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<b>Coordinator</b>	<i>VTI</i>
<b>Project Manager</b>	<i>Jesper Sandin (<a href="mailto:jesper.sandin@vti.se">jesper.sandin@vti.se</a>)</i>
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<b>Author(s)</b>	Jesper Sandin
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## Summary

Advanced Emergency Braking Systems (AEBS) have been mandatory on Heavy Goods Vehicles (HGVs) in Europe since 2015. AEBS warns the driver with light and sound, and if the driver does not respond, it automatically brakes the vehicle. Initially designed for rear-end situations, newer versions can detect and react to vulnerable road users. While AEBS and similar systems have been shown to reduce crashes for passenger cars, quantitative studies for HGVs are lacking. The pre-study aims to review data sources and methodologies for evaluating AEBS on HGVs and write an application for a larger research project to be submitted during Q3 2025. The developed evaluation methodology may be used for other safety systems and vehicles.

# Evaluation of real-world safety performance of AEBS on HGVs – Data, methodologies and research project application

## 1. Background

Advanced Emergency Braking Systems (AEBS) have been a legal requirement on Heavy Goods Vehicles (HGV) in Europe since November 2015. An extended legal requirement came in November 2018 where AEBS must work at higher speeds. Simply described, an AEBS first warns the driver with light and sound, and if the driver doesn't react, the system brakes the vehicle automatically. The first generations were developed for rear-end situations, while the more recent generations may detect and react to vulnerable road-users.

Collision avoidance systems like AEBS have been standard or optional equipment on passenger cars since mid-2000s. A dozen studies have quantitatively estimated the real-world efficiency of such systems. One Swedish [study](#) based on insurance claims showed that Forward Collision Warning and Brake support combined with Adaptive Cruise Control (CWB+ACC) reduced rear-end crashes with frontal impacts with 38%-45% depending on system generation. Another recent Swedish [study](#) on Strada data investigated the effectiveness of Automatic Emergency Braking (AEB) in reducing car-to-pedestrian and car-to-bicyclists collisions. The overall reduction in crash risk was 20%, which was lower than the expected effectiveness potential of the systems.

For HGVs, in-depth data have been used to [case-by-case evaluate](#) the effect of several active safety systems, including AEBS, in fatal accidents with vulnerable road-users. However, quantitative efficiency studies are entirely missing for HGVs. And in fact, there is a lack of knowledge regarding crashes involving HGVs on a more detailed level. A better knowledge of HGV crashes and their ADAS efficiency is highly relevant because EuroNCAP is now including HGVs in their testing programme.

## 2. Project set up

### 2.3 Purpose

Quantitative efficiency studies of ADAS are entirely missing for HGVs. Thus, the purpose of the pre-study was to review data sources and methodologies for the evaluation of real-world safety performance of AEBS on HGVs, as well as write an application to a larger research project with the purpose of conducting an actual evaluation of AEBS efficiency.

### 2.4 Objectives

The objectives of the project were:

- Review data sources and methodologies for the evaluation of real-world safety performance of AEBS on HGVs.
- Write an application to a larger research project with the purpose of conducting an actual evaluation of AEBS efficiency.

## 2.5 Project period

Start date: 2025-06-01

End date: planned for 2025-12-31 but ongoing until 2026-03-18 when the FFI-application is submitted.

## 2.6 Partners

AB Volvo

AstaZero

Chalmers

Combitech

Folksam

If

Länsförsäkringar AB

Scania

Terranet

Trafikverket

VTI (Project leader)

## 3. Method and activities

The databases, assessment methodologies, AEBS technology and project application were reviewed in meetings with preparations from the partners.

- Assessment methodologies were presented at one occasion by Folksam and If with subsequent discussions
- The functionality of AEBS generation 1 and 2 (pre/post 2018) as required by regulations was presented at one occasion by AB Volvo and Scania with subsequent discussions
- Project applications were discussed at two meetings, with additional discussions over mail.

## 4. Results and Deliverables

The first objective of the project was to review data sources and methodologies for the evaluation of real-world safety performance of AEBS on HGVs.

### 4.3 Basic research questions

The two basic research questions in the planned research project are:

- Is the rear-end crash rate for HGVs reduced with AEBS?
- Is the rear-end crash rate lower for AEBS generation 2 compared to generation 1 (pre/post November 2018)

### 4.4 Choice of databases

The research project will use two kinds of crash databases: Strada with police-reported crashes and databases with insurance claims.

### 4.5 Identification of rear end-crashes with HGVs

Identifying rear-end crashes poses challenges in both Strada and insurance-claims data, but for different reasons. Although Strada includes a specific accident-type category for rear-end collisions, no database parameter indicates which vehicle struck the other. Determining the striking vehicle therefore requires manual review

of the police narrative, inspection of accident sketches, and, in some cases, review of the health care record where drivers may have provided relevant information.

Insurance claims data present additional challenges because they are not structured like police reported crash databases. Insurance records are designed primarily for administrative and financial purposes, which means they typically lack standardized accident type categories. Much of the information is reported by the insured party, and therefore important contextual variables—such as weather conditions, road surface, and lighting—are not routinely collected. The precise crash location is also often uncertain, in contrast to Strada, where crash coordinates are recorded using GPS.

As a result, preparing insurance claims data for accident analysis requires considerably more manual interpretation, classification, and cleaning to achieve the level of detail typically available in police-reported crash databases.

#### 4.6 Identification of trucks with AEBS

When assessing the effectiveness of ADAS it is commonly necessary to identify the vehicles that are equipped with the system of interest. Therefore, records are usually restricted to police reported crashes involving motor vehicles for which vehicle identification numbers (VINs) or other system identification information are available. ADAS-equipped vehicles are identified using VIN decoding, manufacturer records, or technical registries. Non-equipped vehicles of comparable model years and categories are retained as the reference group. Cases missing accident or collision type, or vehicle information are excluded.

In the case of AEBS on HGVs, however, this step is not necessary. Because AEBS has been mandatory for new HGVs in Europe since November 2015, all vehicles produced after that date are equipped by default. As a result, AEBS-equipped HGVs can be identified simply by model year, eliminating the need for VIN-based system identification, which is typically cumbersome and time consuming. Due to the extended legal requirement from November 2018 where AEBS must work at higher speeds, there will be two groups of HGVs produced before and after November 2018, thus equipped with the two different generations of AEBS.

#### 4.7 Assessment methodology

When assessing the real-world safety effects of ADAS based on crashes it is necessary to control for exposure because crash frequency depends on how much a vehicle is driven. Thus, if an ADAS-equipped vehicle group drives more (or less) than a non-equipped group, comparing raw crash counts will falsely attribute these differences to the ADAS instead of to exposure.

In conventional crash databases direct measures of exposure (e.g., distance driven, driving time, roadway usage) are typically unavailable. Thus, for the Strada crashes, exposure will be estimated using the induced exposure method, which infers relative driving exposure from involvement in selected crash types that would not be affected by the ADAS. The method is explained in more detail below.

When assessing AEB effectiveness using insurance claim data, insured vehicle-years can serve as the exposure measure. In this approach, the rate of rear-end impacts per

insured vehicle-year is calculated and compared between vehicles with and without AEB. However, because AEB has been mandatory for HGVs since 2015, all trucks registered from that year onward are equipped with the system. As a result, the number of non-AEB trucks declines steadily after 2015, which restricts the availability of a meaningful comparison group of trucks. Consequently, this type of analysis is only feasible for a limited period following the introduction of the AEB mandate. Thus, it may become valuable to use additional assessment methodologies, for example induced exposure, or other methods as compiled in [ISO/TR 12353-4:2024](#).

#### 4.7.1 Induced exposure

In the induced exposure method, the analysis distinguishes between target crashes, which the ADAS is intended to prevent or mitigate, and baseline crashes, which are used to approximate exposure. Target crash definitions are based on system functionality (e.g., forward collision scenarios for systems supporting braking, lane-departure scenarios for lateral control systems).

Baseline crashes are selected assuming that the ADAS in question is unlikely to influence the course of the accident or the probability of the baseline vehicle being struck. Typical baseline example is vehicles struck from behind or single vehicle crashes. These involvements are assumed to reflect the relative amount of driving among different vehicle groups. However, great caution is required when choosing baseline crash types. Modern vehicles are increasingly equipped with multiple ADAS features with varying functions. For example, a truck equipped with AEBS may also have lane departure prevention systems. In such cases, single vehicle crashes are no longer suitable as baseline events because their frequency may already have been reduced by the lane departure prevention system, which is present alongside AEBS.

Crash involvement rates (R) are calculated using  $R = C_{\text{target}}/C_{\text{baseline}}$  where  $C_{\text{target}}$  represents the number of at fault, target-type crashes, and  $C_{\text{baseline}}$  represents the number of baseline crashes. Rates are calculated separately for equipped and non-equipped vehicles.

Real-world effectiveness is estimated using the standard induced-exposure formulation,  $\text{Effectiveness} = 1 - R_{\text{equipped}}/R_{\text{control}}$

Confidence intervals are typically derived assuming Poisson-distributed counts.

#### 4.8 Deliveries

The second objective of the pre-study was to write an application to a larger research project with the purpose of conducting an actual evaluation of AEBS efficiency. Two applications have been written. The first one was submitted to Trafikverket in September 2025. However, that application was rejected on December 18, 2025, with the recommendation to send it to FFI. Therefore, a second application will be submitted to FFI Traffic-safe automation in March 2026.

## 5. Conclusions, Lessons Learnt and Next Steps

There is great interest in quantitatively assessing the real-world efficiency of ADAS on HGVs, from the project partners, Trafikverket and Euro NCAP. Similar assessments have been conducted on passenger cars, but none exist for HGVs.

Assessing ADAS effectiveness using both police-reported crashes and insurance claims offers several advantages. First, these data sources capture different types of events: insurance claims include a broader range of crashes, while police reports primarily cover crashes involving personal injury. Using both sources therefore provides complementary information. Comparing the results will lead to a more robust evaluation of AEBS performance and offer insights into the strengths and limitations of each methodological approach. Such knowledge will be valuable for future research projects.

Collaboration with partners from the heavy-vehicle industry, insurance companies, universities, and research institutes has been highly valuable and effective for the project's progress. The combined expertise in heavy-truck technology, crash safety, traffic accidents, personal injuries, driver behavior, and statistical methods has enabled rapid and efficient knowledge sharing.

## 6. Dissemination and Publications

No results or publications have been produced in the project other than the two project applications.