



FMVSS 227

BUS ROLLOVER

STRUCTURAL INTEGRITY

FMVSS 227 aims to enhance passenger safety in the event of rollover by ensuring buses are designed and built with robust structural integrity. FMVSS 227 has been in effect since Dec'2024

AT A GLANCE!

Scope:

Federal Motor Vehicle Safety Standard (FMVSS 227) establishes performance requirements for the structural integrity of buses during rollover events.

Background:

- Previously, there was no standard for dynamic rollover for high-occupancy buses; this standard addresses that gap.
- FMVSS 227 is based on the proven ECE R66 rollover standard currently in use in Europe, with a few minor adjustments for the U.S. market.
- This standard establishes minimum acceptable structural integrity to protect occupants in real-world rollover scenarios.
- It defines a survival space for occupants and aims to minimize intrusion into this space, thereby improving safety.

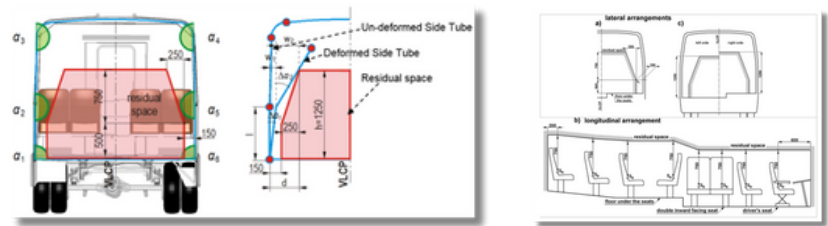
Need:

There is a need for a standard because existing quasi-static standards like FMVSS 220 (Roof Crush) cannot adequately predict real-world dynamic rollover scenarios.

TECHNICAL DETAILS:

Applicability:

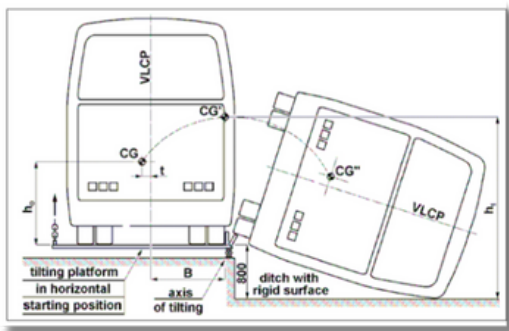
- Applies to all Over-The-Road Buses (OTRBs) regardless of Gross Vehicle Weight Rating (GVWR).
- Applies to all non-OTRBs with a GVWR of over 26,000 lbs, with a few exceptions.* (OTRB = Elevated passenger deck over the baggage compartment.)
- The standard works on the principle of protecting passenger survival space by limiting intrusion into this space.



Testing:

- The bus is placed on a tilting platform, which is rotated about the longitudinal axis until the bus reaches an un-equilibrium position, after which it is allowed to free fall into an 800 mm deep ditch.
- The bus is loaded to curb weight plus all seated and belted passengers.

$$DI = \frac{\text{Utilized lateral distance between side wall and residual space at time } t}{\text{Available lateral distance between side wall and residual space before impact}}$$



Range	Descriptive strength rating	Star rating
$DI_{\alpha} < 0.4$	strong	*****
$0.4 \leq DI_{\alpha} < 0.6$	intermediate	****
$0.6 \leq DI_{\alpha} < 0.8$	acceptable	***
$0.8 \leq DI_{\alpha} < 1$	poor	**
$DI_{\alpha} \geq 1$	inacceptable	*

Manufacturers may use alternate methods, as described in ECE-R66, with reasonable care, including computer simulations.

Requirements:

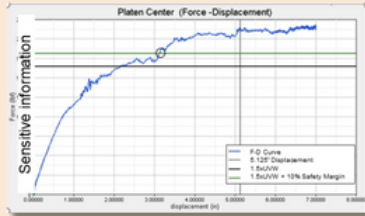
- No part originally outside of the survival space shall enter that space.
- No loose part greater than 60 grams (e.g., loose fasteners, window glazing, trim pieces, etc.) is permitted.
- Emergency exits must not open during testing and upon impact. Additionally, emergency exits must be operable after the crash event.
- The rating is based on the principle of the deformation index.

Case Study

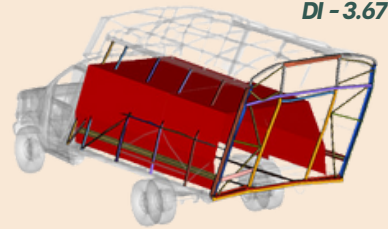
An intriguing case involves a para-transit bus that successfully passes the FMVSS 220 (Roof Crush) test with ease. However, when subjected to the dynamic rollover test, it fails catastrophically.

InDepth Engineering Solutions were engaged to root-cause failure and improve the design.

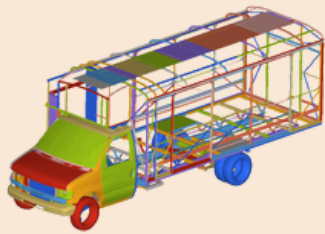
Proven-field tested design as a starting point



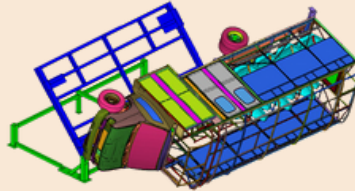
Dynamic rollover of the same design



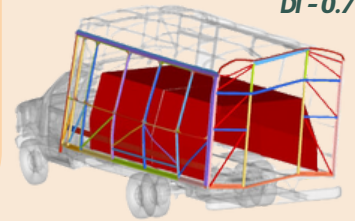
Improved design meets requirement



FMVSS220 (Roof Crush) Excellent performance



Poor performance - Failed FMVSS227 test



Reasons For Failure of The Field Tested Design:

Significantly different load paths compared to quasi-static roof crush and unaccounted inertia.

Design Improvement & Success:

Strategic use of structural members, redesigning load-carrying members, and strengthening joints contribute to enhanced performance in both analyses.

InDepth Advantage!

- InDepth has been working with paratransit and full length bus manufacturers for over a decade helping improve their products for dynamic rollover safety.
- Extensive experience working with European dynamic rollover standard(ECE R66) which is the back bone of new FMVSS 227.
- InDepth has know-how of delivering best strength-to-weight solutions while meeting all applicable standards.

About InDepth Engineering Solutions

We are a full service provider to the motorcoach, shuttle & para-transit bus industry. Our capabilities include product design, computer aided engineering, prototyping & fabrication, Instrumentation & Testing, Electricals & Control Systems.



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