BENDIX® SAFETY SYSTEMS CHALLENGING SCENARIOS OVERVIEW

Bendix safety technologies complement safe driving practices.

No commercial vehicle safety technology replaces a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training.

Responsibility for the safe operation of the vehicle remains with the driver at all times.

Document Overview

Autonomous Emergency Braking (aka collision mitigation) and alert systems, such as the family of Bendix® Wingman® Fusion™ solutions, continuously monitor what is happening on and around the vehicle. Their purpose is to determine if the vehicle is approaching or near a roll or yaw threshold, collision, a following distance threshold, or blindspot condition. If such a situation develops, the system can warn, then sometimes automatically intervene, to assist the driver. However, all collision mitigation systems have limitations and may misinterpret a scenario leading to a reaction when one is not anticipated by the driver or may not be required to mitigate an intended situation.

Systems Covered In This Document

This document covers some but not all aspects of the Wingman Fusion systems, Bendix® ESP®, and Bendix® BlindSpotter® with an emphasis on conditions that limit their performance.

Wingman Fusion System (alerts and active braking):

This system can warn the driver and automatically apply foundation brakes in some situations in order to help the driver mitigate a potential forward crash. Since each scenario is different and the system has limitations, in some cases, the driver may get little or no alert or braking.

Primary Product and Service Documentation available at bendix.com:

- *SD-61-4963, Bendix® Wingman® Fusion™ Active Safety System Service Data sheet*
- *SD-64-20124, Bendix™ AutoVue® FLC-20™ Camera Service Data sheet*
- *BW2769, Bendix™ VORAD® Collision Warning System Operator's Manual*

Key System Notes and Clarifications:

- High differences in speed will limit system performance due to the time needed to recognize the scenario.
- Radars work based on reflections from irregular metallic objects which can overlap, cancel, or interfere, causing the radar sensor to miss targets or see false targets.
- Low light or low roadway-background contrast conditions can impact the camera's ability to recognize the forward vehicle and limit system braking performance.
- The system may detect speed signs on parallel roads to the highway being traveled which can erroneously warn the driver and reduce throttle.
- The Overspeed Alert & Action feature never applies the vehicle foundation brakes. It is capable of alert and dethrottle only.
- When the Wingman Fusion system cannot confirm the stationary forward vehicle is actually a vehicle, only an alert can be issued. For example, the angle of the forward vehicle, lane position of the forward vehicle, shape of the forward object, size of the forward object, when the object comes into view, etc., may impact the system's ability to confirm.
- Although false alerts are much less prevalent on the Wingman Fusion system than on other systems, the system may, at times, detect and warn the driver on overhead signs and bridges.
- Asphalt-to-grass/asphalt-to-snow transitions, as well as road barriers or guard rails, may be mistaken for lane lines and temporarily suppress Lane Departure Warning (LDW), Highway Departure Warning (HDW), or Highway Departure Braking (HDB).
- Skid marks, tar stripes, or severe or high-contrast shadows may be mistaken for lane lines and could lead to a false-positive activation of LDW, HDW, or HDB.

<u>Important:</u> Because each truck manufacturer may implement differing feature sets of the Bendix Wingman Fusion system, please check with the OE or dealer to confirm available features and vehicle capabilities.

Bendix® ESP® (alerts and active braking):

The ESP system has the power to help the driver act to help avoid or recover from roll and loss-of-control events. It is a tractor-based system that monitors the vehicle and driver intent, and typically acts before the driver realizes a situation exists and in ways the driver cannot replicate. It can activate both the tractor and trailer brakes in order to help maintain stability. During a stability event, it also helps the driver keep the tractor going in the intended direction.

Primary Product and Service Documentation available at bendix.com:

- *SD-13-4986, Bendix® ESP® EC-80™ Controller Service Data sheet*

Key System Notes and Clarifications:

- At times, drivers misinterpret ESP interventions as interventions from the Bendix® Wingman® Fusion™ collision mitigation system. Sometimes the vehicle may be in line with an object during the ESP intervention and the driver may, incorrectly, believe the Wingman system activated the brakes on that object, when more accurately, it was the ESP system that activated the brakes while trying to maintain vehicle stability.

Bendix® BlindSpotter® Radar System:

The BlindSpotter radar system uses a small radar typically mounted to the right side of the vehicle to detect objects in the adjacent lane. This system is intended to warn a driver when an object is detected in the vehicle blind spot.

Primary Product and Service Documentation available at bendix.com:

- *SD-61-5010, Bendix BlindSpotter Side Object Detection System Service Data sheet*
- *BW2860, Bendix BlindSpotter Collision Warning System Operator's Manual*

Key System Notes and Clarifications:

- The BlindSpotter radar system can issue an audible warning when an object is detected, and the vehicle turn signal is active. It DOES NOT activate brakes.
- This system should not be confused with the Wingman Fusion system or Bendix ESP system. It is an independent, standalone system.

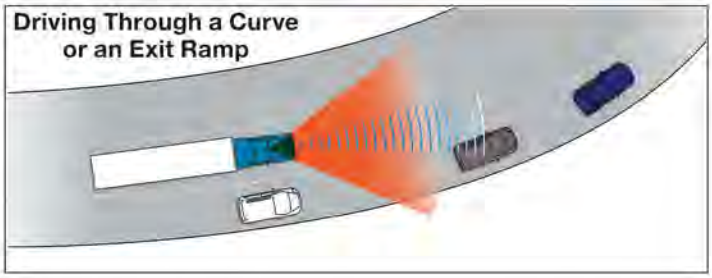
Potentially Challenging Situations and System Limitations

Driver Assistance Systems (DAS), such as the family of Bendix Wingman Fusion active safety solutions, help to continuously monitor a variety of vehicle parameters and sensors to determine if the vehicle is near a collision or a following distance threshold.

As a reminder, all Driver Assistance Systems have limitations and may misinterpret a scenario leading to a reaction when one may not be required. The following section describes driving scenarios that may be challenging for any Bendix safety system.

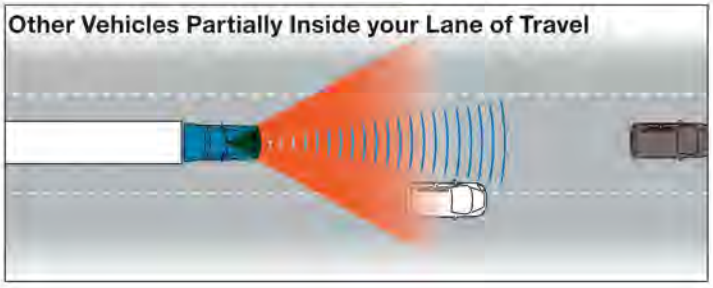
Driving Through Curves:

When driving through curves, adaptive cruise control and collision mitigation systems may detect vehicles in adjacent lanes. The system also may not recognize forward targets as in-lane depending on curvature and may react late to in-lane objects within a curve.



Offset Forward Vehicles:

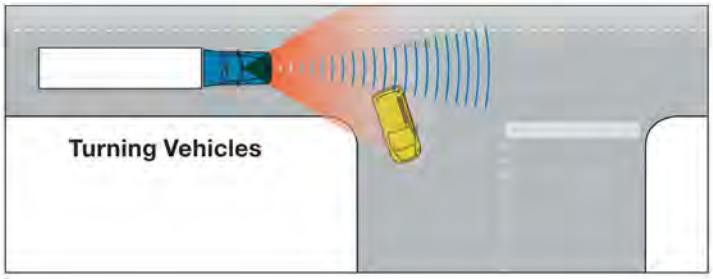
Vehicles that are offset, or not completely in the host vehicle's lane of travel, may not be detected or trigger a reaction by the vehicle's collision mitigation system.

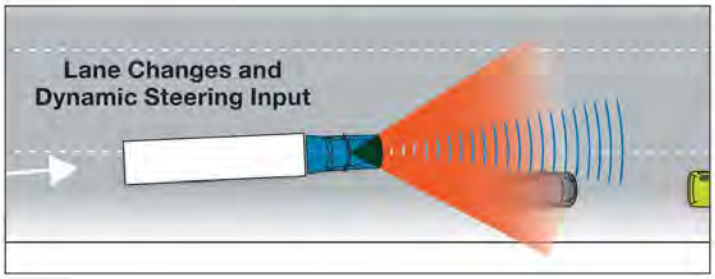


In-Lane Slow Vehicles:

When the targeted forward vehicle makes a sharp turn or the host vehicle changes lanes behind a slow, in-lane vehicle, the Bendix® Wingman® Fusion™ system can perceive this as an in-lane slow or stopped vehicle. The system may continue to track the vehicle as the forward vehicle continues through the turn or the host vehicle completes a lane change causing the Fusion system to possibly warn or brake.

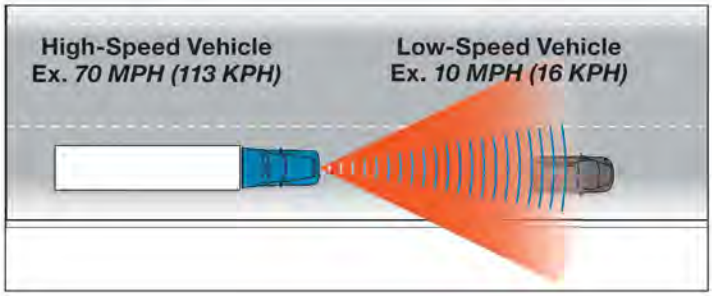
The system may continue reacting as the forward vehicles turns off the original road and onto the new road or as the host vehicle has transitioned into the other lane. The system will release control when the forward vehicle is sufficiently out of the initial lane and no longer considered a targeted forward vehicle by the system.





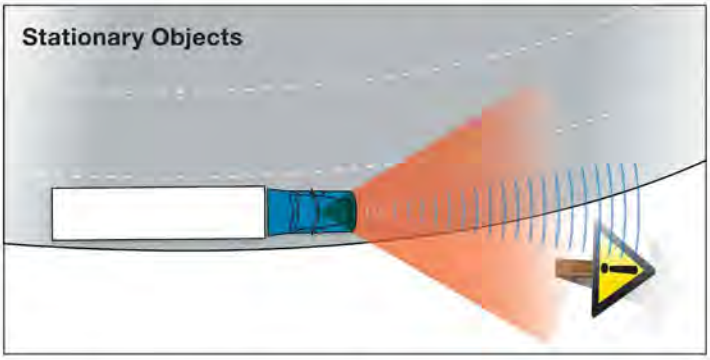
High Differences in Speed:

The higher the difference in speed between the host truck and the targeted forward vehicle, the less time the system has to react. High speed differences can cause little to no system alert or activation.

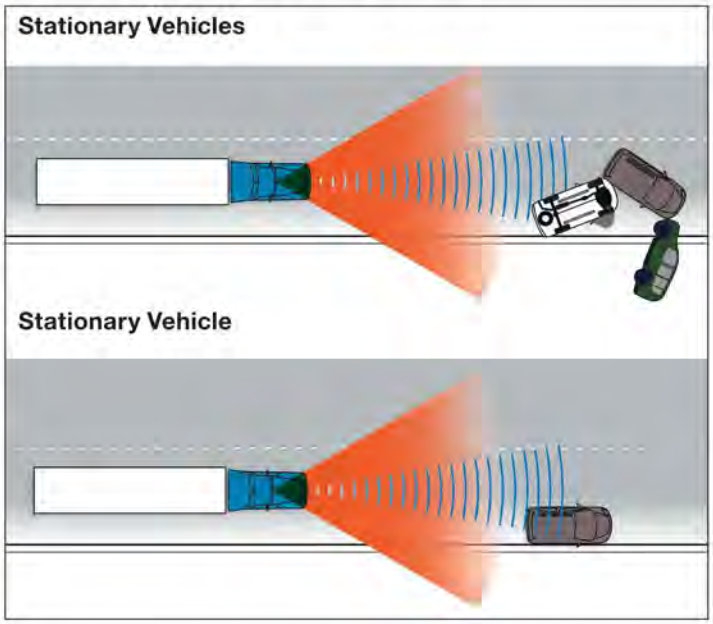


Stationary Vehicles and Objects:

- Signs, bridges, or other sizeable, stationary metallic objects may be falsely detected by collision mitigation systems. Although not very common and usually not very long in duration, the system may, on occasion, activate a false alert or possibly a momentary false braking event on these objects.
- Objects that are not recognized as a forward vehicle may not trigger a reaction by the system.
- Objects that are offset in the host vehicle's lane of travel may not trigger a reaction by the system.



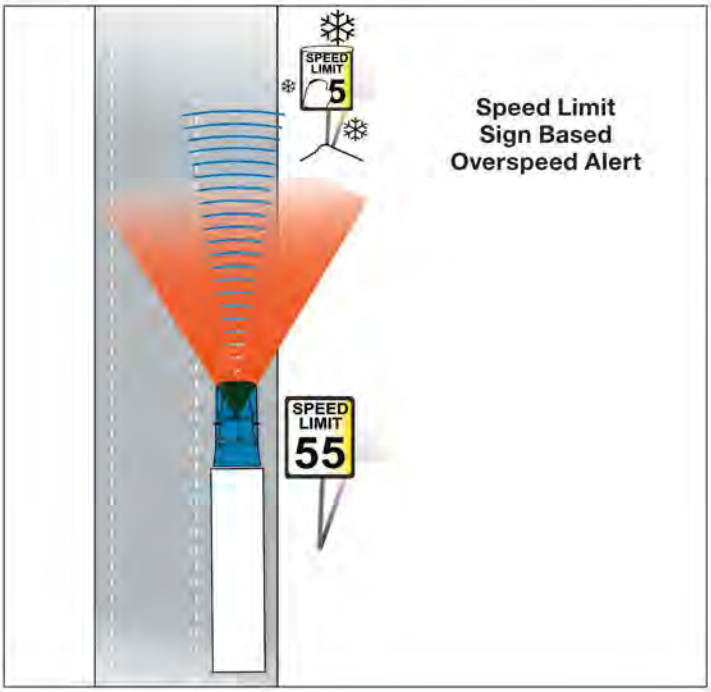
Normal Response on Vehicles Equipped with the Stationary Object Alert Feature - Alert Only



Speed Limit Sign Detection:

The Bendix® Wingman® Fusion™ system detects roadway speed signs in order to alert the driver and sometimes dethrottle the vehicle when traveling over the posted speed limit (Overspeed Alert & Action). In some scenarios, the system may detect the speed limit sign from a parallel roadway and alert the driver.

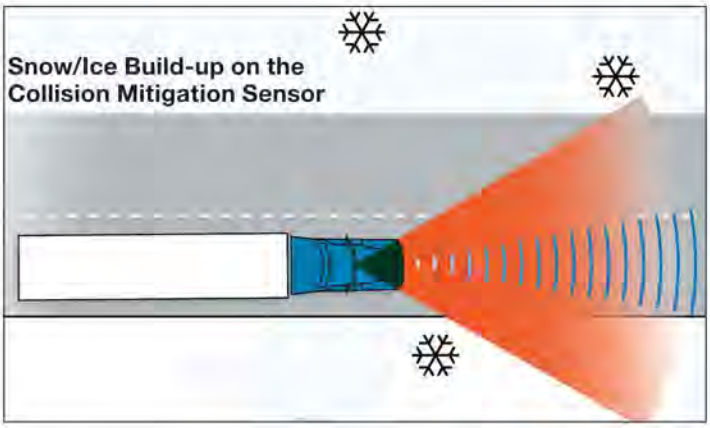
In some other situations, the system may not detect roadway speed signs. In about the first five (5) minutes of driving, the Fusion system will conduct a calibration procedure in which the system will not provide any Overspeed alert or dethrottling.



Weather Conditions:

Heavy precipitation – in particular, snow and ice build-up in front of a collision mitigation radar – may contribute to false detection of objects. This may, in turn, lead to false alerts or nuisance braking events.

If the forward radar becomes blocked and the Fusion system cannot reliably detect forward objects, a radar fault will be set.



Potential Causes of False Object Detection, Warning, and Braking

Potential Cause	Solution
Obstruction of radar – deer and moose guards, bumpers, etc.	*Refer to Appendix A of the Bendix® Wingman® Fusion™ Active Safety System Service Data sheet (SD-61-4963)* for radar mounting clearance. Ensure the guard/bumper does not interfere with the radar beam clearance area.
Obstruction of radar or camera – debris	Inspect the radar or camera and remove any road debris blocking the front of the radar.
Obstruction of radar – mud/ice/snow accumulation in front of the radar or on a radar cover	Inspect the radar and remove any mud, snow, or ice build-up in front of the radar or the cover.
Radar misalignment	*Refer to Appendix B of the Bendix Wingman Fusion Active Safety System Service Data sheet (SD-61-4963)* for radar sensor alignment.

If after becoming familiar with the contents of this document you still believe the Bendix® Wingman® Fusion™ system is not performing properly, Bendix recommends the following:

- Run the most current version of the Bendix® ACom® PRO™ Diagnostic Software to determine if an active fault exists with the system. Correct the fault(s) prior to placing the vehicle back in service.
- Verify the radar is operating the latest software version. This can be determined by using the ACom PRO Diagnostic Software or by contacting your Bendix account manager. This radar software helps reduce sensitivity to road conditions that may cause a radar blind condition.
- Fully understand when the braking occurred. It may be a challenging condition for the system that may not be called out in this document. Driver training may be required to fully understand how the system(s) operate.

Note that all radar systems are sensitive to conditions such as those described within this document, and all radar systems have limitations. It is unlikely that full elimination of unwanted false-positive activations will be possible with this generation of technology. There is no substitute for a skilled, alert driver exercising safe driving techniques and proactive, comprehensive driver training. Responsibility for the safe operation of the vehicle remains with the driver at all times.

Bendix®-brand Electronic Control Units (ECUs) are not designed to store data for purposes of accident reconstruction and Bendix® ACom® PRO™ Diagnostic Software is not intended to retrieve data for purposes of accident reconstruction. Bendix makes no representations as to the accuracy of data or video retrieved and interpreted from ECUs for purposes of accident reconstruction. Bendix does not offer accident reconstruction services or interpretation of stored data. Bendix ECUs are not protected from fire, loss of power, impact damage, or other conditions that may be sustained in a crash situation and may cause data to be unavailable or irretrievable.

List of Acronyms and Terms

Term	Meaning
AEB	Autonomous Emergency Braking (generic industry term).
Bendix® ESP®	Bendix Electronic Stability Program (full stability system).
Bendix® Wingman® Fusion™	Bendix-branded collision mitigation system using a forward facing camera, radar and integration with the Bendix ESP full stability system.
CMT	Collision Mitigation Technology (generic industry term).
Forward Vehicle	The car/truck/other vehicle directly in front of the host vehicle. Sometimes it is locked in and becomes targeted, other times it is not.
Host Vehicle	The truck/tractor/specialty vehicle equipped with the safety system.
Targeted Forward Vehicle	A forward vehicle identified by the safety system that can cause a system reaction (alert or automatic braking).

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