Engine Valves for Automobiles

1. Scope

This Standard specifies engine valves for automobiles (hereinafter referred to as valves).

Remark: In this Standard, units and numerical values are based on SI (International System of Units), while units and numerical values given in { } are customary units system, and are specified values.

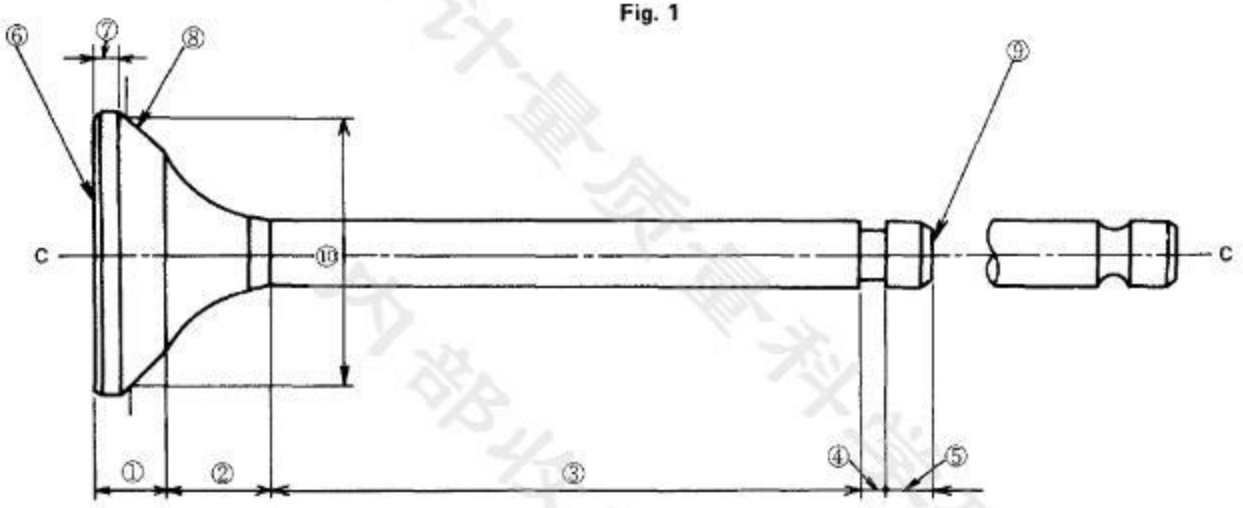
2. Purpose

This Standard aims to ensure the standardization of valves, unification of quality standard and reduction of cost.

3. Nomenclature

The nomenclature of valve parts shall be as shown in **Fig.1**.

Fig. 1



No.	Nomencalture	Definition
①	Top	The portion from head to face
②	Fillet radius	The portion connecting the top and stem with each other. Strictly speaking, it consists of a sloped portion under the top, rounded portion under the top and joint.
③	Stem	The cylindrical portion including the portion in sliding contact with the valve guide
④	Groove	The portion in which the cotter is to be fitted.
⑤	Stem end	The portion between the groove and tip
⑥	Head	The face of top on the opposite side of stem
⑦	Margin	The portion intermediate between the face and head
⑧	Face	The conical face in contact with

5. Materials

5.1 Chemical Composition

The chemical composition of materials shall be as shown in **Table 1.**

5.2 Mechanical Properties

The mechanical properties of materials shall be as shown in **Table 2.**

Table 1

Symbol	Chemical composition (%)																Application
	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	Co	W	Al	Ti	N	Fe	Other	
SUH 1	0.40 ~ 0.50	3.00 ~ 3.50	Max. 0.60	Max. 0.030	Max. 0.030	—	—	7.50 ~ 9.50	—	—	—	—	—	—	Base	—	Intake valve
SUH 3	0.35 ~ 0.45	1.80 ~ 2.50	Max. 0.60	Max. 0.030	Max. 0.030	—	—	10.00 ~ 12.00	0.70 ~ 1.30	—	—	—	—	—	Base	—	Intake valve
SUH 11	0.45 ~ 0.55	1.00 ~ 2.00	Max. 0.60	Max. 0.030	Max. 0.030	—	Max. 0.60	7.50 ~ 9.50	—	—	—	—	—	—	Base	—	Intake valve
SUH 31	0.35 ~ 0.45	1.50 ~ 2.50	Max. 0.60	Max. 0.040	Max. 0.030	—	13.00 ~ 15.00	14.00 ~ 16.00	—	—	2.00 ~ 3.00	—	—	—	Base	—	Exhaust valve
SUH 35	0.48 ~ 0.58	Max. 0.35	8.00 ~ 10.00	Max. 0.040	Max. 0.030	Max. 0.30	3.25 ~ 4.50	20.00 ~ 22.00	—	—	—	—	—	0.35 ~ 0.50	Base	—	Exhaust valve
SUH 36	0.48 ~ 0.58	Max. 0.35	8.00 ~ 10.00	Max. 0.040	0.040 ~ 0.090	Max. 0.30	3.25 ~ 4.50	20.00 ~ 22.00	—	—	—	—	—	0.35 ~ 0.50	Base	—	Exhaust valve
SUH 37	0.15 ~ 0.25	Max. 1.00	1.00 ~ 1.60	Max. 0.040	Max. 0.030	Max. 0.30	10.00 ~ 12.00	20.50 ~ 22.50	—	—	—	—	—	0.15 ~ 0.30	Base	—	Exhaust valve
SUH 38	0.25 ~ 0.35	Max. 1.00	Max. 1.20	0.18 ~ 0.25	Max. 0.030	Max. 0.30	10.00 ~ 12.00	19.00 ~ 21.00	1.80 ~ 2.50	—	—	—	—	—	Base	B 0.001~ 0.010	Exhaust valve
NCF 751	Max. 0.10	Max. 0.50	Max. 1.00	Max. 0.030	Max. 0.015	Max. 0.50	Min. 70.00	14.00 ~ 17.00	—	—	—	0.90 ~ 1.50	2.00 ~ 2.60	—	5.00 ~ 9.00	Nb + Ta 0.70~ 1.20	Exhaust valve
NCF80 A	0.04 ~ 0.10	Max. 1.00	Max. 1.00	Max. 0.030	Max. 0.015	Max. 0.20	Base	18.00 ~ 21.00	—	Max. 2.00	—	1.00 ~ 1.80	1.80 ~ 2.70	—	Max. 1.50	—	Exhaust valve
CoCr 1	2.0 ~ 3.0	0.4 ~ 2.0	Max. 1.00	—	—	—	Max. 3.0	26.0 ~ 33.0	Max. 1.0	Base	11.0 ~ 14.0	—	—	—	Max. 3.0	Max. 0.5	Filling for stem end
CoCr 6	0.9 ~ 1.4	0.4 ~ 2.0	Max. 1.00	—	—	—	Max. 3.0	26.0 ~ 32.0	Max. 1.0	Base	3.0 ~ 6.0	—	—	—	Max. 3.0	Max. 0.5	Filling for face
CoCr 12	1.2 ~ 1.7	0.4 ~ 2.0	Max. 1.00	—	—	—	Max. 3.0	26.0 ~ 33.0	Max. 1.0	Base	7.0 ~ 9.5	—	—	—	Max. 3.0	Max. 0.5	Filling for face
CoCr 32	1.5 ~ 2.0	0.9 ~ 1.3	Max. 0.3	—	—	—	21.0 ~ 24.0	24.0 ~ 32.0	Max. 0.6	Base	11.5 ~ 13.0	—	—	—	Max. 2.0	Max. 0.5	Filling for face

Remarks 1: SUH1, SUH3, SUH11, SUH31, SUH35, SUH36, SUH37 and SUH38 shall conform to **JIS G 4311** (Heat-Resisting Steel Bars), and NCF751 and NCF80A to **JIS G 4901** (Corrosion-Resisting and Heat-Resisting Superalloy Bars).

2: CoCr1, CoCr6 and CoCr12 shall conform to AWS A5. Table 12-20 RCoCr-C, RCoCr-A and RCoCr-E

Table 2

Symbol	Heat treatment °C					Mechanical properties							
	Annealing	Hardening	Tempering	Solution heat treatment	Aging	Yield strength N/mm² {kgf/mm²}	Tensile strength N/mm² {kgf/mm²}	Elongation %	Reduction of area %	Charpy impact value J/cm² {kgf-m/cm²}	Brinell hardness H_B	Rockwell hardness	Heat treating conditions
SUH 1	800~900 Slow cooling	980 ~1080 Oil cooling	700~850 Quenching	–	–	686 and over {70} and over	932 and over {95} and over	15 and over	35 and over	–	269 and over	–	Hardening Tempering
SUH 3	800~900 Slow cooling	980 ~1080 Oil cooling	700~800 Quenching	–	–	686 and over {70} and over	932 anb over {95} and over	15 and over	35 and over	20 and over {2} and over	269 and over	–	Hardening Tempering
SUH 11	750~850 Slow cooling	1000 ~1050 Oil cooling	650~750 Quenching	–	–	686 and over {70} and over	883 and over {90} and over	15 and over	35 and over	20 and over {2} and over	262 and over	–	Hardening Tempering
SUH 31	–	–	–	950 ~1050 Quenching	–	314 and over {32} and over	735 and over {75} and over	30 and over	40 and over	–	248 and over	–	Solution heat treatment
SUH 35	–	–	–	1100 ~1200 Quenching	730~780 Air cooling	559 and over {57} and over	883 and over {90} and over	8 and over	–	–	302 and over	–	Aging after solution heat treatment
SUH 36	–	–	–	1100 ~1200 Quenching	730~780 Air cooling	559 and over {57} and over	883 and over {90} and over	8 and over	–	–	302 and over	–	Aging after solution heat treatment
SUH 37	–	–	–	1050 ~1150 Quenching	750~800 Air cooling	392 and over {40} and over	785 anv over {80} and over	35 and over	35 and over	–	248 and over	–	Aging after solution heat treatment
SUH 38	–	–	–	1120 ~1150 Quenching	730~760 Air cooling	490 and over {50} and over	883 and over {90} and over	20 and over	25 and over	–	269 and over	–	Aging after solution heat treatment
NCF 751	–	–	–	1135 ~1165 Quenching	830~860× 24 Hrs Air cooling 690~720× 20 Hrs Air cooling	618 and over {63} and over	961 and over {98} and over	8 and over	–	–	–	–	Aging after solution heat treatment
NCF 80A	–	–	–	1050 ~1100 Quenching	690~710× 16 Hrs Air cooling	600 and over {61} and over	1000 and over {102} and over	20 and over	–	–	–	–	Aging after solution heat treatment
CoCr 1	–	–	–	–	–	–	–	–	–	–	–	50~62	–
CoCr 6	–	–	–	–	–	–	–	–	–	–	–	40~50	–
CoCr 12	–	–	–	–	–	–	–	–	–	–	–	45~55	–
CoCr 32	–	–	–	–	–	–	–	–	–	–	–	38~48	–

Remarks: 1: SUH1, SUH3, SUH11, SUH31, SUH35, SUH36, SUH37 and SUH38 shall conform to **JIS G 4311** (Heat-Resisting Steel Bars), and NCF751 and NCF80A to **JIS G 4901** (Corrosion-Resisting and Heat-Resisting Superalloy Bars).

2: The hardness of CoCr1, CoCr6, CoCr12 and CoCr32 is the hardness after gas welding and is applied as reference value.

6. Appearance, Surface Roughness and Tip Hardness

6.1 Appearance

There shall not exist any flaws, burrs and other harmful defects on the valve.

6.2 Surface Roughness

The roughness of finished surface of valve shall be as specified in **Table 3.**

Table 3

Finished surface	Surface roughness	Remarks
Face	3.2S (grinding finish)	To be measured in the direction rectangular to the grinding direction.
Stem		
Tip	3.2S or 6.3S (grinding finish)	
Groove	18S (12.5S)	For the locking type, externally locked type.
	6.3S or 12.5S	For the locking type, internally locked type.

6.3 Tip Hardness

The hardness of hardened tip shall be more than H_RC48 or equivalent for SUH3, and H_RC50 or equivalent for SUH1 and SUH11. In case of the Vickers hardness, it shall be more than $H_V(10)484$ or equivalent for SUH3, and $H_V(10)513$ or equivalent for SUH1 and SUH11.

7. Shape and Dimensions

7.1 Indication of Dimensions

The dimensions of valve shall be indicated as shown in **Fig. 2** or by the gauge diameter system shown in **Fig. 3**.

7.2 Diameter and Tolerance of Stem

(1) The diameter of stem shall be, as a rule, as specified in **Table 4**.

(2) The tolerance on the diameter (D_2) of stem shall be, as a rule, as specified in **Table 5**.

Table 4

Unit: mm

4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	11	12

Table 5

Unit: mm

Diameter of stem	Tolerance
6 and under	0.012
Over 6 to 10 incl.	0.015
Over 10 to 12 incl.	0.018

7.3 Tolerances

(1) **Tolerances of Valve Parts**
The tolerances of valve parts shown in **Fig. 2** shall be as specified in **Table 6**.

(2) ***Ordinary Dimensional Tolerance for Valve Parts***
Unless otherwise specified, the dimensional tolerance for valve parts shall be common grade specified in **JIS B 0405** (Permissible Machining Deviations in Dimensions without Tolerance Indication) and extra grade specified in **JIS B 0415** [Dimensional Tolerance for Steel Die Forgings (Hammer and Press Forging)] and **B 0416** [Dimensional Tolerance for Steel Die Forgings (Upsetting)].

Table 6

Unit: mm

Item		Tolerance
Overall length	L_1	0.5
Groove position	L_2	0.4
Straight grinding length	L_3	2.0
Top thickness	t_1	0.5
Face height	t_2	0.4 or 0.6
Margin thickness	t_3	0.4 or 0.6
Top external diameter	D_0	0.2
Groove diameter	d_1	external 0.2 internal 0.1
Groove width	l	0.2

Remarks 1: For the top thickness, face height and margin thickness, any two of them, for example, top thickness and face height, top thickness and margin thickness or face height and margin thickness shall be specified.

2: The groove diameter shall include that of circular groove.

3: The groove width shall exclude that of circular groove and taper groove.

7.4 Shape Accuracy

The shape accuracy of valve parts shall be as specified in **Table 7**.

Table 7

Item	Shape accuracy
Face angle	Tolerance for angle α 30′
Deviation of face	0.03 mm
Roundness of stem	0.01 mm
Straightness of stem	0.01 mm
Cylindricality of stem	1/2 of tolerance for stem diameter
Coaxiality of groove	0.05 mm
Rectangularity of tip	0.015 mm
Rectangularity of head	0.2 mm

Remark: The roundness of stem indicates the value obtained in the case when 60° V block was used.

8. Inspection

8.1 Material Inspection

The valve steel shall be inspected in accordance with the test methods specified in **JIS G 4311** (Heat-Resisting Steel Bars) and **JIS G 4901** (Corrosion-Resisting and Heat-Resisting Superalloy Bars), and shall conform to the requirements in **5**.

Filling alloys shall, after filling, conform to the requirements in **5.2**.

8.2 Appearance, Surface Roughness and Tip Hardness

(2) **Surface Roughness**
The roughness of finished surface of valve shall be based on **JIS B 0601** (Definitions and Designation of Surface Roughness). It shall be inspected by **JIS B 0651** (Instruments for the Measurement of Surface Roughness by the Stylus Method) or **JIS B 0652** (Instruments for the Measurement of Surface Roughness by the Interferometric Method), and shall conform to the requirements in **6.2**.

(3) **Tip Hardness**
The hardness of hardened tip shall be inspected by **JIS B 7725** (Vickers Hardness Testing Machines) or **JIS B 7726** (Rockwell and Rockwell Superficial Hardness Testing Machines) according to the agreement between the parties concerned, and shall conform to the requirements in **6.3**.

8.3 Inspection of Shape and Dimensions

The shape and dimensions shall be inspected by direct measurement and limit gauge and in the following steps (1) to (9), and shall conform to the requirements in **7**.

(1) **Face Angle**
The angle α made by the ideal shaft centre C-C of valve shown in **Figs. 2** and **3** and the generating line of conical face of valve shall be measured.

(2) **Deviation of Face**
With the valve supported on two 90° or 60° V blocks (to be in point to point contact with the object of measurement) nearly at both ends of stem, a stopper shall be applied nearly at the centre of tip and a dial gauge shall be applied nearly at the centre of face width at right angle. Then, the valve shall be rotated to measure the deviation of indicator on the dial gauge.

(3) **Roundness of Stem**
With the valve supported horizontally on a 90° or 60° V block (to be point to point contact with the object of measurement), a stopper shall be applied nearly at the centre of tip and a dial gauge shall be applied at right angle just above the supporting position of V block. Then, the valve shall be rotated to measure the deviation of indicator on the dial gauge. The roundness shall be, as a rule, indicated by mm

(4) **Straightness of Stem**
With the valve supported on two 90° or 60° V blocks (to be point to point contact with the object of measurement) nearly at both ends of stem, a dial gauge shall be applied nearly at the centre between the supporting points at right angle to the stem. Then, the valve shall be rotated to measure a half of deviation of the indicator on the dial gauge.

(5) **Cylindricality of Stem**
The deviation in diameter of stem shall be measured.

(6) **Coaxiality of Groove**
With the valve supported on two 90° or 60° V blocks (to be point to point contact with the object of measurement) nearly at both ends of stem, a dial gauge shall be applied nearly at the centre of groove at right angle to the stem. Then, the valve shall be rotated to measure a half of deviation of the indicator on the dial gauge.

(7) **Rectangularity of Tip**
With the valve supported on two 90° or 60° V blocks (to be point to point contact with the object of measurement) nearly at both ends of stem, a stopper shall be applied nearly at the centre of tip and a dial gauge shall be applied to the circumference of tip in the axial direction. Then, the valve shall be rotated to measure a half of deviation of the indicator on the dial gauge.

(8) **Rectangularity of Head**
With the valve supported on two 90° or 60° V blocks (to be in point to point contact with the object of measurement) nearly at both ends of stem, a stopper shall be applied nearly at the centre of tip and a dial gauge shall be applied to the circumference of head in the axial direction. Then, the valve shall be rotated to measure a half of deviation of the indicator on the dial gauge.

(9) **Face Dimensions**
As is shown in **Figs. 2** and **3**, B can be specified and measured in place of t_2. In this case, t_2 shall be calculated on the assumption that $B \cdot \mathrm{Cos}\,\alpha = t_2$.