Highway-Rail Grade Crossing Safety 101

A Primer on Grade Crossing Safety

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Introduction & General Overview of Highway-Rail Crossing Safety

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Webinar Layout

• Introduction & general overview – Aemal Khattak
• Crossing design, warning signs & devices – Terry Byrne
• Crossing diagnostics, planning & programming – Jason Field
• Crossing safety education & enforcement programs & evaluation – Steve Laffey
Introduction

• US Railroad transportation started ~ 1820s
• Accelerated westward expansion of the US, facilitated establishment & growth of many towns
• Concern with automobiles in the early 1900s
• National statistics on crossing collisions kept since then ( Accident Reports Act, 1910)
Grade Crossing

• A crossing between highway and rail on one level (public, private, pedestrian)
• Includes a crossing between highway and light rail with separate right-of-way
• As of 2009, 137,659 public grade crossings
  – 40,344 equipped with gates
  – 22,635 equipped with flashing lights
  – 1,223 have highway signals, wigwags, bells
  – 10,071 with stop signs
  – 56,861 with crossbucks only
Safety - Grade Crossings Incidents

Incidents at Highway-Rail Crossings

% change: -45.5%
Grade Crossing Fatalities/Injuries

### Fatalities at Highway-Rail Crossings

- 1999: 407
- 2000: 426
- 2001: 421
- 2002: 357
- 2003: 334
- 2004: 371
- 2005: 359
- 2006: 369
- 2007: 337
- 2008: 290
- 2009: 245

% change: -39.8%

### Injuries at Highway-Rail Crossings

- 1999: 1401
- 2000: 1233
- 2001: 1157
- 2002: 1001
- 2003: 1035
- 2004: 1095
- 2005: 1053
- 2006: 1072
- 2007: 1067
- 2008: 972
- 2009: 714

% change: -49.0%
The Crossbuck Sign

- “As a minimum, one crossbuck sign shall be used on each highway approach to every highway-rail grade crossing along or in combination with other traffic control devices”
- Requires road users to yield the right-of-way to rail traffic
Motorist Unsafe Maneuvers

- Most accidents result of motor vehicle encroachment of tracks
- Motorists quite persistent
Bicyclist/Pedestrian Unsafe Maneuvers

• Bicyclists/pedestrians frequently indulge in unsafe maneuvers
  – Crossing in front of oncoming train
  – Climbing between carriages of a stopped train
  – Climbing under a stopped train
  – Hopping on & jumping off a slow moving train

Source: FRA Compilation of Pedestrian Safety Devices In Use at Grade Crossings, 2008
Crossing Safety Assessment

• Need for safety assessment – reduce number & severity of accidents &

• Steps involved
  – Collection of relevant data
  – Analysis of data to determine hazardous crossings
  – Conduct engineering studies, generate & evaluate alternatives, implement changes
FRA Safety Information

• National Highway-Rail Crossing Inventory
  – Originally developed during the early 1970s
  – Cooperative effort among FRA, FHWA, AAR, states, and railroad companies

• Crossing Accident Data
  – State & local police, FRA, NHTSA

• http://safetydata.fra.dot.gov/officeofsafty/
Accident Reporting

• Railroad must report any impact between railroad on-track equipment and vehicle (truck, motorcycle, bicycle, ...) or pedestrian

• FRA prepares an annual summary of the inventory/accident data
Safety Hazard Estimation

- A systematic method needed
- Identify crossings that have the most need for safety improvements
- Hazard indices – ranks crossing in relative terms – higher index → more hazardous
- Accident prediction formulae – predict accident frequency
Welcome to the newly redesigned FRA Office of Safety Accident/Prediction Web Site. This site was established for the purpose of making railroad safety information readily available to a broad constituency which includes FRA personnel, railroad companies, research and planning organizations and the public, in general.

Visitors have access to railroad safety information including accidents and incidents and highway-rail crossing data. From this site users can run dynamic queries and view current statistical information on railroad safety.

**Search by:** Location □ Crossing

**Select Location(s) and/or Railroad(s), and Choose 'Select'**

**State:** Nebraska □ Entire State

**County/City:**
- KIMBALL
- KNOX
- LANCASTER
- LINCOLN

*Select more than one County/City in the list by holding down your PC's ctrl key while you click.

**Search by:**

**Railroad:**

*Click here for a complete listing of Railroads*

**Location selected:**

NE LANCASTER

**Railroad selected:**

Remove

**How many Records?**

- □ 30
- □ 50
- □ 100
- □ All

Reports
## PUBLIC HIGHWAY-RAIL CROSSINGS RANKED BY PREDICTED ACCIDENTS PER YEAR AS OF 12/31/2009*

*Num of Collisions: Most recent year is partial year (data is not for the complete calendar year) unless Accidents per Year is 'AS OF DECEMBER 31'.

<table>
<thead>
<tr>
<th>RANK</th>
<th>PRED COLL.</th>
<th>CROSSING</th>
<th>RR</th>
<th>STATE</th>
<th>COUNTY</th>
<th>CITY</th>
<th>ROAD</th>
<th>NUM OF COLLISIONS</th>
<th>DATE CHG</th>
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</table>
Grade Crossing Guidance

- General information on grade crossings
- Prevalent and best practices
- Adopted standards
- Guidelines for improvements


Geometric Design Guidance

• Highway geometric design
  – Horizontal and vertical alignment
  – Sight distances for highway users
  – Cross section

• A Policy on geometric design of highways and streets (AASHTO, 2004)

(available from the AASHTO Bookstore)
Sign & Marking Guidance

• Traffic control devices
  – Needed to control & coordinate movement of different types of traffic
  – Passive control devices
  – Active control devices

• Manual on uniform traffic control devices (2009 edition)

(http://mutcd.fhwa.dot.gov/kno_2009.htm)
Signal Interconnection Guidance

- Traffic signal preemption
  - Signalized intersections within 200 ft. of crossing or beyond 200 ft.
  - Consider traffic volume, queue length vehicular mix, vehicle approach speeds, train frequency, ...

- Preemption of traffic signals near railroad crossings: An ITE recommended practice (2006)

(available from the ITE Bookstore)
Pedestrian Safety

• A compilation of pedestrian safety devices in use at grade crossings, FRA 2008
  – Includes both passive and active devices
  – Some of the included devices are not in the MUTCD

(www.fra.dot.gov/downloads/safety/small_Jan08_Ped_Devices_GX2.pdf)
TERRY BYRNE
Senior Project Manager
Train Control Systems

tbyrne@vhb.com

617-728-7777
WHO DESIGNS RAILROAD GRADE CROSSINGS?

• No One Entity Determines the Design
• Design Team Approach
  ✓ STATE DOTs
  ✓ FRA
  ✓ Local Town Officials and Community
  ✓ Railroads Operations and Engineering
  ✓ Consultants and Engineers
UNDERSTANDING GRADE CROSSING USE

• FRA Grade Crossing Database
  ✓ Inventory Characteristics
    Railroad
    Division
    Location – State/City Town
    Train Movements – Speeds
    Roadway –
    Type of Warning System
UNDERSTANDING GRADE CROSSING USE

- FRA Grade Crossing Database
  - Accident History
    - General Data From Inventory
    - Date/Time
    - Weather Conditions
    - Type Of Accident
    - Injuries/Fatalities
    - Property Damages
CROSSING SURFACES AND TYPES

Dirt / Gravel
Bituminous
Rubber
Concrete
CROSSING SURFACES AND TYPES

Bituminous

Rubber

Concrete
DESIGN CONCERNS AND ISSUES

✓ Humped Crossings
Roadways
Preview – Highway and Rail
Rail Operations
DESIGN CONCERNS AND ISSUES

- Humped Crossings
- Roadways
  Preview Highway and Rail
  Rail Operations
DESIGN CONCERNS AND ISSUES

- Humped Crossings
- Roadways
- Preview Highway and Rail Rail Operations
DESIGN CONCERNS AND ISSUES

- Humped Crossings
- Roadways
- Preview Highway and Rail
- Rail Operations
DESIGN CONCERNS AND ISSUES

SUMMARY

✓ Adjacent Roadway and Intersections
✓ Rail Yards and Siding Tracks
✓ Passenger Stations
✓ Types of Traffic (Truck/Trailers/Buses)
✓ Schools and/or School Bus Route
✓ Nearby Fire and Life Safety Services
✓ Pedestrian Traffic
HEAR THE WHISTLE BLOW

The Train Horn or Whistle Is The Oldest Form Of Warning

Code Of Federal Regulations (CFR) 49 Mandates That Every Train Sound Their Horn or Whistle At All At-grade Crossings
APPLICATIONS

PASSIVE

• Rural Or Private
• Low High Rail and/of Highway Traffic
• Non-Signaled Track (Dark Territory)

ACTIVE

• Public Roadways
• High or Frequent Rail and Highway Traffic
• School Area of Bus Route
• High Pedestrian Traffic
• Vital Railroad Signal System In Place
WARNING SIGNS

PASSIVE

Cross Buck  Pedestrian Warning  Advanced Warning
ACTIVE WARNING COMPONENTS

- Bell
- Flashers
- Gate Motor Assembly
- Cantilever
Grade Crossing Activation Sequence

A Circuit

B Circuit

C Circuit

APPROACH

ISLAND
Grade Crossing Activation

A Circuit

Train Detected 30 Seconds Prior To Arrival At The Crossing

B Circuit

Lights Flash 3-5 Seconds

C Circuit

Gates Descend 10-15 Seconds

ISLAND
Grade Crossing Activation

Approach “A” and Island “B” Circuits in Detection Establishes Direction Of Trains Movement

Gates Fully Down/Closed 5 Seconds Prior To Train Arrival
Grade Crossing Activation

Train Clears Island Circuit
Gates Rise To Clear
Roadway Even With “C” Approach Circuit Occupied

Gates Rise 8-12 Seconds
After Train Clears Island
Grade Crossing Activation

Train Clears Approach “C” Circuit Warning System Reset With No Direction Of Train Movements Established
DETECTION SYSTEMS

- Direct Current (Type C)

  Set Approach Distance

  Requires Insulated Joints To Separate Circuits

  Warning Time Established By Maximum Authorized Speed (MAS) Operating On The Line To Provide 30 Seconds Of Warning
Audio Frequency Overlay (AFO)

Set Approach Distance

Requires Insulated Joints To Separate Circuits

Warning Time Established By Maximum Authorized Speed (MAS) Operating On The Line To Provide 30 Seconds Of Warning
DETECTION SYSTEMS

- Set Approach Distance
- Requires Insulated Joints To Separate Circuits
- Detects Trains Stopped Within The Approach To The Crossing And Allows Gates And Roadway To Clear After A Specified Time Has Expired
- Warning Time Established By Maximum Authorized Speed (MAS) Operating On The Line To Provide 30 Seconds Of Warning

✓ Motion Sensor
DETECTION SYSTEMS

- Speed Of Approaching Train Is Calculated By The Predictor And Warning Time Set
- No Insulated Joints Required (In Most Cases)
- Detects Stopped Train Within The Approach
- Provides For Constant Warning Time

PREDICTOR
Diagnostic Review

Jason Field, PE

Moffatt & Nichol

(919) 781-4626

Creative People, Practical Solutions.
SO NOW WHAT?
Why do I have to worry about the railroad crossing?

**Code of Federal Regulations (CFR)**

- **Better known as CFR Title 49 (Transportation)**
  - Sub Part 234 (Grade Crossing Signal System Safety and State Action Plans)
  - There are extensive federal and state requirements on how the railroad signals must operate and what type of signal devices are used for at-grade crossings
Why Bother with a Diagnostic Team?

Code of Federal Regulations (CFR)

• Better known as CFR Title 49 (Transportation)
  – Sub Part 222 and 229 (Use of Locomotive Horns at Highway Rail Grade Crossings)
    • Often referenced as the quiet zone rule (It is actually the “Horn Rule”)
    • Diagnostic Team – “a group of knowledgeable representatives of parties of interest in a highway-rail grade crossing, organized by the public authority responsible for that crossing, who using crossing safety management principles, evaluate conditions at a grade crossing to make determinations or recommendations for the public authority concerning safety needs at that crossing.”

• The diagnostic team can save you time, money, liability and save lives
Get the Diagnostic Team Together
(they can keep you out of trouble and save a lot of headaches)

- State DOT and/or State Public Utility Commission
- Railroad
- Transit
- Municipality
- County
- Law Enforcement (optional)
Meet at the crossing

- You can't see what you need to from space.
What do you look at?

- Signals and the pavement adequate?
- ADA Compliance?
- Sign Placements?
What else?

- Upgrade Signals?
- PREEMPTION?!?!?!
- Adequate Storage?
  - Will your design cause cars to store back to and across the tracks? (Will your design kill someone?)
What else?

- Wayside signals to be moved?
- Nearby industry a factor?
- Turn radius’ adequate?
What else?

- Sight distance obstructions?
- Drainage concerns?
- Impact to nearby crossings?
What else?

- Pedestrian access issues?
Pull it together.

- Look at all existing infrastructure
- Request input from all stakeholders
- Get buy in from all stakeholders
- Designate one person to record modifications needed
Who pays for it?

- Decision process varies from state to state, but generally you can count on whoever wants to do the project has to pay for the changes to the RR crossing and signals.
- Your State PUC or State DOT is the first place you should go to for this discussion.
IT COSTS HOW MUCH !?!?

• Be realistic
• Typical costs
  – Signals $150,000 - $350,000
  – Crossing surfaces $25,000 - $150,000
  – Roadway Costs $20,000 - $500,000
• Potential Funding sources
  – Federal
  – State
  – Municipal
  – Private
  – RR funds
How do you save money?

- Sometimes the roadway authority may have a project already under way to improve a crossing
- If you coordinate efforts, it opens the opportunity for cost sharing which saves everyone money
- CONSOLIDATION! – Incentives are available from Federal, State DOT, State PUC, FRA, FHWA and RR’s
  - Examples of state cash incentives range from a few thousand dollars to $70,000 (ADT > 500)
  - Incentive is determined by your individual state which is another good reason to start there
If we don’t do a diagnostic, what’s the worst that could happen?
Highway/Rail Grade Crossing Safety Education & Enforcement Programs

Steve Laffey
Railroad Safety Specialist
Illinois Commerce Commission
Chair, TRB Committee Highway/Rail Grade Crossings
slaffey@icc.illinois.gov
(217) 785-9026

We Use Education & Enforcement to Show People Proper Behavior and Consequences of Bad Choices
Rail Safety Education

- Operation Lifesaver – Since 1972; AAR Before
  - Stay Off, Stay Away, Stay Alive
  - Look, Listen & Live
  - State Coordinator = www.oli.org
  - Audiences = Many & Diverse

- FRA - RSIA of 2008 - New Programs
  - Sec. 202: State Action Plans – Target Top 10 States
  - Sec. 205: Telephone Number to Report Grade Xing Problems
  - Sec. 206 (b): RR Safety Public Awareness Program (Top 10)
  - Sec 22501 (1): 3 Grants For Enhanced Public Education &
    Awareness Campaigns (Based on ICC/FRA PEERS)
  - Small Grants Go A Long Way ($20,000)

At 60% Labor & $50/hour = 240 Hours of Effort
## Menu of Educational Opportunities

<table>
<thead>
<tr>
<th>Educational Tools</th>
<th>Effectiveness</th>
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<tbody>
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<td>1 Hour Operation Lifesaver Presentation</td>
<td>Very High</td>
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<td>Six Feature Articles for Print or Radio</td>
<td>Medium</td>
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<tr>
<td>Town Hall Meetings</td>
<td>Medium</td>
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<tr>
<td>&quot;Voice of Metra&quot; Platform Announcements</td>
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<tr>
<td>Metra On-Board Announcements</td>
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<td>&quot;It's The Law&quot; Poster Campaign</td>
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<td>Marquee Signs</td>
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<td>Newspaper Ads</td>
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<td>30 Second Public Service Announcements</td>
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<td>Continuous Video Loop at Town Hall/Metra Station</td>
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<tr>
<td>Bank Statement Insert (Stuffer)</td>
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**Relative Effectiveness & Cost Trade Off**
Galesburg, IL – Poster Contest in Schools
Three Different Signs @ $1,270 for 45 Days
Health World Educator, Ilana Brown presents the Operation Lifesaver program to 3rd Grade Students at Dean Elementary
Enforcement

Signs to Warn The Public, Then Follow Through. Positive Reinforcement Very Successful. Citations/Warnings. GCCI.
Photo Enforcement
Only After an Engineering Analysis Can Decrease Violations by as Much as 70%
Evaluation of Programs & Projects

• Important To Evaluate Success (or Failure) of Program and/or Project
• Before and After Studies
  – Violation Analyses – expensive
  – Violations per train event
  – Surveys of Actual and Perceived Behaviors

Evaluation Can Cost Far More Than Actual Program
## Cost of Violation Counting

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### Activations and Violations at the Three Coon Rapids Sites

- **Cost per activation** = $160,000 / 8,978 = $17.82
- **Total violations per activation** = 2,608 / 8.978 = .29
- **Technical violations per activation** = 2,473 / 8,978 = .27
- **Citable violations per activation** = 135 / 8,978 = .015
Violation Counting – Pedestrians Are Very Fluid, Difficult to Count, and Add to Overall Expense

Examples from the FRA/ICC PEERS Project Via Volpe National Transportation Systems Ctr.
Emergency Notification Sign
Required at All Public Crossings as of April 2010. NPRM for Sign Design.

To report stalled vehicle on tracks or other emergency, call 1-800-555-5555 and refer to crossing #123-123A on Cherry Street.

Do Not Forget Elimination (Of Crossings) And Enthusiasm (Of Staff). Thank you!
Summary

• Grade crossings present unique challenges
• Determined users can circumvent best warning systems
• Design & construction of safest crossings requires a team approach
• Simple and complex engineering treatments
• Education & enforcement are inexpensive options
Thank you

Questions?