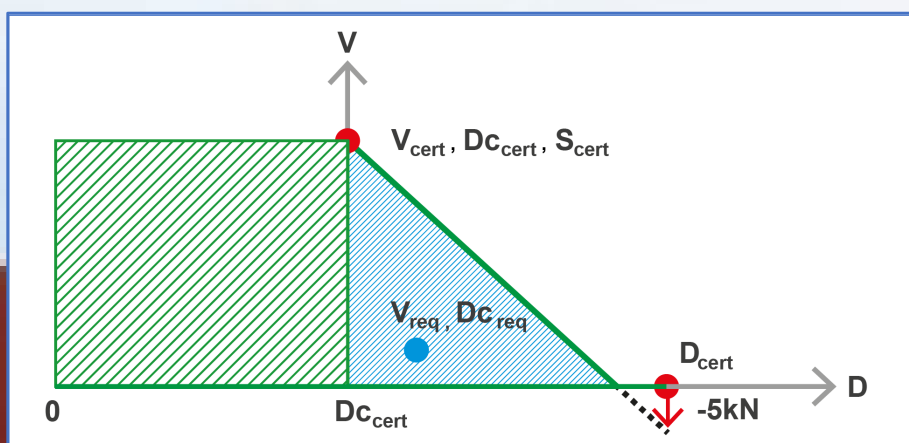
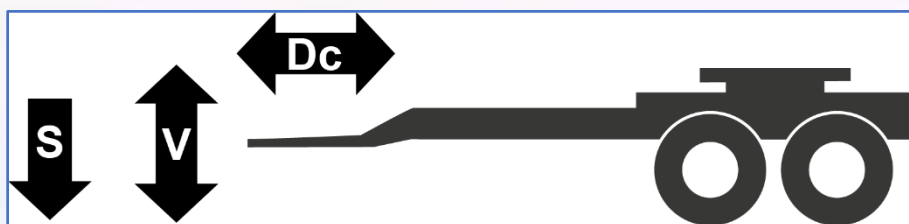


# HCT Vehicles with Coupling Equipment Requiring Coupling Performance Trade-off



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## Preface

The Nordic Road Association's (NVF) Haulage working group is a network of Nordic experts from road authorities, research organisations, inspection bodies, the haulage industry, and vehicle manufacturers.

The NVF Haulage working group's goals for the 2020-2024 period involve contributing to more efficient, more environmentally friendly, safer, and more economically sustainable freight transport on the roads.

The goals shall be achieved by:

- mainly focusing on heavy vehicles > 3.5 tonnes total weight
- considering the need for infrastructure, rest areas, transshipment points, bearing capacity, and accessibility to industry, as well as terminals including interconnection with other modes of transport such as rail, maritime, and aviation
- contributing to measures that, in relative comparison, reduce the negative impact of freight transport, such as emissions, road wear, noise, and congestion
- working towards having safe roads, vehicles, and drivers
- contributing to increased knowledge about alternative energy and propulsion systems for vehicles, including biofuels and electrification
- contributing to increased knowledge about automation and digitalisation
- contributing to international efficiency improvements, such as harmonisation and/or mutual acceptance of sustainable procedures

This report, *HCT Vehicles with Coupling Equipment Requiring Coupling Performance Trade-off*, was prepared by Tobias Johansson, VBG Group Truck Equipment AB, and Per Olsson, Parator AB, to whom many thanks are extended.

We also thank the reference group in NVF Haulage who provided input and viewpoints for the report.

March 2024

Mårten Johansson, The Swedish Association of Road Transport Companies  
Chair of NVF Haulage

## Summary

This report summarises trade-off procedures which contribute to ensuring that truck combinations are coupled safely. Trade-off forms part of the assessment of the performance of the coupling product, which is a fundamental requirement that must be met before transporting by road.

**The driver is responsible for:** Ensuring that the truck combination is coupled in a way that is safe to drive on the road. In some cases, this may require coupling performance calculations and the use of trade-off for the certified performance values of the coupling product. Methods for ensuring this evaluation are described in this report.

**Vehicle inspectors must:** Evaluate, according to established procedure, the performance value of the coupling equipment for the current vehicle combination and make use of the various information contained in the vehicle documentation or on the type plates of the coupling products (subject to availability). Methods for ensuring this evaluation are described in this report.

**A manufacturer of vehicles and/or coupling equipment is responsible for:** Mounting type plates in accordance with applicable regulations and which clearly display the performance values for evaluation of coupled vehicle combinations.

**For authorities:** We show that there are differences in the Nordic countries' definition of mass for calculating coupling performance, and that the Nordic countries currently have different procedures for checking coupling performance during roadside inspections. At present, only Finland has a comprehensive method for analysing coupling performance with regard to trade-off at roadside inspections. Methods for ensuring the evaluation and inspection of coupling performance are described in this report.

## Background

In the Nordic countries, the total weight of vehicle combinations has increased over time, yet, to some extent, we still use the same vehicles today for combinations up to 76 tonnes gross mass, which were previously designed for 60 tonnes.

An increased gross mass places higher demands on products used to couple vehicle units in the same way that increased weight places higher demands on the number of axles in a vehicle combination in order for it to be driven on the road network.

If we were to examine existing vehicles when used in heavier combinations over 60 tonnes, most of them, according to their documentation, would not be certified for road use depending on how their coupling equipment/performance is registered and in keeping with roadside inspection procedures in the Nordic countries.

Since the limitation, in practice, does not lie with the existing products, the purpose of the report is to show how drivers, haulage companies, and authorities can manage vehicle coupling appropriately and simplify procedures for drivers, haulage companies, and authorities during roadside inspections.

## Introduction

Requirements relating to the performance of coupling equipment used in a vehicle combination are calculated according to formulae defined in ISO 18868 and UNECE R55. Concisely, it can be said that performance is contingent on the coupling type and on the axle weight of towing and towed vehicles, which is transferred to the roadway. If the towing and towed vehicles are coupled with a drawbar, the calculation depends on whether the drawbar has rigid or hinged attachment. For rigid attachment, there is a requirement that the coupling equipment must cope with vertical forces, which is not required for hinged drawbar attachment.

Vehicle combinations relevant to this issue are those coupled with a rigid drawbar e.g. for dollies or centre-axle trailers.



FIG. 1: TRUCK + CENTRE-AXLE TRAILER



FIG. 2: TRUCK + DOLLY + SEMI-TRAILER

To describe the issue, we use the example: Truck + Dolly + Semi-trailer.

Using a vehicle's existing coupling equipment but in a heavier combination than for which it was originally designed is possible, in most cases, for vehicles on the Nordic market. In practice, it does not normally constitute a limitation in the performance of the coupling equipment, but rather a limitation in how the performance has originally been registered for the vehicle's coupling products in the vehicle register and in terms of the performance values specified on the type plate. Regulation UNECE R55 only permits a limited number of alternative performance values on the coupling product's type plate.

This limitation relating to alternative performance values on the coupling product's type plate can now be addressed through **UNECE R55 Supplement 7 to the 01 series of amendments**, which came into force in February 2018. This update allows for the use of "Performance Extension", also referred to as *coupling performance trade-off*. Trade-off enables existing coupling products to be verified for use in heavier combinations, such as Truck + Dolly + Semi-trailer, without modification, and it is the responsibility of the driver of the vehicle to know if the vehicle is approved for driving according to Trade-off for the coupling products.

For the driver to be able to ensure the coupled combination before departure, and to be sure that the vehicle combination is approved at a roadside inspection, a common approach or procedure is needed that is accepted by all Nordic countries.

The basis for the report was produced together with the authorities responsible for road transport in the Nordic countries (Denmark, Sweden, Norway, and Finland).

Common to all countries is that information specified on the type plates of coupling products are valid for the validation of interconnected vehicle combinations as an alternative to the documentation carried in vehicles or contained in vehicle registers. Refer to Appendix 2 for examples of type plates.

## Description of Trade-off

### Definitions

The D and Dc values are the characteristic performance values of the horizontal force that arises in coupling equipment.

- $D_{cert}$  = certified D-value performance for existing coupling equipment
- $D_{c_{cert}}$  = certified Dc-value performance for existing coupling equipment
- $D_{req}$  = calculated (required) D-value requirement in the existing combination
- $D_{c_{req}}$  = calculated (required) Dc-value requirement in the existing combination

The V value is the characteristic performance value of the dynamically vertical force that arises in the coupling equipment of a coupled centre-axle trailer (CAT) or dolly with rigid drawbar.

- $V_{cert}$  = certified V-value performance for existing coupling equipment
- $V_{req}$  = calculated (required) V-value requirement in the existing combination

The S value is the characteristic performance value of the static vertical load, in kilograms, that arises in coupling equipment on a coupled centre-axle trailer (CAT) or dolly with rigid drawbar.

- $S_{cert}$  = certified S-value performance for the existing coupling equipment
- $S_{req}$  = shall always be  $\leq 1,000$  kg for Trade-off to be applied

On Nordic roads, only hinged drawbars are used on trailers. A trailer is equipped with a ballrace between the front axle and the chassis to steer the axle. With a hinged drawbar on a trailer, only horizontal forces (D) arise at the coupling point. See Fig. 3.

On Nordic roads, rigid drawbars are only found on centre-axle trailers and dollies. With a rigid drawbar, both dynamic horizontal and vertical forces (Dc & V) arise, as well as static vertical load (S). See Fig. 4 below

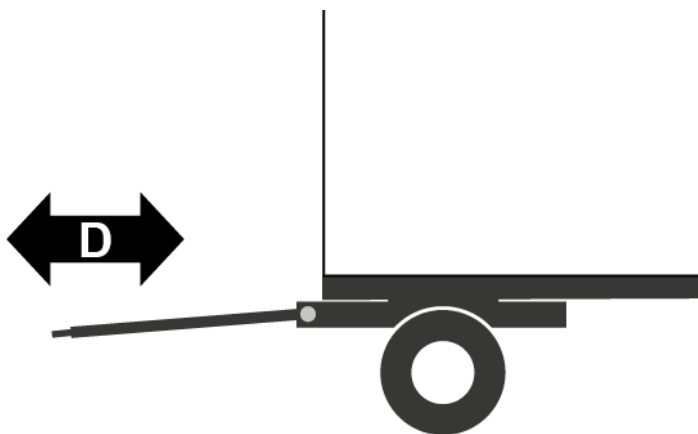


FIG. 3: TRAILER WITH HINGED DRAWBAR

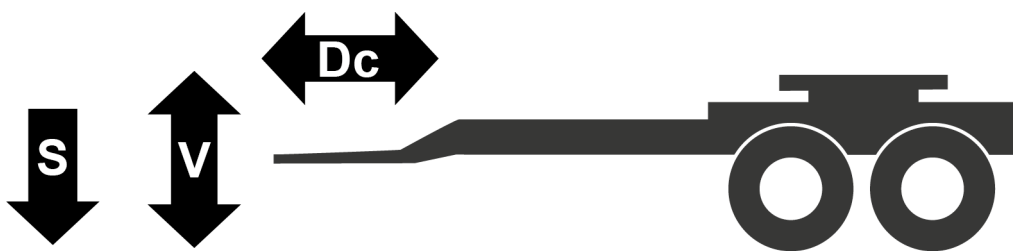


FIG. 4: DOLLY WITH RIGID DRAWBAR

The need to introduce Trade-off is summarised in the following 3 points and Fig. 5 & Fig. 6

1. It is only possible to use coupling equipment in an application where the calculated required performance values  $D_{req}$ ,  $V_{req}$  och  $S_{req}$  fall within the green striped area in Fig. 5. If the calculated required performance values  $D_{req}$ ,  $V_{req}$  and  $S_{req}$  fall outside the green striped area in Fig. 6, the equipment **is not** approved.
2. It is possible to recertify products for use outside the green dashed area in Fig. 6, provided that  $V_{req}$  and  $D_{req}$  are lower than the current  $V_{cert}$  and  $D_{cert}$ . Recertification is done from time to time, but this procedure results in a number of alternative performance values, only some of which can be found on the type plate. With Trade-off, recertification would only be required if the calculation shows a need for  $V_{req}$  that is higher than the current  $V_{cert}$  or  $D_{req}$  that is higher than the current  $D_{cert}$ .
3. In exceptional cases, the use of products with  $V_{req}$  and  $D_{req}$  according to Fig. 6 for manufacturer certificates with good results. The method has been analysed from a theoretical standpoint by applying fatigue analysis.<sup>1)</sup> Furthermore, the analysis has shown that the static load should be kept at the certified value  $S_{cert}$ . Not every change in  $S_{req}$  can be replaced by a change in the  $V$  value. This means that new combinations of  $S_{cert}$  must be addressed by means of recertification.

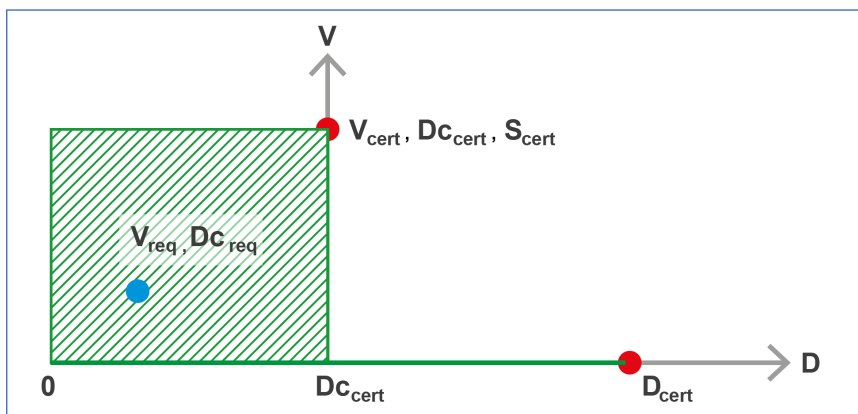


FIG. 5: THE BLUE DOT IS LOCATED IN THE AREA DENOTING AN **APPROVED** COUPLING PRODUCT

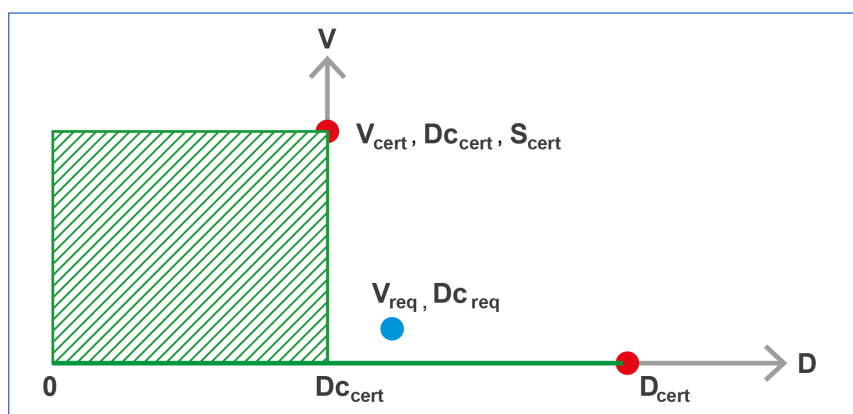


FIG. 6: THE BLUE DOT IS OUTSIDE THE APPROVED AREA, AND THE COUPLING PRODUCT IS THEREFORE **NOT APPROVED**

<sup>1)</sup> The fatigue analysis applies Haigh formalism

## Using Trade-off/Performance Extension

Trade-off can be used on a coupling system that includes a clevis coupling, drawbar, and drawbar eye, and a diagram as shown in Fig. 7 can be produced for each component with certified performance values.

If the calculated performance value requirements  $D_{req}$  and  $V_{req}$  fall within the blue striped area in Figure 7, the limiting variable  $V$  value (green line) applies instead of the certified  $V$  value of the installed coupling equipment.

$S_{req}$  must always be less than or equal to 1,000 kg.

$S_{req}=1000$  kg corresponds to a force of 10kN

-5kN: The starting point is that the  $S$  value [kg] raises the mean value of the alternating vertical load  $V$  value [N] <sup>2)</sup>.

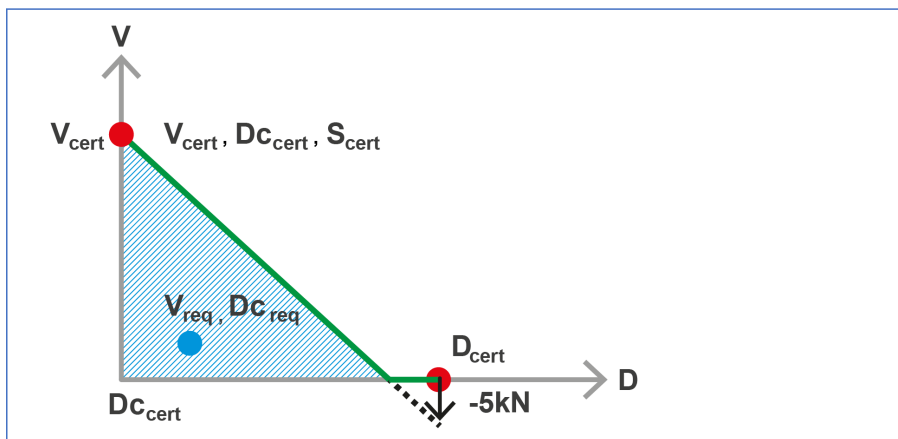


FIG. 7: TRADE-OFF DIAGRAM

## Calculation formula

Trade-off can also be shown using the following formula

$$\text{If } D_{C_{req}} \leq D_{C_{cert}} \text{ then } V_{req} \leq V_{cert}$$

$$\text{If } D_{C_{cert}} \leq D_{C_{req}} \leq D_{cert} \text{ then } V_{req} \leq V_{cert} + \frac{-5 - V_{cert}}{D_{cert} - D_{C_{cert}}} (D_{C_{req}} - D_{C_{cert}})$$

### CALCULATION FORMULA 1: FORMULA FOR TRADE-OFF

<sup>2)</sup>The effect of the raised mean value is evaluated using the Goodman-Haigh diagram, which considers that acceptable amplitude decreases by 50% of the increase in the mean.



## Example

To calculate the performance requirement of a vehicle combination's coupling equipment ( $D_{req}$ ,  $V_{req}$ ) we have used an IT tool that is freely available from the VBG Truck Equipment website: VBG Performance Value Calculator (PVC)<sup>3)</sup>. PVC is verified according to the formulae defined in UNECE Regulations 55 (Annex 8). The diagrams shown here are for visualisation purposes only and are not shown in VBG PVC.

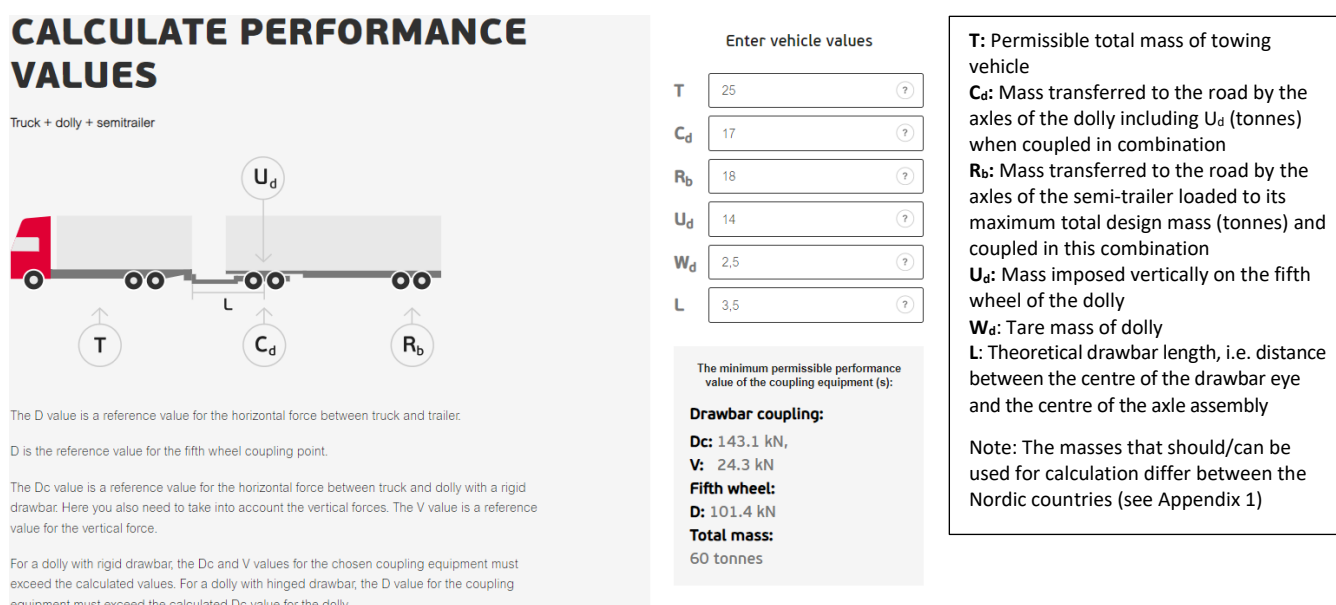
Commonly used coupling products for this combination are products with certified performance values as shown below and which are found on the product type plate (see pictures in Appendix 2):

Drawbeam:  $D_{cert}=200\text{kN}$ ,  $D_{cert}=150\text{kN}$ ,  $V_{cert}=50\text{kN}$ ,  $S_{cert}=1000\text{kg}$

Clevis coupling:  $D_{cert}=290\text{kN}$ ,  $D_{cert}=145\text{kN}$ ,  $V_{cert}=95\text{kN}$ ,  $S_{cert}=1000\text{kg}$

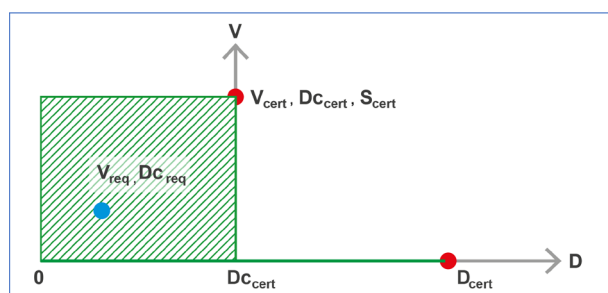
Drawbar eye:  $D_{cert}=290\text{kN}$ ,  $D_{cert}=145\text{kN}$ ,  $V_{cert}=95\text{kN}$ ,  $S_{cert}=1000\text{kg}$

**Note:** The D/Dc performance requirements are greatest when the combined mass is distributed equally on both sides of the coupling point. For example, in a 60-tonne combination as shown below, the highest Dc performance requirement exists when the mass is distributed with 30 tonnes on the truck and 30 tonnes on the dolly/semi-trailer.



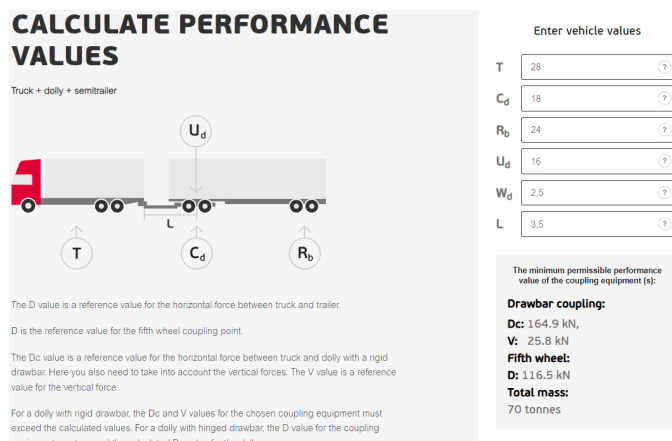
**FIG. 8: 60 TONNES TOTAL MASS, PVC CALCULATION**

For the 60-tonne combination (as shown in Fig. 8) the performance requirement for the combination's coupling equipment is as follows:  $D_{req} \geq 143.1\text{ kN}$  and  $V_{req} \geq 24.3\text{ kN}$ . The certified performance values for all constituent parts are greater than the requirement. The requirement then falls within the green striped area (see Fig. 9).



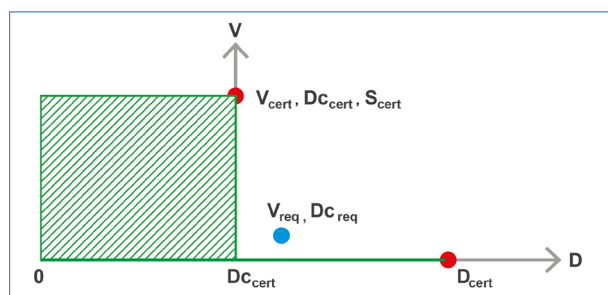
**FIG. 9: THE BLUE DOT IS LOCATED IN THE AREA DENOTING AN APPROVED COUPLING PRODUCT**

3) <https://www.vbg.eu/sv/berakning/>



**FIG. 10: 70 TONNES GROSS WEIGHT, PVD CALCULATION**

For the 70-tonne combination (as shown in Fig. 10) the performance requirement for the combination's coupling equipment is as follows:  $D_{req} \geq 164.9 \text{ kN}$  och  $V_{req} \geq 25.8 \text{ kN}$ . The certified performance values for all constituent parts are now lower than the requirement for the combination regarding Dc. The requirement therefore falls outside the green striped area (see Fig. 11:).



**FIG. 11: THE BLUE DOT IS OUTSIDE THE APPROVED AREA, AND THE COUPLING PRODUCT IS THEREFORE NOT APPROVED**



Evaluation example 1 (60 tonnes total mass), combination **OK** without Trade-off

## EVALUATE COUPLING EQUIPMENT

Truck + dolly + semitrailer









In order to evaluate your combination, you need to enter both the vehicle values and the certified performance values for each component of the coupling equipment.

You can find the certified performance values for the components of the coupling equipment either on the type plate affixed to the component or in the documentation for the component. You can also find certified performance values for each product at [vbg.eu](http://vbg.eu).

The calculation is based on a S-Value of 1000 kg.

### Enter vehicle values

T	<input type="text" value="25"/>	
C <sub>d</sub>	<input type="text" value="17"/>	
R <sub>b</sub>	<input type="text" value="18"/>	
U <sub>d</sub>	<input type="text" value="14"/>	
W <sub>d</sub>	<input type="text" value="2,5"/>	
L	<input type="text" value="3,5"/>	

### Enter certified performance values

#### Drawbeam Truck

D	<input type="text" value="200"/>
Dc	<input type="text" value="150"/>
V	<input type="text" value="50"/>

#### Coupling Truck

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>

#### Drawbar eye dolly

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>

### YOU'RE GOOD TO GO!

Yes, your coupling equipment is adequate and is safe to use for this combination.

Evaluation example 2 (70 tonne total mass), combination **OK**, but Trade-off must be applied

## EVALUATE COUPLING EQUIPMENT

Truck + dolly + semitrailer



In order to evaluate your combination, you need to enter both the vehicle values and the certified performance values for each component of the coupling equipment.

You can find the certified performance values for the components of the coupling equipment either on the type plate affixed to the component or in the documentation for the component. You can also find certified performance values for each product at [vbg.eu](http://vbg.eu).

The calculation is based on a S-Value of 1000 kg.

### Enter vehicle values

T	<input type="text" value="28"/>	<input data-bbox="1321 331 1342 360" type="button" value="?"/>
C <sub>d</sub>	<input type="text" value="18"/>	<input data-bbox="1321 387 1342 416" type="button" value="?"/>
R <sub>b</sub>	<input type="text" value="24"/>	<input data-bbox="1321 443 1342 472" type="button" value="?"/>
U <sub>d</sub>	<input type="text" value="16"/>	<input data-bbox="1321 499 1342 528" type="button" value="?"/>
W <sub>d</sub>	<input type="text" value="2,5"/>	<input data-bbox="1321 555 1342 584" type="button" value="?"/>
L	<input type="text" value="3,5"/>	<input data-bbox="1321 611 1342 640" type="button" value="?"/>

### Enter certified performance values

#### Drawbeam Truck

D	<input type="text" value="200"/>
Dc	<input type="text" value="150"/>
V	<input type="text" value="50"/>

#### Coupling Truck

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>

#### Drawbar eye dolly

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>



### YOU SHOULD NOT DRIVE, BUT...

Our trade-off analysis shows that you could actually drive with this combination. But you will need a certificate to say that the coupling equipment is sufficient.


[Trade-off](#)

Note: If VBG products are used for all the constituent coupling parts, a certificate can easily be obtained from VBG PVC in PDF format. The certificate can be printed out and kept in the vehicle for convenient validation at roadside inspections (see Appendix 3 – Trade-off certificates)

Evaluation example 3 (74 tonnes total mass), combination **Not OK**

## EVALUATE COUPLING EQUIPMENT

Truck + dolly + semitrailer



In order to evaluate your combination, you need to enter both the vehicle values and the certified performance values for each component of the coupling equipment.

You can find the certified performance values for the components of the coupling equipment either on the type plate affixed to the component or in the documentation for the component. You can also find certified performance values for each product at [vbg.eu](http://vbg.eu).

The calculation is based on a S-Value of 1000 kg.

### Enter vehicle values

T	32	?
C <sub>d</sub>	18	?
R <sub>b</sub>	24	?
U <sub>d</sub>	15,5	?
W <sub>d</sub>	2,5	?
L	3,5	?

### Enter certified performance values

#### Drawbeam Truck

D	200
Dc	150
V	50

#### Coupling Truck

D	290
Dc	145
V	45

#### Drawbar eye dolly

D	290
Dc	145
V	45

**✗ STOP! YOU MUST NOT DRIVE!**

No, your coupling equipment is not sufficient for this combination. If you drive with this, you will expose yourself and others to danger!

Example 3 is based on a combination with a total mass of 74 tonnes. The combination is equipped with the same components with the same performance values as the vehicle combinations with a total mass of 60 and 70 tonnes. The evaluation now shows that one or more of the constituent components are not adequate. A deeper analysis shows that it is the drawbeam that is not adequate. As shown in Example 4, by replacing the drawbeam with another type, the vehicle combination will be approved.

Evaluation example 4 (74 tonnes total mass), combination **OK**, but Trade-Off must be applied

## EVALUATE COUPLING EQUIPMENT

Truck + dolly + semitrailer









In order to evaluate your combination, you need to enter both the vehicle values and the certified performance values for each component of the coupling equipment.

You can find the certified performance values for the components of the coupling equipment either on the type plate affixed to the component or in the documentation for the component. You can also find certified performance values for each product at [vbg.eu](http://vbg.eu).

The calculation is based on a S-Value of 1000 kg.

### Enter vehicle values

T	<input type="text" value="32"/>	
C <sub>d</sub>	<input type="text" value="18"/>	
R <sub>b</sub>	<input type="text" value="24"/>	
U <sub>d</sub>	<input type="text" value="15,5"/>	
W <sub>d</sub>	<input type="text" value="2,5"/>	
L	<input type="text" value="3,5"/>	

### Enter certified performance values

#### Drawbeam Truck

D	<input type="text" value="247"/>
Dc	<input type="text" value="150"/>
V	<input type="text" value="50"/>

#### Coupling Truck

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>

#### Drawbar eye dolly

D	<input type="text" value="290"/>
Dc	<input type="text" value="145"/>
V	<input type="text" value="45"/>



### YOU SHOULD NOT DRIVE, BUT...

Our trade-off analysis shows that you could actually drive with this combination. But you will need a certificate to say that the coupling equipment is sufficient.

[Trade-off](#)

Note: If VBG products are used for all the constituent coupling parts, a certificate can easily be obtained from VBG PVC in PDF format. The certificate can be printed out and kept in the vehicle for convenient validation at roadside inspections (see Appendix 3 – Trade-off certificates).

## Guide for driver/haulage company

### Options

1. Two-step calculation
  - a. Use UNECE R55 to calculate the performance requirements for the relevant vehicle combination (see Appendix 4 for calculation).
  - b. Apply Trade-off calculation (according to the calculation model in Calculation formula 1) based on the estimated performance requirement for the current vehicle combination and the certified performance of the constituent coupling products.
2. Use the Finnish Excel model for validation of vehicle combinations and components. This model is described below as the Finnish example.
3. Use the tool available from VBG Truck Equipment, VBG PVC (Performance Value Calculator). VBG PVC is verified according to the formulae defined in UNECE Regulations 55 (Annex 8). With VBG PVC, the status of the current vehicle combination and its constituent components can be easily checked. Checking the status can be done regardless of the make of products. The tool is free to use at <https://www.vbg.eu/sv/berakning/>, and it is also suitable for use on mobile devices.

**If VBG products are used for all the constituent coupling parts, a certificate can easily be obtained from VBG PVC in PDF format. The certificate can be printed out and kept in the vehicle for convenient validation at roadside inspections (see Appendix 3 – Trade-off certificates).**





## Appendix 1 – Status of national oversight of coupling equipment (20/05/2021)

6 questions posed to each country.

1. How is registration inspection/approval of vehicles carried out?
2. Which regulation(s) is/are used?
3. What weight is the basis for coupling performance calculations?
4. Who is responsible and what tools are available for calculation?
5. How is roadside inspection carried with regard to coupling equipment?
6. Is Trade-off implemented for coupling equipment analysis?

### Summary

	1 <sup>st</sup> inspection/ Vehicle approval	Regulation	Weight	On road usage requirement	Tools to help driver to do right	Road side inspection	Trade-off implemented
Finland	Each vehicle is approved individually and the performance value of the respective coupling product is what is recorded in the registration certificate of the vehicle. The lowest input value sets the maximum level.	UNECE R55	Total weight of the vehicle.	The driver is responsible for ensuring that the equipment of the combination meets the requirements for coupling the vehicles. If the total total weight exceeds 76 tonnes (maximum total weight), performance shall be calculated with a distribution up to 76 tonnes.	Form/excel file provided by Traficom. Calculation is based on UNECE R55.	A form/excel file provided by Traficom is used for roadside inspections. Checks are made against registered weights and performance according to the type plate on the coupling product.	Implemented by the controlling authority.
Norway	Each vehicle is approved individually and the performance value of the respective coupling product is what is recorded in the registration certificate of the vehicle. The lowest input value sets the maximum level.	UNECE R55	Technical weight + 5%.	The driver is responsible for ensuring that the equipment of the combination meets the requirements for coupling the vehicles.	UNECE R55	Coupling performance of the vehicle combination is not assessed during roadside inspection	Not implemented by a controlling authority.
Denmark	Each vehicle is approved individually and the performance value of the respective coupling product is what is recorded in the registration certificate of the vehicle. The lowest input value sets the maximum level.	UNECE R55	Total weight or technical weight, not clear	The driver is responsible for ensuring that the equipment of the combination meets the requirements for coupling the vehicles. If the total total weight exceeds 60 tonnes (maximum total weight), performance shall be calculated on the basis of 30 + 30 tonnes for road trains.	UNECE R55	In roadside inspection, VBG PVC is used for calculation and control of coupling performance. Checks are made against registered weights and performance according to the type plate on the coupling product.	Not implemented by a controlling authority.
Sweden	Each vehicle <sup>1)</sup> is approved individually and the performance value of the respective coupling product is that recorded in the vehicle registration certificate. The lowest input value sets the maximum level.	UNECE R55	Total weight	The driver is responsible for ensuring that the equipment of the combination meets the requirements for coupling the vehicles. As an alternative method, the driver may use the current gross weight to calculate the performance requirements of the combination.	Lastbils kalkylatorn.se If the registration number is not available, e.g. for a foreign vehicle, it is possible to manually enter the input weights and performance values according to the type plate on the coupling product. The truck calculator is based on UNECE 55, but does not have a function for analysis of trade-off.	In roadside inspection, Lastbils kalkylatorn.se is used and control is done based on registered weight and performance value. If the registration number is not available, e.g. for a foreign vehicle, it is possible to manually enter the input weights and performance values according to the type plate on the coupling product.	Not implemented by a controlling authority.

- 1) Prior to TSFS 2019:127, calculations for dollies were based on towing and towed vehicles, which resulted in a lower registered performance value than stated on the type plate. However, the data on the type plate can always be used at roadside inspection or for the driver to ensure coupling.

## Appendix 2 – Products and type plates

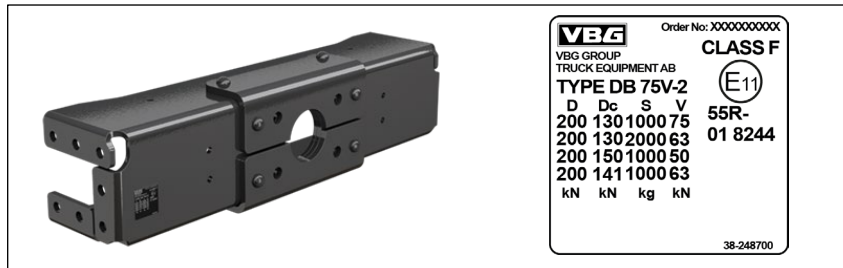


FIG. 15: DRAWBEAM

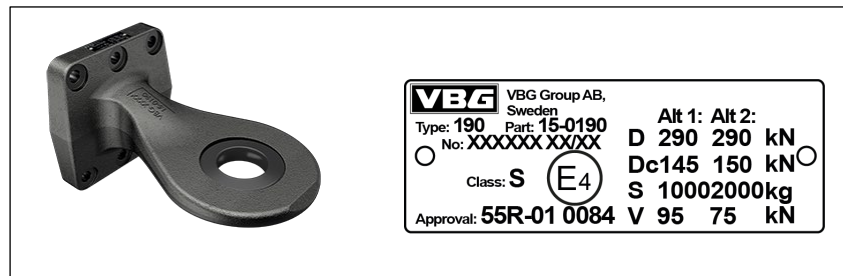


FIG. 14: DRAWBAR EYE

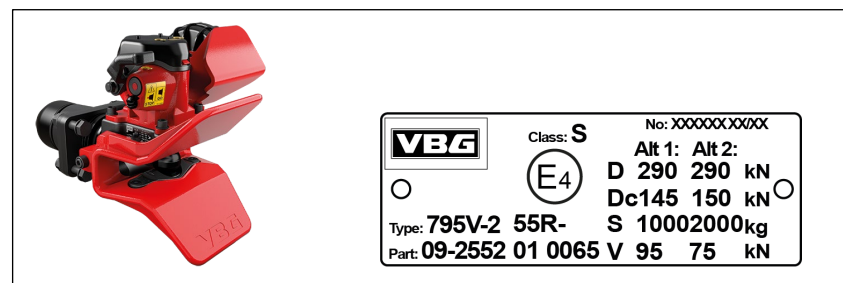


FIG. 13: CLEVIS COUPLING

## Appendix 3 – Trade-off certificates

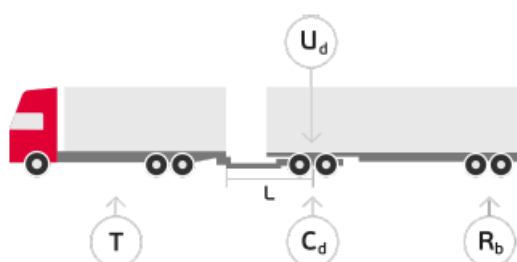
Examples of certificates from VBG that can be kept in the vehicle to facilitate roadside inspection. The VIN number indicated in the certificate is for the vehicle combination to which the certificate applies.



# CERTIFICATE

From the performance calculation and trade-off analysis, we can confirm that the vehicle combination shown below with the vehicles specified here can be driven without any increased risk.

Our attestation assumes that the vehicles are those with the chassis numbers/VINs specified here, that they are coupled in the order shown and that all components of the coupling equipment are made by VBG Group.



<p>For vehicle combination with specified vehicles:</p>

### VEHICLE VALUES

T - 28 tonne

C<sub>d</sub> - 18 tonne

R<sub>b</sub> - 24 tonne

U<sub>d</sub> - 15.5 tonne

W<sub>d</sub> - 2.5 tonne

L - 3.6 metres

#### THE MINIMUM PERMISSIBLE PERFORMANCE VALUE OF THE COUPLING EQUIPMENT (S):

##### Drawbar coupling:

D<sub>c</sub>: 164.9 kN,

V: 25 kN

##### Fifth wheel:

D: 115.2 kN

##### Total mass:

70 tonnes

## PERFORMANCE VALUES

---

### VIN 1 / CHASSI

no::

XXXXXXXXXXXXXXXXXXXX

### VIN 2 / CHASSI

no::

XXXXXXXXXXXXXXXXXXXX

#### Part No - VBG DB

75V-2

D - 200 kN

Dc - 130 kN

V - 75 kN

#### Part No - VBG 795V-2

PA

D - 290 kN

Dc - 145 kN

V - 95 kN

#### Part No - DBE 190

D - 290 kN

Dc - 145 kN

V - 95 kN

Reviewed by

Clarification of name

Place and date

### VBG Group Truck Equipment AB

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## Appendix 4 – Performance calculation according to UNECE R55

Excerpt from UNECE R55 Supplement 7 to the 01 series of amendments

### 3. Calculation formulae applicable to Multi-vehicle combinations

#### 3.1. Combination 1:

Description: Rigid truck + Dolly + Semitrailer

Masses [tonnes]:

$M_1$  = total axle load of rigid truck as coupled

$M_2$  = total axle load of dolly and semitrailer as coupled

$M_3$  = total axle load of dolly as coupled

$M_4$  = total axle load of rigid truck as coupled plus tare weight of dolly

$M_5$  = support load at king-pin of semitrailer

$M_6$  =  $M_5$  + total axle load of semitrailer as coupled

Total combination mass =  $M_1 + M_2$

Towable mass of the rigid truck:  $M_2$

Towable mass of the dolly:  $M_6$

Dimensions:

$L$  = distance from drawbar eye to centre of dolly axle group [m]

Coupling capability requirement:

Clevis coupling:  $D = g \frac{M_1 * M_2}{M_1 + M_2} + V = \text{Max}(\frac{54}{L}; 5 \frac{M_3}{L})^\dagger$

Fifth wheel:  $D = 0.5g \frac{M_4(M_6 + 0.08M_4)}{M_4 + M_6 - M_5}$

---

<sup>†</sup> Dolly with rigid drawbar:

This calculated D-value requirement shall be lower than the certified D<sub>C</sub>-value performance of coupling equipment used.

Dolly with hinged drawbar:

This calculated D-value requirement shall be lower than the certified D-value performance of coupling equipment used. With a hinged drawbar there is no V-value requirement.

## Bilaga 5 - Referenser

### **TSFS 2019:127**

[https://www.transportstyrelsen.se/TSFS/TSFS%202019\\_127.pdf](https://www.transportstyrelsen.se/TSFS/TSFS%202019_127.pdf)

### **UNECE R55 Supplement 7 to the 01 series of amendments**

<https://unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2018/R055r2am3e.pdf>

### **VBG PVC**

<https://www.vbg.eu/sv/berakning/>

### **Finnish example for calculation and Trade-off assessment**

Kaavojen laskuri 4.0

<https://www.traficom.fi/sites/default/files/media/file/HCT-m%C3%A4%C3%A4r%C3%A4ys%20laskuri%204.0.xlsx>

<https://www.traficom.fi/fi/saadokset/ajoneuvoyhdistelmien-tekniset-vaatimukset>