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Canadian Council of Motor Transport Administrators
Conseil canadien des administrateurs en transport motorisé
BIENVENUE ASSEMBLÉE ANNUELLE 2018 DU CCATM
WELCOME TO THE 2018 CCMTA ANNUAL MEETING
QUÉBEC

MINISTÈRE DES TRANSPORTS, DE LA MOBILITÉ DURABLE
ET DE L'ÉLECTRIFICATION DES TRANSPORTS

Proposed solution to improve pedestrian detection in urban areas by heavy vehicle drivers

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Background

Study on heavy vehicle driver visibility

- Initiated by MTMDET in partnership with:
  - SAAQ
  - Ville de Montréal

Objective: Reduce the risk of accidents caused by insufficient heavy vehicle driver visibility

- Study structure:
  - Step 1: Analyze problematic situations
  - Step 2: Assess available solutions
  - Step 3: Implement better solution

Step 1
Analyze problematic situations

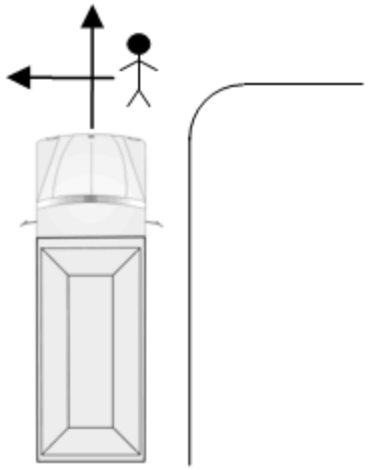
Identify problematic situations
(associated with heavy vehicle driver visibility)

- Conduct literature review
- Analyze various coronor's reports

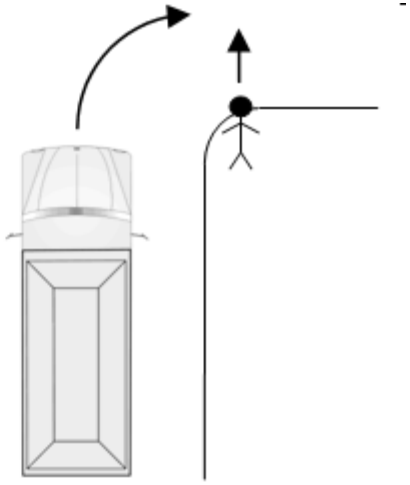
Findings:

- 6 problematic situations were identified

Problematic situations involving vulnerable users



Pedestrian crossing directly in front of the vehicle



Pedestrian crossing the intersection where the vehicle is turning right

Example of a front blind spot

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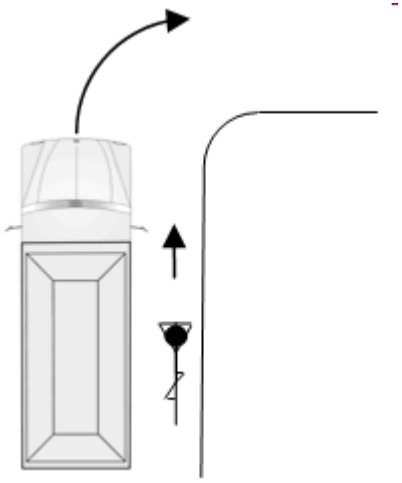
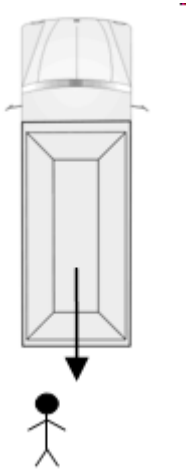
Problematic situations involving vulnerable users

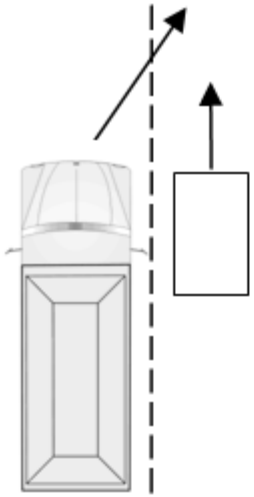


Cyclist and vehicle are both turning right

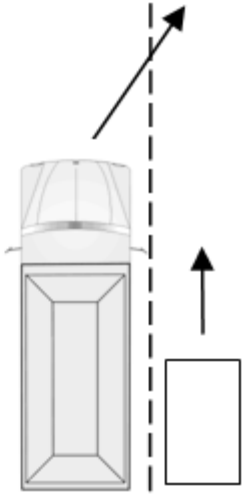


Pedestrian crossing behind a vehicle in reverse

Problematic situations involving another vehicle



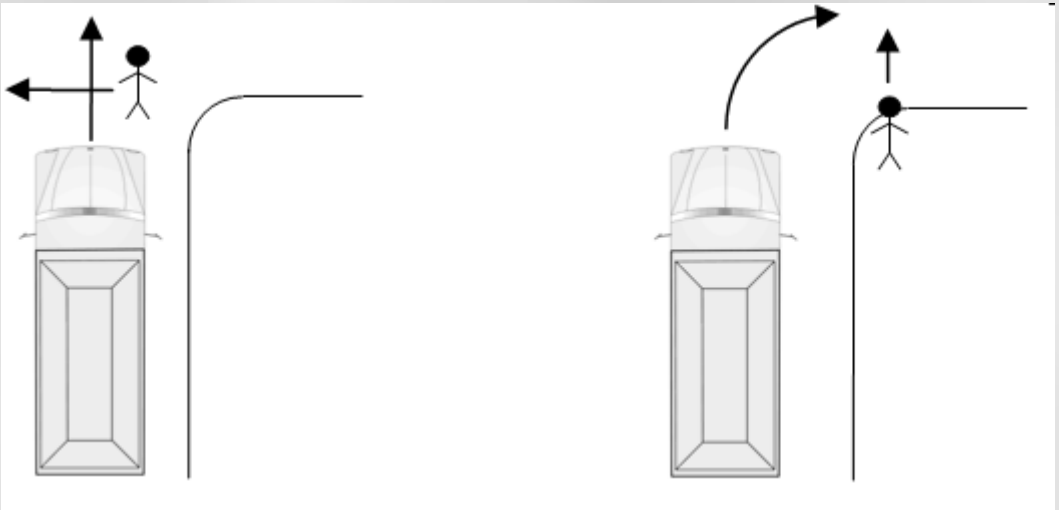
Small car directly to the right of the vehicle cab



Small car in the right lane next to the rear of a heavy vehicle

Key visibility problems

Detecting pedestrian in urban environments



- Serious danger for pedestrians
- Most common situations involving vulnerable users
- Account for many of the cases studied by coroners
- Low-speed situations with similar potential solutions

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Issues specific to winter and snow removal

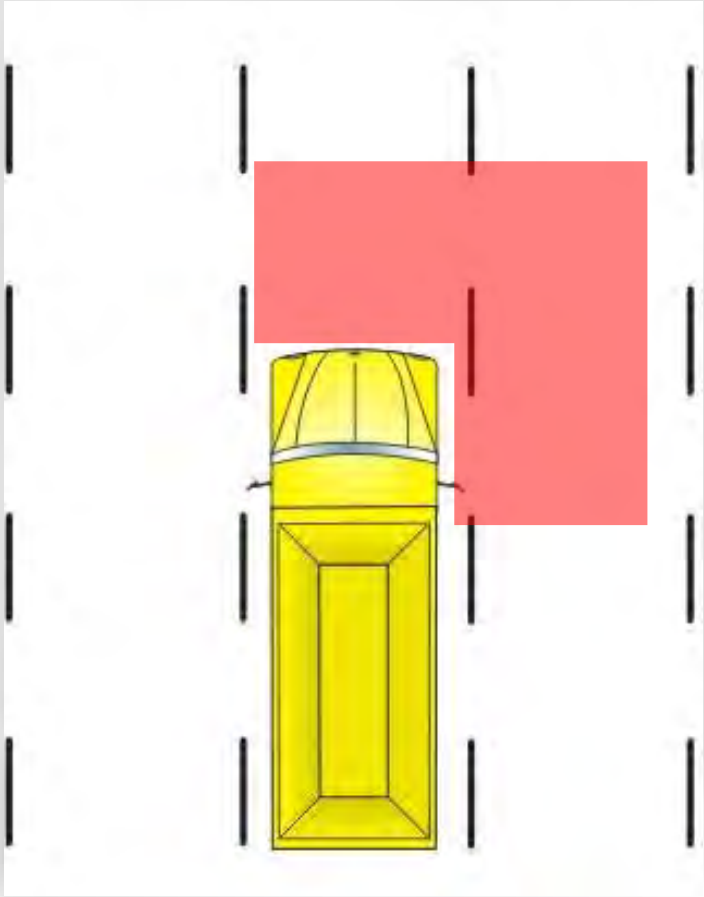
- Problems specific to snow removal operations
  - Reduced driver visibility (weather)
  - Snow on windows or mirrors
  - Additional blind spots
- Very few accidents caused specifically by these factors have been identified

Issues specific to winter and snow removal

- This study focuses on visibility problems as a whole, not those specific to snow removal
- Issues specific to snow removal will be used as criteria for assessing possible solutions:
  - Effective at night?
  - Effective in snowy conditions?

Step 2
Assess available solutions

Problematic blind spots



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Assess available solutions

List of potential solutions:

- Vehicles with better visibility
- Additional mirrors (optical devices)
  - European standard
  - School bus mirrors
  - Other types of mirrors
- Camera/monitor systems
- Detection technology systems

Solution preferred by the working group

Additional mirrors

- Inexpensive
- Equipment available:
  - Easy to get
  - Easy to install
- Complete solution:
  - Typically accepted by drivers
  - Easy for drivers to use

Solutions ruled out by the working group

Advanced technology systems (cameras, detection systems)

- Reliability and effectiveness of pedestrian detection unknown
- Driver acceptance and behavior unknown
  - Driving task
  - False alarms
  - …
- Acquisition, installation, and maintenance costs presumably somewhat high

To be looked into if mirrors are not effective

Solution assessment (mirrors)

Objectives:

- Carefully compare the effectiveness of multiple types and combinations of mirrors
- Effectiveness = ability to improve **detection** of pedestrians

Assessments conducted in cooperation with the road safety team from École polytechnique de Montréal

Methodology

- Develop a testing protocol:
  - Rigorous
  - Reliable
  - Reproducible
- Draw up a testing plan:
  - Choice of mirrors
  - Choice of vehicles
- Conduct testing in controlled conditions:
  - Phase 1: All mirrors on a single vehicle
  - Phase 2: Environmental conditions

Pedestrian

According to testing protocol

- Pedestrian: 6-year-old child (50th percentile)
- Cylinder approximately 115 cm (45 in.) tall
- Detection in a mirror = cylinder completely visible

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Testing site

- Ville de Montréal warehouse
- Grid pattern floor
- Interior
- Adjustable lighting

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First phase of testing

- 1 vehicle: International 7600 (MTMDET)

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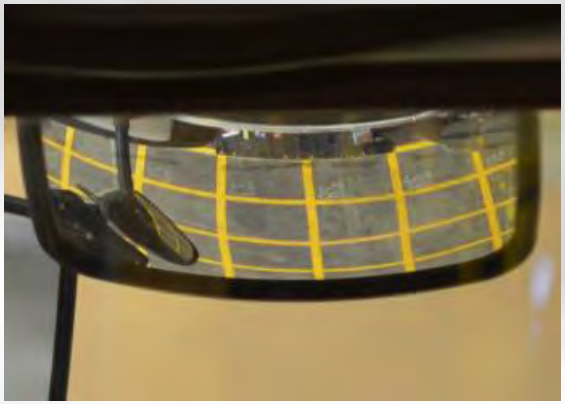
First phase of testing

16 mirrors separated into 5 categories

1. School bus mirrors (standardized)
2. Other types of front mirrors
3. Convex mirror on each fender
4. Front-view mirror only
5. Mirror above passenger-side door



Testing results

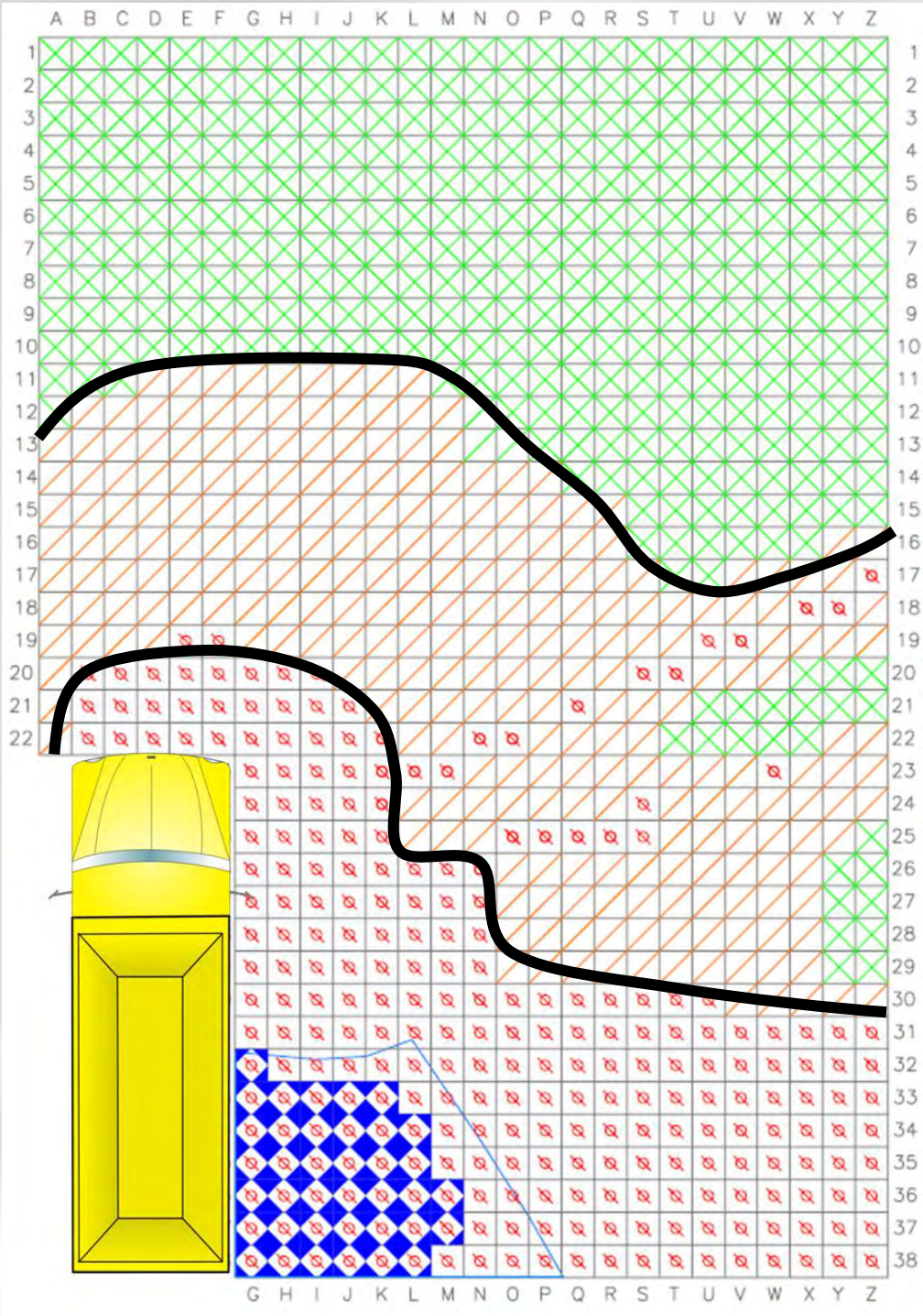
Truck with no front mirrors

<u>Direct visibility</u>

Green	Full
Orange	Partial
Red	Zero

<u>Detection by a mirror</u>

Blue



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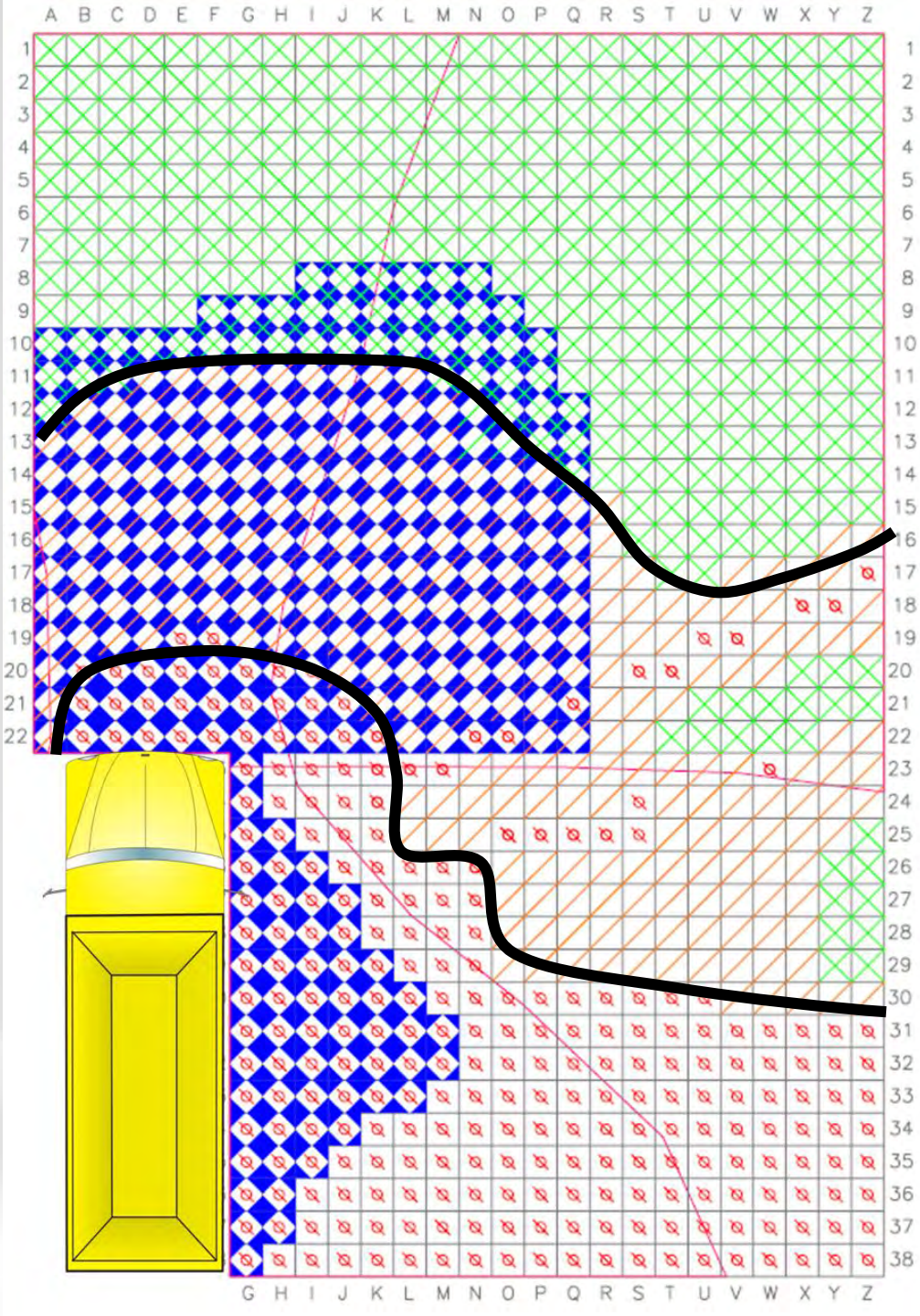
Testing results

Front mirrors

Type 1: School bus

Adjustment

School bus standard



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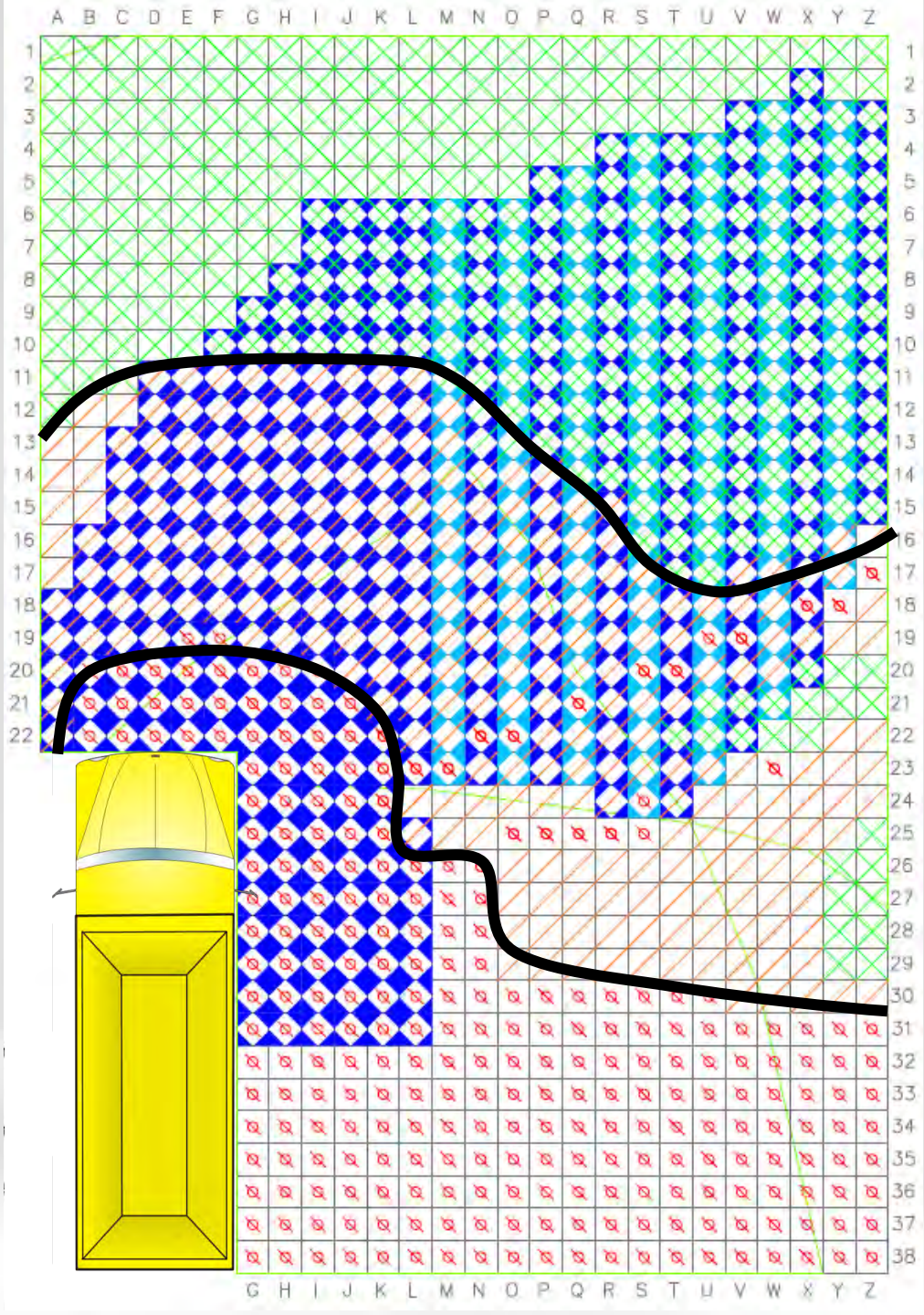
Testing results

Front mirrors

Type 2: Others

Adjustment

- Impossible to adjust to the school bus standard
- Tandem method: Adjusted to the right of the two front mirrors



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Phase 1 findings

Preferred solution:

- Combination of two front mirrors
- **The adjustment method is very important**

2nd phase of testing:

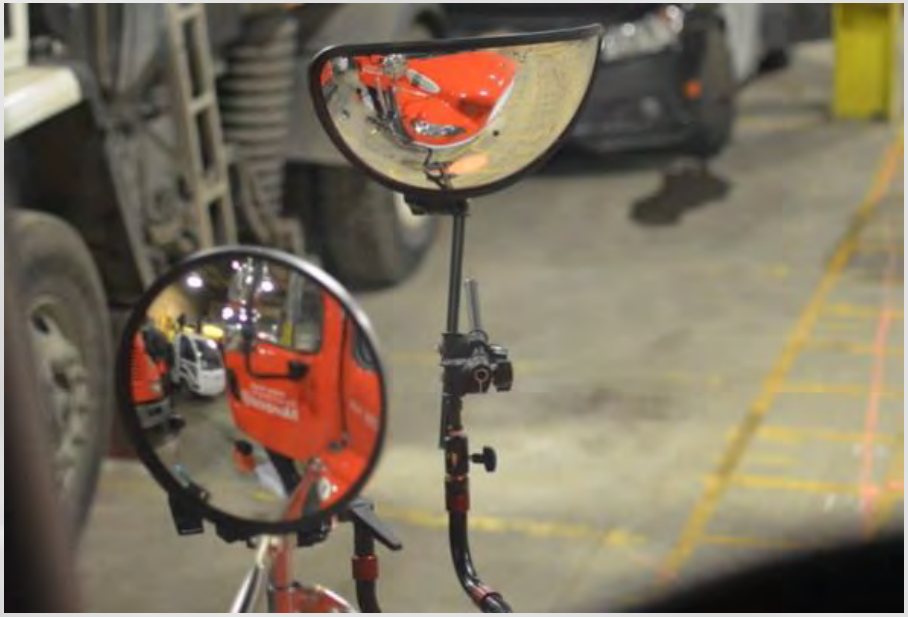
- Assess a “hybrid” adjustment
  - Left-hand mirror: school bus adjustment
  - Right-hand mirror: adjusted per the tandem method
- Carry out testing in other environmental conditions

Phase two of testing

- Different vehicle: Freightliner M2-106 (Ville de Montréal)

Phase two of testing – hybrid adjustment

- 2 Safety Crossview mirrors, adjusted per the hybrid method



Left

Right

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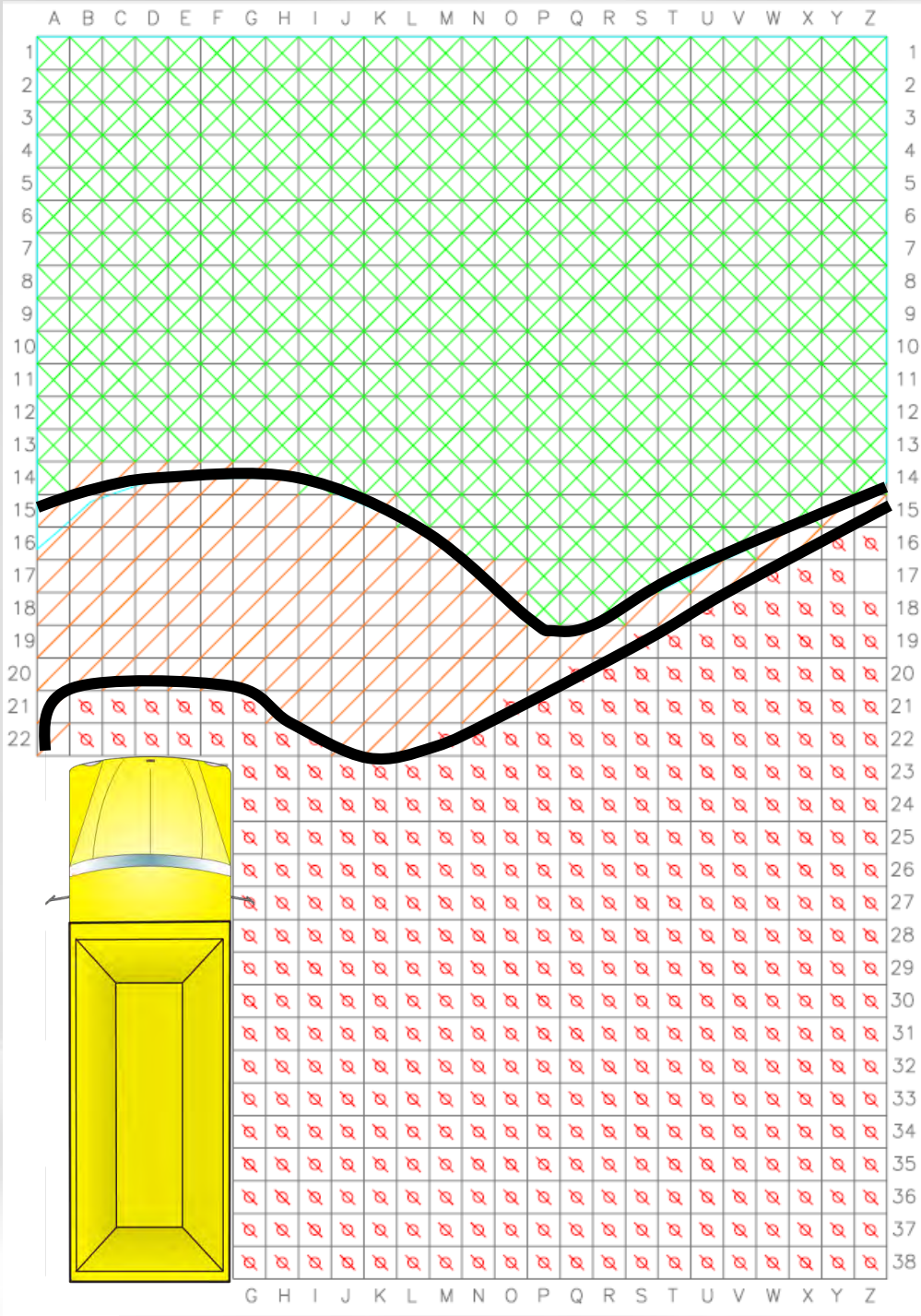
Phase 2 findings

Truck with no front mirrors

<u>Direct visibility</u>

Green	Full
Orange	Partial
Red	Zero



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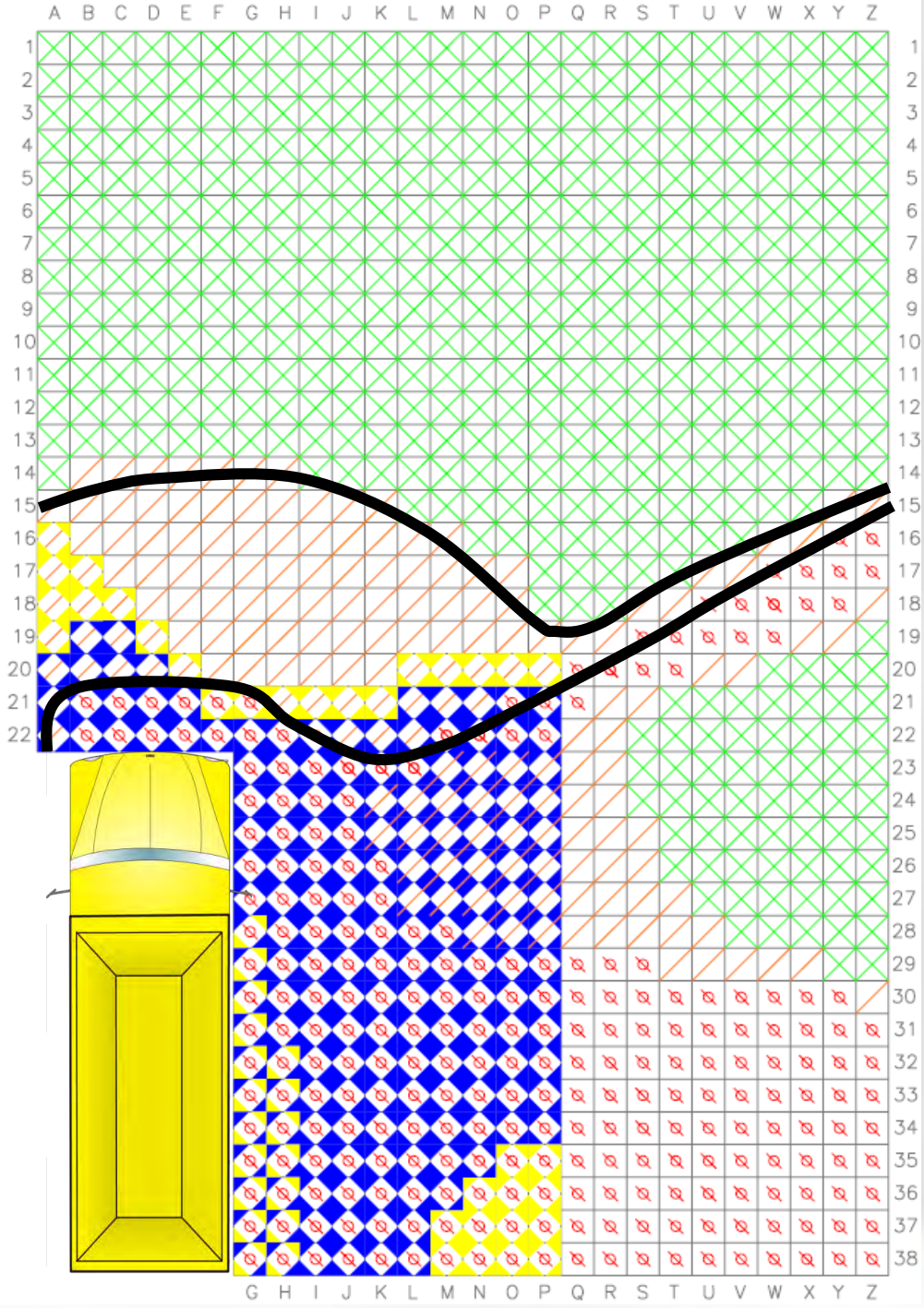
Phase 2 findings

Right front mirror

<u>Direct visibility</u>

Green	Full
Orange	Partial
Red	Zero

Blue	Detectable in mirror
Yellow	Partially detectable in mirror



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Phase 2 findings

Left front mirror

<u>Direct visibility</u>

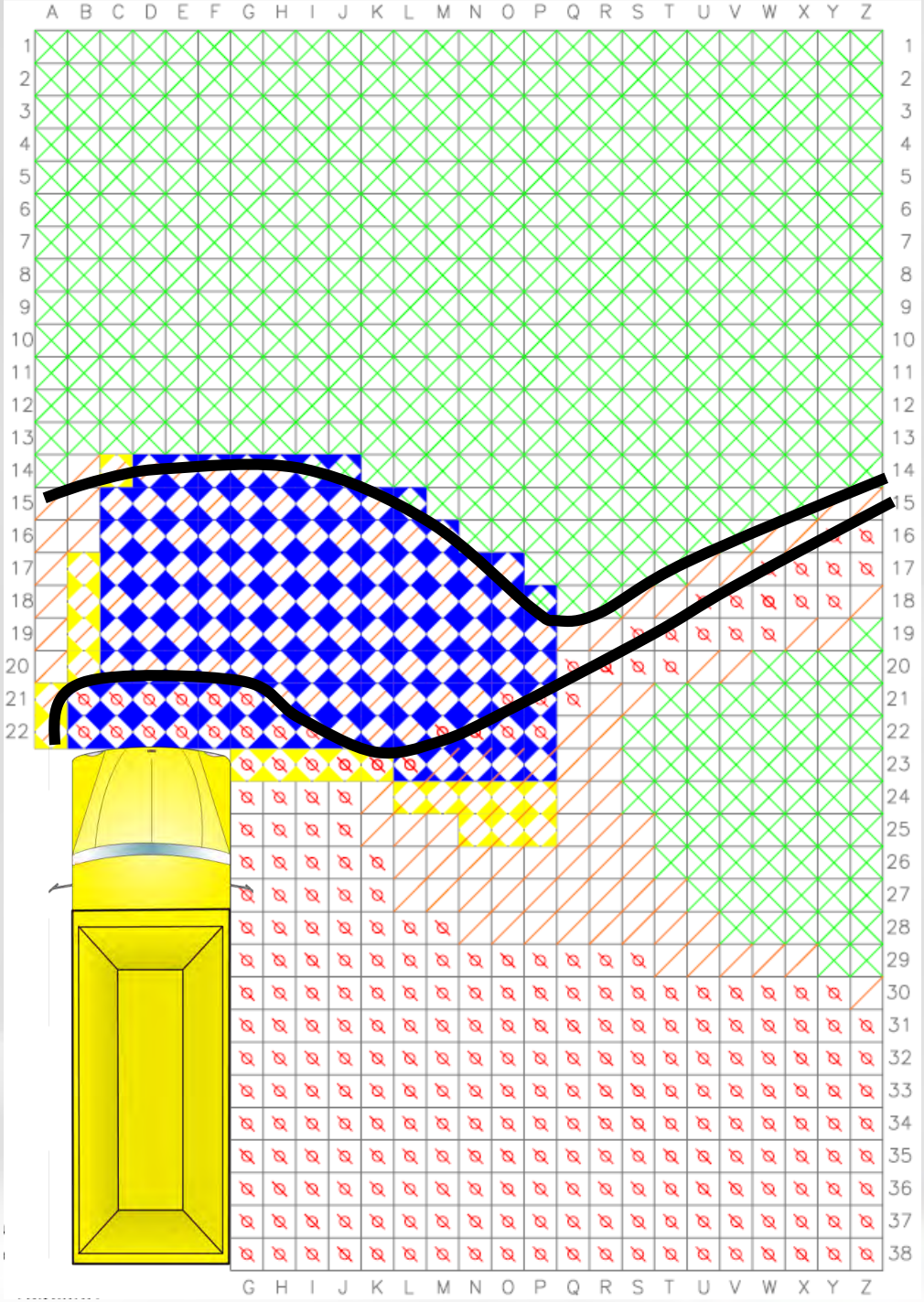
Green Full

Orange Partial

Red Zero

Blue Detectable in mirror

Yellow Partially detectable in mirror



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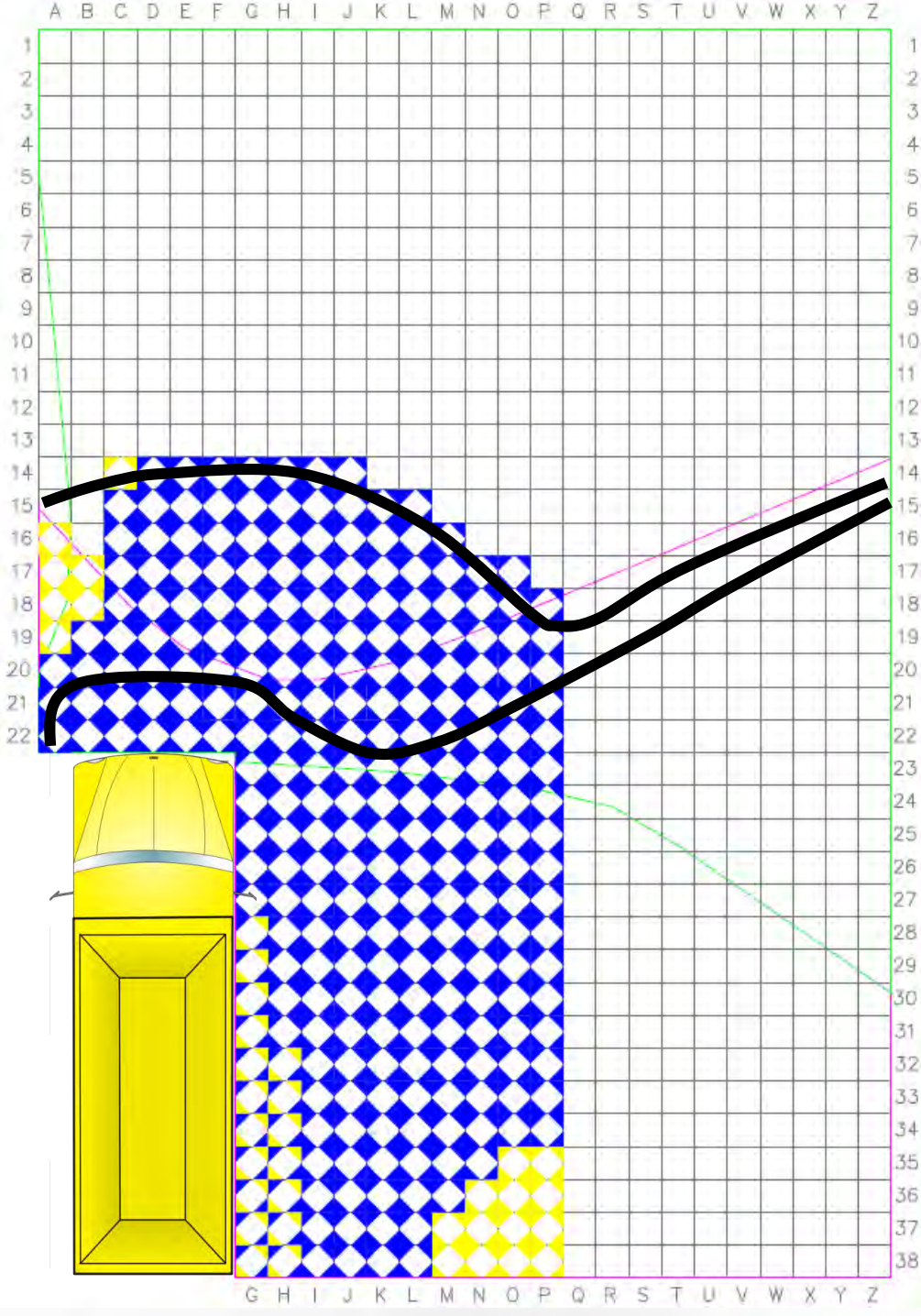
Phase 2 findings

Combined visibility

- Left front mirror covers area in front of truck
- Right front mirror covers right-hand side



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2nd phase of testing – environmental conditions

Objective: Assess effectiveness in the following conditions:

- Night
- Rain
- Winter (messy conditions)
- Night + rain
- Night + winter (messy conditions)

2nd phase of testing – environmental conditions

Detectability findings:

Day – messy conditions: Slight decrease

Day – rainy: Large decrease

Night: Slight decrease

Night – messy conditions: Very large decrease

Night – rainy: Very large decrease

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Scenario - Night

Scenario - Rainy day

Scenario - Rainy night

Scenario – Snowy day (messy conditions)

Scenario – Snowy night (messy conditions)

Conclusions of mirror testing

Best solution for improving pedestrian detection:

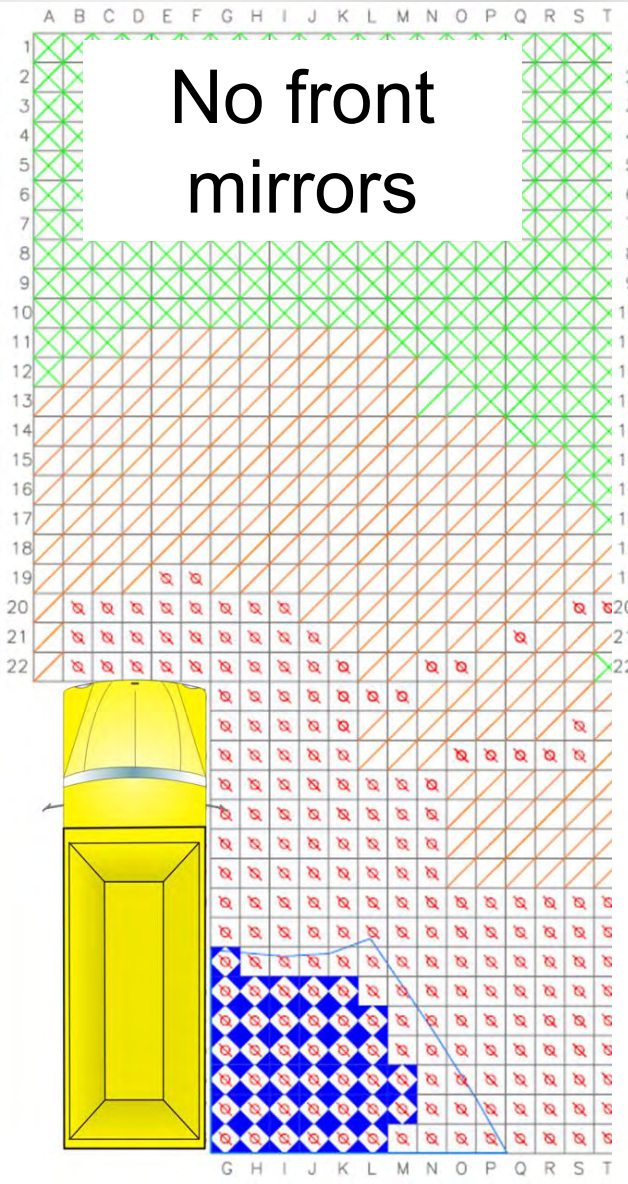
- Combination of two front mirrors
- Hybrid adjustment method

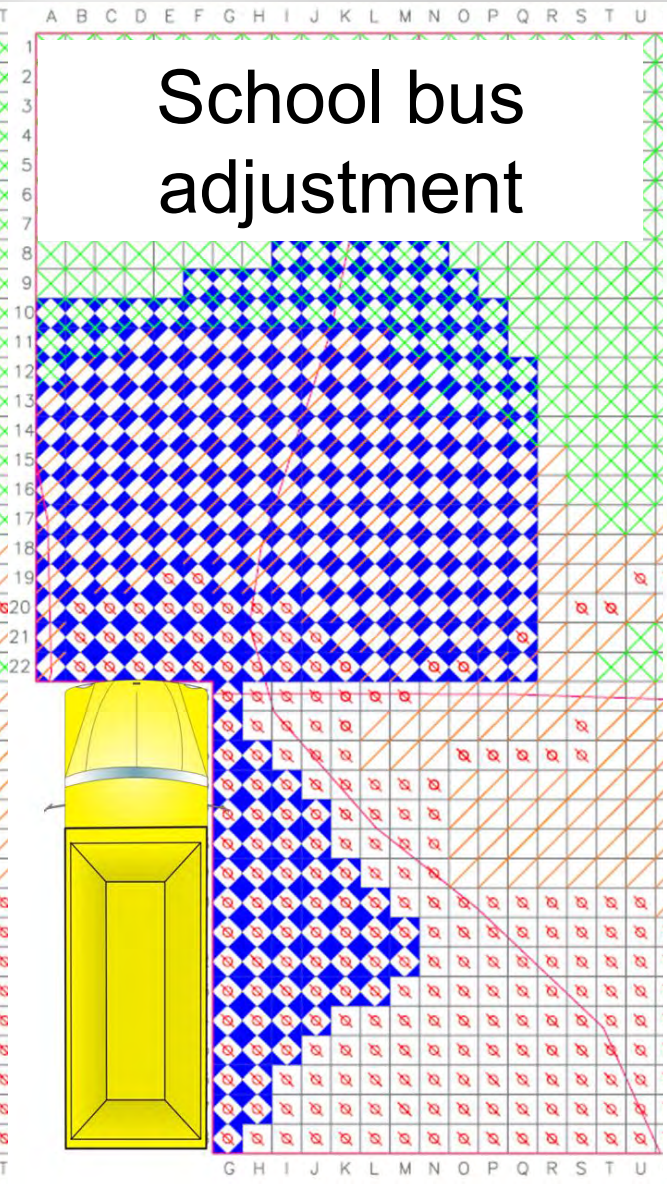
Both of these factors are critical

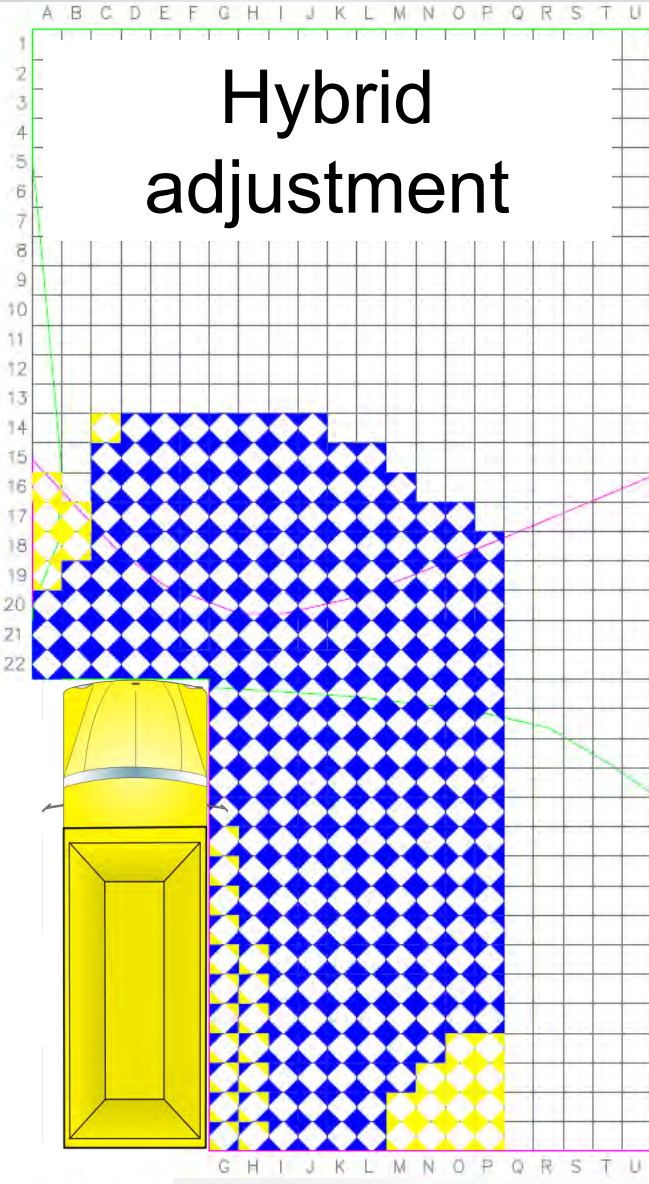
However, in all environmental conditions other than the “dry” night scenario, the solution is considerably less effective

- Heated mirrors may help.
- Difficult to do any better with mirrors
- Technology solutions could be required if we want to improve detection in these conditions

Comparison







Testing in real operating conditions

Field testing to assess the proposed solution

Four objectives:

1. Check feasibility of this installation/adjustment method on other configurations
2. Check effectiveness of other configurations
3. Check acceptability and use by drivers in real operating conditions

Testing in real operating conditions

4th objective: Put together a best practices guide

- Who is this solution for?
- What types of front mirrors should be used?
- Where exactly should the mirrors be installed?
- How should the mirrors be installed?
- Other relevant information

Testing in real operating conditions

Other project objectives:

- Develop a general installation method
- Develop a simplified method for measuring effectiveness and fields of visibility
- Conduct testing in summer/fall/winter conditions
- Scope of project:
  - 4 combinations of front mirrors (standardized and non-standardized)
  - 16 vehicles (8 from MTMDET and 8 from Ville de Montréal)
- Driver feedback via questionnaires

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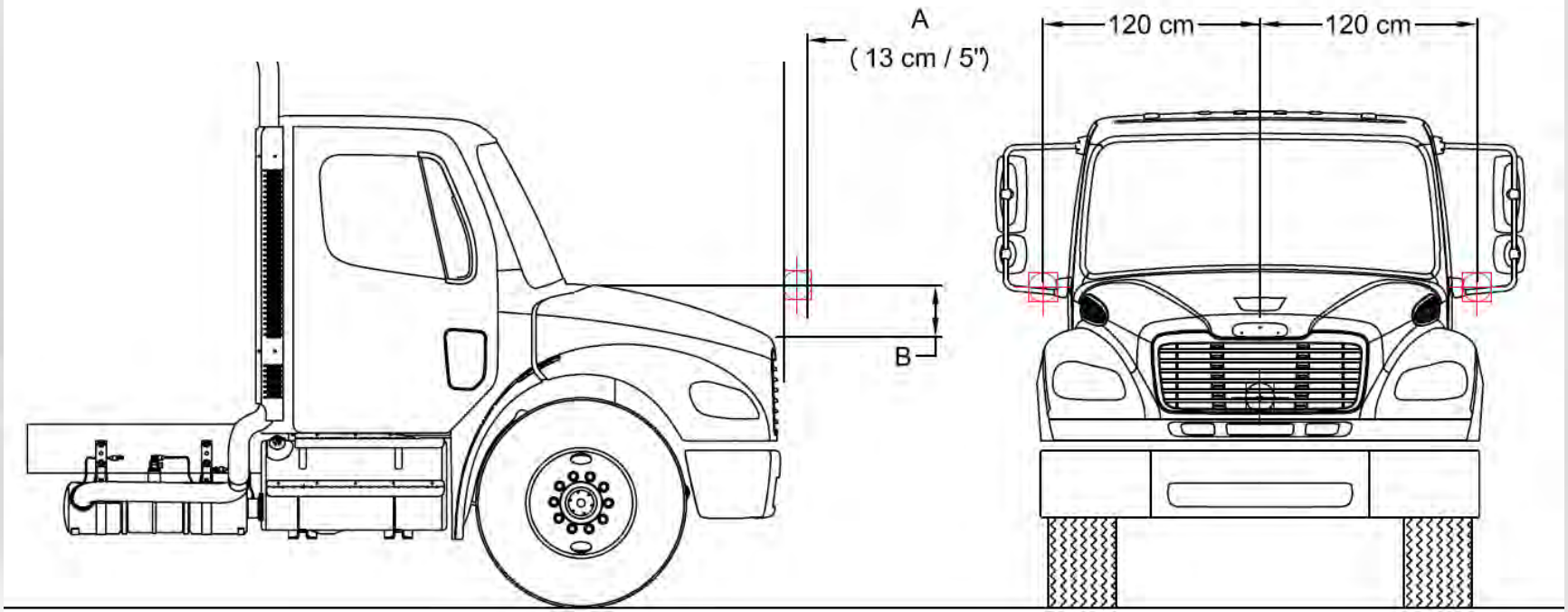
Mirror positioning (mirror attachment point)

A: Recommended mirror distance in front of hood

B: Mirror height in relation to hood

Recommended side positions



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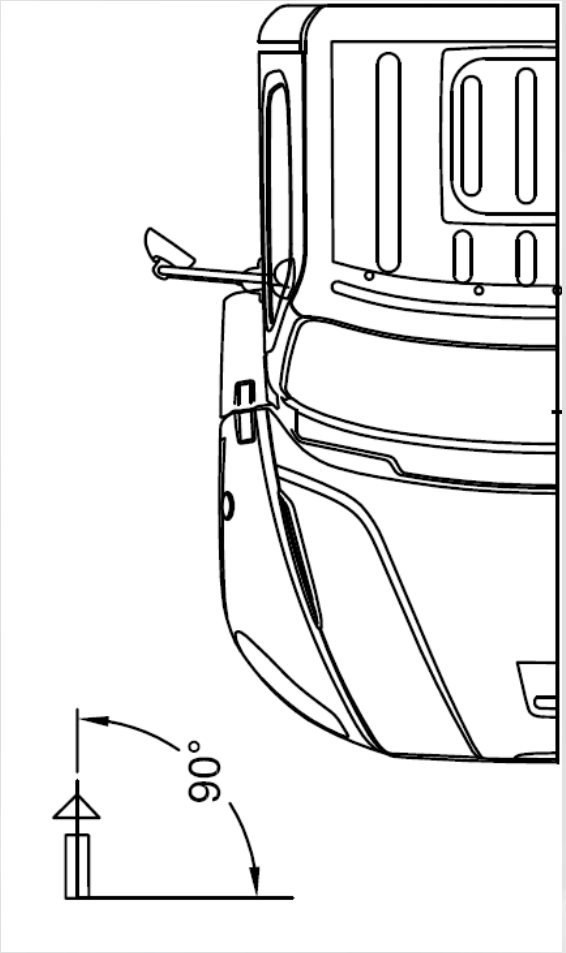
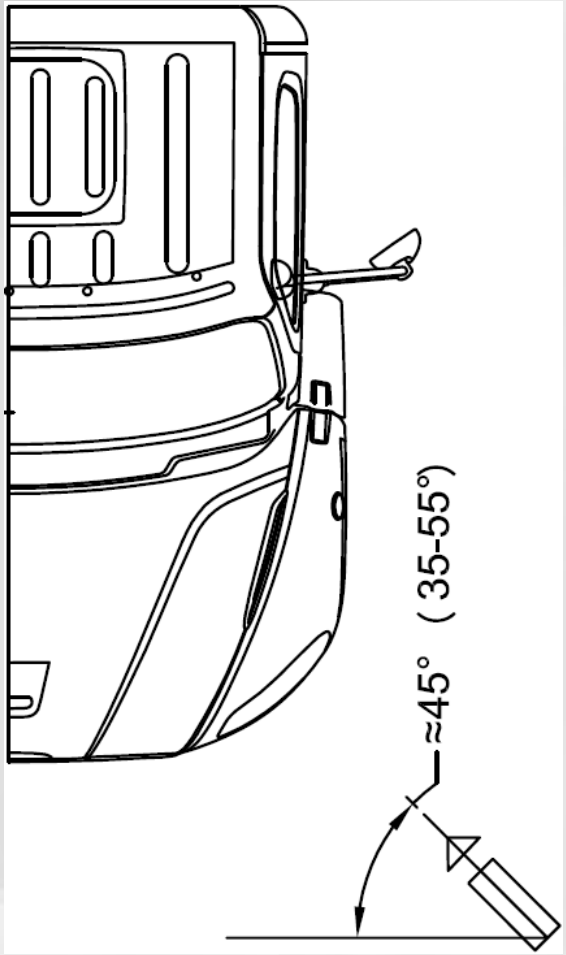
Mirror orientation





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Testing in real operating conditions Objective #1 - Feasibility

Problems encountered during installation/adjustment

- Difficulty adjusting non-standardized mirrors
  - Attachment point not flexible enough for adjustment
- Interference with snow removal equipment
  - Move mirror
  - Check effectiveness of new position
  - Possibility of simply removing mirrors in winter

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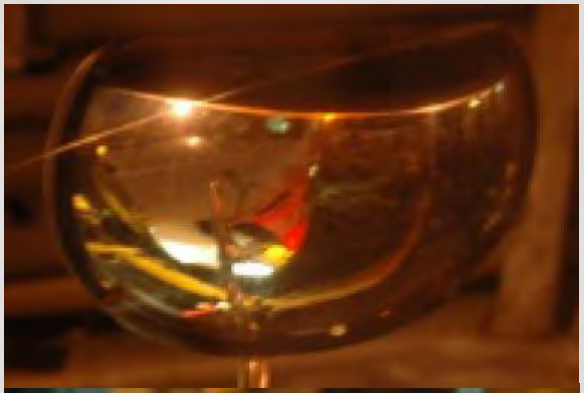
Testing in real operating conditions
Objective #1 - Feasibility

Problems encountered during installation/adjustment

- Driver glare (discomfort)
  - Caused by auxiliary headlights
  - Solution: headlight deflector



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Testing in real operating conditions
Objective #1 - Feasibility

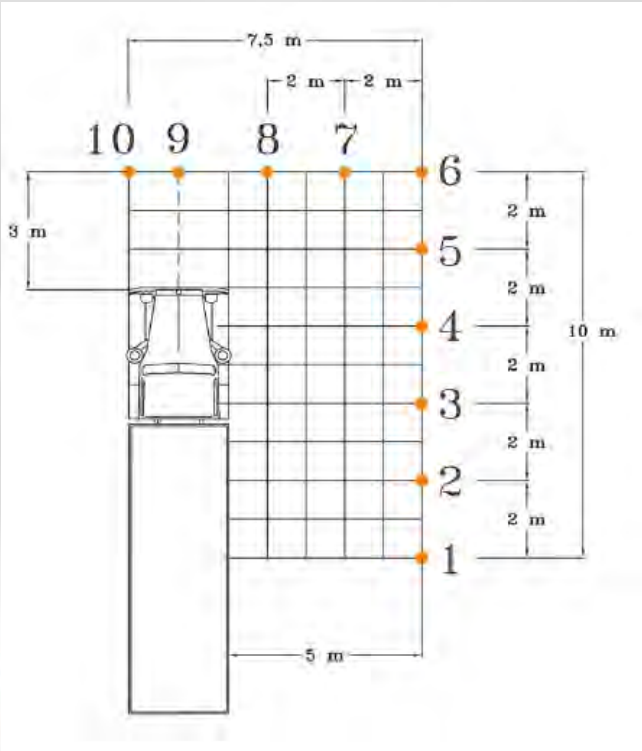
Results:

- It was possible to correctly install and adjust practically all mirrors on all types of hoods
- The suggested positioning method is valid

Testing in real operating conditions
Objective #2 - Effectiveness

Simplified assessment method:

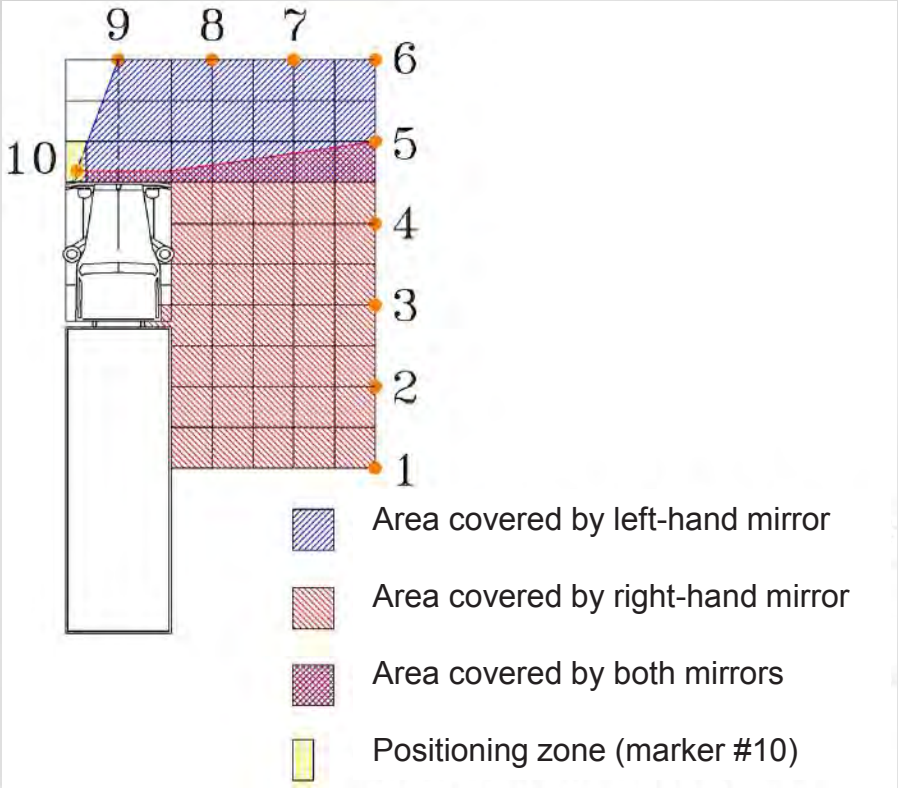
- TRV7 markers must be visible in mirrors
- Non-visible markers moved in



Testing in real operating conditions
Objective #2 - Effectiveness

Results:

- Effective and consistent in all combinations
- Very significant improvement in visibility in problem areas
- Regardless of driver size and position
- Effective despite of certain driver position errors



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Testing in real operating conditions
Objective #3 – Driver acceptance

Very difficult to get relevant, meaningful feedback from drivers:

- Delays in installing front mirrors
- Unplanned removal of certain convex mirrors used by ministry drivers for operational purposes
- Drivers divided between a number of boroughs
- Drivers sometimes have part-time and/or seasonal schedules
- By the end of the study, less than half of the original drivers remained
- Reliable response rate

Testing in real operating conditions
Objective #3 – Driver acceptance

Findings:

- Nearly all drivers felt that adding front mirrors was a useful or very useful solution for effectively detecting vulnerable users in urban environments:
  - Especially when the vehicle is stopped or driving at slow speeds
- Drivers in urban environments particularly appreciated and used front mirrors
  - Facilitated driving
  - Improved visibility around the vehicle

Testing in real operating conditions
Objective #3 – Driver acceptance

Other findings:

- Highway drivers generally did not appreciate or use front mirrors
  - Reflected image too distorted
  - Difficult to judge distances

Context:

- Removal of convex hood mirrors used for work
- Delays in installation, testing, training, etc.

Testing in real operating conditions
Objective #3 – Driver acceptance

Other findings:

- The solution is less effective in difficult environmental conditions (night, rain, snow)
- Mirrors repeatedly come loose and must be readjusted
- Equipment on front of truck may hinder installation and/or effectiveness of front mirrors

All these findings (whether positive or negative) are instructive for drawing up a guide

Testing in real operating conditions
Objective #4 – Content of a guide

- Details on the proposed solution
  - Standardized mirrors preferred (FMVSS/CMVSS 111)
  - Possible variations in mirror positioning
- Improved installation and adjustment method
  - Opt for installation with 3 or 4 struts to limit vibrations
  - Use self-locking nuts to minimize loosening
- Limitations and cautions with regard to the solution
  - Keep convex hood mirrors if they do not hinder operation
  - Solution less effective for highway driving and on snow removal vehicles

Testing in real operating conditions Conclusion

The project objectives have been met.

The proposed solution is:

- Feasible
- Effective
- Believed to be acceptable to drivers operating in urban environments were detecting vulnerable users is a constant challenge

Testing in real operating conditions
Working group's opinion

In the short run, the simplest, most effective low-cost solution for improving pedestrian detection by heavy vehicle drivers in urban environments involves:

- Adding standardized front mirrors (FMVSS/CMVSS111)
- Adjusting mirrors according to the hybrid method
- Implementing mirrors on a voluntary basis
- Writing up a best practices guide

Despite the limitations identified

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Next steps

- Write up a best practices guide
- Distribute guide to owners of heavy vehicles operating in urban environments
- Follow up on various research projects on adding technology solutions to improve safety of vulnerable users

Questions?


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