



## Gravel Entrapment - Critical Vehicle Systems

### 1 Introduction

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** To evaluate the effects of gravel entrapment on a vehicle's critical subsystems and components.

**1.2 Applicability.** All vehicles.

**1.3 Remarks.**

**1.3.1** This procedure evaluates if a vehicle experiences performance due to stone/gravel entrapment. The vehicle is driven over a gravel ridge (windrow) as described in this procedure.

**1.3.2** The gravel windrow height, configuration and test speed is set based on vehicle classification and expected vehicle usage (Moderate, Severe or High Performance (HP) -Track Ready).

**1.3.3** Gravel windrows as described in Appendix A, Figure A1 may occur from the grading of gravel roads. The grader's blades may push gravel to the edges of a road as the grader levels out the center. This can result in a gravel ridge or windrow being left at the edge of the road. Gravel Windrows also represent Slush and Snow on roads.

### 2 References

**Note:** Only the latest approved standards are applicable unless otherwise specified.

**2.1 External Standards/Specifications.**

MDOT 23A

**2.2 GM Standards/Specifications.**

None

**2.3 Additional References.** None.

### 3 Resources

**3.1 Facilities.** Level gravel road to accommodate a 30 m long windrow with 40 km/h approach and exit area. In addition, "Severe" usage vehicles require 100 mm diameter rocks to be placed every 900 mm on top of the windrow. **Gravel to be used must meet Michigan Department of Transportation (MDOT) 23A specification.**

The percent weight passing through various size screens is as follows:

| Screen Size: | Percent  |
|--------------|----------|
| 25 mm:       | 100      |
| 10 mm:       | 65 to 85 |
| 2.5 mm:      | 25 to 60 |
| 0.06 mm:     | 09 to 16 |

**3.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

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### 3.2 Equipment.

**3.2.1** Shovel to adjust gravel windrow, if necessary.

**3.2.2** Measuring tape to verify length of gravel windrow.

**3.2.3** Ruler or measuring tape to measure height of gravel windrow.

**3.2.4** Flashlight to inspect vehicle.

**3.2.5** Digital camera to document vehicle results.

### 3.3 Test Vehicle/Test Piece.

**3.3.1** In the event that not all models are available to test, determine which vehicles are “worst test case” scenarios (i.e., lowest ride height, low position subsystems, etc.)

**3.3.2** Vehicle level validation requires all parts being evaluated to be of production design including production intent material properties. This includes production intent fasteners.

**3.3.3** The test vehicle shall be fitted with all the production front-end features (bumper, grille, front openings, etc.) and all the components in the engine compartment affecting flow, such as engine encapsulation, cooling module, active grill aero shutters, etc.

**3.3.4** For specific regions, a corresponding front license plate shall be mounted.

### 3.4 Test Time.

Calendar time: 4 days

Test time: 24 hours

Coordination time: 16 hours

Technician time: 16 hours

Engineer time: 4 hours

### 3.5 Test Required Information.

**3.5.1** Record desired vehicle test mass on Appendix A, Data Sheet A1. The test mass shall be curb mass plus driver and full fuel.

**3.5.1.1** Record vehicle test heights on Appendix A, Data Sheet A1. The vehicle shall be set within design specifications.

**3.5.1.2** Determine the height of the gravel windrow per Appendix A, Figure A1. The height of the gravel windrow shall be 25 mm higher than the lowest structural front cross-member (“Moderate” and “HP” classification vehicles) and 50.0 mm higher than the lowest structural front cross-member (“Severe” classification vehicles). Record on Appendix A, Data Sheet A1 the height of the gravel windrow and the lowest component used for the calculation.

**3.5.1.3** Test with Production design intent and material property Air Dams and Underbody Panels.

**3.5.1.4** Measure A/C charge pressure and record on data sheet. Contact local HVAC/Thermal team for measurement if needed.

**3.6 Personnel/Skills.** Technician or Engineer familiar with requisite methodologies to execute procedure.

## 4 Procedure

**4.1 Preparation.** Verify that the gravel windrows are set to the correct height and length.

### 4.2 Conditions.

**4.2.1 Environmental Conditions.** Not applicable.

**4.2.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

### 4.3 Instructions.

**4.3.1 See Appendix A, Figure A1.** The vehicle runs are defined as follows:

**4.3.1.1 First Pass (Severe Classification Only).** Vehicle positioned with the left tire lined up just outside of windrow.

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**4.3.1.2** Approach gravel windrow at 40 km/h. Tires should be on level ground and not on the windrow. Maintain speed and direction for full length of the windrow. Slow to a stop after completion of pass.

**4.3.1.3** Perform a steering check by turning steering wheel to full-left and then full-right and then back to center position five times (5X). If the steering shows signs of gravel entrapment then stop steering input. Then, return vehicle to garage for inspection without disturbing gravel. This may need to be done by flatbed truck or tow truck. Record observations on Appendix A, Data Sheet A1.

**4.3.1.4** Perform a brake system functional check. Record observations on Appendix A, Data Sheet A1.

**4.3.1.5** Shut off engine and inspect vehicle for gravel entrapment or other damage. Inspect all underbody and engine compartment areas. Use a flashlight, if necessary. Record observation on Appendix A, Data Sheet A1.

**4.3.1.6** Reconstruct gravel windrow after each pass.

**4.3.2 Second Pass (Severe Classification Only).** Repeat 40 km/h run with vehicle in Second Pass position (Appendix A, Figure A1). Vehicle positioned with center of vehicle lined up on windrow.

**4.3.2.1** Approach gravel windrow at 40 km/h. Tires should be on level ground and not on the windrow. Maintain speed and direction for full length of the windrow. Slow to a stop after completion of pass.

**4.3.2.2** Perform a steering check by turning steering wheel to full-left and then full-right and then back to center position five times (5X). If the steering shows signs of gravel entrapment then stop steering input. Then, return vehicle to garage for inspection without disturbing gravel. This may need to be done by flatbed truck or tow truck. Record observations on Appendix A, Data Sheet A1.

**4.3.2.3** Perform a brake system functional check. Record observations on Appendix A, Data Sheet A1.

**4.3.2.4** Shut off engine and inspect vehicle for gravel entrapment or other damage. Inspect all underbody and engine compartment areas. Use a flashlight, if necessary. Record observation on Appendix A, Data Sheet A1.

**4.3.2.5** Reconstruct gravel windrow after each pass.

**4.3.3 Third Pass (Severe Classification Only).** Repeat 40 km/h run with vehicle in Third Pass position (Appendix A, Figure A1). Vehicle positioned with right front tire lined up just outside of windrow.

**4.3.3.1** Approach gravel windrow at 40 km/h. Tires should be on level ground and not on the windrow. Maintain speed and direction for full length of the windrow. Slow to a stop after completion of pass.

**4.3.3.2** Perform a steering check by turning steering wheel to full-left and then full-right and then back to center position five times (5X). If the steering shows signs of gravel entrapment then stop steering input. Then, return vehicle to garage for inspection without disturbing gravel. This may need to be done by flatbed truck or tow truck. Record observations on Appendix A, Data Sheet A1.

**4.3.3.3** Perform a brake system functional check. Record observations on Appendix A, Data Sheet A1.

**4.3.3.4** Shut off engine and inspect vehicle for gravel entrapment or other damage. Inspect all underbody and engine compartment areas. Use a flashlight, if necessary. Record observation on Appendix A, Data Sheet A1.

**4.3.3.5** Reconstruct gravel windrow after each pass.

**4.3.4 Fourth Pass (All Classifications).** Repeat at 40 km/h (10 km/h for HP - Track Ready vehicles) with vehicle in Fourth Pass position (Appendix A, Figure A1). Vehicle safely driven with steering input such that the vehicle moves from left to right, such that both sets of wheels completely cross over the windrow, then vehicle moves from right to left, such that both sets of wheels completely cross over the windrow.

**4.3.4.1** Approach gravel windrow at 40 km/h (10 km/h for HP - Track Ready). Completely cross over windrow safely with both sets of wheels (cross windrow at a maximum of 45 degrees), then back so that vehicle is now on original side of windrow, see Appendix A, Figure A1.

**4.3.4.2** Perform a steering check by turning steering wheel to full-left and then full-right and then back to center position five times (5X). If the steering shows signs of gravel entrapment then stop steering input. Then, return vehicle to garage for inspection without disturbing gravel. This may need to be done by flatbed truck or tow truck. Record observations on Appendix A, Data Sheet A1.

**4.3.4.3** Perform a brake system functional check. Record observations on Appendix A, Data Sheet A1.

**4.3.4.4** Shut off engine and inspect vehicle for gravel entrapment or other damage. Inspect all underbody and engine compartment areas. Use a flashlight, if necessary. Record observation on Appendix A, Data Sheet A1.

**4.3.5** Allow vehicle to soak for 24 h.

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