PRODUCT MANUAL FOR ALLOYS
FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS-SPECIFICATION
AS PER IS 7494:2023

1.	**Product**	**:**	**IS 7494:2023**
	Title	:	**ALLOYS FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS-SPECIFICATION**
	No. of amendments	**:**	**NIL**
2.	**Sampling Guidelines**		
a)	**Raw material**	**:**	No specific requirement for raw material
b)	**Grouping Guidelines**	**:**	Please refer Annex -A
c)	**Sample Size**	**:**	For Chemical tests: 1) For chemical composition test: 5 pcs of 50 mm x 50 mm 2) For tensile test and hardness- 1 pc of 1 m length 3) For Grain Size and Non-Metallic Inclusion - 1 pc of 500 mm length
3.	**List of Test Equipment**	**:**	Please refer Annex -B
4.	**Scheme of Inspectionand Testing**	**:**	Please refer Annex -C
5.	**Possible tests in a day**	**:**	Please refer Annex -D
6.	**Scope of the Licence:**		
	License is granted to use Standard Mark as per IS 7494:2023 with the following scope:		
	Name of the product		**ALLOYS FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS-SPECIFICATION**
	Designation (Number/Grade)		VM-1/X45CrSi9-3, VA-1/X55CrMnNiN20-8,……
	Condition of Supply		Hot Rolled/Forged/ Drawn and Centreless Ground
	Heat treatment condition		As-rolled/As-forged/Annealed/Solution Treated/ Quenched and Tempered or any other condition

	Shape and Size	Round/Square/Hexagonal Bars/RCS or Billets of diameter/size from …xx…mm to up to and including ….xx… mm Flats of thickness from …xx…mm to up to and including …xx…mm, Width from …xx…mm to up to and including …xx… mm Hot Rolled Round/Square/Rectangular/Hexagonal Wire Rods of diameter/size from …xx… mm to up to and including …xx… mm
	Optional Requirements	With/Without Tensile Properties at Elevated Temperatures With/Without Creep Test

ANNEXURE A

GROUPING GUIDELINES for ALLOYS FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS as per IS 7494:2023

1. IS 7494:2023 covers the requirements for Alloys supplied in the form of bars and wire rods, up to 40 mm size, used for manufacturing of inlet and exhaust valves of internal combustion engines.

2. Valve Alloys have been classified based upon their chemical composition into 4 categories as under:
   I) Martensitic Steels (VM)
   II) Austenitic Steels (VA)
   III) Super Alloys (VSA)
   IV) Titanium Alloys (VTA)

3. Bars and Flats can be supplied in the Hot Rolled/Forged /Drawn and Centreless Ground Condition. Wire Rods are to be supplied in the Hot Rolled Condition. Further, the alloys shall be supplier either in the Heat Treated condition or any other condition,as applicable, as per Table 4

4. In view of above, the following Grouping Guidelines shall be considered for the purpose of GoL/CSoL:

Group	Designation (Number/Grade)	Grouping
I	Martensitic Steels- VM-1/X45CrSi 9-3 VM-2/X40CrSiMo10-2 VM-3/X50CrSi8-2 VM-4/40CrMoV47 VM-5/X85CrMoV18-2	One sample of any designation (number/grade) of each supply condition (Hot Rolled/Forged /Drawn and Centreless Ground) and each heat treatment condition (Annealed/Solution Treated/ Quenched and Tempered or any other condition) of any shape,size shall be drawn and tested to cover all designations, shapes and sizes for that supply condition and heat treatment condition
II	Austenitic Steels- VA-1/X55CrMnNiN 20-8 VA-2 /X53CrMnNiN 21-9 VA-3/X33CrNiMnN 23-8 VA-4/X20CrNiMnN 21-12 VA-5/X50CrMnNiNbN 21-9	One sample of any designation (number/grade) of each supply condition (Hot Rolled/Forged /Drawn and Centreless Ground) and each heat treatment condition (Annealed/Solution Treated/ Quenched and Tempered or any other condition) of any shape,size shall be drawn and tested to cover all designations, shapes and sizes for that supply condition and heat treatment condition

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III	Super Alloys- VSA-1/NiCr20TiAl VSA-2 /NiCr15Fe7TiAl VSA-/NiCr22TiMoAl VSA-4/NiCr22TiMoAlCo VSA-5/NiFe25Cr20NbTi VSA-6/NiCr19Co14MoTiAlFe VSA-7/NiCr20Co17TiFe VSA-8/X5NiCrTiAl30-15-2	One sample of any designation (number/grade) of each supply condition (Hot Rolled/Forged /Drawn and Centreless Ground) and each heat treatment condition (Annealed/Solution Treated/ Quenched and Tempered or any other condition) of any shape,size shall be drawn and tested to cover all designations, shapes and sizes for that supply condition and heat treatment condition
IV	Titanium Alloys- VTA-1/TiAl6V4 VTA-2/TiAl6Zr4Mo2Sn2	One sample of any designation (number/grade) of each supply condition (Hot Rolled/Forged /Drawn and Centreless Ground) and each heat treatment condition (Annealed/Solution Treated/ Quenched and Tempered or any other condition) of any shape,size shall be drawn and tested to cover all designations, shapes and sizes for that supply condition and heat treatment condition

5. In case the licensee/applicant desires tensile properties at elevated temperatures and creep values to be covered in the scope of licence, the licensee/applicant shall declare the guaranteed tensile properties at elevated temperatures and creep values, taking reference of Table 6 and 7, and sample of each designation(number/grade) for which the properties are guaranteed shall be tested for the guaranteed tensile properties at elevated temperatures and creep values for covering the same in the scope of licence.

6. However, it shall be ensured that the firm is having all the necessary manufacturing and testing facilities for the manufacture and testing of all the designations, conditions, heat treatments, shapes and sizes to be covered in the scope of licence.

7. During the operation of licence, BO shall ensure that all the varieties covered in the license are drawn for independent testing on rotation over a period of time.

ANNEXURE B

LIST OF TESTING EQUIPMENT for
ALLOYS FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS
as per IS 7494:2023

Major test equipment required to test as per requirements of Indian Standard.

Sr.No	Test Equipment/Chemicals	Tests Used in with Clause Reference
1	Rough Polishing Machine, Abrasive Cutting Machine, FinePolishing Machine, Grinding Machine, Molding machine, Longitudinal cutting machine	Preparation of specimen
2	Clause 8 (Freedom from Defects)	Vision-based inspection system, Eddy Current Tester or any other NDT based Surface Inspection
3	Chemical Composition Clause - 7, 7.1, 7.2 for C, Si, Mn, Ni, Cr,Mo, T, V, S, P, N,W, Ti, Nb, Ta, Al, Co, Cu, B, Zr, Y, Sn, O	**Instrumental methods** Spectrometer: atomic-absorption spectrometry, inductively coupled plasma atomic emission, inductively coupled plasma mass spectrometry techniques, spark source optical emission spectrometry, Gas Analyzer (O-H-N Analyzer), Standard Reference Material with certificate **Chemical methods** Laboratory reagents and apparatus as per parts of IS 228 (indicative list enclosed)
4	Tensile Test at Room Temperature, Clause 9.1, 9.3.3	Tensile Testing Machine of suitable range fitted with extensometer,
5	Hardness Test, cl.9.1, 9.3.2	Brinell Hardness Tester of suitable Range preferably 9,807 N to 29,42 kN with Standard Reference Blocks of Thickness 6mm, 12mm and 16mm.Conditioning Facilities - control the temperature within a range, such as 23 °C ± 5 °C.
6	Creep Test, cl.9.3, cl.9.3.4	Tensile Testing Machine with Extensometer, Thermocouples, Temperature Measuring Equipment with sensitivity of 0.5 deg celsius, Laboratory Furnace, Stop Watch, Vernier Caliper, Micrometer
7	Grain Size, cl.10,Inclusion Rating, Clause 11	Microscope (up to 500X Magnification), Etchants
9	Tensile Test at Elevated Temperatures, Clause 9.3.3	Universal Tensile Testing machine for High Temperature Test with temperature control arrangement and strain/Strain measurement arrangement.
10	13(Dimensions and Dimensional Tolerances)	Vernier Calipers, Micrometer, Scale, Cord, Measuring Tape, Straight Edge, Flatbench, Surface Plate, Steel Tape

Note 1: The list above is meant for guidance and may not be taken as exhaustive.

INDICATIVE LIST OF TEST APPARATUS, CHEMICALS AND REAGENTS FOR CHEMICAL ANALYSIS THROUGH CHEMICAL METHODS AS PER IS 228

1.	Strohlein or Leco apparatus with all attachments Barometer with chart, Hot plate, Muffle furnace, Complete range of glass wares, measuring cylinders, Desiccators, porcelain boats or ceramic crucibles, Thermometer, Electronic Balance, Distilled Water, Hot air oven, Oxygen - 99.5 percent minimum purity, ether or acetone Standard Reference Material (NML) with certificate Reagents for C: tin granules or pure iron fillings, acidulated water/brine water, methyl red, caustic potash Reagents for S: Ceramic boats/crucibles – desiccators, Fluxes - Low sulphur copper, tin or iron, Dilute hydrochloric acid, Starch Iodide solution, Potassium iodate	C & S (chemical method, alternative to instrumental method)
2.	Weighing balance, Heater/ Heating element along with energy regulator, Ice water bath, Vol Flask Cap – 1 litre, (Whatman) filter paper No. 040, Suction Filtration Facility, Filter paper pulp pad, Standard Reference Material (NML) with certificate, Potassium Permanganate (KMnO4), Sodium Nitrite (Na2NO3), Ammonium Molybdate [(NH4)2 Mo2O7], Ammonium Phosphate [(NH4)3 PO4], Potassium Nitrate (K2NO3), Phenolphthalein Solution, Rectified spirit or methyl alcohol, Sodium Hydroxide (NaOH), Hydrofluoric Acid (HF), Perchloric Acid (HClO4), Sulphurous Acid, ,Hydrobromic Acid (HBr) , other chemicals and reagent as applicable	Phosphorus content (chemical method, alternative to instrumental method)
3.	Hot plate, Conical flask Reagents: silver nitrate, ammonium persulphate sodium arsenite solution, Dilute Nitric Acid, Phosphoric Acid, Dilute Sulphuric Acid, Concentrated .Nitric Acid, NaCl Solution, Permanganic acid	Manganese content (chemical method, alternative to instrumental method)
4.	Medium textured filter paper, Porcelain casserole, platinum crucible, filter paper pulp, hot plate, hot air oven, muffle furnace Reagents: Silver nitrate solution, concentrated nitric acid, concentrated sulphuric acid, Dilute Hydrochloric Acid, Dilute Sulphuric Acid, Perchloric Acid, Tartaric acid and hydrofluoric acid	Silicon content (chemical method, alternative to instrumental method)
5.	Plate, Muffle Furnace, porcelain or silica crucible, Reagents: Hot Wash Solution(dilute sulphuric acid solution 1 : 99 v/v with hydrogen sulphide), dilute sulphuric acid, hydrogen sulphide, Dilute Nitric Acid, Sodium Fluoride, solid, Dilute Ammonium Hydroxide, Acetic Acid, Potassium Iodide, Starch Solution, Sodium Thiosulphate Solution, Ammonium Bifluoride Solution	Cu content (chemical method, alternative to instrumental method)
6.	ashless paper pulp, paper pulp pad, hot plate, desiccators, Reagents: ammonium nitrate, methyl red, dilute ammonium hydroxide, Concentrated hydrochloric acid Concentrated nitric acid, Perchloric acid, Hydrofluoric Acid	Ni content (chemical method, alternative to instrumental method)
7.	Hot plate, stop watch Reagents: dilute sulphuric acid and phosphoric acid mixture, concentrated nitric acid, ammonium persulphate, silver nitrate, dilute hydrochloric acid, ferrous ammonium sulphate, and standard potassium permanganate solution.	Cr content (chemical method, alternative to instrumental method)

8.	Reagents: Perchloric Acid, Phosphoric Acid, Nitric Acid, Hydrochloric Acid, Dilute sulphuric acid, potassium thiocyanate solution, stannous chloride solution, n-butyl acetate, Iron-Mo free, molybdenum metal (99.9 pc pure) Spectrophotometer, Volumetric flask, conical flask, titration apparatus (burette, pipette etc.), hot plate, thermometer, separating funnel, dry filter paper and other laboratory glassware and apparatus	Mo content (for determination of Mo by thiocyanate (photometric method) method in low and high alloy steels for Mo 0.01 to 1.50 percent) as per IS 228 Part 10
9.	Reagents: Dilute sulphuric acid, conc nitric acid, hydrofluoric acid, boric acid solution, potassium bisulphite, ferrous sulphate solution, Alpha-Bentoinoxime Solution, Bromine Water, Sulphuric Acid-Benzoinoxime Wash Solution, Dilute Ammonium Hydroxide Solution, Concentrated Hydrochloric Acid, Dilute Hydrochloric Acid, Tartaric Acid, solid, Hydrogen Sulphide, gas, Hydrogen sulphide Wash Solution, Cinchonine Solution Platinum crucible, Volumetric flask, conical flask, titration apparatus (burette, pipette etc.), hot plate, thermometer, separating funnel, ashless filter paper and other laboratory glassware and apparatus	Mo content (for determination of Mo by Alpha-benzoinoxime method in alloy steels for Mo > 1 percent and not containing Tungsten)

Note 1: The list above is meant for guidance and may not be taken as exhaustive.

ANNEXUREC
To PRODUCT MANUAL FOR
ALLOYS FOR INTERNAL COMBUSTION ENGINE VALVE APPLICATIONS
as per IS 7494:2023

SCHEME OF INSPECTION AND TESTING

1. LABORATORY - A laboratory shall be maintained which shall be suitably equipped (as per the requirement given in column 2 of Table 1) and staffed, where different tests given in the specification shall be carried out in accordance with the methods given in the specification.

1.1 The manufacturer shall prepare and implement a calibration plan for the test equipment.

2. TEST RECORDS–The manufacturer shall maintain test records for the tests carried out to establish conformity.

3. PACKING AND MARKING– The Standard Mark, as given in the Schedule of the licence, shall be incorporated on each bundle of the material or on a metal tag affixed to each bundle, provided always that material so marked conform to requirements of the specification.

3.1 Marking shall be done as per the provisions of the Indian Standard. In addition, the following shall be incorporated on each bundle of steel bars or the metal tag affixed thereto:

i) BIS Licence Number CM/L—and
ii) BIS website details i.e. "For details of BIS certification please visit www.bis.gov.in"

3. CONTROL UNIT – For the purpose of this Scheme, a control unit is defined as material of same cast, condition, heat treatment , shape and processed to same dimensions under uniform conditions of production.

4. LEVELS OF CONTROL - The tests as indicated in column 1 of Table 1 and the levels of control in column3 of Table1, shall be carried out on the whole production of the factory which is covered by this plan and appropriate records maintained in accordance with paragraph 2above.

4.1 All the production which conforms to the Indian Standards and covered by the licence should be marked with Standard Mark.

5. TEST CERTIFICATE-For each consignment of BIS Certified material conforming to IS 7494:2023 there shall be a test certificate issued that shall indictae the corresponding test results (as given in Annexure-I, enclosed)

6. REJECTIONS–Disposal of non-conforming product shall be done in such a way so as to ensure that there is no violation of provisions of BIS Act, 2016. Disposal of non-conforming product shall be done in such a way so as to ensure that there is no violation of provisions of BIS Act, 2016. Any rejected material which is potentially resalable be sheared or cut or deformed in such a manner that it cannot be used for any other purpose. A separate record shall be maintained giving information on quantity and batch number/control unit number, as applicable, relating to all such rejections/defective/substandard material of the production not conforming to the requirements of the Specification and the method of its disposal. Such material shall in no case be stored together with that conforming to the Specification. The Standard Mark (if already applied) on rejected material should be defaced.

TABLE 1 LEVELS OF CONTROL
(PARA 4 OF THE SCHEME OF INSPECTION ANDTESTING)

(1)				(2)	(3)		
Test Details				**Test equipment requirement R:required (or)S:Sub-contracting permitted**	**Levels of Control**		
Cl.	**Requirement**	**Test Methods**			**No. of Sample**	**Frequency**	**Remarks**
		Clause	**Reference**				
7	Chemical Composition	IS 228 (All Parts) or Any established instrumental/chemical method. However, records of referee method as agreed to between manufacturer andpurchaser shall be maintained.					
	Ladle Analysis	7.1, Table 1	IS 7494	R	One	Each Heat	Applicable for primary producers only. Manufacturers without steel making facilities shall maintain records of test certificates for ladle analysis of each heat.
	Product analysis	7.2, 14.1, 15.1, Table 1, Table 2	IS 7494	R	One	Each Cast	For manufacturers not having steel making facilities If the material fed to rolling/forging/drawing dies is ISI marked, no further testing is required.

8	Freedom from Defects	8.1, 8.2.	IS 7494 IS 919 (Part 2)	R	Manufacturer shall exercise adequate in-process control to ensure that the material manufactured is free from harmful defects.		
9	Mechanical Properties (Tensile Test at Room Temperature, Hardness)	9.1, 9.2, 9.3, 9.3.1, 9.3.2,14.2, 14.3, 15.2,Table 3, Table 4	IS 1608 (Part 1) IS 1500 (Part 1) IS 3711	R	One	Each Control Unit	----
9.3.3	Tensile Test at Elevated Temperature	9.3.3, Table 6	IS 1608 (Part 2)	S	----	----	Optional
9.3.4	Creep Strength	9.3.4, Table 7	IS 3407 (Part 1) IS 3407 (Part 2) IS 17795	S	----	----	Optional
10	Grain Size	---	IS 4748	R	One	Each Control Unit	----
11	Non-Metallic Inclusions	11.1	IS 4163	R	One	Each Control Unit	----
13	Dimensions and Tolerances	---	IS 3739 IS 10604 (Part 2) IS 919 (Part 2) IS 919 (Part 1) IS/ISO 16124	R	Adequate inspection to ensure that each item conforms to the requirements of specification		

Note-1: Whether test equipment is required or sub-contracting is permitted in column 2 shall be decided by the Bureau and shall be mandatory. Sub-contracting is permitted to a laboratory recognized by the Bureau or Government laboratories empanelled by the Bureau.

Note-2: Levels of Control given in column 3 are only recommendatory in nature. The manufacturer may define the control unit/batch/lot and submit his own levels of control in column 3 with proper justification.

Annexure-I

(Para 5 of the Scheme of Inspection and Testing)

_____IRON AND STEELCOMPANY

(Registered office Address and works address)

BIS STANDARD MARK

TEST CERTIFICATE

FOR STEEL FOR VALVES FOR INTERNAL COMBUSTION ENGINES

TEST CERTIFICATE No._____ DATE_____

To M/s_____

We certified that the material described below fully conforms to IS 7494:2023 Chemical composition and Physical properties of the product, as tested in accordance with the Scheme of Inspection and Testing contained in the BIS Certification Marks LicenceNo.CM/L_____areas indicated below against each order No.

(PLEASE REFER TO IS 7494:1981 FOR DETAILS OF SPECIFICATION REQUIREMENTS)

TEST RESULTS

Order no and date	Size/Shape /Type	Designation/ Condition	Cast	Quantity	Chemical Composition											Mechanical Properties		Elevated Temperature # tests/Creep Strength Remarks	Grains size, Inclusion Rating
					C	Si	Mn	Ni	Cr	Mo	T	V	S	P	N	Others	Hardness	TS (Mpa)	

if required by purchaser

REMARKS WAGON NO.

TRUCK NO.

FOR_____IRON AND STEELCOMPANY

(It is suggested that size A4 paper be used for this test certificate)