

KES

Rack and Pinion Type Power Steering Gear

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Appendix



1. Purpose

This standard aims at securing proper quality by standardizing specifications.
Remark: This standard and a drawing communicate together our requirements.

2. Scope of Application

This standard specifies the rack and pinion type power steering gear for automobiles (hereinafter referred to as the "P/S gear").

3. Report of Evaluation Results

The quality evaluation results at each stage from development to mass production shall be submitted to KIA and/or MMUC according to the Appendix.

4. Definition of Terminology

Piping in vehicle condition: This is the piping in vehicle condition shown in a drawing, including the routes, length and the sizes of the piping of a vehicle.

5. Specification Indicated in Drawings

- (1) Dimensions of gears (including strokes)
- (2) Installation details of a gear (including the body configuration and the tightening torque)
- (3) An allowable space for P/S piping, the piping route on vehicle sides and conditions for keeping clearances
- (4) Connecting position of P/S piping and the shape of connecting part
- (5) Input axis torque - rack thrust curve or input axis torque - hydraulic characteristics curve
- (6) Surface treatment and rust prevention target
- (7) Straighthead running total ratio and the effective radius of a knuckle arm
- (8) Dimensions of serration and the notch configuration
- (9) Tie-rod angle in the table below (φ , ψ)

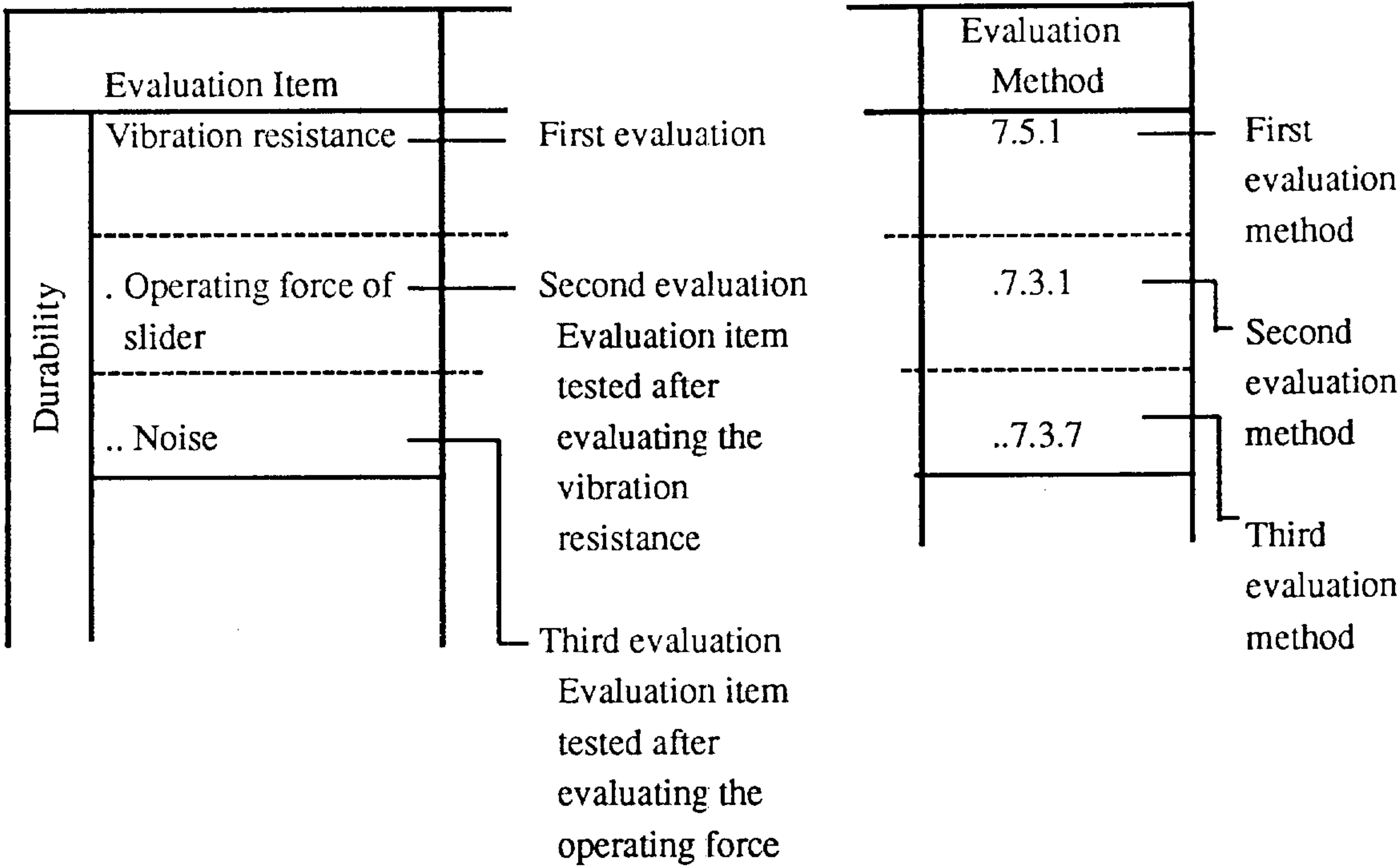
		Empty Car		Performance Standard		Strength Standard		Full Rebound		Full Bump	
		Straight-ahead running	Full stroke	Straight-ahead running	Full stroke	Straight-ahead running	Full stroke	Straight-ahead running	Full stroke	Straight-ahead running	Full Stroke
Right	φ ψ										
Left	φ ψ										

- (10) Flow characteristics and the relief pressure of a pump
- (11) Working fluid
- (12) Impact load of a falling weight: PDT (loading 10 times) PDM (breaking load)
- (13) Target weight
- (14) The route, length and the sizes of the piping in vehicle condition
- (15) Withstanding pressure specification of P/S piping

6. Evaluation Standard

The evaluation standard of the P/S gear shall conform to Table 1.

Remark 1. The way of reading evaluation items and methods in Table 1 shall conform to the following example.



Remark 2. The quality rank shall be represented by A, AR, B or C.

The definitions shall conform to KES Q-A002 (Determination and Procedure of Quality Ranking).

Table 1

Evaluation Item		Evaluation Standard	Quality Rank	Evaluation Method
Structure	High pressure steel pipe	It shall be double winding steel pipe according to KES C-E003.	A	Visual
Performance	Input axis operation torque	The medial value: 12 ± 2 kgf.cm (118 ± 20 N.cm), and the fluctuation range: ± 1.5 kgf.cm (± 14.7 N.cm).	C	7.2.1
	Stiffness of input axis	(1) Without a mount rubber: 1.5 deg /0.2 kgf.m {1.5 deg/2N.m} max. (2) With a mount rubber: 1/7 deg /0.2 kgf.m {1.7 deg/2 N.m} max.	C	7.2.2
	Input axis torque -pressure characteristics	(1) The input axis torque and the pressure or the output thrust: within the allowable limits indicated in a drawing. (2) At pressure of 20 kgf/cm ² {1960 kPa}, the torque difference between in left and in right when going 0.08 kgf.m {0.8 N.m} max. (3) The torque difference between in going and in coming back: 0.18 kgf.m {1.8 N.m} max.	C	7.2.3
	Internal leakage	0.8 ℓ / min. max. : in each case of turning to the left or the right.	C	7.2.4
	Flow noise of valves	53 dB(A) max.: at a point 10cm apart from a valve.	C	7.2.5
	Startability at low temperature	(1) No catching, smooth gear operation. (2) The starting torque: 20 kgf.cm {196 N.cm} max. (3) Relief pressure shall be generated.	B	7.2.6
	Noise and vibration	(1) No noise or vibration except for relief noise. (2) The pressure fluctuation at an inlet port: 5% of the input pressure max.	C	7.2.7

Table 1 (Continued)

Evaluation Item		Evaluation Standard	Quality Rank	Evaluation Method
Performance	Starting and operation torque of inner ball joint	The swing starting torque shall be 90 kgf.cm {882.N.cm} max. The swing operation torque shall be 5 to 30 kgf.cm {49 to 294 N.cm}. Rotating operation torque shall be 60 kgf.cm {588 N.cm} max.	C	7.2.8
	Rattle noise	No occurrence of rattle.	C	7.2.9
	Vacuum resistance	No air suction. No seal trouble etc.	C	7.2.10
	Return characteristics	The time constant in returning $t_s = 0.2$ to 0.5 sec.	C	7.2.11
Strength against a heavy load	Impact strength against a falling weight in the direction of the rack axis I	(1) No damages nor malfunction after loading P_{DT} 10 times. (2) Gears shall be able to be operated to full stroke by an input axis torque of 50 kgf.cm {490 N. cm}). (3) No damages with max. 100% of P_{DM}	A	7.3.1
	Impact strength against a falling weight in the direction of the rack axis II	① No damages with a force of 3000 kgf {29.4 kN} max.	A	7.3.2
	Static torsional strength	After loading of 20 kgf.m {196N.m} gears shall be able to be operated to full stroke by an input axis torque of 50 kgf.cm {490 N.cm} max.	A	7.3.3
	High pressure strength	No damages.	A	7.3.4
	Drawing force for inner ball joints	3000 kgf {29.4 kN} min.	A	7.3.5
	Buckling strength of a tie-rod	Within 2500 to 3000 kgf {24.5 to 29.4 kN}	A	7.3.6

Table 1 (Continued)

Evaluation Item		Evaluation Standard	Quality Rank	Evaluation Method
Strength against a heavy load	Impact torsional strength	No damages.	A	7.3.7
	Low temperature impact strength	No damages at 1200 kgf {11.8 kN}. Report the limit strength.	A	7.3.8
	Strength of a clamping plate	No sudden damages when the amount of deformation δ is 4mm max under a specified load.	A	7.3.9
	Tightening force of bolts	Report the limit torque of tightening bolts for KIA's approval.	A	7.3.10
Durability	Input torque fatigue (including mud water resistance)	(1) No damages, malfunctions nor external leakage. (2) Performance deterioration shall satisfy the following items: a) The drop of the starting torque of the input axis: 30% max. b) The drop of the stiffness of the input axis: 30% max. c) The change in the input pressure characteristics: 5% max. d) Internal leakage: 1 ℓ /min. max. e) The wear of the rack bush: 20 μ max. f) The wear of the yoke plug: 10 μ max. (3) Ball joint load - displacement characteristics shall satisfy the followings: In the radius direction: 0.15mm/100 kgf {0.15mm/980 N} max. In the axial direction: 0.1 mm/100 kgf {0.1mm/980 N} max. (4) The drop of fastening torque shall be 20% max.	A	7.4.1

Table 1 (Continued)

Evaluation Item		Evaluation Standard	Quality Rank	Evaluation Method
Durability	Reaction fatigue	1) Satisfy the evaluation standard of 7.4.1 Input torque fatigue. 2) No fretting on the tooth surface of the rack & pinion.	A	7.4.2
	Leakage resistance at high temperature	1) No external leakage at the relief pressure and the input pressure. 2) Inner leakage: 1 ℓ /min. max.	A	7.4.3
	Durability against heat	The evaluation standard for input torque fatigue shall be satisfied.	A	7.4.4
	Durability against back pressure	No external leakage.	A	7.4.5
	Inner ball joint swing durability	Ball joint load-displacement characteristics shall satisfy the evaluation standard in 7.4.1 Input torque fatigue.	A	7.4.6
	Weatherability	No cracks nor deformation.	A	7.4.7
Strength and durability of boots	Tearing-up strength	40 kgf/cm ² {392 N/cm ² } min.	A	7.5.1
	Sealability at low temperature	No cracks. No grease leakage.	A	7.5.2
	Heat resistance	No cracks. No grease leakage.	A	7.5.3
	Torsion	No torsion. However, torsion is acceptable if it can be restored to the original state within 5 seconds.	A	7.5.4
	Impact strength against a falling weight	No crack.	A	7.5.5
	Impact strength against a falling steel ball	No crack.	A	7.5.6
	Inclusion of a boot	No bite and catch of a boot.	A	7.5.7

Table 1 (Continued)

Evaluation Item		Evaluation Standard	Quality Rank	Evaluation Method
Strength and durability of boots	Sealability of a boot (1)	No air leakage nor air suction at 2 kgf/cm ² {196 kPa} and -0.8 kgf/cm ² {-78.4 kPa}	A	7.5.8
	Sealability of a boot (2)	No water infiltration.	A	7.5.9
	Air vent connector strength	No disconnection of the connector jointing part	A	7.5.10

7. Evaluation Method

7.1 Common Evaluation Conditions

7.1.1 Standard ambient condition: Unless otherwise specified, the standard atmospheric condition for testing shall be the normal temperature and normal humidity, that is grade 5 of 20°C (20 ± 5°C) and grade 20 of 65% (65 ± 20%) respectively specified in JIS Z 8703 (Standard Atmospheric Condition for Testing).

7.1.2 Evaluation condition: Unless otherwise specified, evaluate according to the following conditions.

- (1) Execute evaluation at the specified values of tightening torque indicated in a specification drawing or the lowest limit of the values decided by vendors.
- (2) Working oil: Use the working oil indicated in a specification drawing.
- (3) Flow rate of working oil: Use the value indicated in a specification drawing.
- (4) Set pressure for relief: Use the maximum value indicated in a specification drawing.
- (5) Working oil temperature: Unless otherwise specified, it shall be 55 ± 5°C
- (6) When the valve characteristics are changed, the evaluation items for performance in 7.2.1 to 7.2.7 and those for durability in 7.4.1 shall be carried out.

7.2 Performance

7.2.1 The operation torque of an input axis

- (1) Conditions and methods: Keeping the output axis end free, turn an input axis to stroke rack full.

Rotating speed of a pinion gear: 5 rpm

Measuring flow rate: 3.5 ℓ /min

- (2) Items and methods for measurement: Measure the operation torque at the pinion shaft within the full stroke range.