SWOV Fact sheet

Electronic Stability Control (ESC)

Summary
Electronic Stability Control (ESC) is a vehicle safety system that can prevent skidding in many cases. This means that the vehicle remains controllable and that the crash rate is diminished subsequently. Various studies have estimated that this positive effect of ESC on road safety is substantial. Especially a large number of single-vehicle crashes with passenger cars can be prevented by ESC: between 30% and 62% of the fatal single-vehicle crashes, according to some studies. It is not known whether this effect is equally substantial in the Netherlands, considering that its infrastructure is already relatively safe. Meanwhile, the European Commission has decreed that all new vehicle models (passenger cars and lorries) have to be fitted out with ESC from November 2011 onwards. From November 2014, this will apply to all newly sold vehicles, including current models.

Background and contents
This fact sheet will examine the functioning of Electronic Stability Control (ESC) and will discuss its effects as they have been determined by various studies. The major part of the available information applies to passenger cars, but this fact sheet will deal with lorries as well. The system installed in lorries is often indicated by a different name: Directional Control (DC).

ESC was first mass-marketed in 1995 (under the name of ESP, Electronic Stability Program) to enhance vehicle safety. Owing to the positive effects of ESC, the European Parliament voted in March 2009 that ESC should be mandatory in all new vehicle models from November 2011 onwards and in all new vehicles (current and new models) from November 2014 (Schwab, 2009; European Commission, 2008). This Directive applies to both passenger cars and lorries.
Since January 2009, ESC has also become an integral component of the European New Car Assessment Program (Euro NCAP). Only vehicles fitted out with ESC can still obtain five stars (the maximum number) in the Euro NCAP tests.
Finally, an information campaign is presently being conducted in Europe under the name of 'Choose ESC' (www.chooseesc.eu) to promote ESC. Both Euro NCAP and the European Commission support this campaign.

What is ESC?
ESC is a vehicle safety system that supports the driver. When the driver finds him/herself in a critical situation and the vehicle threatens to skid, ESC intervenes autonomously; the driver does not have to do anything. When a vehicle is skidding, the driver quite often loses control of the vehicle, which may result in a crash. With ESC the driver can maintain control of the vehicle in critical situations so that a crash can be prevented in many cases.

ESC is available under many different names: many car brands have given it their ‘own’ name. A few examples are: ESP (Electronic Stability Program), VSA (Vehicle Stability Assist), DSC (Dynamic Stability Control), VSC (Vehicle Stability Control), DSTC (Dynamic Stability and Traction Control), VDCS (Vehicle Dynamics Control Systems) and PSM (Porsche Stability Management).

How does ESC function?
ESC compares the direction desired (the steering angle indicated by the driver with the steering wheel) with the actual movement of the vehicle. The actual movement of the vehicle is determined by the sum of the lateral acceleration (sideward movement) of the vehicle, the rotation of the vehicle and the speed of the individual wheels. When a vehicle begins to skid, the actual movement of the vehicle differs from the intention of the driver. In such a situation, ESC applies the brakes of individual wheels by means of the same technique as with ABS (the Anti-lock Braking System). ABS guarantees that the wheels do not lock and thus do not slip across the road surface. By means of this technique, the wheels maintain grip on the road surface and as a result the vehicle remains under control. ESC does

not only intervene in the wheels, but in many cases directly in the gas supply as well. The gas supply (and subsequently the engine power produced) is decreased, as a result of which the vehicle will slow down (Ferguson, 2007) and will come under greater control. A vehicle with ESC will always be fitted out with two other safety systems as well: the previously mentioned ABS and ASR systems. ASR is short for Anti-Slip Regulator (also called TCS or Traction Control System). ASR prevents the wheels from slipping out of control at the moment of driving off or accelerating. Thus, ABS and ASR have an effect on the longitudinal dynamics of the vehicle and ESC on the transverse dynamics. Adding ESC is therefore beneficial to stable driving into all directions.

What is the share of ESC in the Dutch fleet in percentages?

In 2007 an estimated 7% of all passenger cars in the Dutch fleet was fitted out with ESC (Grošanić & Assenmacher, 2008). According to BOVAG-RAI (2009), in 2008, 17.5% of the standard models of the fifty best-sold passenger cars were fitted out with ESC as a standard option. Ten years earlier this had amounted to less than 2% (see *Figure 1*).

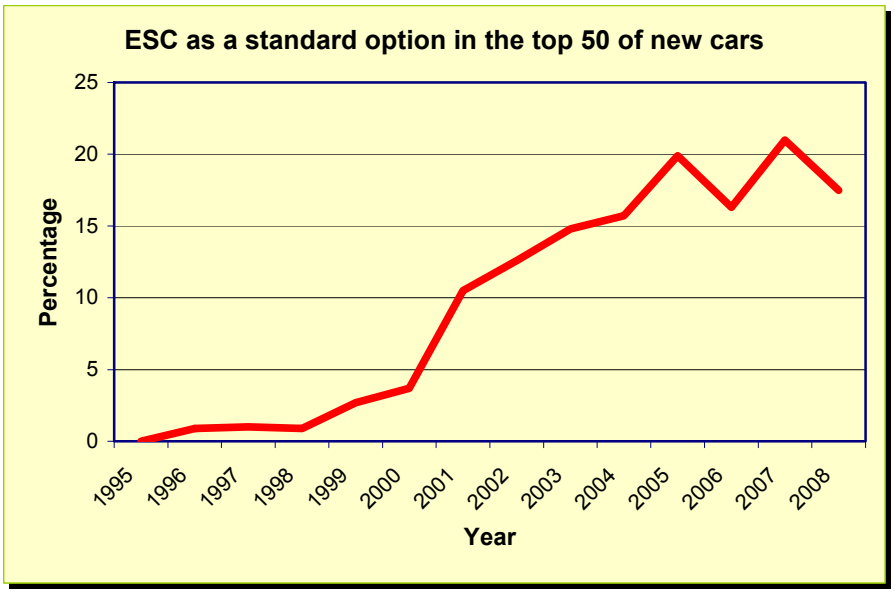

Figure 1. *ESC as standard option with standard models of the fifty best-sold passenger cars in percentages (BOVAG-RAI, 2009).*

Taking into account the above-mentioned Directive by the European Parliament (Schwab, 2009; European Commission, 2008), this percentage will strongly increase.

What are the effects of ESC?

The first foreign studies into the effectiveness of ESC have indicated highly favourable effects on the stability of the vehicle (Ferguson, 2007). Since then, a range of studies has been conducted into the possible effects of ESC on road safety and they confirm the results of the earlier studies.
Erke (2008), as well as Ferguson (2007) conducted a meta-analysis of the existing literature about the effects of ESC. These analyses show that the various studies are unanimous about the positive effect of ESC, particularly on single-vehicle crashes. Single-vehicle crashes are accidents involving only one moving vehicle.

The estimates of the reduction of fatal single-vehicle crashes due to ESC vary from 30% to 62% for passenger cars (Erke, 2008; Ferguson, 2007). In the case of single-vehicle crashes with road injuries, the reduction varies from 18% to 64% (Erke, 2008). The effects for SUVs (Sports Utility Vehicles) are on average more substantial than the effects for 'ordinary' passenger cars. This is the result of the SUVs' centre of gravity being higher than that of other passenger cars. A high centre of gravity is disadvantageous for the stability of the vehicle. ESC in SUVs partly cancels out this disadvantage.
The effect of ESC on multi-vehicle crashes (accidents involving more than one moving vehicle) is slightly less clear. A positive effect of ESC seems to occur mainly in cases of multi-vehicle crashes with fatal outcome. Ferguson ascertains a reduction in multi-vehicle crashes with fatal outcome ranging from 17% to 38%; Erke reports a reduction ranging from 20% to 43%. The reduction with

multi-vehicle crashes with road injuries appears to be rather small or zero. Erke has even detected a small, for as yet, unexplained increase (+1% to +3%) for this type of crashes.

Finally, ESC also appears to reduce the number of rollover accidents (when a vehicle turns over). The estimated effects from the meta-analyses of Erke and Ferguson are presented in *Table 1*.

Type of crash/severity of injury	Erke (2008)		Ferguson (2007)
	Point estimate (%)	95%-validity interval	Average 'minimum and maximum' from the analyses (%)
Single-vehicle fatal	-49	(-62;-33)	-30;-53
Single-vehicle with road injuries	-46	(-64;-18)	-40;-50
Multi-vehicle fatal	-32	(-43;-20)	-17;-38
Multi-vehicle with road injuries	+2	(+1;+3)	0

Table 1. *Effects of ESC according to the meta-analyses of Erke (2008) and Ferguson (2007); reduction of the number of crashes in percentages.*

eIMPACT (Malone et al., 2008) has estimated that DC in lorries results in a reduction of 35% in fatal crashes and 20% in crashes with road injuries. The eIMPACT project has estimated the socio-economic effects of various vehicle safety systems in terms of road safety, traffic flow and efficiency (cost/benefit) of the system.

It is noteworthy that the previously mentioned (meta-)analyses do not distinguish between the effects of ESC in the case of a dry or a wet/slippery road surface. A wet/slippery road surface has lower friction resistance than a dry road surface, so that skidding occurs more easily. Therefore, more could be expected to be gained with ESC on a wet road surface (Aarts et al., 2008). Only one study distinguishes between a dry and a wet/slippery road surface and it shows that ESC indeed has a greater effect on a wet/slippery road surface. With respect to fatal crashes and crashes with road injuries, Lie et al. (2006) reach conclusions on the crash-reducing effects of ESC as represented in *Table 2,* taking into account the condition of the road surface.

Condition of road surface	Reduction in crashes with different outcome	
	Fatal	Road injuries
Overall effect	22%	13%
Wet road surface	56%	24%
Road surface icy/snowy	49%	30%

Table 2. *Crash-reducing effects of ESC under various road surface conditions, Lie et al. (2006).*

Does ESC have any side effects?

Based on a telephone survey (1.517 interviews), Rudin-Brown et al. (2009) reported that the use of ESC might possibly result in behavioural adaptation. In this context, behavioural adaptation means that drivers, thinking that their vehicle has become safer because of ESC, will drive more recklessly and with greater risk-taking. However, not enough research has been conducted into possible behavioural adaptation as a result of ESC to be able to present a well-founded conclusion. The previously mentioned meta-analyses and their calculated reduction factors are based on crash studies, i.e. on 'real life' data. If behavioural adaptation occurred in real life, this has already been taken into account in the reduction factors.

What are the effects of ESC in the Netherlands?

In a recent SWOV report (Christoph, 2010), an estimate has been made of the expected road safety effects of ESC for passenger cars in the Netherlands for 2020 and 2030. The year 2020 is an important reference date in many an outlook and policy document, such as the Dutch *Mobility Policy Document* (Ministry of Transport & Ministry of Housing, Spatial Planning and the Environment, 2004)

and in the Dutch *Strategic Road Safety Plan 2008-2020* (Ministry of Transport, 2008). Christoph (2010) adheres to the minimum and maximum effects of ESC on road safety as described in the previously mentioned foreign meta-analyses (Erke, 2008; Ferguson, 2007). The percentage of vehicles with ESC (penetration rate), as well as the number of single- and multi-vehicle crashes in 2020 and 2030 have been estimated on the basis of historical progression. The number of crashes have been estimated with, as well as without the effect of ESC, with otherwise unaltered policy. The reduction as a result of ESC has been presented as the difference (in percentages) between these two estimates. These estimates are presented in *Table 3.*

Year	2020	2030
Penetration rate	57%	78%
Reducing factor	30%-62% for single-vehicle fatal crashes 17%-43% for multi-vehicle fatal crashes	
Reduction in number of fatalities	33-72	33-71
Reduction compared with total number of fatalities without ESC	7-15%	10-21%

Table 3. *Reduction in number of fatalities in passenger cars with ESC for the years 2020 and 2030 in the Netherlands (Christoph, 2010).*

The given reduction may be somewhat high for the Dutch situation. Seeing that the infrastructure in the Netherlands is relatively safe, less is expected to be 'gained' in comparison with countries with a less safe infrastructure (Aarts et al., 2008). Besides, the situation of the road surface may vary substantially for each country, as a result of differences in climate, for example. The above-mentioned estimate of the effects has opted to adhere to the figures from the meta-analyses, because not enough data was available to be able to make an estimate of the deviations, resulting from these two factors, for the Dutch situation.

In a study into the effects of anti-crash systems for lorries, Eenink (2009) estimated that DC results in two fewer fatalities per year in the case of single-lorry crashes. For injury crashes, he calculated a reduction of seven to ten hospitalized road injuries.

Conclusion

ESC considerably enhances the stability and controllability of vehicles in critical situations. ESC is therefore expected to have a substantial positive effect on road safety. Although the estimates in foreign studies may be slightly too high for the Netherlands, because of the relatively safe Dutch infrastructure, ESC can nevertheless result in a considerable reduction of the number of road casualties. The number of vehicles with ESC will increase substantially, also because of the Directive of the European Commission that makes ESC gradually mandatory from November 2011 for passenger cars, as well as lorries. There are slight indications that ESC might trigger behavioural adaptation, but further research is necessary to gain insight into this matter.

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