- Is signage clear/uncluttered and properly spaced?  
- Are traffic control devices sufficiently visible?  

#### B. SIGNS:
- Adequate  
- Inadequate  
- Need to be (removed/repositioned/covered)  
- Need (cleaning/replacement)  
- Conflicting (permanent/temporary signing)  
- Non-approved sign support  
- Blocked by vegetation  

#### C. PORTABLE CHANGEABLE MESSAGE SIGN:
- Adequate  
- Inadequate  
- Application does not meet guidelines  
- Inappropriate (message)  
- More information on P.C.M.S.  
- Not delineated, no cones/barrels  

#### D. ARROW BOARD:
- Adequate  
- Inadequate  
- Malfunction (bulb out, etc.)  
- Incorrect placement  
- Misaligned bulbs  
- Not dimmed at night  

#### E. DRUMS = D / OTHER = O:
- Adequate  
- Inadequate  
- Inappropriate taper length  
- Spacing inadequate/too long/too short  
- (repair/clean/replacement)  
- Reflective bands  
- (damaged/missing)  
- On drums/other devices  
- Additional devices needed  
- Misaligned  

#### F. TRAFFIC BARRIER:
- Adequate  
- Inadequate  
- Improper barrier wall flare  
- Improper terminal treatment  
- Barrier needs to be (realigned/removed)  
- Warning light (service/clean)  
- Delineators (clean/additional)  
- 8' x 12' vertical barrier panels  
- Clean additional  
- Attenuator (repair/replace)  

#### G. FLAGGING OPERATION:
- Adequate  
- Inadequate  
- Need additional advance signing  
- Are flagpersons certified?  
- Positioned correctly?  
- Highly visible?  
- Properly clothed?  
- Flagging correctly?  

#### J. TRUCK-MOUNTED ATTENUATOR:
- Properly positioned?  
- Properly maintained/delined?  

#### K. MISCELLANEOUS:
- Adequate buffer space?  
- Is the work area protected?  
- Materials properly stored?  
- Are lane closures in accord with allowed hours?  

#### ACCIDENTS:
- Evidence of an accident  
- Damaged traffic control devices  
- Skid marks  
- Debris  

### COMMENTS / RECOMMENDATION:  

**REVIEWED BY:**  
**REVIEWED WITH:**  
**SIGN & DATE:**  
**SIGN & DATE:**  

COPY: CONTRACTOR, INSPECTOR, RESIDENT ENGINEER, OR OTHER
Best Practices

Training and Enforcement

- ATSSA training on TC technician and TC supervisor (Federal Grant, Cost is minimal for States)
- ATSSA/FHWA Work Zone Positive Protection Toolbox, Guidelines for Positive Protection
- ATSSA/FHWA training on “Minimizing Worker Exposure in Highway Work Zones through the Use of Positive Protection and Other Strategies”
Implementation

- While there are some outstanding guidance in manuals and policies such as Colorado and Virginia, implementation is the key to making great ideas become great performance.

- Factors for Performance:
  - Clear Expectations in policies, procedures, manuals
  - Training for inspection staff, contractor
  - Management support of safety, empowering of personnel (contractor and owner) in the field to make needed changes
How Could the Process Be Improved?

- Ideas to think about:
  - Involve contractor or require Contractor to design certain aspects of work zone
    - Contractors understand phasing, methods and means
    - Collaborative process Engineering and Contracting side both have an important part
    - Alternative Contracting Methods bring out innovation in design of traffic control
    - Bid Lump Sum rather than items
      - Allow innovation to be competitive advantage
      - Certain items may need to be bid as a unit – (Barrier?)
    - Have construction personnel involved in WZ design as they very familiar and trained in design
      - Performance based specifications rather than items (MUTCD/clear requirements for other performance targets)
      - Have project specific training on work zone and positive protection.
DEFINITION OF TREATMENT ZONES FOR VARIOUS EDGE CONDITIONS

Edge Height (D) in Inches versus Lateral Clearance (Y) in Feet

Edge Condition I
S = (3:1) (or flatter)
Y

Edge Condition II
S = (12.99:1) to (1:1)
Y

Edge Condition III
S is steeper than (1:1)
Y

Zone Treatment Types Suggested

A. No treatment

B. On-site “White Line” signs

C. Off-site “shoulder channel” or On-road “white Line” signs

D. Vertical barriers

Check conditions (Figure 1) for positive barriers, where positive barrier is not indicated, the treatment shown above for Zone I may be used after consideration of other applicable factors.

Where is TxDOT?

FIGURE 1. CONDITIONS INDICATING USE OF POSITIVE BARRIER FOR ZONE 1 ( ______ )

Where is TxDOT? Where is the right portion of the average daily traffic volume traveling with an 80
feet width on the right side of the roadway.

These guidelines apply to temporary traffic control areas or work zones where operational practices may not apply to permanent locations used by motorists. The edge conditions may be present between drivers and the edge of the roadway, between operators and the edge of the roadway, or between operators and the edge of the roadway. These guidelines may not be used on the Design Division’s corridor.

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TxDOT - Texas Department of Transportation Traffic Operations Division

WORKSHEET FOR EDGE CONDITION TREATMENT TYPES
Figure B-2: Conditions Indicating Use of Positive Barrier

Notes:

1. \( E = C \times T \)

Where:
- \( C \) = portion of average daily traffic volume traveling within 20 feet (6.0 m) (generally two adjacent lanes) of the edge of the dropoff condition.
- \( T \) = duration time in years of the dropoff condition.
References

- Alabama DOT Guidelines for Operation: Temporary Traffic Control Devices Section 3.65; updated 2011

- Colorado DOT Guidelines for the Use of Positive Protection in Work Zones, 2010,

- Virginia Work Area Protection Manual 2011

- Fatalities in Work Zones; National Highway Traffic Safety Administration, Referenced from:
  http://www.workzonesafety.org/crash_data/workzone_fatalities
Resources for Work Zone Safety

- National Work Zone Safety Information Clearinghouse
  http://www.workzonesafety.org/

- AMERICAN TRAFFIC SAFETY SERVICES ASSOCIATION
  http://www.atssa.com/
THANK YOU...