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A Uniform Specification of Metallic Materials used in Machine Building of the USSR

by

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UNIFORM SPECIFICATION OF METALLIC MATERIALS USED FOR MACHINE BUILDING IN THE USSR

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INTRODUCTION

In the USSR all problems of regularization in any technical field, above all problems of classification, of rational terminology, and of the correct construction of a system of standards are of tremendous importance. The socialist character of our economy permits the utilization of all the advantages of uniformity of standardization to a degree unthinkable of in the capitalist world. The All-Union character of the standards and the possibility of constructing them on actual scientific foundations should be considered a distinct feature of standardization in a socialist economy.

The rational construction of a system of standards in the field of metallic materials is very important. Practically all branches of industry are somehow connected with the production or the use of the most variegated metals or alloys. The number of metallic materials in use is very great. It is, therefore, necessary that there exist a uniform system of standardization, designation, and technical specification for various metallic materials. Of course, priority in this work is to be given to the field of machine building in the Soviet Union, with the concept of this field to be adequately wide so as to include such branches of machine building as the aviation- and tank-building industries, the manufacturing of armaments and munitions, transportation- and chemical-machine building, etc. During the war, Soviet industry was frequently subject to difficulties traceable to the absence of standardization. Discrepancies in standards, technical specifications, systems of designations retarded the planning and operational solutions of many problems pertaining to production orders, to the distribution of metals and their switching from one industry to another as needed, and the like. The same causes hindered the proper utilization of the ample experience accumulated by the leading branches of the machine-building industry. The problem of arriving at a rational uniform specification for the metallic materials used in the machine-building industry is of no less importance during the postwar period. We are confronted with the stupendous task for the restoration of the machine-building industry in areas which were temporarily occupied by the enemy, with the final allocation of machine building to the various industrial zones, and, with particular reference to the eastern zones, with the organization of a proper link between the machine-building and the metallurgical industries. This stupendous program will be accomplished more rapidly, at lower cost, and with greater economic effect, if the scientific bases for a series of the most important key problems of machine building are developed a priori. One of such key problems is the creation of a uniform specification for the materials involved in machine building for the entire Soviet Union. A sharp reduction in the number of makes of metallic materials and semi-finished products, a simplification in the designation of the materials in technical drawings and in the marking of semi-finished products, will facilitate the work of the metallurgical plants and improve the utilization of the metal. Furthermore, the transition to a uniform specification for metallic materials will undoubtedly improve the utilization of accumulated experience in the use of metals and will facilitate the work of the designing, technological, and planning sections.

At the present time industry disposes of several thousands of various materials. Not only in different countries, but even within the boundaries of one and the same country, the same material is known by several names and designations, in relation to the plant that produces it, the plant that processes it, and, frequently, even the plant that uses it in the manufacturing of an end product. For example, in the United States, the typical stainless steel, containing 0.1 % C, 18% Cr, 8% Ni, is known under the following names and brand names: USS 18-8, Allegheny 22.0-KA-2, SS4, DHKA-", Industrial No 188, Otisel 1, UHB, etc.

Thus, there are tens of thousands of names and makes of the most variegated metallic materials in circulation, making it rather difficult and chaotic. To bring order out of chaos in this field, is to solve the following problems:

(1) To establish a simple and reliable principle for the uniform designation of all metallic materials so that the latter are disposed in natural groups. In other words, the principle of designation, marking, is to conform to some predetermined classification.

(2) From the tremendous number of metallic materials to

select the most technically and economically suitable (efficient), in numbers adequate to service all branches of machine building. This list, naturally, is to be subject to variations with time, accounting for the progress being made in the field of metallic materials, i.e., obsolete alloys to be replaced by newly developed alloys. Such a list (specification) is to serve as the basis for the metallic materials standard.

(3) To prepare an exhaustive technical characteristic of all standardized metallic materials which will permit the maximum practical utilization of all the data acquired by science and industry pertaining to metallic materials.

Numerous attempts in this fiels, such as the SAE specifications in the United States, the DIN specifications in Germany, the BSA specifications in England, do not venture out any further than the making of some recommendations, at times valuable and with possibilities for practical application, but still miles away from the solution of the problem as posed above. The above mentioned countries have not developed any sizable classifications of metallic materials and any unified and rational system of designation. The International Association of Standards (ISA), to date, has also produced no tangible results of any kind. It is obvious that the chaotic state of the markets and the law of competition are responsible for this condition. Each industrial organization, the metal producer, as well as the metal consumer, come forward with their own system of classification, standardization, and designation of materials. To take only the automotive industry in the United States, General Motors, the Ford Company, and others bring forward different specifications and different methods of designating materials. All this -- alongside the partly in use SAE (Society of Automotive Engineers) specifications, which were especially developed for the automotive industry as a whole. A similar picture is observed in other countries. There is no doubt that the problem of the scientific standardization of metallic materials can be solved in a socialist country only, where the chaotic conditions of the market and uncontrolled competition are replaced by centralized planning. However, we are still far away from the solution of this problem, even to any appreciable degree, in our country. First of all, there is the absence of a uniform system of classification and marking, which should be accepted by the entire machine-building and metallurgical industries, not to mention the absence of a technical characteristic of metallic materials. The systems of classification and marking in use for various metallic materials are clearly non-satisfactory. For instance, the OST pertaining to carbon and alloy steels, and also many departmental standards, attempt, with the aid of letters and figures, to so phrase the make (designation) of the metallic material as to fully reveal the chemical composition of the steel. The deficiency inherent in this principle becomes obvious through the following example: a typical refractory valve steel will have to be designated, in keeping with the above principle, by 16 symbols such as 45KL15N 15VZS1.5MA. Relatively simple steels receive complex and difficult to pronounce designations (as 50S2GA for silicon-manganese steel). It is worth noting that already in the OST's themselves some departures, uncalled for and unjustified, from the accepted system of designations, have been made. The designations are to be punched on each rod, each forging, each pipe, etc, and marked in the drawings. Such complex designations are difficult to remember and they cannot be used orally. It is small wonder that entire branches of industry and individual enterprises have their own specifications and methods of designation, which frequently are very poor in quality, but most of the time are a result of historical stratification of various methods of designation. There also are specifications in which, in addition to four different [domestic] methods of designation, three foreign designations, originating in three different countries, are used. They found their way to us with the "technical" assistance that was rendered in the beginning of the 1930's. Many plants began to arbitrarily abbreviate and simplify the OST designations, which procedure obviously does not improve the situation. As a result of the above, there is confusion which, in terms of money, is very expensive to the State, plus the great difficulties in the way of the orderly flow of production.

The situation is no better with relation to nonferrous metals. In the case of copper alloys there is a system which reduces itself to the abbreviated designation of the chemical composition. For simple alloys, as for instance tin bronze, plain brass, the designations are still simple but already for ternary alloys the designations run into 3-4 letters and 5-6 figures, i.e., they also become very complex as, for instance, LXLM58-1.5-0.8 or I_z65-15-20. For the designation of the light alloys of an exceptionally important group, on which the aviation industry is based to a great extent, no system at all exists in the USSR. As far as departmental standards are concerned they use designations based on simple index numbers, or designations of foreign origin, or designations expressing the factor of the strength of the materials (probably taken from the completely erroneous German DIN system for carbon steel, based on the classification of the steel not by its composition but by its strength).

In addition to the tremendous inconveniences and direct losses resulting from all this contradiction and confusion, the lack of a uniform system creates a condition of rigidity and makes it impossible for the resources of one branch of industry to be utilized in other branches. If the same type of steel is used in various industries under different designations the transmission of experience and, when the need arises, the transfer of materials or the proper substitution of one material with another, from one industry to another, becomes very difficult. In order to accomplish the above, specifications and designations of the most variegated branches of industry must be available. It is, therefore, clear that the creation of a uniform specification for the metallic materials of machine building is a problem of long standing. Under the war conditions it was difficult even to pose the problem of the radical overhauling of the entire system of standardization of metallic materials. There is much more involved in this than the simple authorization of a new technical rule. If some new system of standardization is adopted all the departmental and plant specifications must be changed accordingly, the stamped markings of all the stocks of semifinished goods at the metallurgical plants are to be changed, the designations of all the materials in millions of drawings and technical papers must be changed. Hence, a new solution for the problem of a uniform specification for metallic materials becomes a task of the highest responsibility. It is first of all necessary, with maximum determination, to emphasize two conditions:

(1) The new specification is to be uniform, at least for the entire machine-building industry. Any attempts to create new systems within the framework of any one branch of machine building will only result in the further increase of the number of circulating designations and to still greater confusion. A new specification may become an essential factor in the progress of the machine-building industry only when it will be adopted by the entire machine-building industry and by the metallurgical industry, which supplies the former with metal.

(2) The new specification is to be based on the principles of uniformity for all metallic materials. If there is going to be one system of classification and designations for steel, another one for copper alloys, and still a third one for light alloys, it will only produce confusion and errors in drawings and technical papers.

In order to fulfill this assignment, we decided to adhere to the following plan:

(1) The development of a uniform system of classification and marking (designations) for all metallic materials. The development for all metallic materials of a uniform technical passport (standard tabulation) containing a summary of data which adequately characterizes the material.

(2) The critical review and the processing of all existing OST and departmental standards for metallic materials to

comply with the new system of standards.

It would be entirely improper to develop the new specification in a purely theoretical atmosphere detached from the actualities of production. For the time being the existing standards and technical specifications, with all their shortcomings, still constitute the most generalized form of practical plant experience. Hence, the new system of standardization is to be built, to a considerable extent, upon the critical processing of the data available. Each existing material was represented by its "technical passport". Then, closely related designations were studied comparatively by the technical data in their passports. In so doing, it became possible to merge a number of designations. The chemical compositions were then, within a permissible range of admixtures and saturation points of various elements, subject to some unification. Then, the semifinished products for each designation were scanned by their properties, with everything superfluous eliminated, reducing thereby the number of semifinished products. The contradictions in the properties of the adjacent designations and semifinished products were scanned with a view to eliminating as much of it as possible. Finally, scientific literature was scanned for the extraction therefrom of the most reliable data to serve as additional information required. In such a manner, we derived the "technical passports", which, in the aggregate, constitute a section of the new specification.

In this issue, the first section of the uniform specification "Carbon Steels", in the form of a project, is offered for detailed analysis and criticism. The subsequent issues, containing all the other sections of the uniform specification, will also be published in the form of projects and submitted to scientists and industrial personnel for criticism. We hope that, on the basis of these projects, and the deliberations and criticism that will follow, a final version of a new uniform specification of metallic materials for the Soviet machine-building industry will be constructed and submitted for approval by the proper authorities. Together with the specification, the manner of its practical application, in the industries involved, will have to be authorized.

It is, of course, completely necessary that the specification is periodically modified and amended in keeping with the progress of metallography and metallurgy, and also in keeping with the new demands of the machine-building industry.

PART I

THE SYSTEM OF CLASSIFICATION, DESIGNATION, AND TECHNICAL PASSPORTS FOR METALLIC MATERIALS

1. THE CLASSIFICATION AND DESIGNATION OF METALLIC MATERIALS

The chemical composition, as an index specifying the metallic material, can be represented by a single number /one digit/ and should therefore be the basis of the classification. The structure and the mechanical properties of the materials are not constant -- they are subject to change in treatment. In addition different materials may have a similar structure. Hence neither the structure nor the properties of the material can serve as the basis for the industrial classification of metallic materials. It is quite clear that the destination of the material, too, cannot be used as a basic classification index. We found it rational to construct a system of designations using number indexes only, excluding all letter designations, which can be used to better advantage for other purposes. For the purposes of the machine-building industry of the USSR, no more than a 1,000 different metallic materials are to be standardized. Considering a ten-digit reserve as necessary, it can be seen that the most economical designation should consist of four-digit indexes only. The use of the decimal system, which has amply proved itself in many fields of application, was decided upon, i.e., the basic distribution of the materials to be into ten groups, with subsequent subdivisions into numbers of groups divisible by ten.

This system embraces all structural and tool metal materials (but not reduction materials). The chemical composition of the material is the basis of the classification. All metallic materials are distributed by their chemical composition into ten groups (Table 1).

TABLE 1

Group Index	Groups	Explanatory Note
0	Iron and carbon steels with a carbon content up to 1 %	With manganese up to 1% and silicon up to 1%
1	Carbon steels with carbon from 1 to 2%	Same as above
2	Cast irons	With carbon above 2%
3	Alloy steels (low- and medium-alloy)	With total content of alloying elements up to 10%
4	High-alloy steels	Same as above
5	Aluminum alloys	With aluminum as the predominant component
6	Magnesium alloys	With magnesium as the predominant component
7	Copper alloys	With copper as the predominant component
8	Tin and lead alloys	With tin or lead as the predominant component
9	All other metals and alloys	

The material is designated by a four-digit number. The first figure of this number is the group index. Hence, the characteristic of the material can easily be determined at a glance, i.e., whether it belongs to the aluminum-alloy group (5), or the low-alloy steels (3), etc. The next figure in the four-digit number relegates the material to a subgroup within the range of the given group. The method of dividing groups into subgroups varies in relation to the characteristic of the material. The last two figures in the four-digit number serve to separate individual alloys within the range of the given subgroup.

Such a system of classification has the following advantages:

(1) The simplicity of alloy designation (four digits) and the subsequent ease of pronunciation and ease of designation in drawings.

(2) With this adequate simplicity of designation, the possibility is present for the classification of 10,000 different materials which is more than 10 times in excess of present practical requirements, creating thereby a necessary reserve of designations for changes, additions, etc, for many years to come.

(3) The absence of letter designations simplifies pronunciation and makes the alphabet available for other purposes (see below).

Let us analyze, in order, all the groups.

(0) - Carbon steels (up to 1 percent carbon). The group index is 0. The numbers comprising the group run from 0000 to

0999. The group index (0) is followed by the index of the subgroup, which divides all carbon steels into the following five subgroups:

01 - normal in purity, i.e., with sulfur and phosphorus not to exceed 0.055 percent;

02 - contaminated by excessive sulfur and phosphorus;

03 - with excessive manganese;

04 - automatic, high in sulfur;

09 - special grades.

The last two digits designate the mean carbon content in the steel in hundredths of a percent. Thus, the following markings (designations) are obtained:

0115 - carbon steel of normal purity with a mean carbon content of 0.15 percent.

0220 - excessively contaminated steel with a mean carbon content of 0.20 percent, etc.

(1) Carbon steels (from 1 to 2 percent carbon), the group index being 1. The numbers comprising the group run from 1000 to 1999. In the same manner as the carbon steels of the preceding group (0), these steels are divided into subgroups 01, 02, 03, 04, and 09.

The last two digits designate the mean carbon content in hundredths of a percen , which are present in the steel in excess of 1 percent.

Thus, 1120 designates a steel normal in purity, with 1.2 percent carbon.

(2) Cast irons (the group index is 2). The numbers designating the group run from 2000 to 2999. Only foundry-produced (but not reduction) structural cast irons are relegated into this group. The cast irons are divided into two large divisions -- non-alloy cast irons, with numbers from 2000 to 2099; and alloy cast irons, with numbers from 2100 to 2999. The alloy cast irons, in turn, fall into subgroups by their predominant alloying element. The digit for the alloying element is common to both alloy cast irons and alloy steels.

Alloying Element	Index
Chromium	1
Nickel	2
Manganese	3
Silicon	4
Aluminum	5
Tungsten	6
Chromium + Molybdenum	7
Chromium + Nickel	8
Others	9

In keeping with the above digits, the following numbers (designations) are arrived at for alloy cast irons, which contain as their predominant alloying element the following metals:

Chromium	2100-2199
Nickel	2200-2299
Manganese	2300-2399

Silicon	2400-2499
Aluminum	2500-2599
Tungsten	2600-2699
Chromium + Molybdenum	2700-2799
Chromium + Nickel	2800-2899
Other metals	2900-2999

Thus, the second digit in the designation relegates the cast iron either to the subgroup of non-alloy cast irons or to the corresponding subgroup of alloy cast irons. Any further division of cast irons is done with the aid of the third and fourth digits in the designation (from 01 to 99). If necessary, in the case of non-alloy cast irons, the subgroup held in reserve, i.e., 2900-2999, may be used.

(3) Low-alloy steels (group index 3). The numbers comprising the group run from 3000 to 3999. The low-alloy steels are separated into subgroups in conformity with the above tabulation of digits for the predominant alloying elements. Thus, the following subgroups of low-alloy steels are arrived at. They contain, as their predominant alloying element, the metals tabulated below:

Chromium	3100-3199
Nickel	3200-3299
Manganese	3300-3399
Silicon	3400-3499
Aluminum	3500-3599
Tungsten	3600-3699
Chromium + Molybdenum	3700-3799

Chromium + Nickel	3800-3899
Other metals	3900-3999

The further division of subgroups into individual steels is done with the aid of figures from 01 to 99. It must be noted that more complex steels fall into the corresponding group by their predominant alloying element. For instance, chromo-vanadium steel, with 1 percent chromium and 0.1 percent vanadium falls into group 31. The same happens with steels of a still higher complexity.

(4) High-alloy steels (group index 4). The numbers comprising the group run from 4000 to 4999. The division of high-alloy steels into subgroups is entirely similar to the division in the preceding group. Thus, we arrive at subgroups of high-alloy steels containing as their predominant alloying element the additions of the following metals:

Chromium	4100-4199
Nickel	4200-4299
Manganese	4300-4399
Silicon	4400-4499
Aluminum	4500-4599
Tungsten	4600-4699
Chromium + Molybdenum	4700-4799
Chromium + Nickel	4800-4899
Other metals	4900-4999

The division of the subgroup into individual grades of steel is similar to the division in the preceding group.

(5) Aluminum alloys (group index 5). The numbers comprising the group run from 5000 to 5999. The distribution of the aluminum alloys into groups is done in conformity with the predominant alloying element. The following digits are ascribed to the alloying elements:

Alloying Element	Digit
Iron	1
Manganese	3
Silicon	4
Magnesium	6
Copper	7
Other metals	2, 8, 9

Technical aluminum free of alloying additions is given the subgroup index 50. Thus, by the predominant alloying element, the following subgroups are arrived at:

Pure and technical aluminum	5000-5099
Alloys with the predominant alloying addition of:	
Iron	5100-5199
Manganese (manganous aluminum alloy)	5300-5399
Silicon (silumin alloy)	5400-5499
Magnesium (magnalin alloy)	5600-5699
Copper (alloys of the duralumin type and many others)	5700-5799 and 5800-5999

The distribution into individual alloys within the range of a subgroup is accomplished by stringing on the numberal indexes from 01 to 99.

(6) Magnesium alloys (group index 6). The numbers comprising the group run from 6000 to 6999. The classification for the magnesium alloys is constructed in a manner similar to the classification for the aluminum alloys.

The following subgroups are arrived at:

Pure and technical magnesium	6000-6099
Alloys with the predominant addition of:	
Manganese	6300-6399
Aluminum	6500-6599
Zinc	6800-6899
Other metals	6900-6999

The breakdown into individual alloys is accomplished with the aid of numeral indexes, as in the case of the preceding group.

(7) Copper alloys (group index 7). The numbers comprising the group run from 7000 to 7999. The classification of the alloys is, as above, by the character of the predominant alloying admixture. The following subgroups are arrived at:

Copper	7000-7099
Alloys with the predominant addition of:	
Iron	7100-7199
Nickel	7200-7299
Manganese	7300-7399

Silicon	7400-7499
Aluminum (aluminum-bronze alloy)	7500-7599
Tin (stannous-bronze alloy)	7700-7799
Zinc (brass)	7800-7899
Other metals	7900-7999

(8) Tin and lead alloys (group index 8). The numbers comprising the group run from 8000 to 8999. Due to the relatively slight practical utilization of this group of alloys, it is divided into four subgroups only:

Tin	8000-8099
Tin alloys	8100-8199
Lead	8500-8599
Lead alloys	8600-8699

Within the range of subgroups individual alloys are differentiated with the aid of numeral indexes as above.

In order to simplify the use of this classification system, the indexes for the alloying elements, in the case of nonferrous metals, are selected to be the same. These indexes are also made common to a maximum possible degree in the case of iron alloys, as can be seen from the table below.

Index	Alloying Element in the Group of Iron Alloys	Alloying Element in the Group of Nonferrous Metal Alloys
1	Chromium	Iron
2	Nickel	Nickel

3	Manganese	Manganese
4	Silicon	Silicon
5	Aluminum	Aluminum
6	Tungsten	Magnesium
7	Chromium + Molybdenum	Copper
8	Chromium Nickel	Zinc
9	Other metals	Other metals
0	No alloying elements	--

It is clear that in the case of the iron-alloy group index 1 may be utilized for another element. Such other element is chromium -- the most important alloying addition to iron alloys. In that case magnesium is not an alloying addition (and will hardly ever be) to iron alloys. Hence this index, in the case of iron alloys, is occupied by another important alloying element -- tungsten. Finally, in the place of zinc, which is never used as an alloying addition, index 8 is utilized for a very important and widespread iron group -- a combination of the alloying elements chromium + nickel (chromium-nickel steels).

(9) All other alloys (group index 9). The numbers comprising this group run from 9000 to 9999. This group is divided into the following subgroups:

Alkaline and alkaline-earth metals and alloys	9100-9199
Nickel and cobalt alloys	9200-9299
Subgroup unoccupied	9300-9399
Subgroup unoccupied	9400-9499

Mercury alloys (amalgams)	9500-9599
Tungsten and molybdenum alloys	9600-9699
Silver alloys and alloys of precious metals	9700-9799
Zinc and cadmium alloys	9800-9899
All other alloys	9900-9999

Individual alloys within the range of a subgroup are designated by numbers in sequence (the two last digits).

It must be particularly emphasized that the designations (marking) which, in conformity with this system of classification, are made up of numeral indexes pertain to the raw material only. Semifinished products and semifinished products in various phases of manufacture are designated by a different system of indexes, as per the table below.

Semifinished Products	Permissible Abbreviation for Designation
Rods	Rods
Strips	Strips
Tapes	Tapes
Profiles	Prof
Pipes, seamless	Pipes
Pipes, welded	Pipes weld
Wire	Wre
Forgings	Forgings
Stampings, die	Stamp
Semifinished products, pressed	Press

Castings, in the open	Casting "zeml" (earth)
Castings, chilled and centrifugal	Casting "kokil'n"
Die castings	Casting "dave"
Ingots	Ingots

Footnote. Flanged tape profiles are designated "profiles". Dick-press-made profiles are designated "profiles press". Profiles made by rolling are designated "profiles prokatn" (rolled).

Semifinished products not found in the list above are designated in full -- no abbreviations permissible. The physico-chemical condition of the material, alongside of its chemical composition, is the most important factor for the determination of the technical characteristics of the semifnished product. The following letter designations (as in the table below) of the physico-chemical condition of the semifinished product are to be permitted.

Condition of Semi-manufactures	Designation	Note
1. Heat-treated	T_1, T_2	The numeral subscript in the letter designation of the heat treatment (T) indicates the specific type of heat treatment, inasmuch as the same material may require several cycles of heat treatment in order to obtain various desired properties. The
2. Annealed	Zh	
3. Normalized	N	
4. Cold-hardened		
5. Cold-drawn	D	
6. Cold-rolled		
7. Hot-rolled	G	
8. Cast	L	

corresponding heat treatment is indicated in the "technical passport" of the material. [The designation capital letters are transliterated from the Russian.]

Finally, for the designation of the surface finish of the semimanufacture, the following system is suggested:

Surface Finish	Abbreviation for Surface Finish
Ground	Grnd
Burnished	Brnsh
Calibrated	Clbr
Sandblasted	Sandbl
Pickled	Pckl
Metal Plated (1)	Metpl
Galvanized (2)	Glvn
Cadmium Plated	Cadm
Copper Plated	Copp
Tin Plated	Tinpl
Chromium Plated	Chrompl
Nickel Plated	Nickpl
Varnished (3)	Varn
Passivated	Passiv

Notes

(1) - Unless specially indicated, metal plating, in the case of aluminum alloys, means plating with pure aluminum; in the case of iron alloys -- plating with copper.

(2) - In the case of brief specifications, the method of galvanizing is not indicated.

(3) - Covering with protective lacquer.

Hence, a full designation of a semimanufacture, for the purposes of drawings and specifications, will look, for example, like this:

0120 -- Zh (carbon steel, annealed)

3106 -- T_1 (chromium steel, heat treated)

On the semimanufactures themselves (rods, forgings, pipes, plates, etc), it is mostly necessary to punch out the designation of the material only, i.e., altogether four numeral digits; and, in a small number of cases, the physico-chemical condition, mainly, the heat-treatment index (one or two digits).

2. THE TECHNICAL PASSPORT OF THE METALLIC MATERIAL

The purpose of the technical passport (standard specifications card) is to give an exhaustive technical (quantitative, if possible) description of the material in as brief a form as possible. A scientifically founded description may be derived only on the basis of these passports. In discussing the inclusion (or exclusion) of some given data in the specification, an exhaustive technical description of the material must be available; it being the case that, in characterizing the materials, the same pattern must be followed. Otherwise, the comparing and choosing of materials will become difficult. The basis of the technical passport, as is the case in the classification of metallic materials, is the chemical composition of the material. In addition, the technical passport is to contain reliable calculation characteristics, which are of primary importance to the designer. These are the basic values for the mechanical and physico-chemical properties of the material in the same state in which it is used in construction. This, however, is not to be taken in a narrow sense. Not so long ago, the designer was using primarily the characteristics known as the modulus of elasticity and ultimate strength. Now, the list of mechanical factors the designer must deal with has not only been expanded several times, but new characteristics have been added such as coefficients of expansion (in the case of many machines operating at high temperature gradients); magnetic factors (in the case of electrical machine building); resistance to corrosion in water, air, or special media; heat conduction (as in calculating valve or piston mechanisms); etc. In addition, it is necessary to know all these factors not only at room temperature but also at low and high temperatures, since industry is always becoming more oriented in the direction of extreme conditions under which the material is to function. The diminution in the available reserves of strength in materials in the case of all branches of industry, but particularly in aviation, requires much more detailed data on the performance of materials under various mechanical load conditions, such as alternating and impact loads with notch stops, complex stresses, etc.

Only a small part of the characteristics of materials the modern machine-building designer must know figure as indexes in the control and inspection of the materials. These are usually the mechanical property values most accessible to large-scale testing such as hardness, ultimate strength, elongation, reduction in area, and impact ductility. Since most of the mechanical properties of a given material always display a certain range of values relative to fluctuations in chemical composition, heat treatment, etc, it is necessary to indicate either the lower permissible range of values for a given characteristic. This is of particular importance in the case of characteristics appearing frequently in design computations, and also in the case of indexes to be checked during the inspection of the material.

The technical passport is to contain the most important technological data: weldability, machinability by cutting, the potential for hot and cold deformation, casting characteristics (for molding materials), etc. Also here, much of what only yesterday had no practical significance is today necessary information to the technologist. For instance, electrical conductivity used to be important only as a characteristic of conducting materials. Today, with the rapid development of heating metals by means of the Joule effect (by passing a current through the material) and with high-frequency currents, this characteristic (and at various temperatures) is frequently required. Of course the technical passport must not become unwieldy. The data entering into the technical passport is to be absolutely reliable, thoroughly checked and rechecked, and amenable to practical utilization. First of all, it is to contain the revised standards and technical specifications. Then, the most reliable data developed by research institutes, foremost industrial enterprises, and some data from domestic and foreign literature should be included.

At the present time, exhaustive data pertaining to all the properties of all the materials is not yet available. Hence some materials will be characterized in greater detail, while for others only elementary data will be available. This in itself will further stimulate the process of filling in the missing data. In addition to the numerical and brief quantitative characteristics, the technical passport is to contain the most important diagrams which may be useful to the designer and technologist in the form of supplements.

The technical passport of a metallic material is a generalization of our practical experience. We are of the opinion that the technical passport will become the effective means for the propagation of the foremost experience pertaining to the use of metallic materials in structural assemblies and machines throughout the machine-building industry.

The technical passport (standard chart), as finally laid out, is shown on pages 14-15. Below are instructions for filling in the passport data. This procedure is necessary in order to eliminate all possible ambiguities in making up new passports and in utilizing the passports already available.

PART II

CARBON STEELS

1. THE CLASSIFICATION AND DESIGNATION (MARKING) OF CARBON STEELS

The availability of a wide selection of alloy steels with variegated mechanical and physico-chemical properties sometimes results in the uncalled for replacement of carbon steels with alloy steels.

War-time and postwar conditions call for the utmost care in the consumption of metals, particularly of the high-cost and short-supply alloying admixtures. Hence a wider use of carbon steels is desirable. For this purpose it is important to know exactly the mechanical properties of carbon steels and the effective range of conditions under which these properties prevail. With the proper selection of heat-treating procedures, carbon steels acquire very high mechanical properties. As can be seen from Figure 11 in the Supplement, the ultimate strength of carbon steels is fully comparable to the ultimate strength of many alloy steels if they are annealed to approximately the same hardness. However, with equal hardness carbon steels frequently lose in ductility (Figure 12, Supplement), which is a very important mechanical characteristic in the selection of material for construction purposes. However, in varying the heat-treating procedure, it is sometimes possible to combine high strength with adequately high ductility, as can be seen from the Beyn Table below, which shows simultaneously the effect of both carbon and structure upon the mechanical properties of carbon steel.

Mechanical Properties	Technically Pure Iron	Carbon Steel with 1% C		
		Camellar Perlitic	Granular Perlitic	Structure Upon Hardening and Tempering
Yield point, in kg/sq mm	18	60	28	--
Ultimate strength, in kg/sq mm	30	105	55	182
Elongation, in %	40	10	30	13
Reduction of cross section area, in %	70-75	15 (30)	57	45
Brinell hardness	80-85	300	156	540

The particular characteristic of carbon steels that considerably reduces its application is its relatively low amenability to heat treating. Only articles of small cross section are fully permeable to heat treatment. Hence if, in the case of large cross sections, a homogeneity of high mechanical properties throughout the cross section (and not a stepped-up ductility of the core) is called for, alloy steels must be used. Carbon steels are poor in mechanical properties as compared to alloy steels when operating at stepped-up temperatures, in conditions requiring higher chemical stability, etc. Carbon steel has high mechanical properties only after heat-treating in small sections at room temperature.

Leading Soviet plants, proceeding from the difficulties created by the war, explored the possibility of the wider application of carbon steels as substitutes for alloy steels in short supply. Some plants, after selecting proper heat-treating procedures, considered it feasible to use carbon steel for vital bolts in airplane construction.

There are more than 150 various designations of carbon steels in the Soviet Union. Frequently the various designations are so close by chemical composition that their properties should be identical. Such an abundance of designations is due to the fact that each branch of industry, and sometimes even individual plants, proceeding from their individual needs, have established their own specifications for steel. Naturally such an excessive number of specifications, frequently containing unreasonable demands pertaining to the permissible ranges of chemical composition and purity, creates unnecessary difficulties for the metallurgical plants.

To facilitate production it is necessary first of all to avoid excessive designations, resorting to new specifications only when actually necessary. Secondly, the ranges of content of individual elements must be adequately wide. Thirdly, the specifications for individual subgroups as to the content of admixtures and contaminations are to be unified as far as possible. From the viewpoint of the consumers, the carbon steel specification must contain an adequate number of designations for the wide variation in mechanical properties required by the various branches of the machine-building industry. In many cases, there is no call for steel of high purity, and a higher content of sulfur and phosphorus is permissible. The use of steel of a higher contamination makes for the wider utilization of our industrial resources. Hence the designations for steel of a lower purity, with relation to sulfur and phosphorus, to be used in less vital assemblies, must be entered into the specification. The new specification for carbon steels has been developed on the basis of the GOST VKS, OST, and the technical standards and specifications of the individual people's commissariats, such as NKCLM, NKTM, NKTP, NKB, NKAP, and others.

In the uniform specification project for metallic materials, it is proposed to distribute the group of carbon steels into five subgroups: the first subgroup (01) for carbon steels of normal purity; the second subgroup (02) for carbon steels of a stepped-up contamination; the third subgroup (03) for carbon steels with a stepped-up content of manganese; the fourth subgroup (04) for automatic carbon steels; and the fifth subgroup (09) for particular carbon steels of special purpose. The two following digits in the designation of carbon steels express the average carbon content in the given designation in hundredths of a percent (for group 1 the same, but in excess of 1%). For example, 0320 is a designation of carbon steels with a carbon content of 0.15-0.25% and a stepped-up manganese content; 1110 is a designation of carbon steel of normal purity with 1.1% carbon.

With respect to the carbon content each designation of the normal purity subgroup (01) differs from the adjacent one by 0.05%. An exception to this rule are two designations with low carbon content and designations with a carbon content in excess of 0.9%.

The content of sulfur and phosphorus for all designations (excepting those with a carbon content in excess of 0.75%) of subgroups 01 and 03 is accepted as the same: 0.055% of sulfur and 0.050% of phosphorus. These figures are in conformity with the wartime modifications in GOST B-1050-41. Similar standards exist in the American specification drawn up by the Society of Automotive Engineers (SAE). In subgroup 02, after the juxtaposition of the compositions of steels used at the present, the sulfur content was established at 0.07-0.08%, and the phosphorus content at 0.09%. For the subgroup of automatic steels the norms, as per the existing GOST, were retained: sulfur 0.08-0.15% and phosphorus 0.06%. Finally, for the subgroup 09, the amount of sulfur and phosphorus is established separately for each designation in relation to the purpose and the required mechanical properties.

The limits for the silicon content with the exception of special requirements are established at 0.15 to 0.40%. The upper limit is somewhat higher as compared to the same in the war-time revised GOST, but is almost equal to the originally established GOST (0.37%). This negligible increase in the silicon content does not affect the mechanical properties, but somewhat facilitates the production of steel.

The limits for the manganese content are also somewhat expanded in all subgroups as against the existing standards but they are lower than the SAE specification. This was done for the same reasons as above.

Two designations with a stepped-up manganese content are entered in the subgroup of automatic steels. They are designated

0416 and 0436 as distinct from designations 0415 and 0435 with a lower manganese content.

In order to reduce the number of existing designations they were grouped by the index of carbon content and, in each such group, the designation with normal purity and the designations with contaminations, etc, were amalgamated. Each such amalgamation constituted a new designation. A new designation is almost invariably a unification of several old ones. The distribution of the existing designations in such a manner reduced their number three times. There are in existence 151 designations; the proposal cuts them down to 56 -- see Tables 6 and 7, which will follow further on in the text.

According to GOST and departmental specification the total number of semimanufactures made at the present time from carbon steels amounts to approximately 200 (see Table 8). The reduction in the number of carbon steel designations results in the corresponding reduction of the number of semimanufactures (see Table 9). In setting up the specification for carbon steels it was natural to take into account not only their chemical composition but also their mechanical properties. The characteristic of the mechanical properties relegated to the individual semimanufactures in a particular state was developed predominantly by the data of GOST and of the departmental specifications. It must be remembered that the above data contain unusually varied requirements with reference to the same designation of carbon steel, as seen from the following tabulation:

Carbon	State	σ_v kg/mm^2	δ%	ψ%	Standard
0.45	Deformed	60-90	15	40	Am TU 151
	Deformed	65	6	30	GOST B1051
	Annealed	55	12	40	

In the case of some semimanufactures from a number of carbon steel designations the indications of the required mechanical properties are generally absent. Hence it became necessary to utilize some existing technical literature data, selecting the most reliable of the same.

The data thus derived for each designation of carbon steel was carried onto a special chart -- the technical passport. Physical and other properties are taken predominantly from technical literature. These data frequently pertain no to a definite designation of steel but are obtained as a result of investigating the effect of carbon upon some property of iron, as, for instance, in the case of electrical conductivity and magnetic properties.

For the characteristic of heat conduction the Esser and Putz data were utilized. As compared to the results of some other research these figures, relating to room temperature, are somewhat high but appear to be the most reliable with reference to the thermal coefficient of heat conduction.

A number of diagrams and tables from the most reliable sources, characterizing the properties of many designations of steel under various conditions, are appended to the technical passports of subgroup 01.

Diagrams of variations in the properties of iron alloys in relation to carbon content and a table on the machinability of carbon steels from American sources (Table 3 in the Supplement) are to be found in the Supplement.

Now then, in accordance with this project, it is proposed to establish a new specification for metallic materials, pertaining to carbon steels, that will be uniform for all branches of the machine-building industry of the USSR.

In this specification, 153 heretofore available designations were coordinated and the number of designations reduced to 56.

The newly-proposed designations of carbon steels are distributed into 5 subgroups by the index of purity, content of manganese, and special purpose.

For each designation of carbon steel there is a technical passport plus curve graphs and tables, characterizing its properties under various conditions.

The data contained in the GOST VKS, departmental technical specifications, handbooks, marking instruction manuals and specifications, and also data from Russian and foreign technical literature were all utilized.

Table 10 /Book page 194/ is a proposed collated specification for carbon steels embracing the chemical composition, mechanical properties, applications, and the previous designations that were merged into the new uniform designation.

TABLE 6

COMBINED TABLE OF CARBON STEELS DISTRIBUTED ACCORDING TO GRADES USED IN SOVIET MACHINE BUILDING

Quality			High Quality	Higher Quality	Conventional	Special Purpose		Automatic	Higher Manganese Content	For Profile Castings	Other
						Phosphorous	Steel tire				
Armko A	45	U12	10A	Elec. I	MST 1			Auto. 10G	15G	15-4020	E(Armko type)
08	40	U13	15A (select)	9 P	BSTO	---------	S-54	A-12	20G	15-4024	KS
08 kp	5	P-11	20 A	3 K	TSTO	ST3Ts	S-45	A15	30G	15-4028	KO
10	55	G-18	20 A (select)	ET	BST3	Elec. II	S-63	A-15G	40G	25-4518	A14S
10 kp	60	---	33 A	Axle	TST3	ST4T	S-72	A-20	50G	25-4522	---
10 for cold upsetting	6	---	38 A	Steel Tire	MST2 *	ST5k	L-53	A-30	60G	25-4525	---
15	65	---	40 A	Steel Tire	MCT3	30V	L-65	A-35	65G	35-5015	---
15 kp	70 (VS)	---	43 A	Steel Tire	BST4	35V	G	---	65Gp	35-5019	---
15 for cold upsetting	7	~~p~~	45 A (RS)	---	TST4	Axle	40V	---	70G	35-5022	---

* Differing in carbon content.

38-75

(TABLE 6 continued)

20	70	---	50 A	---	MSTO	Axle	Electrode	---	U8G	45-5512	---
25	70(OVS)	---	U7A	---	MST4	Rail	Pk	---	U8GA	45-5516	---
30	U7	---	U8A	---	TST5	"	---	---	U10G	55-6010	---
30u	75	---	U9A	---	BST5	"	4 steels	---	U10GA	55-6012	---
35	U8	---	U10A	---	MST5	"	Tire grades*	---	---	20-L[illegible]	---
										30-L	---
35u	85	---	U12A	---	MST6	STeel Tire	---	---	---	36-L	---
						"				50-L	---
35 For cold up-setting	U9	---	U13A	---	MST7	"	---		---	L-45	---
40	U10	Tot-al: 38	16	8	16	---	31	7	13	18	4

Total number 151

* Differing in carbon content.

TABLE 7

DIVISION OF CARBON STEEL GRADES INTO SUBGROUPS

(NEW SYSTEM)

Normal Purity Subgroup 01 and 11	Higher Contamination Subgroup 02	Higher Manganese Content Subgroup 04	Automatic Steels Subgroup 04	Special Steels Subgroup 09
0102 (Armko)	--	--	--	-- 0905
0108	0208	0308	--	0908
0110	--	--	0410	0910
0115	0215	0315	0415	0915
0120	0220	0320	0416 0420	--
0125	0225	--	--	--
0130	--	0330	0430	--
0135	0235	--	0435	--
0140	--	0340	0436	0940
0145	0245	--	--	0945
0150	--	0350	--	--
0155	0255	--	--	0955
0160	0260	0360	--	0960
0165	--	0365	--	--
0170	0270	0370	--	--
0175	--	--	--	--
0180	--	0380	--	--
0185	--	--	--	--
0190	--	--	--	--
1110	--	--	--	--
1120	--	--	--	--
1130	--	--	--	--
Total 22	Total 9	Total 10	Total 7	Total 8

Overall Total: 56

TABLE 8

SEMIMANUFACTURES MADE OF CARBON STEEL (Existing System)

Designation: New	Designation: Old	SEMIMANUFACTURES: Rods, Strips, Tapes	Forgings	Pipes	Sheet	Wire	Castings	Finished Items (axles, rails, tires)	Total Number of Semimanufactures
		1	2	3	4	5	6	7	8
0102	Armko A	+			+				2
	E	+			+				2
									4
0905	10 A					+			1
	Electr I					+			1
									2
0108	08	+			+	+			3
	08 kp				+				1
	MST 1	+							1
	P II	+							1
	KS					+			1
	KO					+			1
									8

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
	BSTO	+			+				2
	TSTO	+			+				2
0208	BST3	+			+				2
	TST3	+			+				2
	b/mark	+							1/9
0908	9p	+							1
	Phosphorous	+							1/2
0308	Electrode					+			1
	10	+	+	+	+				4
	10 kp				+				1
0110	b/mark	+							1
	MST2	+			+				2
	b/mark					5			1/9

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
0710	A 12	+							1
	Automatic 10T	+							1
									2
0910	10 for cold upsetting	+				+			2
	15	+	+						2
	15 A			+		+		+	3
	15 kp				+				1
	STZTS				+				1
	3K				+				1
	3T				+				1
0115	15-4028						+		1
	G-18	+							1
	Electr II					+			1
	MST3	+			+				2
									14

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
	35-5015						+		1
0235	35-5019						+		1
									2
0435	A35	+							1
	40	+	+	+	+				4
	40A	+							1
0140	40V	+							1
	41A	+							1
	43A	+							1
									8
0340	40G	+							1
	Axle							+	1
0940	Axle							+	1
	Axle							+	1
									3

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
	45	+	+	+	+				4
	MST6	+	+						2
0145	45A (RS)	+							1
	L-45						+		1
									8
0245	S-45	+							1
	Rail							+	1
	Rail							+	1
0945	45-5512						+		1
	45-5516						+		1
									4
	50	+	+		+	+			4
	50A	+							1
0150	5	[Note: Original document shows no + sign in this line]							1
	50L						+		1
									7

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
0350	50G	+	+						2
	55	+	+						2
	MST7	+			+				2
0115	I53		+						1
	6010						+		1
	6012						+		1
									7
	S54			+					1
0255	55-6010						+		1
	55-6012						+		1
									3
0955	Rail							+	1
	Steel Tire I							+	1
									2

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
	60	+					+		2
0160	6						+		1
									3
0260	S-63	+	+						2
0360	60G	+				+			2
	Steel Tire							+	1
									3
0690	Steel Tire II							+	1
	Steel Tire III							+	1
									2
	65	+				+			2
0165	70					+			1
	L-65		+						1
									4

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
0365	65-G	+				+			2
	65-Gp	+							1
									3
	70	+							1
	Steel Tire							+	1
0170	U7A		+						1
	U7		+						1
	A14S		+						1
	Steel Tire IV							+	1
									6
0270	S-72		+						1

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
	70					+			1
0175	75	+							1
	Steel Tire IV							+	1
									—
									3
0370	70G	+							1
	U8		+						1
0180	U8A	+						+	2
									—
									3
0380	Pk					+			1
	85	+							1
0185	U8G	+							1
	U8GA	+							1
									—
									3

(TABLE 8 Continued)

New	Old	1	2	3	4	5	6	7	8
0190	U9	+							1
	U9A	+							1
									—
									2
1100	U10A	+							1
	U10	+							1
	U10G	+							1
	U10GA	+							1
	G					+			1
									—
									5
1120	U12	+							1
	U12A	+							1
									—
									2
1130	U13A	+							1
	U13	+							1
									—
									2
	TOTALS:	87	21	11	33	20	23	15	210

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TABLE 9

SEMIMANUFACTURES MADE OF CARBON STEEL (NEW SYSTEM)

Designation	Rods Strips Tapes	Forgings	Pipes	Plates	Wire	Castings	Finished items (Axles, Rails, Steel Tires)	Total number of Semimanufactures
1	2	3	4	5	6	7	8	9
0102	+			+				2
0905					+			1
0108	+			+	+			3
0208	+			+				2
0308					+			1
0908	+							1
0110	+	+	+	+				5
0410	+							1
0910	+				+			2
0115	+	+	+	+	+	+	+	7
0215	+			+		+		3
0315	+			+				2
0415	+							1

(TABLE 9 Continued)

1	2	3	4	5	6	7	8	9
0416	+							1
0915	+							1
0120	+	+	+	+	+	+		6
0220	+							1
0320	+							1
0420	+							1
0125	+	+	+	+		+		5
0225	+			+		+		3
0130	+	+	+	+		+		5
0330	+							1
0430	+							1
0135	+	+	+	+		+		5
0235						+		1
0435	+							1
0436	+							1
0140	+	+	+	+				4

(TABLE 9 Continued)

1	2	3	4	5	6	7	8	9
0416	+							1
0915	+							1
0120	+	+	+	+	+	+		6
0220	+							1
0320	+							1
0420	+							1
0125	+	+	+	+		+		5
0225	+			+		+		3
0130	+	+	+	+		+		5
0330	+							1
0430	+							1
0135	+	+	+	+		+		5
0235						+		1
0435	+							1
0436	+							1
0140	+	+	+	+				4

(TABLE 9 Continued)

1	2	3	4	5	6	7	8	9
0340	+							1
0940							+	1
0145	+	+	+	+		+		5
0245	+							1
0945						+	+	2
0150	+	+		+	+	?		5
0350	+	+						2
0155	+	+				+		3
0255			+			+		2
0955							++	2
0160	+				+			2
0260		+						1
0360	+				+		++	4
0960							+	1
0165	+				+			2
0365	+				+		+	3

(TABLE 9 Continued)

1	2	3	4	5	6	7	8	9
0170	+	+					+	3
0270		+						1
0370	·/·							1
0175	+			+	+		+	3
0180	+	+					+	3
0380					+			1
0185	+							1
0190	+							1
1110	+				+			2
1120	+							1
1130	+							1
TOTALS:	45	15	9	15	15	13	12	124

SUMMARY SPECIFICATION

adjoins next page →

Designation (1)	Chemical Composition: C (2)	Mn (3)	Si (4)	NOT MORE THAN: Cr (5)	Ni (6)	S (7)	P N (8)	Semi manufactures (9)	State (10)	Mechanical Properties: σb kg/mm² (11)	σb kg/mm² (12)
0102	Not more than 0.025	Not more than 0.035	Not more than 0.030	Cu 0.08	--	0.025	0.015	Rods	Zh	27	12
0905	Not more than 0.10	Not more than 0.06	Not more than 0.10	--	0.20	0.04	0.04				
0108	0.04-0.12	0.25-0.65	0.15	0.20	0.30	0.055	0.050	Rods	Zh	32-40	18
0208	0.04-0.12	0.40-0.90	0.15-0.40			0.07	0.09	Rods	G	32-47	19
0308	Up to 0.16	0.80-1.10	0.60-0.90			0.055	0.050	Welding Wire			
0908	0.04-0.12	Not over 0.55	Not over 0.20			0.10	0.20-0.35	Rolled	G, Zk, N	40	21

adjoins preceding page

FOR CARBON STEELS

Mechanical Properties

δ % l=N (13)	δ % l=N (14)	ψ % (15)	a kgm/cm² (16)	H_B (17)	Use (18)	Previous Designations Unified into New Designation (19)
26		65		60-70	Parts manufactured by cold stamping; chemical apparatus; parts for use in electric machine building.	Armko, A.
					Welding electrodes.	10 A, Elec. I
24		70-60		Not over 135	Bolts, struts, rivets, wire for the automotive and other branches of industry.	MSG-1; P-11; 08 kp; O 8; KS; KO.
18					Bolts, struts, rivets.	B-STZ; T-STZ; B-STO; T-STO
					For automatic electric welding of items made of 0108, 0115, and 0120 steels	Previous designations: electrode
19		40		Not over 170	~~Parts requiring high plasticity; case hardened parts subject to light loads; welded and stamped parts of low strength; nuts, washers.~~ Hot-stamped nuts	9 P; phosphorous

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0110	0.05	0.25	0.15	0.25	0.30	0.055	0.050	Rods	G, Zh, N	30-42	18-21
0410	0.07-0.16	0.70-1.0	0.15-0.40			0.08-0.15	0.06-0.15	Rods	G	42-60	
0910	0.05-0.15	Not over 0.50	Not over 0.03			0.055	0.050	Rods	D	45	
0115	0.10-0.20	0.25-0.65	0.15-0.40	0.30	0.30	0.055	0.050	Rods	G	35-43	22-23
									N, Zh	35	21
								Castings	L	40	20-23
0215	0.10-0.20	0.40-0.90	0.15-0.40			0.07	0.09	Rods	G, Zh, N	42-52	24

→ adjoins next page, etc throughout this and succeeding pages

(TABLE 10 Continued)

13	14	15	16	17	18	19
	26-31	55	9	135-145	Parts requiring high plasticity; case-hardened parts subject to light loads; welded and stmped parts of low strength; nuts, washers, etc.	10; 10 kp; MST-2; previous designations
	22	35			Parts to be machined on high-speed screw-cutting machines and automatic lathes	A-12; Automatic 10 T
	24	60		Not over 130	Parts manufactured by cold upsetting	10
	21-24	66		145	Bolts, cuts, screws, pins, rivets, welding electrodes, boiler plate and plate for boiler fire boxes, etc; profile castings.	15; 15 kp; 15 A (select) electric II G-18; STZTS; MST3; 3K;3T; 15-4028
	23	55	9	150	Case-hardened parts	
	(l=2.5d) 25-35 25-23	21-19			Railroad bolts, nuts; rolled shapes for ship-building	B-ST4; T-ST-4; 15-4020; 15-4024

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(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
								Castings	L	40	20
0315	0.10-0.20	0.70-1.00	0.15-0.40	0.30	0.30	0.055	0.050	Rods	G, Zh, H	40	23
0415	0.10-0.20	0.70-1.00	0.15-0.40			0.08-0.15	0.06	Rods	G	42-65	
0416	0.10-0.20	1.00-1.40	0.15-0.40			0.08-0.15	0.06	Rods			
0915	0.15-0.20	not over 0.50	not over 0.07			0.055	0.050	Rolled shapes	Zh	not over 55	
0120	0.15-0.25	0.25-0.65	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N, Zh	40-55	22-24
								Castings	N	40	20
0220	0.15-0.25		0.15 0.40			0.07	0.09	Rods	G, Zh, N	32-47	19

(TABLE 10 Continued)

13	14	15	16	17	18	19
	20				Profile castings	
	22	50		Not over 165	Railroad rolling stock axles, case-hardened frame plates; shaft rings	15 G
	19	30			Parts machined on high-speed screw-cutting machines and automatic lathes	A 15; A 15G
					Same	
	18	50		Not over 130	Cold upsetting	15--for cold upsetting
24		55	9	110-150	Parts subject to moderate stresses and requiring considerable ductility in automotive, aircraft and other industries	
	l =2.5d 21	35		Not under 110	Profile castings (cross heads, locomotive wheels, journal boxes, cylinder heads, etc)	20; 20A; 20A (select); 20L; ST4T
18					Non-load carrying structural steel	MSTO

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0320	0.15- 0.25	0.70- 1.00	0.15- 0.40	0.30-	0.30	0.055	0.050	Rods	N	42	25
0420	0.15- 0.25	0.70- 1.00	0.15- 0.40			0.08- 0.15	0.06	Rods	G	50-65	
0125	0.20- 0.30	0.45- 0.80	0.15- 0.40	0.30	0.30	0.055	0.050	Rods	Zh, N	42-55	24-26
								Castings	L	42-45	21-27
0225	0.20- 0.30	0.40- 0.90	0.15- 0.40			0.07	0.09	Rods	G	50-62	27
								Castings	L	45	23
0130	0.25- 0.35	0.45- 0.80	0.15- 0.40	0.30	0.30	0.055	0.050	Rods	N, Zh	48-62	27
								Castings	L	45	22
0330	0.25- 0.35	0.60- 1.00	0.15 0.40	0.30	0.30	0.055	0.050	Rods	N	55	29

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(TABLE 10 Continued)

13	14	15	16	17	18	19
22		50			Railroad car axles, frame plates -- case-hardened	20G
	19	30			Parts to be machined on high-speed screw-cutting machines and automatic lathes	A 20
	18-22	50	7	120-150	Bolts, nuts, screws, washers, axles, shafts, etc, for automotive, aircraft, and other industries	25; MST4; ST5k; 25 L; 25-4518; 26-4522; 25-4525
	18-25	30			Profile castings for locomotives	
17-15					Conventional structural rolled shapes for shipbuilding, non-load carrying profile castings	T-ST5; B-ST5; 25-4518; 25-4522
	23					
	l =2.5d 21-19	50	7	170	Draw bars, axles, crankshafts, cylinders, levers, nuts; parts requiring improved ductility; parts for pipes and high-pressure pipe systems, etc	30; 30L; 30V; 33A; M-ST5; 30U
	l ==2.5d 20	30			Castings for turbine housings, machine tool bases, etc.	
	15	45			Small cross-section parts, car axles, bolts, screws	30 G

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0430	0.25-0.35	0.70-1.00	0.15-0.40			0.08-0.15	0.06				
0135	0.30-0.40	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods	Zh, N	48-65	30
								Castings	L	50	23-29
0235	0.30-0.40	0.40-0.90	0.15-0.40			0.07	0.09	Castings	L	50	25
0435	0.30-0.40	0.70-1.0	0.15-0.40			0.08-0.15	0.06	Rods	G, Zh, N		
0436	0.30-0.40	1.00-1.40	0.15-0.40			0.08-0.15	0.06	Rods			
0140	0.35-0.45	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N, Zh	52-70	32
0340	0.35-0.45	0.70-1.00	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N	60	37

(TABLE 10 Continued)

13	14	15	16	17	18	19
					Parts to be machined on high-speed screw-cutting machines and automatic lathes	A 30
	15-18	45-50	7	140-200	Pipe and plate parts for automotive, aircraft, and other industries; high-pressure pipe systems, small and medium forgings, nuts, screws, shafts, axles, etc.	35; 35A; 35U; 35V; 38A; 36L; 35-502
	19-22				Castings -- cylinders, cam couplings, etc.	
	15				Profile castings	35-5015; 35-5019
					Parts to be machined on high-speed screw-cutting machines and automatic lathes	A 35
					Same	
	14-17	40-45	5	Not over 200	Nuts, gears, axles, shafts, keys, steel tires, high-pressure pipelines, etc.	40.40A; 40V; 41A; 43A
	14	45			Small cross-section parts, axles, screws, bolts	40G

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0940	0.30-0.48	0.50-0.90	0.15-0.40			0.055	0.050	Axle blanks	N	52-62	
0145	0.40-0.50	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N, Zh	60-75	30-34
								Castings	L (T)	65-85	35-50
0245	0.40-0.52	0.40-0.90	0.15-0.40	0.30	0.30	0.08	0.09				
0945	0.40-0.50	0.60-1.00	0.15-0.40			0.07	0.09	Rails	G, N	70-55	
								Castings	L	55	28
0150	0.45-0.55	0.45-0.80	0.15-0.40					Rods	N, Zh	63-80	34
								Castings	L-T	62	31
0350	0.45-0.55	0.70 1.00	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N, Zh	60	35

(TABLE 10 Continued)

13	14	15	16	17	18	19
	23-20		6.0-3.5		Locomotive, tender, and car axles	
	15-30	40	6	170-230	Dies, parts for pipes, gears, rolling rollers, steel tires, bolts, nuts, screws, tapes, etc. Profile castings for aircraft building	45.45A; I45; M-ST-6; 45U
	12-7	35-15	3.5-1.5	180-235		
					Special purpose	S-45
					Wide-gage railroad rails	Rail; 45-5512; 45-5516
	16				Profile castings	
	13	40	6	170-220	Gears,keys, shafts, axles, steel tires, tape springs, etc.	50; 5; 50A; 50L; 50U
	l =2.5d 12			170	Profile castings -- to operate under friction, such as gears, travelling rollers, wheels,etc.	
	10	35	4	not over 230	Friction parts such as disks gears, dies, etc.	50G

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0155	0.50-0.60	0.45-0.80	0.15-0.40			0.055	0.050	Rods	Zh, N	64	36
0255	0.50-0.60	0.40-0.90	0.15-0.40	0.30	0.30	0.07	0.09	Castings	L	60	30
0955	0.50-0.65	0.60-0.90	0.15-0.40	0.30	0.30	0.055	0.050				
0160	0.55-0.65	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods, wire	N	65	37
0260	0.55-0.70	0.40 0.90	0.15-0.40	0.30	0.30	0.08	0.09	Forgings			σ_p 28-34
0360	0.50-0.65	0.70-1.00	0.15-0.40	0.30	0.30	0.055	0.050	Rods	N	70	38
0960	0.50-0.70	0.60-0.90	0.15-0.40			0.055	0.050	Steel tires			
0165	0.60-0.70	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods, wire	N	66	38
0365	0.60-0.70	0.90-1.20	0.15-0.40	0.30	0.30	0.055	0.050	Rods, wire	N	75	40

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(TABLE 10 Continued)

13	14	15	16	17	18	19
	12	35		Not over 230	Forgings, dies, plate parts, rolling rollers, eccentrics, springs, profile castings	55; MST7; L-53; 55-6010; 55-6012
	10				Special purpose; profile castings	S-54; 55-6010; 55-6012
					Rails, steel tires	Rail, Tire I
	10	35		230 (Zh)	Forgings, dies, plate parts, wire for high-load carrying cables	60; 6; steel tire
		40-45			Special purpose	S-63
	9	35		230 (Zh)	Forgings, dies, plate parts, passenger and freight locomotive steel tires, rails and railroad car steel tires, steel tires for use in electric-machine building	60-G; rail; steel tire; previous designations
					Steel tires	Steel tire II; III
	10	30		230 (Zh) ~~Springs,~~	Springs, shock absorbers, coils	65, L-65; 70 (VS); 7
	8	35		230 (Zh)	Springs, shock absorbers, coils, wire for steel tires, etc.	65G; 65GP

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
0170	0.65-0.75	0.45 0.80	0.15-0.40	0.30	0.30	0.055	0.050	Rods, wire	N	67	39
0270	0.65-0.08	0.40-0.90	0.15-0.40	0.30	0.30	0.08	0.09	Forgings			op 34
0370	0.65-0.75	0.90-1.20	0.15-0.40	0.30	0.30	0.005	0.050	Rods	N	80	42
0175	0.70-0.80	0.45-0.80	0.15-0.40	0.30	0.30	0.055	0.050	Strips, wire	T	110	90
0180	0.75-0.85	0.45-0.80	0.15-0.40	0.30	0.30	0.040	0.040	Strips, plates	N	75-120	
0380	0.75-0.85	0.60-1.0	0.15-0.40			0.040	0.040	Rods, wire			
0185	0.80-0.90	0.45-0.80	0.15-0.40	0.30	0.30	0.040	0.040	Strips, wire	T	115	
0190	0.85-0.95	not over 0.40	0.15-0.40	0.30	0.30	0.040	0.040	Tapes	T	165-200	

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(TABLE 10 Continued)

13	14	15	16	17	18	19
	8	30		230 (Zh)	Steel tires, coils, hot-rolling rollers. Tools subject to impact and shocks requiring considerable ductility at a moderate degree of hardness	70, U7A; U7; A14S; Steel tire
		35			Special purpose	S-72
7		30		230 (Zh)	Forgings; die stampings	70G
7		30			Springs, bumpers, coils, steel tires for freight locomotives	75, 70 (OVS)
5					Flat coils, coils for high-pressure valves and for impact tools of increased hardness	
					Shaft rings, side-pieces, parts, subject to impact and wear, etc.	PK
6		30			Springs, bumpers, coils, tools	85, U8G; U8GA
3					Flat coils; tools requiring hardness and some ductility	U9; U9A

(TABLE 10 Continued)

1	2	3	4	5	6	7	8	9	10	11	12
1110	0.95-1.10	not over 0.40	0.15-0.40	0.30	0.30	0.04	0.040	Wire	G	75	
1120	1.10-1.25	not over 0.40	0.15-0.40	0.20	0.30	0.04	0.04	Wire, rods			
1130	1.25-1.40	not over 0.40	0.15-0.40	0.20	0.30	0.04	0.04	Rods			

(TABLE 10 Continued)

13	14	15	16	17	18	19
					Special purpose wire; tools subject to abrupt and heavy impacts and requiring some ductility	U10, U10A; (G), U10G; U10GA
					Coils; non-impact tools of great hardness	U12; U12A
					Exceptionally hard non-impact tools	U13; U13A

TABLE 3

THE MACHINABILITY OF SAE CARBON STEELS

(as per J. Sorenson, W. Gates, and H. Knowlton) -- the machinability of SAE 1112 steel (0.08-0.16% C, 0.6-0.9% Mn, 0.09-0.13% P, 0.10-0.20% S) is taken as 100%, which corresponds to a cutting speed of 150 feet per minute.)

Steel Designation (1) By SAE Specification	(2) Proposed Specification	(3) State of Material	(4) Brinell Hardness	Cutting Speed (5) Ft/min	Cutting Speed (6) %	(7) Feed in Inches/rev.	(8) Cutting Depth (d) or Width (w) (inches)	(9) Operation
1010	0110	D	140-170	120	80	0.0012	1 (w) 3/16 (d)	Rough pr ofile turning
1015	0115	D	--	--	50-65	--	--	--
1020	0120	D	--	--	50-65	--	--	--
1020	0120	G	135	--	55	--	--	--
Kh1020	0320	D	160-200	130	87	0.0016	7 (w) 3/16 (d)	Rough profile turning
Kh1020	0320	G	145	--	63	--	same	--
1025	0125	D	--	--	50-65	--	--	--
1025	0125	Case-hardened and cooled slowly	269-311	95	64	0.010	--	Turning
1030	0130	G	190	--	62	--	--	--
1030	0130	Zh	151	--	71	--	--	--
1035	0135	D	--	--	55-60	--	--	--
1035	0135	G	200	--	55	--	--	--

(TABLE 3 Continued)

1	2	3	4	5	6	7	8	9
1035	0135	Zh	165	--	68	--	--	--
1040	0140	D	--	--	55-60	--	--	--
1040	0140	G	255	--	45	--	--	--
1040	0140	Zh	180	--	70	--	--	--
1045	0145	Heat treated for hardening at 900° C. in water; tempered at 500° C.	229-269	87	58	0.051	1-5/8 (w)	Lateral turning
"	"	"	--	51	34	0.0053	5/16 drill	Drilling
1045	0145	D	--	--	55-60	--	--	--
1050	0150	G	--	110	73	0.004	1-3/4 (w)	Turning
1050	0150	Zh	--	45	30	0.006	1-5/8 drill	Drilling
1050	0150	--	187-207	110	73	0.008	1-5/6 drill	Drilling
0.6-0.7% C	0165	Cycle annealing at 750° C.	197-223	105	70	0.040	--	Milling
				150	100	0.002	1/16 (w)	Cut-off
1112	0412	D	163-197	50	33	--	--	External thread cutting
1112	0410	D	--	130	87	0.005	--	Countersinking

(TABLE 3 Continued)

1	2	3	4	5	6	7	8	9
1112	0410	D	175	--	100	--	--	--
1112	0410	D	175	--	100	--	--	--
1115				100	61	0.0058	24/64 drill	Internal thread cutting
	0415	--	163-197	142	95	0.003	0.125 (w)	
1120	0420	D	150-180	135	90	0.0017	1.0 (w) 3/16 (d)	Finish and rough profile turning
1120	0420	D	--	215	143	0.0102	--	Drilling, profile turning
1120-	0420	G	140	--	70	--	--	Turning

-75-

- E N D -