

BMW Group

OFFICE OF DEFECTS & INVESTIGATIONS

September 24, 2010

2010 SEP 28 A 9:46

Scott Yon
Chief, Vehicle Integrity Division
Office of Defects Investigation
National Highway Traffic Safety Administration
1200 New Jersey Ave., S.E.
Washington, DC 20590

Re: PE10-020 (Questions 8 - 12)

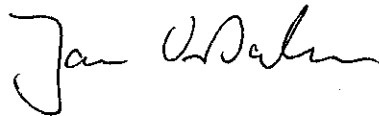
Dear Mr. Yon:

With this letter, BMW is responding to NHTSA's Information Request dated July 7, 2010 in the above captioned matter. As agreed, we would be submitting our response to Questions 8 through 12 by approximately September 16th. This letter, and the attachment (CD No. 1b), provides such information. As requested, BMW has repeated each question verbatim and provided our response accordingly. Our detailed responses are contained in the attachments.

Because a portion of our response to Questions 8 through 12, specifically CD No. 2, is considered by BMW to be confidential, it is not being submitted to your office. Rather, as instructed, CD No. 2 is being submitted to the Office of Chief Counsel, along with information supporting our request for confidentiality. We are attaching to this letter the non-confidential portion of our response.

Should you have any questions pertaining to the information enclosed with this letter, please contact me at (201) 571-5360, or Martin Rapaport of my staff at (201) 571-5208.

Sincerely,



Jan Urbahn
General Manager
Safety Engineering & Intelligent Transportation Systems

Attachment
CD No. 1b

Cc:

S. Wood, NHTSA (Office of Chief Counsel)

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BMW of North America, LLC

BMW Group Company

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**BMW Response
to
NHTSA PE10-020
(Questions 8 – 12)
24 Sep 2010**

- 8. Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions") that relate to, or may relate to, the alleged defect in the subject vehicles that have been conducted, are being conducted, are planned, or are being planned by, or for, BMW. For each such action, provide the following information:**

- a. Action title or identifier;**
- b. The actual or planned start date;**
- c. The actual or expected end date;**
- d. Brief summary of the subject and objective of the action;**
- e. Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and**
- f. Brief summary of the findings and/or conclusions resulting from the action.**

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action. If an action is not complete, provide a detailed schedule for the work to be done, tentative findings and/or conclusions, and provide an update within 10 days of completion of the action.

Response:

The source of this information is our various technical development departments at BMW AG and is current as of 8 Sep 2010.

Attachment "CONF-TA-1.pdf" in folder "Q8" on CD No. 2 provides a summary of the "actions" and provides the information requested in Questions 8(a) through 8(f).

All of the attachments contained within sub-folder "TA-2" in folder "Q8" on CD No. 2 consist of the pertinent test and analyses documentation, and account for the "actions" conducted.

- 9. Describe all modifications or changes made by, or on behalf of, BMW in the design, material composition, manufacture, quality control, supply, or installation of any component in the subject system, from the start of production to date, which relate to, or may relate to, the alleged defect in the subject vehicles and MY 2006 BMW Z4 vehicles. For each such modification or change, provide the following information:**

- a. The date or approximate date on which the modification or change was incorporated into vehicle production;**
- b. A detailed description of the modification or change;**
- c. The reason(s) for the modification or change;**
- d. The part numbers (service and engineering) of the original component;**
- e. The part number (service and engineering) of the modified component;**
- f. Whether the original unmodified component was withdrawn from production and/or sale, and if so, when;**
- g. When the modified component was made available as a service component; and**
- h. Whether the modified component can be interchanged with earlier production components.**

Also, provide the above information for any modification or change that BMW is aware of which may be incorporated into vehicle production within the next 120 days.

**BMW Response
to
NHTSA PE10-020
(Questions 8 – 12)
24 Sep 2010**

Response:

The source of this information is our various technical development departments at BMW AG and is current as of 30 Aug 2010.

Outlined below are the three modifications to the subject system that were implemented in order to resolve the issue.

Modification #1: Reduction of friction in steering system during parts assembly.

- a) Available as a service part only mid-Jun 2005.
- b) Parts assembled with lower friction in steering system due to adjustment / spacing between worm gear and worm gear shaft; parts were phased into service usage.
- c) Reduction of friction during high ambient temperatures.
- d) Previous service part number 6 766 491/490 (transmission – automatic/manual).
- e) New service part number 6 772 421/420 (transmission – automatic/manual).
- f) New part only available as a service part.
- g) New part available in service mid-Jun 2005.
- h) Parts are compatible.

Modification #2: New machining of the worm gear shaft.

- a) Available in production 5 July 2006.
- b) Worm gear shaft milled with hard metal (e.g., carbide) cutting tools.
- c) Reduction of friction during high ambient temperatures via smoother surface of the worm gear.
- d) Previous part number 6 773 614/612 (transmission – automatic/manual).
- e) New part number 6 777 328/327 (transmission – automatic/manual).
- f) Previous parts replaced by new parts in production, and in service, 5 July 2006.
- g) New part available in service 5 July 2006.
- h) Parts are compatible.

Modification #3: New lubrication for the worm gear.

- a) Available in production 5 July 2006.

**BMW Response
to
NHTSA PE10-020
(Questions 8 – 12)
24 Sep 2010**

- b) Change of lubricant from Klueber LR44-21 to Kyodo Yushi Multemp SC-U.
- c) Reduction of friction during high ambient temperatures.
- d) Previous part number 6 773 614/612 (transmission – automatic/manual).
- e) New part number 6 777 328/327 (transmission – automatic/manual).
- f) Previous parts replaced by new parts in production, and in service, 5 July 2006.
- g) New part available in service 5 July 2006.
- h) Parts are compatible.

* * *

BMW does not plan on any modification or change to the subject components that will be incorporated into vehicle production within the next 120 days.

10. Describe the design, operation, failure modes, and diagnostics of the EPS systems in the subject vehicles, including:

- a. A list and description of each system component;
- b. Drawings and diagrams of the system and its components;
- c. Copies of all Failure Mode and Effects Analyses (FMEA) related to the subject system;
- d. A list and description of all system diagnostic fault codes related to the subject system, including the effects of the faults on vehicle operation;
- e. Steering effort/force required during normal system operation and after a system failure (describe each failure mode/condition and include failures that are not associated with a system fault); and
- f. Any similarities or differences in the EPS system design and operation between the subject vehicles and MY 2006-2008 BMW Z4 vehicles.

Response:

The source of this information is our various technical development departments at BMW AG and is current as of 30 Aug 2010.

Question 10(a):

Refer to Attachment "Produktbeschreibung 08 2010.pdf" in folder "Q10" on CD No. 1b.

Question 10(b):

Refer to Attachment "CONF-Lenksäule_E85.pdf" in folder "Q10" on CD No. 2.

**BMW Response
to
NHTSA PE10-020
(Questions 8 – 12)
24 Sep 2010**

Question 10(c):

The information is considered by our supplier to be proprietary and confidential. Accordingly, BMW has only insight to the FMEA and reviews them together with the supplier, but is not in possession of such documents; however, we would offer to give insight to the documents to NHTSA's Office of Chief Counsel upon request.

Question 10(d):

Refer to Attachment "CONF-EPS Fehlermatrix_EN.xls" in folder "Q10" on CD No. 2.

There is a diagnostic function within the electric power steering system to prevent it from overheating. A sensor measures the temperature in the system's control unit. Up to a maximum of 85 degrees Celsius, the electric power steering system remains fully functional. Between 85 degrees Celsius (power steering fully functional) and 95 degrees Celsius (power assistance off), functionality decreases linearly. If this happens, a warning lamp is illuminated in the instrument cluster, and a fault code is stored in the system.

Importantly, for the issue that is the subject of this information request, a fault code was rarely registered in a customer vehicle. Therefore, customer vehicles rarely experience temperatures near 85 degrees Celsius. Accordingly, testing of vehicles at 80 degrees Celsius, for the issue that is the subject of this information request, is appropriate, i.e., "worst-case".

Question 10(e):

System Fault

Refer to Attachment "E85 Typzulassung durch KBA pages6-9 english.pdf" in folder "Q10" on CD No. 1b which contains the relevant test results of the steering system for the subject vehicle pursuant to the European type approval requirements.

Refer to Attachment "70_311_EEC+2004-09-24.pdf" in folder "Q10" on CD No. 1b which contains the European type approval requirements pertaining to the steering system of the subject vehicle.

Notably, the steering effort required, when the vehicle is tested without power assisted steering (which could occur if the system experienced a fault condition), is far below the maximum steering effort permitted pursuant to the European type approval regulations. Therefore, even in a situation involving complete loss of power assisted steering (system fault), the operator should only experience a minor increase in effort in steering the vehicle.

We are including these test results because there are no corresponding NHTSA requirements.

Specific Issue is Not Associated with System Fault

As noted within the documentation provided in response to Question 8, the issue that is the subject of this information request is not associated with a system fault. In other words, even if the issue occurs, the electric power steering system remains fully functional, and the system does not register a fault code.

Notably, if the issue occurs, then as noted in the documentation, the steering effort required may increase up to a maximum of approximately 5 Nm. This is a minor increase, and is a level of effort

**BMW Response
to
NHTSA PE10-020
(Questions 8-12)
24 Sep 2010**

that is also within the range of torque that is experienced during parking (i.e., low speed) maneuvers. In other words, the effort level is within the "normal range".

Question 10(f):

The modifications to the subject system described in response to Question 9 have also been incorporated into the MY2006-08 BMW Z4 vehicles.

- 11. State the number of the subject systems and its components that BMW has sold that may be used in the subject vehicles by part number (both service and engineering/production) and month/year of sale (including the cut-off date for sales, if applicable). Include any kits that have been released, or developed, by BMW for use in service repairs to the subject system which relate, or may relate, to the alleged defect in the subject vehicles.**

For each component/system part number, provide the supplier's name, address, and appropriate point of contact (name, title, and telephone number). Also, identify by model and model year, any other vehicles of which BMW is aware that contain the identical component/system, whether installed in production or in service, and state the applicable dates of production or service usage.

Response:

The source of this information is our BMW AG parts database and is current as of 31 July 2010.

We believe that parts sales data has limited analytical value regarding its use in assessing the performance of the subject components because this data does not contain information pertaining to the reason for the sale of a particular part. Therefore, it is not possible from parts sales information to determine the number of these parts that have been installed in the subject vehicles for the purpose of repairing a vehicle in which the alleged issue is occurring.

Parts sales are depicted as totals per calendar year, and are irrespective of vehicle model year. Parts sales by vehicle model year are not available. These parts are only used in the subject vehicles. Specifically, it represents the number of parts distributed from BMW AG to BMW NA. The information is depicted in Table 1.

Calendar Year	Part Number (Automatic / Manual Transmission)	Parts Sold (Automatic / Manual Transmission)
2003	6762587 / 6762585	77 / 44
2004	6762587 / 6762585	5 / 0
2005	6762587 / 6762585	0 / 8
2005	6772421 / 6772420	102 / 105
2006	6772421 / 6772420	122 / 120
2007	6772421 / 6772420	5 / 6
2008	6772421 / 6772420	0 / 1
2006	6777328 / 6777327	183 / 80
2007	6777328 / 6777327	197 / 94
2008	6777328 / 6777327	14 / 1
2009	6777328 / 6777327	0 / 0

**BMW Response
to
NHTSA PE10-020
(Questions 8 - 12)
24 Sep 2010**

2010	6777328 / 6777327	0 / 0
2007	6780729 / 6780728	336 / 265
2008	6780729 / 6780728	420 / 272
2009	6780729 / 6780728	344 / 170
2010	6780729 / 6780728	110 / 46

Table 1.

The supplier information is as follows:

ZF Lenksysteme GmbH
Richard-Bullinger-Straße 77
D-73527 Schwäbisch Gmünd
Norbert Schwarz / HQ
Phone: 49-7171-31-2541

12. Furnish BMW's assessment of the alleged defect in the subject vehicles, including:

- a. The causal or contributory factor(s);
- b. The failure mechanism(s);
- c. The failure mode(s);
- d. The risk to motor vehicle safety that it poses;
- e. What warnings, if any, the operator would have that the alleged defect was occurring or subject system was malfunctioning; and
- f. The reports included with this inquiry.

Response:

Question 12(a), (b), (c):

During conditions of sustained high ambient temperatures, combined with long periods of intense sunlight, the electric power steering system may experience an increase in internal temperature. In these rare conditions, the worm gear within the electric power steering system can expand. If the worm gear expands sufficiently, this may increase the friction within the system. As a result, in these conditions, the driver can experience an increase in steering effort. However, as noted within the documentation provided, the increase in steering effort is minor. Furthermore, there is not a loss of electric power steering assist. The electric power steering system remains functional.

Question 12(d):

We believe that the issue that is the subject of this information request does not represent an unreasonable risk to safety; rather, it is a quality/comfort issue for the reasons set forth below:

The Steering Effort Increase is Minor

The documentation we have provided in response to Question 8 indicates that, during specific environmental conditions, the steering effort may increase up to a **maximum** of approximately 5 Nm. This is a minor increase. Furthermore, this level of effort is also within the range of torque that is experienced during parking (i.e., low speed) maneuvers. In other words, the effort level is within the "normal range".

**BMW Response
to
NHTSA PE10-020
(Questions 8 - 12)
24 Sep 2010**

The Effect Occurs During Specific/Limited Environmental Conditions

This issue occurs during conditions of sustained high ambient temperatures combined with long periods of intense sunlight. In these conditions, the worm gear within the electric power steering system may expand. If the worm gear expands sufficiently, this may increase the friction within the system. As a result, in these specific conditions, the driver can experience a minor increase in steering effort. However, after ambient temperatures decrease, the effect disappears completely.

The Electric Power Steering System Remains Functional

If the issue occurs, there is not a loss of electric power steering assist. The electric power steering system remains fully functional. Therefore, although an issue with the torque may be occurring, the overall system functionality continues to be available as needed for power steering assistance.

The Effect Does Not Occur Suddenly

The increase in steering effort is ambient temperature related and may occur either gradually as the temperatures increase, or after a parked hot soak, the increased steering effort may be noticed immediately when driving off. It is important to note that any increased steering effort does not appear suddenly, that is, the driver is not surprised by a sudden and unexpected increase in steering effort compared to previous steering inputs. Therefore, the driver is able to adapt to the change in steering behavior. Although drivers may notice the increased steering effort from a comfort perspective, the driver's ability to quickly steer is not suddenly compromised.

The Steering Effort Without Power Assist Satisfies European Regulations

As noted in response to Question 10(e), and the associated documentation, European regulations require that vehicles be subject to specific requirements under conditions in which there is a failure of the power assisted steering system.

Documentation provided in response to Question 10(e) illustrates that the steering effort required, when the vehicle is tested without power assisted steering, is far below the maximum steering effort permitted pursuant to the European type approval regulations. Therefore, even in a situation involving complete loss of power assisted steering, the operator may only experience a minor increase in effort in steering the vehicle.

In fact, the issue that is the subject of this information request is not associated with a system fault. Even if this issue occurs, the electric power steering system remains fully functional; there is no loss of power steering assistance. There may be only a minor increase in steering effort.

The Effect is Temporary

Because the issue only occurs during specific/limited environmental conditions, i.e., in conditions of sustained high ambient temperatures combined with long periods of intense sunlight, the effect is temporary. In other words, it will no longer be prevalent when ambient temperatures decrease.

The Effect is Characterized as "Not-Safety-Related"

As noted in the documentation, a system from a customer car was specifically tested. It was heated to approximately 80-deg. Celsius within a BMW test vehicle and driven at highway speeds.

**BMW Response
to
NHTSA PE10-020
(Questions 8 - 12)
24 Sep 2010**

As noted, as vehicle speed increases, electric power steering assist, as designed, decreases. In these conditions, the effect was assessed as "not-safety-related". Rather, it was reported that the issue was one of quality/comfort.

Question 12(e):

The increase in steering effort is ambient temperature related and may occur either gradually as the temperatures increase, or after a parked hot soak, the increased steering effort may be noticed immediately when driving off. It is important to note that any increased steering effort does not appear suddenly, that is, the driver is not surprised by a sudden and unexpected increase in steering effort compared to previous steering inputs. Although drivers may notice the increased steering effort from a comfort perspective, the driver's ability to quickly steer is not suddenly compromised. Moreover, the issue will no longer exist once ambient temperatures decrease.

Question 12(f):

The reports (customer complaints) that NHTSA has provided describe similar environmental conditions which allow the issue to occur, i.e., high ambient temperatures combined with intense sunlight.

* * *

PE10-020

BMW

9-24-2010

ATTACHMENT

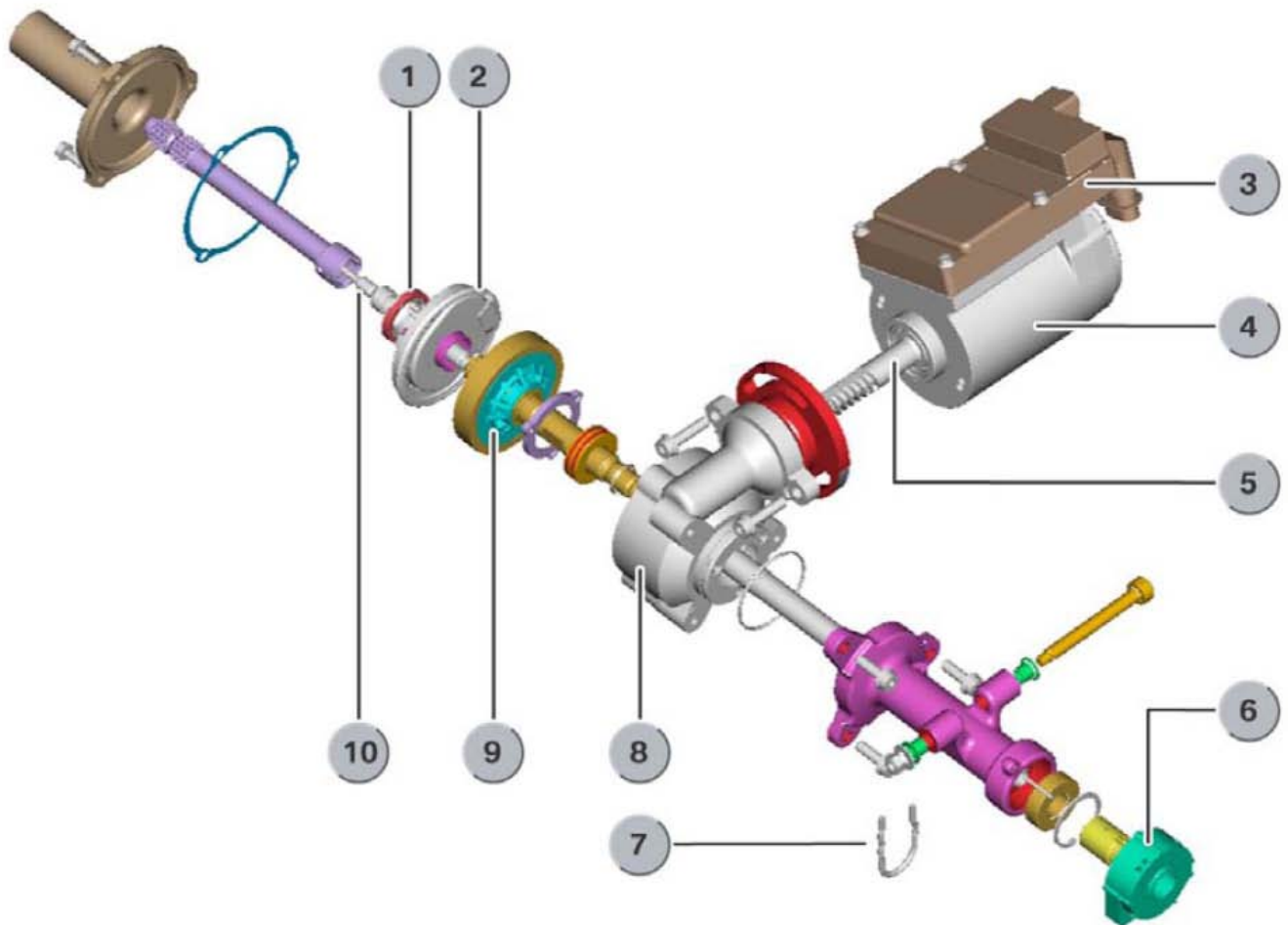
Produktbeschreibung 08 2010

E85 Electromechanic Power Steering System (EPS-System)

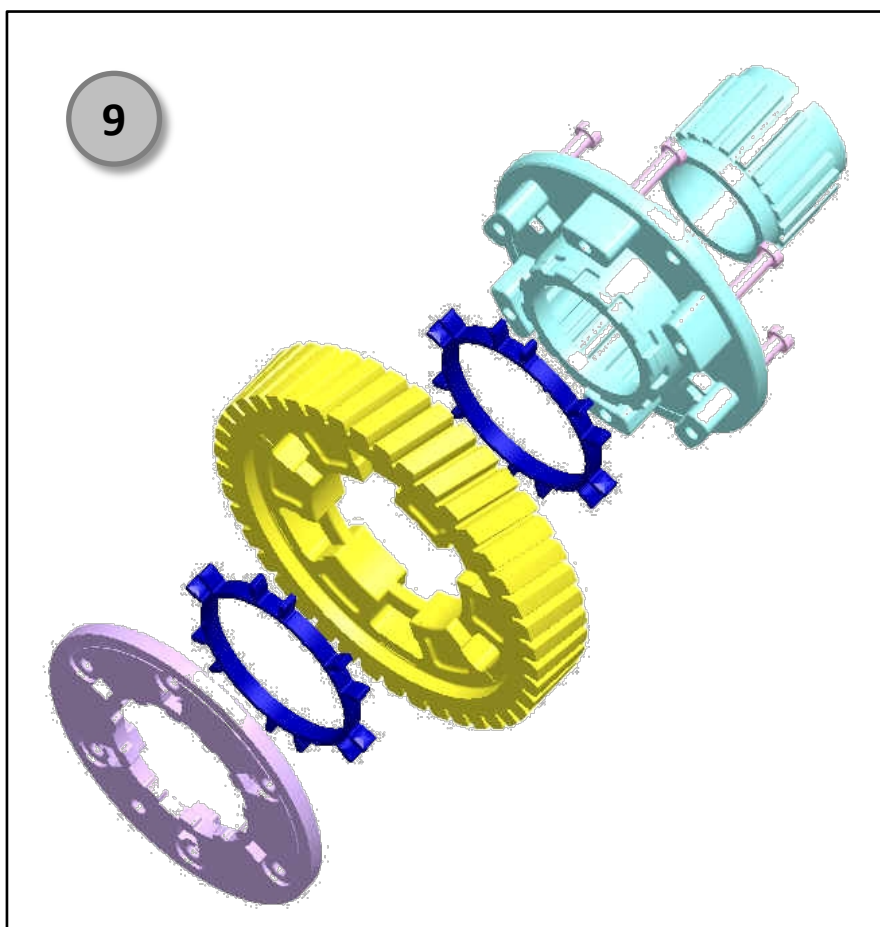
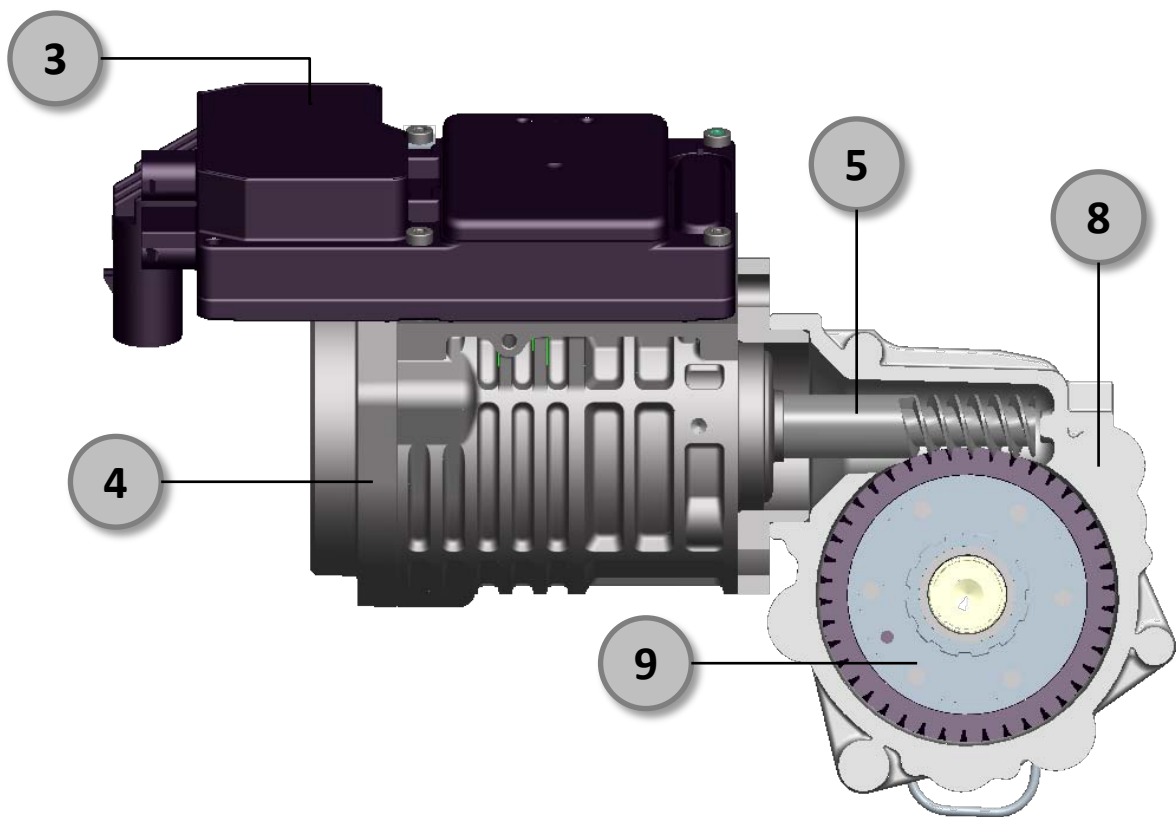
The assembly of the upper steering column can be divided into the mechanical section of the upper steering column and the electrical section: the servo unit.

The mechanical section of the upper steering column starts at the steering wheel and ends at the connection to the lower steering spindle. This mechanical section transmits the entire steering-torque effort to the lower steering spindle.

The electrical section assumes the functions of power assistance.



Index	Explanation	Index	Explanation
1	Magnet wheel	6	Steering-angle sensor
2	Steering-torque sensor with coil-spring cassette	7	Turning lock
3	EPS control unit	8	Housing for worm gear and steering-torque sensor
4	Servo-unit electric motor	9	Worm gear
5	Worm-gear shaft	10	Torsion bar



PE10-020

BMW

9-24-2010

ATTACHMENT

70_311_EEC+2004-09-24

Acknowledgement and Disclaimer:

The following consolidated text of the Directive) was edited by DaimlerChrysler AG.

As from 1999 the legal documents available online in the database EUR-Lex (<http://europa.eu.int/eur-lex>) are used to integrate amendments and corrections.

Only European Union legislation published in paper editions of the Official Journal of the European Communities is deemed authentic.

COUNCIL DIRECTIVE

of 8 June 1970

on the approximation of the laws of the Member States relating to the steering equipment
for motor vehicles and their trailers

(70/311/EEC)

(as last amended by 1999/7/EC)

Directive and Amendments

70/311/EEC	of 08.06.1970	OJ No. L133	of 18.06.1970
		OJ No. L196	of 03.09.1970
		OJ No. L73	of 27.03.1972
92/62/EEC	of 02.07.1992	OJ No. L199	of 18.07.1992
1999/7/EC	of 26.01.1999	OJ No. L40	of 13.02.1999

TABLE OF CONTENTS

TABLE OF CONTENTS	2
COUNCIL DIRECTIVE	3
TRANSITIONAL PROVISIONS OF COMMISSION DIRECTIVE 1999/7/EC.....	5
LIST OF ANNEXES.....	6
ANNEX I SCOPE, DEFINITIONS, APPLICATION FOR EC TYPE-APPROVAL, GRANTING OF EC TYPE-APPROVAL CONSTRUCTION PROVISIONS, TEST PROVISIONS, MODIFICATIONS OF THE TYPE AND AMENDMENTS TO APPROVALS, CONFORMITY OF PRODUCTION	7
Appendix 1 INFORMATION DOCUMENT No.	16
Appendix 2 MODEL EC TYPE-APPROVAL CERTIFICATE.....	19
ANNEX II BRAKING PERFORMANCE FOR VEHICLES USING THE SAME ENERGY SOURCE TO SUPPLY STEERING EQUIPMENT AND BRAKING DEVICE.....	21
ANNEX III ADDITIONAL PROVISIONS FOR VEHICLES EQUIPPED WITH ASE	22
ANNEX IV PROVISIONS FOR TRAILERS HAVING PURELY HYDRAULIC STEERING TRANSMISSIONS	24

COUNCIL DIRECTIVE

of 8 June 1970

on the approximation of the laws of the Member States relating to the steering equipment for motor vehicles and their trailers

(70/311/EEC)

(as last amended by 1999/7/EC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100 thereof;

Having regard to the proposal from the Commission;

Having regard to the Opinion of the European Parliament ⁽¹⁾;

Having regard to the Opinion of the Economic and Social Committee ⁽²⁾;

Whereas the technical requirements which motor vehicles must satisfy pursuant to national laws relate, *inter alia*, to their steering equipment;

Whereas those requirements differ from one Member State to another; whereas it is therefore necessary that all Member States adopt the same requirements either in addition to or in place of their existing rules, in order, in particular, to allow the EEC type approval procedure which was the subject of the Council Directive ⁽³⁾ of 6 February 1970 on the approximation of the laws of the Member States relating to the type approval of motor vehicles and their trailers to be applied in respect of each type of vehicle;

HAS ADOPTED THIS DIRECTIVE:

Article 1

For the purpose of this Directive, "vehicle" means any vehicle as defined in Article 2 of Directive 70/156/EEC.

Article 2

No Member State may refuse to grant EEC type approval or national type approval of a vehicle on grounds relating to its steering equipment if this equipment satisfies the requirements set out in the Annexes.

Article 2a

No Member State may refuse or prohibit the sale or registration, entry into service or use of a vehicle on grounds relating to its steering equipment if this equipment satisfies the requirements set out in the Annexes.

⁽¹⁾ OJ N° C , 18.12.1969, p. 7.

⁽²⁾ OJ N° C 10, 27.1.1970, p. 18.

⁽³⁾ OJ N° L 42, 23.2.1970, p. 1.

Article 3

The amendments necessary for adjusting the requirements of the Annexes so as to take account of technical progress shall be adopted in accordance with the procedure laid down in Article 13 of the Council Directive of 6 February 1970 on the type approval of motor vehicles and their trailers.

Article 4

1. Member States shall put into force the provisions containing the requirements needed in order to comply with this Directive within eighteen months of its notification and shall forthwith inform the Commission thereof.

2. Member States shall ensure that the text of the main provisions of national law which they adopt in the field covered by this Directive are communicated to the Commission.

Article 5

This Directive is addressed to the Member States.

Done at Brussels, 8 June 1970.

For the Council

The President

P. HARMEL

TRANSITIONAL PROVISIONS OF COMMISSION DIRECTIVE 1999/7/EC**Article 2**

1. With effect from 1 January 1999, Member States may not on grounds relating to the steering equipment:

- refuse, in respect of a type of vehicle, to grant EC type-approval or national type-approval, or
- prohibit the sale, registration, entry into service of vehicles

if the vehicles comply with the requirements of Directive 70/311/EEC as amended by this Directive.

2. With effect from 1 October 2000, Member States:

- shall no longer grant EC type-approval, and
- may refuse to grant national type-approval

for a new type of vehicle on grounds relating to the steering equipment if the requirements of Directive 70/311/EEC as amended by this Directive are not fulfilled.

3. With effect from 1 October 2001, Member States may refuse the registration, sale or entry into service of new vehicles of category M₂, M₃, N₂, or N₃ equipped with auxiliary steering equipment which does not comply with the provisions of Directive 70/311/EEC as amended by this Directive.

Article 3

1. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 30 June 1999 at the latest. They shall forthwith inform the Commission thereof.

When Member States adopt those provisions, they shall contain a reference to this Directive or shall be accompanied by such a reference on the occasion of their official publication. Member States shall determine how such reference is to be made.

2. Member States shall communicate to the Commission the text of the main provisions of national law which they adopt in the field governed by this Directive.

Article 4

This Directive shall enter into force on the third day following its publication in the Official Journal of the European Communities.

Article 5

This Directive is addressed to the Member States.

LIST OF ANNEXES

Annex I: Scope, definitions, application for EC type-approval, granting of EC type-approval construction provisions, test provisions, modifications of the type and amendments to approvals, conformity of production

Appendix 1: Information document

Appendix 2: Type-approval certificate

Annex II: Braking performance for vehicles using the same energy source for steering and braking

Annex III: Additional provisions for vehicles with auxiliary steering equipment (ASE)

Annex IV: Provisions for trailers having purely hydraulic steering transmissions

ANNEX I

SCOPE, DEFINITIONS, APPLICATION FOR EC TYPE-APPROVAL, GRANTING OF EC TYPE-APPROVAL CONSTRUCTION PROVISIONS, TEST PROVISIONS, MODIFICATIONS OF THE TYPE AND AMENDMENTS TO APPROVALS, CONFORMITY OF PRODUCTION

0. SCOPE

- 0.1. This Directive applies to the steering equipment of vehicles of categories M, N and O as defined in Annex IIA to Directive 70/156/EEC.
- 0.2. It does not cover steering equipment with a purely pneumatic, purely electric or purely hydraulic transmission except:
 - 0.2.1. auxiliary steering equipment (ASE) with a purely electric or a purely hydraulic transmission for vehicles of categories M and N;
 - 0.2.2. steering equipment with a purely hydraulic transmission for vehicles of category O.

1. DEFINITIONS

For the purposes of this Directive:

- 1.1. *Approval of a vehicle* means the approval of a vehicle type with regard to its steering equipment;
- 1.2. *Vehicle type* means a category of vehicle which does not differ with respect to the manufacturer's designation of the vehicle type and/or variations which can affect its steering;
- 1.3. *Steering equipment* means all the equipment the purpose of which is to determine the direction of movement of the vehicle.

The steering equipment consists of:

- the steering control,
 - the steering transmission,
 - the steered wheels,
 - the energy supply, if any;
- 1.3.1. *Steering control* means the part of the steering equipment which controls its operation, it may be operated with or without direct intervention of the driver. For steering equipment in which the steering forces are provided solely or partly by the muscular effort of the driver the steering control includes all parts up to the point where the steering effort is transformed by mechanical, hydraulic or electrical means;
 - 1.3.2. *Steering transmission* includes all parts of the steering equipment which are the means of transmitting the steering forces between the steering control and the steered wheels; it includes all parts down from the point where the steering control effort is transformed by mechanical, hydraulic or electrical means;

- 1.3.3. *Steered wheels* means the wheels the alignment of which may be altered directly or indirectly in relation to the longitudinal axis the vehicle in order to determine the direction of movement of the vehicle. (The steered wheels include the axis around which they are rotated in order to determine the direction of movement of the vehicle);
- 1.3.4. *Energy supply* includes those parts of the steering equipment which provide it with energy, control the energy and where appropriate, process and store it. It also includes any storage reservoirs for the operating medium and the return lines, but not the vehicle's engine (except for the purposes of item 4.1.3) or its drive to the energy source;
- 1.3.4.1. *Energy source* means that part of the energy supply which provides the energy in the required form e.g. hydraulic pump, air compressor;
- 1.3.4.2. *Energy reservoir* means that part of the energy supply in which the energy provided by the energy source is stored;
- 1.3.4.3. *Storage reservoir* means that part of the energy supply in which the operating medium is stored at or near to the atmospheric pressure.
- 1.4. Steering parameters
- 1.4.1. *Steering control effort* means the force applied to the steering control in order to steer the vehicle;
- 1.4.2. *Steering time* means the period of time from the beginning of the movement of the steering control to the moment at which the steered wheels have reached a specific steering angle;
- 1.4.3. *Steering angle* means the angle between the projection of a longitudinal axis of the vehicle and the line of intersection of the wheelplane (being the central plane of the tyre, normal to the spin axis of the wheel) and the road surface;
- 1.4.4. *Steering forces* mean all the forces operating in the steering transmission;
- 1.4.5. *Mean steering ratio* means the ratio of the angular displacement of the steering control to the mean of the swept steering angle of the steered wheels for a full lock-to-lock turn;
- 1.4.6. *Turning circle* means the circle within which are located the projections onto the ground plane of all the points of the vehicle, excluding the external mirrors and the front direction indicators, when the vehicle is driven in a circle;
- 1.4.7. *Nominal radius of steering control* means in the case of a steering wheel the shortest dimension from its centre of rotation to the outer edge of the rim. In the case of any other form of control, it means the distance between its centre of rotation and the point at which the steering effort is applied. If more than one such point is provided the one requiring the greatest effort shall be used.
- 1.5. Types of steering equipment
- Depending on the way the steering forces are produced, the following types of steering equipment are distinguished:
- 1.5.1. For motor vehicles
- 1.5.1.1. *Manual steering equipment* in which the steering forces result solely from the muscular effort of the driver;

- 1.5.1.2. *Power assisted steering equipment* in which the steering forces result from both the muscular effort of the driver and the energy supply (supplies);
 - 1.5.1.2.1. Steering equipment in which the steering forces result solely from one or more energy supplies when the equipment is intact, but in which the steering forces can be provided by the muscular effort of the driver alone if there is a fault in the steering (integrated power systems), is also considered to be power assisted steering equipment;
- 1.5.1.3. *Full-power steering equipment* in which the steering forces are provided solely by one or more energy supplies;
- 1.5.1.4. *Self-tracking equipment* is a system designed to create a change of steering angle on one or more wheels only when acted upon by forces and/or moments applied to the tyre to road contact.
- 1.5.2. For trailers
 - 1.5.2.1. *Self-tracking equipment*
see item 1.5.1.4 above.
 - 1.5.2.2. *Articulated steering equipment* in which the steering forces are produced by a change in direction of the towing vehicle and in which the movement of the steered trailer wheels is firmly linked to the relative angle between the longitudinal axis of the towing vehicle and that of the trailer;
 - 1.5.2.3. *Self-steering equipment* in which the steering forces are produced by a change in direction of the towing vehicle and in which the movement of the steered trailer wheels is firmly linked to the relative angle between the longitudinal axis of the trailer frame or a load replacing it and the longitudinal axis of the sub-frame to which the axle(s) is (are) attached.
- 1.5.3. Depending on the arrangement of the steered wheels, the following types of steering equipment are distinguished:
 - 1.5.3.1. *Front-wheel steering equipment* in which only the wheels of the front axle(s) are steered. This includes all wheels which are steered in the same direction;
 - 1.5.3.2. *Rear-wheel steering equipment* in which only the wheels of the rear axle(s) are steered. This includes all wheels which are steered in the same direction;
 - 1.5.3.3. *Multi-wheel steering equipment* in which the wheels of one or more of each of the front and the rear axle(s) are steered;
 - 1.5.3.3.1. *All-wheel steering equipment* in which all the wheels are steered;
 - 1.5.3.3.2. *Buckle steering equipment* in which the movement of chassis parts relative to each other is directly produced by the steering forces.
 - 1.5.3.4. *Auxiliary steering equipment (ASE)* in which the wheels of axle(s) of vehicles of categories M and N are steered in addition to the wheels providing principal steering input not purely electric, hydraulic or pneumatic, in the same direction or in the opposite direction to the wheels providing principal steering input, and/or the steering angle of the front, centre and/or the rear wheels may be adjusted relative to vehicle behaviour.

1.6. Types of steering transmission

Depending on the way the steering forces are transmitted, the following types of steering transmission are distinguished:

1.6.1. *Purely mechanical steering transmission* means a steering transmission in which the steering forces are transmitted entirely by mechanical means;

1.6.2. *Purely hydraulic steering transmission* means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only by hydraulic means;

1.6.3. *Purely electric steering transmission* means a steering transmission in which the steering forces, somewhere in the transmission, are transmitted only through electric means;

1.6.4. *Hybrid steering transmission* means a transmission in which part of the steering forces are transmitted through one and the other part through another of the above-mentioned means;

1.6.4.1. *Hybrid mechanical steering transmission* means a steering transmission where a part of the steering forces is transmitted by purely mechanical means and the other parts either by:

1.6.4.1.1. hydraulic or mechanical/hydraulic

or

1.6.4.1.2. electric or mechanical/electric

or

1.6.4.1.3. pneumatic or mechanical/pneumatic means.

In either case, where the mechanical part of the transmission is designed only to give position feedback and is too weak to transmit the total sum of the steering forces, this system shall be considered to be purely hydraulic, respectively purely electric, or purely pneumatic steering transmission;

1.6.4.2. *Other hybrid steering transmission* means any other combination of the above-mentioned steering transmissions.

2. APPLICATION FOR EEC TYPE-APPROVAL

2.1. The application for EC type-approval pursuant to Article 3(4) of Directive 70/156/EEC of a vehicle type with regard to its steering equipment shall be submitted by the manufacturer.

2.2. A model for the information document is given in Appendix 1.

2.3. A vehicle representative of the vehicle type to be approved shall be submitted to the technical service responsible for conducting approval tests.

3. GRANTING OF EC TYPE-APPROVAL OF A VEHICLE TYPE

- 3.1. If the relevant requirements are satisfied, EC type-approval pursuant to Article 4(3) and, if applicable, 4(4) of Directive 70/156/EEC shall be granted.
- 3.2. A model for the EC type-approval certificate is given in Appendix 2.
- 3.3. A type-approval number in accordance with Annex VII to Directive 70/156/EEC shall be assigned to each type of vehicle approved. The same Member State shall not assign the same number to another type of vehicle

4. CONSTRUCTION PROVISIONS

4.1. General provisions

- 4.1.1. The steering equipment shall ensure easy and safe handling of the vehicle up to its maximum design speed or, in the case of a trailer, up to its technically permitted maximum speed. There must be a tendency to with centre when tested in accordance with item 5. The vehicle shall meet the requirements of item 5.2 in the case of motor vehicles and of item 5.3 in the case of trailers.

If a vehicle is fitted with ASE, it shall also meet the requirements of Annex III. Trailers equipped with purely hydraulic steering transmissions shall also comply with Annex IV.

- 4.1.1.1. It must be possible to travel along a straight section of the road without unusual steering correction by the driver and without unusual vibration in the steering system at a maximum engine speed of the vehicle.
- 4.1.1.2. There must be travel synchronization between the steering control and the steered wheels, except for the wheels steered by ASE.
- 4.1.1.3. There must be time synchronization between the steering control and the steered wheels except for the wheels steered by ASE.
- 4.1.2. The steering equipment shall be designed, constructed and fitted in such a way that it is capable of withstanding the stresses arising during normal operation of the vehicle, or combination of vehicles. The maximum steering angle shall not be limited by any part of steering transmission unless specifically designed for this purpose.
- 4.1.2.1. Unless otherwise specified, it will be assumed that for the purposes of this Directive, not more than one failure can occur in the steering equipment at any one time and two axles on one bogie shall be considered as one axle.
- 4.1.3. Should the engine stop or a part of the steering equipment fail, with the exception of those parts listed in item 4.1.4, the steering equipment shall always meet the requirements of item 5.2.6 in the case of motor vehicles and of item 5.3 in the case of trailers.
- 4.1.4. For the purposes of this Directive the steered wheels, the steering control and all mechanical parts of the steering transmission shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit safety features at least equal to those prescribed for other essential components (such as the braking system) of the vehicle. Where the failure of any such part would be likely to result in loss of control of the vehicle, that part must be made of metal or of a material with equivalent characteristics and must not be subject to significant distortion in normal operation of the steering system.

- 4.1.5. Any failure in transmission other than purely mechanical shall clearly be brought to the attention of the vehicle driver; in the case of a motor vehicle, an increase in steering effort is considered to be a warning signal; in the case of a trailer, a mechanical indicator is permitted. When a failure occurs, a change in the average steering ratio is permissible if the steering effort given in item 5.2.6 below is not exceeded.
- 4.2. Special provisions
- 4.2.1. Steering control
- 4.2.1.1. If the steering control is directly handled by the driver,
- 4.2.1.1.1. it must be manageable;
- 4.2.1.1.2. the direction of operation of the steering control must correspond to the intended change in direction of the vehicle;
- 4.2.1.1.3. except for ASE, there must be a continuous and monotonic relation between the steering control angle and the steering angle.
- 4.2.2. Steering transmission
- 4.2.2.1. Adjustment devices for steering geometry must be such that after adjustment a positive connection can be established between the adjustable components by appropriate locking devices.
- 4.2.2.2. Steering transmission which can be disconnected to cover different configurations of a vehicle (e.g. on extendible trailers), must have locking devices which ensure positive relocation of components; where locking is automatic, there must be an additional safety lock which is operated manually.
- 4.2.3. Steered wheels
- 4.2.3.1. The steered wheels shall not be solely the rear wheels. This requirement does not apply to semi-trailers.
- 4.2.3.2. Trailers (with the exception of semi-trailers) which have more than one axle with steered wheels and semi-trailers which have at least one axle with steered wheels must fulfil the conditions given in item 5.3 below. However, for trailers with self-tracking equipment a test under item 5.3 is not necessary if the axle load ratio between the unsteered and the self-tracking axles equals or exceeds 1,6 under all loading conditions.
- 4.2.4. Energy supply
- 4.2.4.1. The same energy source may be used to supply the steering equipment and the braking device. However, in the case of a failure of either the energy supply or a failure in one of the two systems the following conditions must be fulfilled:
- 4.2.4.1.1. The steering equipment shall meet the requirements of item 5.2.6.
- 4.2.4.1.2. If an energy source failure occurs, the braking performance shall not drop below the prescribed service brake performance, as given in Annex II ⁽¹⁾, on the first brake application.

⁽¹⁾ The requirements set out in Annex II may also be checked during approval tests according to Directive 71/320/EEC.

- 4.2.4.1.3. If an energy supply failure occurs, the braking performance must comply with the prescriptions of Annex III ⁽¹⁾.
- 4.2.4.1.4. If the fluid in the storage reservoir drops to a level liable to cause an increase in steering or braking effort an acoustic or optical warning must be given to the driver. This warning may be combined with a device provided to warn of brake failure; the satisfactory condition of the signal must be easily verifiable by the driver.
- 4.2.4.2. The same energy source may be used to supply the steering equipment and systems other than the braking device if, when the fluid level in the storage reservoir drops to a level liable to cause an increase in steering effort, an acoustic or optical warning is given to the driver; the satisfactory condition of the signal must be easily verifiable by the driver.
- 4.2.4.3. The warning devices must be directly and permanently connected to the circuit. When the engine is running under normal operating conditions and there are no faults in the steering equipment, the alarm device must give no signal except during the time required for charging the energy reservoir(s) after start-up of the engine.

5. TEST PROVISIONS

5.1. General provisions

- 5.1.1. The test shall be conducted on a level surface affording good adhesion.
- 5.1.2. During the test(s), the vehicle shall be loaded to its technically permissible maximum mass and its maximum technically permissible load on the steered axle(s). In the case of axles fitted with ASE, this test shall be repeated with the vehicle loaded to its technically permissible maximum mass and the axle equipped with ASE loaded to its maximum permissible load.
- 5.1.3. Before the test begins, the tyre pressures shall be as prescribed by the manufacturer for the load specified in item 5.1.2 when the vehicle is stationary.

5.2. Provisions for motor vehicles

- 5.2.1. It must be possible to leave a curve with a radius of 50 m at a tangent without unusual vibration in the steering equipment at the following speed:
- category M₁ vehicles: 50 km/h,
 - categories M₂, M₃, N₁, N₂ and N₃ vehicles: 40 km/h
- or the maximum design speed if this is below the speeds given above.
- 5.2.2. The requirements of items 4.1.1.1, 4.1.1.2 and 5.2.1 shall also be satisfied with a failure in the steering equipment.
- 5.2.3. When the vehicle is driven in a circle with its steered wheels at approximately half lock and at a constant speed of at least 10 km/h, the turning circle must remain the same or become larger if the steering control is released.
- 5.2.4. During the measurement of the control effort, forces with a duration of less than 0,2 seconds shall not be taken into account.
- 5.2.5. The measurement of steering efforts on motor vehicles with intact steering equipment

- 5.2.5.1. The vehicle shall be driven from straight ahead into a spiral at a speed of 10 km/h. The steering effort shall be measured at the nominal radius of the steering control until the position of the steering control corresponds to turning radius given in the table below for the particular category of vehicle with intact steering. One steering movement shall be made to the right and one to the left.
- 5.2.5.2. The maximum permitted steering time and the maximum permitted steering control effort with intact steering equipment are given in the table below for each category of vehicle.
- 5.2.6. The measurement of steering efforts on motor vehicles with a failure in the steering equipment
- 5.2.6.1. The test described in item 5.2.5 shall be repeated with a failure in the steering equipment. The steering effort shall be measured until the position of the steering control corresponds to the turning radius given in the table below for the particular category of vehicle with a failure in the steering equipment.
- 5.2.6.2. The maximum permitted steering time and the maximum permitted steering control effort with a failure in the steering equipment are given in the table below for each category of vehicle.

Steering control effort requirements

Vehicle category	Intact			With a failure		
	Maximum effort(daN)	Time(s)	Turning radius (m)	Maximum effort (daN)	Time (s)	Turning radius(m)
M ₁	15	4	12	30	4	20
M ₂	15	4	12	30	4	20
M ₃	20	4	12 ⁽¹⁾	45	6	20
N ₁	20	4	12	30	4	20
N ₂	25	4	12	40	4	20
N ₃	20	4	12 ⁽¹⁾	45 ⁽²⁾	6	20
⁽¹⁾ Or full lock if 12 is not attainable.						
⁽²⁾ 50 for rigid vehicles with two or more steered axles excluding self-tracking equipment						

5.3. Provisions for trailers

- 5.3.1. The trailer must travel without excessive deviation or unusual vibration in its steering equipment when the towing vehicle is travelling in a straight line on a flat and horizontal road at a speed of 80 km/h or the technically permissible maximum speed indicated by the trailer manufacturer if this is less than 80 km/h.
- 5.3.2. With the towing vehicle and trailer having adopted a steady state turn so that the front outside edge of the towing vehicle is turning alongside a circle of radius 25 m in accordance with item 1.4.6, at a constant speed of 5 km/h, the circle described by the rearmost outer edge of the trailer shall be measured. This manoeuvre shall be repeated under the same conditions but a speed of 25 km/h $\pm$ 1 km/h. During these manoeuvres, the rearmost outer edge of the trailer travelling at a speed of 25 km/h $\pm$ 1 km/h shall not move outside the circle described at a constant speed of 5 km/h by more than 0,7 m.

- 5.3.3. No part of the trailer must move more than 0,5 m beyond the tangent to a circle with a radius of 25 m when towed by a vehicle leaving the circular path described in item 5.3.2 along the tangent and travelling at a speed of 25 km/h. This requirement must be met from the point the tangent meets the circle to a point 40 m along the tangent. After that point, the trailer must fulfil the condition specified in item 5.3.1.
- 5.3.4. The tests described in items 5.3.2 and 5.3.3 shall be conducted with one steering movement to the left and one to the right.

6. MODIFICATIONS OF THE TYPE AND AMENDMENTS TO APPROVALS

- 6.1. In the case of modifications of the type approved pursuant to this Directive, the provisions of Article 5 of Directive 70/156/EEC shall apply.

7. CONFORMITY OF PRODUCTION

- 7.1. Measures to ensure the conformity of production shall be taken in accordance with the provisions laid down in Article 10 of Directive 70/156/EEC.

Appendix 1**INFORMATION DOCUMENT No. ...^(*)**

pursuant to Annex I to Council Directive 70/156/EEC relating to EC type-approval
of a vehicle with respect to the steering equipment

(Directive 70/311/EEC, as last amended by Directive ... / ... /EC)

The following information, if applicable, must be supplied in triplicate and include a list of contents. Any drawings must be supplied in appropriate scale and in sufficient detail on size A4 or folder of A4 format. Photographs, if any, must show sufficient detail.

If the systems, components or separate technical units have electronic controls, information concerning their performance must be supplied.

0. GENERAL

- 0.1. Make (trade name of manufacturer):
- 0.2. Type:
- 0.3. Means of identification of type, if marked on the vehicle ^(b):
- 0.3.1. Location of that marking:
- 0.4. Category of vehicle ^(c):
- 0.5. Name and address of manufacturer:
- 0.8. Address(es) of assembly plant(s):

1. GENERAL CONSTRUCTION CHARACTERISTICS OF THE VEHICLE

- 1.1. Photographs and/or drawings of a representative vehicle:
- 1.3. Number of axles and wheels:
- 1.3.1. Number and position of axles with double wheels:
- 1.3.2. Number and position of steered axles:
- 1.3.3. Powered axles (number, position, interconnection):
- 1.8. Hand of drive: left/right ⁽¹⁾

**2. MASSES AND DIMENSIONS ^(e) (in kg and mm)
(Refer to drawing where applicable)**

- 2.1. Wheel base(s) (fully loaded) ^(f):

^(*) The item numbers and footnotes used in this Information Document correspond to those set out in Annex I to Directive 70/156/EEC. Items not relevant for the purpose of this Directive are omitted.

- 2.3.1. Track of each steered axle ⁽ⁱ⁾:
- 2.4. Range of vehicle dimensions (overall)
- 2.4.1. For chassis without bodywork:
- 2.4.1.1. Length ^(j):
- 2.4.1.2. Width ^(k):
- 2.4.1.4. Front overhang ^(m):
- 2.4.1.5. Rear overhang ⁽ⁿ⁾:
- 2.4.2. For chassis with bodywork:
- 2.4.2.1. Length ^(j):
- 2.4.2.2. Width ^(k):
- 2.4.2.4. Front overhang ^(m):
- 2.4.2.5. Rear overhang ⁽ⁿ⁾:
- 2.8. Technically permissible maximum laden mass stated by the manufacturer ^(y) (maximum and minimum):
- 2.9. Technically permissible maximum load/mass on each axle:
6. SUSPENSION
- 6.6. Tyres and wheels
- 6.6.1. Tyre/wheel combination(s) (for tyres indicate size designation, minimum load-capacity index, minimum speed category symbol; for wheels indicate rim size(s) and off-set(s)):
- 6.6.1.1. Axle 1:
- 6.6.1.2. Axle 2:
- etc.
- 6.6.3. Tyre pressure(s) as recommended by the vehicle manufacturer: kPa
7. STEERING
- 7.1. Schematic diagram of steered axle(s) showing steering geometry:
- 7.2. Transmission and control
- 7.2.1. Type of steering transmission (specify for front and rear, if applicable):
- 7.2.2. Linkage to wheels (including other than mechanical means; specify for front and rear, if applicable):

- 7.2.3. Method of assistance, if any:
- 7.2.3.1. Method and diagram of operation, make(s) and type(s):
- 7.2.4. Diagram of the steering equipment as a whole, showing the position on the vehicle of the various devices influencing its steering behaviour:
- 7.2.5. Schematic diagram(s) of the steering control(s):
- 7.3. Maximum steering angle of the wheels
- 7.3.1. to the right: °
Number of turns of the steering wheel (or equivalent data):
- 7.3.2. to the left: °
Number of turns of the steering wheel (or equivalent data):

Appendix 2**MODEL**

(maximum format: A4 (210 × 297 mm))

EC TYPE-APPROVAL CERTIFICATE

Stamp of Administration

Communication concerning the:

- type-approval ⁽¹⁾
- extension of type-approval ⁽¹⁾
- refusal of type-approval ⁽¹⁾
- withdrawal of type-approval ⁽¹⁾

of a type of a vehicle/component/separate technical unit ⁽¹⁾ with regard to Directive 70/311/EEC, as last amended by Directive ... / ... /EC.

Type-approval number:

Reason for extension:

SECTION I

- 0.1 Make (trade name of manufacturer):
- 0.2. Type:
- 0.3 Means of identification of type if marked on the vehicle/component/separate technical unit ^{(1) (2)}:
- 0.3.1. Location of that marking:
- 0.4. Category of vehicle ^{(1) (3)}:
- 0.5 Name and address of manufacturer:
- 0.7. In the case of components and separate technical units, location and method of the affixing of the EC approval mark:
- 0.8. Address(es) of assembly plant(s) :

⁽¹⁾ Delete where not applicable.

⁽²⁾ If the means of identification of type contains characters not relevant to describe the vehicle, component or separate technical unit types covered by this type-approval certificate such characters shall be represented in the documentation by the symbol: ? (e.g. ABC??123??).

⁽³⁾ As defined in Annex IIA to Directive 70/156/EEC.

SECTION II

1. Additional information (where applicable): See Addendum
2. Technical service responsible for carrying out the tests:
3. Date of test report:
4. Number of test report:
5. Remarks (if any): See Addendum
6. Place:
7. Date:
8. Signature:
9. The index to the information package lodged with the approval authority, which may be obtained on request, is attached.

Addendum to EC type-approval certificate No. ...

concerning the type approval of a vehicle with regard to Directive 70/311/EEC
as last amended by Directive ... / ... /EC

1. Additional information:

Type of steering:

Steering control:

Steering transmission:

Steered wheels

Energy source:

Braking performance:

Statement of the type-approval number granted in accordance with Directive 71/320/EEC, if available:

and /or information concerning the state of the vehicle during tests:

laden/unladen ⁽¹⁾
2. Remarks:
(e.g. valid for both left-hand and right-hand drive vehicles)

⁽¹⁾ Delete as appropriate.

ANNEX II**BRAKING PERFORMANCE FOR VEHICLES USING THE SAME ENERGY SOURCE TO SUPPLY STEERING EQUIPMENT AND BRAKING DEVICE**

1. If an energy source failure occurs, service braking performance on the first brake application shall achieve the values given in the table below.

Category	V (km/h)	m/s ²	Force (daN)
M ₁	80	5.8	50
M ₂ and M ₃	60	5.0	70
N ₁	80	5.0	70
N ₂ and N ₃	60	5.0	70

2. After any failure in the steering equipment, or the energy supply, it shall be possible after eight full stroke actuations of the service brake control, to achieve at the ninth application, at least the performance prescribed for the secondary (emergency) braking system (see table below).

In the case where secondary performance requiring the use of stored energy is achieved by a separate control, it shall still be possible after eight full stroke actuations of the service brake control to achieve at the ninth application, the residual performance (see table below).

Secondary and residual efficiency

Category	V (km/h)	Secondary braking (m/s ²)	Residual braking (m/s ²)
M ₁	80	2.9	1.7
M ₂	60	2.5	1.5
M ₃	60	2.5	1.5
N ₁	70	2.2	1.3
N ₂	50	2.2	1.3
N ₃	40	2.2	1.3

ANNEX III**ADDITIONAL PROVISIONS FOR VEHICLES EQUIPPED WITH ASE****1. GENERAL PROVISIONS**

This Annex does not require vehicles to be fitted with ASE. However, if vehicles are fitted with such a device, they shall comply with the provisions of this Annex.

2. SPECIFIC PROVISION**2.1. Transmission****2.1.1. Mechanical steering transmissions**

Item 4.1.4 of Annex I to this Directive applies.

2.1.2. Hydraulic steering transmissions

The hydraulic steering transmission must be protected from exceeding the maximum permitted service pressure T.

2.1.3. Electric steering transmissions

The electric steering transmission must be protected from excess energy supply.

2.1.4. Combination of steering transmissions

A combination of mechanical, hydraulic and electric transmissions shall comply with the requirements specified in items 2.1.1, 2.1.2 and 2.1.3 above.

2.2. Testing requirements for failure**2.2.1. Malfunction or failure of any part of the ASE (except for parts not considered to be susceptible to breakdown as specified in item 4.1.4 of Annex I to this Directive) shall not result in sudden significant change in vehicle behaviour and the requirements of items 5.2.1 to 5.2.4 and 5.2.6 of Annex I to this Directive shall still be met. Furthermore, it must be possible to control the vehicle without abnormal steering correction. This shall be verified by the following tests:****2.2.1.1. Circular test**

The vehicle shall be driven into a test circle with a radius 'R' (m) and a speed 'V' (km/h) corresponding to its category and the values given in the table below:

Vehicle category	R ⁽¹⁾	V ⁽²⁾⁽³⁾
M ₁ , N ₁	100	80
M ₂ , N ₂	50	50
M ₃ , N ₃	50	45

⁽¹⁾ If the ASE is in a mechanically locked position at this specified speed, the test speed will be modified to correspond to the maximum speed where the system is functioning. Maximum speed means the speed when ASE becomes locked, minus 5 km/h.

- (2) If the dimensional characteristics of the vehicle imply an overturning risk, the manufacturer shall provide to the technical service behaviour simulation data demonstrating a lower maximum safe speed for conducting the test. Then the technical service will choose this test speed.
- (3) If, due to the configuration of the test site, the values of the radii cannot be observed, the tests may be carried out on tracks with other radii (maximum deviation $\pm 25\%$), provided that the speed is varied to obtain the transverse acceleration resulting from the radius and speed indicated in the table for the particular category of vehicle.

The failure shall be introduced when the specified speed has been reached. The test shall include driving in a clockwise direction and in a counter-clockwise direction.

2.2.1.2. Transient test

Until uniform test procedures have been agreed, the vehicle manufacturer shall provide the technical services with their test procedures and results for transient behaviour of the vehicle in the case of a failure.

2.3. Warning signals in case of failure

- 2.3.1. Except for parts of ASE not considered susceptible to breakdown as specified in item 4.1.4 of Annex I of this Directive, the following failure of ASE shall be clearly brought to the attention of the driver:

- 2.3.1.1. A general cut-off of the ASE electrical or hydraulic control;

- 2.3.1.2. Failure of the ASE energy supply;

- 2.3.1.3. A break in the external wiring of the electrical control if fitted.

2.4. Electromagnetic interference

- 2.4.1. The operation of the ASE must not be adversely affected by electromagnetic fields. Until uniform test procedures have been agreed, the vehicle manufacturer shall provide the technical services with their test procedures and results.

ANNEX IV

PROVISIONS FOR TRAILERS HAVING PURELY HYDRAULIC STEERING TRANSMISSIONS

1. If vehicles are fitted with purely hydraulic steering transmissions, they shall comply with the provisions of this Annex.
2. **SPECIFIC PROVISIONS**
 - 2.1. Performance of hydraulic lines and hose assemblies
 - 2.1.1. The hydraulic lines of purely hydraulic transmissions must be capable of withstanding a pressure of at least four times the maximum normal service pressure T specified by the manufacturer. Hose assemblies shall comply with the following ISO Standards: 1402 (1984), 6605 (1986) and 7751 (1983).
 - 2.2. In systems dependent on an energy supply
 - 2.2.1. The energy supply must be protected from excess pressure by a pressure limiting valve which operates at the pressure T.
 - 2.3. Protection of steering transmission
 - 2.3.1. The steering transmission must be protected from excess pressure by a pressure limiting valve which operates between 1,5T and 2,2T.
 - 2.4. Tractor/trailer alignment
 - 2.4.1. With the tractor of a tractor/trailer combination travelling in a straight line, the trailer must remain in alignment with the tractor;
 - 2.4.2. In order to maintain steering alignment in accordance with item 2.4.1 above, trailers shall be provided with a means of readjustment which may be either automatic or manual.
 - 2.5. Steerability with a failure in the steering transmission
 - 2.5.1. The steerability of vehicles with purely hydraulic steering transmissions shall be maintained with a failure in any part of the transmission. Vehicles shall be tested in this (failed) condition and satisfy the requirements of item 5.3 of Annex I to this Directive. In particular the 5 km/h and 25 km/h tests specified at item 5.3.2 shall be conducted with the steering transmission in the intact and failed conditions respectively.
 - 2.6. Electromagnetic interference
 - 2.6.1. The operation of steering equipment must not be adversely affected by electromagnetic fields. Until uniform test procedures have been agreed, the vehicle manufacturer shall provide the technical services with his test procedures and results.

PE10-020

BMW

9-24-2010

ATTACHMENT

E85 Typzulassung durch KBA
pages6-9 english

Technical Report

No. 351-0393-02-FBTP

Test according to the EEC directive relating to

Steering Systems

No.: 70/311/EWG vom 08.06.1970

Including all amendments up to

No.: 1999/7/EWG of 01/26/1999

I. Technical description

0.1. Make: BMW

0.2. Type: Z85

0.3. Means of identification of type, if marked on the vehicle: N/A

0.4. Category of vehicle: M1

0.5. Name and address of the manufacturer: Bayerische Motoren Werke AG, D-80788
Munich

II. Test Protocol

1. Test Conditions

1.1. Technical data of test vehicle

Typ: Z85

VIN: 4USBT53473LU00033

Test weight of vehicle: 1616 kg

Axle loads

Front: 828 kg

Rear: 788 kg

Tires

Size: front 225/40 R18 88W

rear 255/35 R18 90W

Tire pressure: front 2,5 bar

rear 2,6 bar

Rim: front 8J x 18, ET 47

rear 8J x 18, ET 47

1.2. Measuring devices: measuring steering wheel 375 mm Ø with DMS measuring amplifier, X-Y-recorder

1.3. Other test conditions

Testing ground: skid pad, asphalt

Weather: dry, 28°C

2. Test Results

2.1. Steering control efforts/-times are:

mit power assist / steering wheel motion leftward: 18 N / 2,0 s

mit power assist / steering wheel motion rightward: 21 N / 2,5 s

without power assist / steering wheel motion leftward: 50 N / 2,5 s

without power assist / steering wheel motion rightward: 49 N / 2,3 s

2.2. Circular course driving according to 5.2.1. Annex I: fulfilled

2.3. Circular course driving according to 5.2.3. Annex I: fulfilled

2.4. Failure in the steering system according to

5.2.2. Annex I: the requirements in

Annex I, 4.1.1.1.,

4.1.1.2. and 5.2.1.

Are fulfilled.

2.5. Further test results: the test result cover all track widths and energy supplies mentioned in the information document.

3. Test date: 06/12/2002

III. Attachments

1. Information document No. Z85 dated 06/11/2002

IV. Statement of Conformity

The information document mentioned above and the vehicle type described therein are in compliance with the applicable legislation mentioned above.

The report includes pages 1 to 4.

Jürgen Aigner

Garching, 06/24/2002

PE10-020

BMW

9-24-2010

ATTACHMENT

E85 Typzulassung durch KBA

pages6-9

Technischer Bericht Nr. 351-0393-02-FBTP
Hersteller: Bayerische Motoren Werke AG, D-80788 München
Typ: Z85

Seite 1

TECHNISCHER BERICHT

Nr. 351-0393-02-FBTP

Prüfung gemäß Richtlinie des Rates der Europäischen Gemeinschaften zur
Angleichung der Rechtsvorschriften der Mitgliedstaaten über

Lenkanlagen von Kraftfahrzeugen und Kraftfahrzeuganhängern

Nr.: 70/311/EWG vom 08.06.1970

einschließlich aller Änderungen bis

Nr.: 1999/7/EWG vom 26.01.1999

I. Technische Angaben

- | | | |
|------|---|--|
| 0.1. | Fabrikmarke
(Firmenbezeichnung): | BMW |
| 0.2. | Typ: | Z85 |
| 0.3. | Merkmale zur Typidentifizierung,
sofern am Fahrzeug vorhanden: | -- |
| 0.4. | Klasse des Fahrzeugs: | M1 |
| 0.5. | Name und Anschrift des
Herstellers: | Bayerische Motoren Werke AG
D-80788 München |

Technischer Bericht Nr. 351-0393-02-FBTP
Hersteller: Bayerische Motoren Werke AG, D-80788 München
Typ: Z85

Seite 2

II. Prüfprotokoll

1. Prüfbedingungen

1.1. Technische Daten des Prüffahrzeuges

Typ:	Z85
VIN:	4USBT53473LU00033
Prüfgewicht des Fahrzeugs:	1616 kg
Achslasten	
vorne:	828 kg
hinten:	788 kg
Bereifung	
Größenbezeichnung:	vorne 225/40 R18 88W hinten 255/35 R18 90W
Reifenfülldruck:	vorne 2,5 bar hinten 2,6 bar
Felge:	vorne 8J x 18, ET 47 hinten 8J x 18, ET 47

1.2. Messgeräte: Messlenkrad 375 mm Ø mit DMS-Messverstärker, X-Y-Schreiber

1.3. Sonstige Prüfbedingungen

Prüfstrecke: Kreisplatte, Asphalt
Witterung: trocken, 28°C

Technischer Bericht Nr. 351-0393-02-FBTP
Hersteller: Bayerische Motoren Werke AG, D-80788 München
Typ: Z85

Seite 3

2. Prüfergebnisse

2.1. Die Betätigungskräfte/-zeiten betragen:

mit Hilfskraft / Lenkeinschlag links:	18 N / 2,0 s
mit Hilfskraft / Lenkeinschlag rechts:	21 N / 2,5 s
ohne Hilfskraft / Lenkeinschlag links:	50 N / 2,5 s
ohne Hilfskraft / Lenkeinschlag rechts:	49 N / 2,3 s

2.2. Kreisfahrt gemäß 5.2.1. Anhang I: erfüllt

2.3. Kreisfahrt gemäß 5.2.3. Anhang I: erfüllt

2.4. Störung in der Lenkanlage gemäß 5.2.2. Anhang I: Die Anforderungen in Anhang I, 4.1.1.1., 4.1.1.2. und 5.2.1. werden erfüllt.

2.5. Weitere Prüfergebnisse: Die Prüfergebnisse umfassen alle im Teil-Beschreibungsbogen genannten Spurweiten und Energieversorgungen.

3. Datum der Prüfung: 12.06.2002

Technischer Bericht Nr. 351-0393-02-FBTP
Hersteller: Bayerische Motoren Werke AG, D-80788 München
Typ: Z85

Seite 4

III. Anlagen

1. Teil-Beschreibungsbogen Nr. Z85 vom 11.06.2002

IV. Schlussbescheinigung

Der oben angegebene Teil-Beschreibungsbogen und der darin beschriebene Fahrzeugtyp entspricht der genannten Prüfgrundlage.

Der Bericht umfasst die Seiten 1 bis 4.



Jürgen Aigner

Garching, 24.06.2002