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George K. Burgess, Director

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### UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR LAMPS, ELECTRIC, INCANDESCENT, LARGE, TUNGSTEN FILAMENT.

#### FEDERAL SPECIFICATIONS BOARD SPECIFICATION No. 23b

[Revision Promulgated November 23, 1927. Supersedes F. S. B. No. 23.]

This specification was officially promulgated by the Federal Specifications Board on February 15, 1922, for the use of the departments and independent establishments of the Government in the purchase of large tungsten filament incandescent electric lamps.

[The technical requirements of this revision of this specification shall become mandatory for all departments and independent establishments of the Government not later than February 23, 1928. They may be put into effect, however, at any earlier date, after promulgation.]

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### INTRODUCTORY STATEMENT

An informal conference called by the engineers of the various Government departments, and attended by them, by representatives of the manufacturers of incandescent lamps in the United States, and by representatives of the Bureau of Standards and the Electrical Testing Laboratories, was held in Washington, February 25 to 27, 1907, at which specifications for electric incandescent lamps, then including only the carbon class, were adopted. These specifications were revised at further conferences held in 1908, 1909, and 1910. In the revision made in 1909, schedules for metallized carbon, tantalum, and tungsten lamps were added. In 1910 carbon lamps were placed on the same basis as the other classes, namely, a rating in watts instead of in candlepower.

No general conference of the lamp manufacturers and Government engineers has been held since 1910, but the general specifications and schedules were thoroughly revised in April, 1912, after informal conferences between representatives of the Bureau of Standards and of the various departments of the Government, and after consultation with representatives of various lamp manufacturers.

Six further revisions have been made by the bureau after consulting with representative manufacturers. These revisions were made in 1913, 1915, 1917, 1921, 1923, and the latest, for the present (eleventh) edition, in 1927. The tenth edition marked the passing of carbon filament lamps. Future purchases of carbon lamps by the Federal Government are expected to be very small, and such purchases will be made under the specifications of the ninth edition.

One clause of the specifications which has given rise to much discussion is that which permits the manufacturer on notice to the buyer to reduce the efficiency rating of any size of lamps by as much as 4 per cent. (See Section II 2, (d), p. 8.) This provision was originally adopted during the war to allow for manufacturing difficulties arising from the unsettled conditions of the time, but it has worked so well in practice that it has been retained. Lamps are essentially a variable product. Without this clause it would be necessary to set the specified efficiencies correspondingly lower, so that any reasonably good factory could be sure of meeting the requirements for all sizes of lamps at all times. Having this provision, the manufacturers are willing that the specified efficiencies shall be high enough to constitute a challenge to the skill of their engineering staffs. A factory which encounters special difficulties can take advantage of a lower efficiency rating, but in so notifying the buyer it advertises its failure to keep up with the leaders in the industry. The effect is therefore to stimulate a very active competition in improving the quality of the lamps, and, in fact, the number of cases in which manufacturers holding Government contracts have reduced their efficiency ratings is very small in comparison with those in which increases above the specified ratings have been made.

This provision for adjustment of specified efficiency ratings should not be confused with the tolerances which are allowed for efficiency and wattage ratings and for the test results for small numbers of samples. These tolerances are necessary in order to allow for unavoidable variations in making individual lamps and for probable departures of test results from the true average quality of the lamps represented by the samples.

On account of the standardization of voltages the lamp schedules recognize specifically only 110, 115, and 120, and 220, 230, 240, and 250 volt lamps for use on multiple circuits.

Criticisms and suggestions concerning these specifications and lamp ratings are invited from both manufacturers and users of lamps. All such suggestions will be carefully considered when the specifications are again revised.

These specifications have been prepared, primarily, for the use of the departments of the Government in purchasing incandescent lamps, but it seems desirable, on account of the thoroughness with which the subject has been studied and discussed, that the specifications should be available to the general public. In circulating them, however, the bureau desires to call attention to the necessity of extreme caution in the application of the tests described. Only those thoroughly instructed in the art of lamp manufacture and in the science of photometry should undertake to determine the acceptability of lamps under the terms of these specifications.

Complete specifications for the purchase of large tungsten filament incandescent lamps consist of the following sections:

Section I. General specifications.

Section II. Test specifications.

Section III. Tables of initial rating tolerances.

Section IV. Manufacturers' schedules of commercial ratings.

Sections I and II describe in detail the tests and methods that may be employed for the determination of the inherent quality of the lamps. Section III gives tables of initial rating tolerances, while Section IV sets forth the ratings of lamps which are considered at the present time to represent good practice under conditions of use most commonly prevailing in the United States, and are, therefore, made a part of the specifications under which the United States Government purchases such lamps. Sections III and IV are printed separately in order that the schedules contained therein may be readily revised.

## Section I. GENERAL SPECIFICATIONS<sup>1</sup>

### 1. GENERAL CONDITIONS

Incandescent lamps to be furnished under these specifications shall be new lamps. The full provisions of these specifications shall apply only to lamps specifically mentioned in the Tables of Initial Rating Tolerances (Sec. III), and to no other lamps, except by mutual written agreement. These specifications shall not apply to any outside-frosted, white-bowl, bowl-enameled, etched, or colored lamps, or to lamps other than those with the usual clear glass or inside-frosted bulbs, unless specifically included by mutual written agreement. These specifications in so far as they refer exclusively to mechanical and physical characteristics shall apply to any tungsten filament lamps regularly listed in the manufacturer's current schedules.

<sup>1</sup> Sections III and IV of this specification are issued separately as a supplement to this circular to facilitate revision.

All tests shall be made in a competent and expert engineering manner at the expense of the purchaser, excepting that when initial tests and inspections are made at the factory the manufacturer will be required to supply the necessary equipment, assistance, current, and facilities for making such initial tests and inspections. The manufacturer shall have the privilege of witnessing and verifying all tests of his lamps made hereunder, and shall also have the privilege of obtaining copies of the results of the tests of his lamps and of having access to the records of such tests at all reasonable times. With the consent of the manufacturer, the method of test procedure may be modified in any particular whenever such modification is desirable to secure test results in a more practicable, representative, and accurate manner.

## 2. DEFINITIONS AND STANDARDS

(a) ELECTRICAL UNITS.—The values of the electrical units in these specifications are the international units which have been in force since January 1, 1911.

(b) UNIT OF LIGHT INTENSITY.—The unit of light intensity shall be the international candle as maintained by the Bureau of Standards at Washington, D. C.

(c) PHOTOMETRIC MEASURE.—The basis of photometric measure for all lamps shall be total flux expressed in lumens, but, if desired, the equivalent luminous intensity expressed in spherical candles may be used.

(d) STYLE OF LAMPS.—Lamps are classified under two styles—large and miniature. "Large lamps" designate broadly lamps regularly fitted with other than miniature bases. All lamps covered by this specification are large lamps.

(e) TYPE OF LAMPS.—The word "type" is used to distinguish between lamps which differ in general construction or are designed for different classes of service.

(f) RATING OF LAMPS.—The rating of lamps is expressed by:

(1) Size.—The size of incandescent lamps is expressed in rated watts or rated lumens.

(2) Rated volts (or rated amperes).—The rated volts (or rated amperes) of a lamp are the volts (or amperes) for which the lamp is designed.

(g) DESIGN AND SIZE OF BULBS.—The design of a bulb is designated by a letter. The size of a bulb is expressed by a number denoting the greatest diameter in eighths of an inch.

(h) BASES.—There are two varieties of bases used on lamps covered by this specification, medium screw, and mogul screw.

(i) REGULAR LAMPS.—Regular lamps are lamps whose construction conforms to that regarded as standard and are so listed by the

manufacturer. Only large regular lamps are covered by this specification.

### 3. RETURN OF REJECTED LAMPS

Lamps which have not been used and are rejected under the terms of this specification may be returned to the manufacturer at his expense and no payment made therefor. All lamps placed in service shall be considered as accepted.

### 4. CANCELLATION OF CONTRACT

A contract for lamps furnished under this specification may be canceled in the event that the total quantity of lamps represented on life-performance tests exceeds in value 25 per cent of the face value of the contract and is represented on life-performance test by at least 50 lamps and is rejectable as an aggregate quantity under life-performance test (see Sec. II, 3 (i), (m), or (p)), or in the event that the total quantity of lamps is represented by not less than 200 lamps completed on the life-performance test and is rejectable as an aggregate quantity under this specification.

## Section II. TEST SPECIFICATIONS

### 1. MECHANICAL AND PHYSICAL INSPECTION TEST

(a) SELECTION OF LAMPS FOR MECHANICAL AND PHYSICAL INSPECTION TEST.—From the packages of lamps of any one size, type, and voltage offered for acceptance at any one time, the inspector may choose as a lot to be inspected any individual package or any group of packages. From each lot of lamps to be inspected there shall be taken at random the test quantity for the purpose of determining the mechanical and physical characteristics of the lamps. The manufacturer may present lamps for mechanical and physical inspection test which have not been sufficiently burned or seasoned to have reached stable values of wattage and lumens.

(b) TEST QUANTITY.—The test quantity shall consist of not less than 5 per cent of each lot of lamps being inspected, and in no case shall be less than 10 lamps. The lamps so taken shall be known as the inspection-test lamps. In case the lot to be inspected comprises more than one package, the inspection-test lamps shall be taken proportionately from the several packages.

(c) GENERAL.—The lamps shall be well made and free from defects and imperfections which would prevent their meeting satisfactorily the lighting service conditions. All lamps shall conform to the manufacturer's standard shapes and sizes of bulbs and forms of filament.

(d) BULBS.—Bulbs shall be uniform in size and shape, clean and free from flaws and blemishes detrimental to service.

(e) BASES.—Moisture-proof bases, fitted with glass insulation, shall be used on all lamps unless otherwise specified, and, when bases have extended skirts, the skirt shall be insulated from the screw shell. The bases shall be firmly and accurately fitted to the bulbs with moisture-proof cement. The shells and skirts of the bases shall be of brass of good quality.

(f) FILAMENTS.—The filaments shall be uniform and free from imperfections, spots, and discolorations detrimental to service.

(g) LEADING-IN WIRES.—Leading-in wires shall be securely attached to the ends of the filaments and shall be securely attached, without excess of solder, to the terminals of the base which make contact with the socket. The threads of the base shall be free from solder.

(h) MARKING.—The rating and the manufacturer's name or trademark shall be placed on the bulb or the base of each lamp. The marking shall show the rated watts and volts (or voltage of the circuit upon which a stated number of lamps are to burn in series), or the rated lumens and amperes.

(i) REJECTION FOR MECHANICAL AND PHYSICAL DEFECTS.—The inspection-test lamps shall be inspected for physical defects, and when so inspected, if 20 per cent or more of the inspection-test lamps show physical defects incompatible with good workmanship, good service, or with any clause of this specification, the particular lot which has thus been inspected and from which the test quantity was selected, may be rejected without further test, provided that the inspection test is made at the factory. If the inspection test is made elsewhere than at the factory, the percentage of defective lamps required for rejection shall be 30 per cent.

(j) REJECTION FOR MAJOR DEFECTS.—Also, when so inspected, if the number of the inspection-test lamps that are inoperative, or that would unquestionably give poor service (such defects to be mutually agreed upon), exceeds the quantity indicated in the table below for the number of lamps inspected, the particular lot which has thus been inspected and from which the test quantity was selected may be rejected without further test.

TABLE 1.—*Rejection for major defects*

Total number of test lamps inspected	Number of vitally defective lamps required for rejection (see 1 (j) above)	
	When inspection test is made at the factory	When inspection test is made elsewhere
Above 500.....	More than 2 per cent of number inspected.....	More than 4 per cent of number inspected.....
500-401.....	More than 9 lamps.....	More than 18 lamps.....
400-301.....	More than 8 lamps.....	More than 16 lamps.....
300-201.....	More than 6 lamps.....	More than 12 lamps.....
200-151.....	More than 5 lamps.....	More than 10 lamps.....
150-101.....	More than 4 lamps.....	More than 8 lamps.....
100-51.....	More than 3 lamps.....	More than 6 lamps.....
50-20.....	More than 2 lamps.....	More than 4 lamps.....

## 2. INITIAL RATING TEST

(a) SELECTION OF LAMPS FOR INITIAL RATING TEST.—From the packages or lamps of any one type, size, and voltage offered for acceptance at any one time the inspector may choose as a lot to be inspected any individual package or any group of packages. From each lot of lamps to be inspected, there shall be taken at random the test quantity for the purpose of making the initial rating test, or the test may be made upon the same lamps that were taken for the mechanical and physical inspection test. Lamps may be presented for initial rating test that have not been sufficiently burned or seasoned to have reached stable values of wattage and light output, but such of these lamps as are taken for the intitial rating test must be properly seasoned before the test is begun.

(b) TEST QUANTITY.—The test quantity shall consist of not less than 5 per cent of each lot of lamps being inspected, and in no case shall be less than 10 lamps. The lamps so taken shall be known as the rating-test lamps. In case the lot to be inspected comprises more than one package, the rating-test lamps shall be taken proportionately from the several packages.

(c) REJECTION FOR DEFECTIVE RATING.—Lamps shall be tested at rated volts, amperes, or lumens. When tested at the factory, the particular lot which has thus been inspected may be rejected without further test if 20 per cent or more of the rating-test lamps therefrom taken depart from the manufacturer's standard initial rating in effect at the time of manufacture of the lamps by more than the intitial rating tolerances given in the tables of tolerances. The initial rating thus used shall not be more than 4 per cent lower than the standard initial rating in effect at the time of inspection. When tested elsewhere than at the factory, the percentage required for rejection shall be 30 per cent.

(d) CHANGES IN EFFICIENCY.—For the purpose of maintaining the rated life given in the Manufacturers' Schedules of Commercial Ratings (see Sec. IV) the initial rated lumens per watt (and there with, proportionately, the mean lumens per watt) of any size of lamps may, upon notice from the manufacturer, be changed, but not numerically decreased by more than 4 per cent. The initial rating tolerance specified shall apply to the lamps at the changed rated lumens per watt.

## 3. LIFE-PERFORMANCE TEST

(a) SELECTION AND TEST QUANTITY OF LAMPS FOR LIFE-PERFORMANCE TEST.—For the purpose of selecting lamps for the life-performance test, packages containing less than 100 lamps of any one type, size, and voltage may be grouped to aggregate not more than 250 lamps, and for the purposes of this test these groups will be called

package groups. In case the lot of lamps of any one size, type, and voltage offered for acceptance consists of 1,000 lamps or less, there shall be taken from the rating-test lamps representing each package of 100 lamps or more, or representing each package group, the one lamp which approximates most closely to the average of these rating-test lamps. The lamps thus taken will be designated as the life-test lamps. If the lot of lamps exceeds 1,000 lamps, life-test lamps will be taken from the first 1,000 lamps as above directed, and for each 500 (or part thereof) by which the lot exceeds 1,000, an additional life-test lamp shall be similarly taken from the rating-test lamps representing any one of the additional packages. Not more than one life-test lamp shall be taken from any package or package group, except that a second or duplicate lamp may be reserved to replace this life-test lamp in case of accidental breakage or damage during test. Lamps taken for life test shall be considered as delivered to the purchaser.

(b) LIFE-TEST VOLTAGES.—Life-test lamps shall be operated on the test rack at voltages (or currents) corresponding either to the initial rated lumens per watt as given in the Manufacturers' Schedules or Commercial Ratings (Sec. IV), or any special efficiency mutually agreed upon. Operation at approximately the voltages indicated is sanctioned, provided proper life corrections are made.

(c) VOLTAGE REGULATION.—Accurate recording voltmeter records shall be obtained during the tests to show the variation of the voltage on the circuit. Variations of voltage are not to exceed one-quarter of 1 per cent above and below the test voltage.

(d) LAMP LIFE.—The life of a lamp is the number of hours life of the lamp to burn out. Lamps broken in handling or when current is not on them shall not be counted to reduce the average lamp life. In case any life-test lamps (and their duplicates) are broken or damaged before the test is completed, the average life of all lamps of the same type, size, and voltage tested under the same contract shall be assigned to the package or group of packages represented by such broken or damaged life-test lamps.

(e) INHERENT QUALITY CRITERION.—The accepted measure of inherent quality of incandescent lamps is the average hours life to burn out, as determined in accordance with this specification at any stipulated mean lumens per watt throughout life. Lamps designated for any specific position of burning, as noted in Manufacturers' Schedules of Commercial Ratings (Sec. IV), shall be tested in this specified position.

(f) LIFE CORRECTIONS.—All life corrections from one efficiency to another are to be made in accordance with life-efficiency relations mutually agreed upon or as determined by the Bureau of Standards, at Washington, D. C.

(g) GUARANTEED INHERENT QUALITY.—The lamps furnished under these specifications are guaranteed to give an average total life to burn out, as determined in accordance with this specification, not less than the rated total life, at the mean lumens per watt, as specified in Section IV, Manufacturers' Schedules of Commercial Ratings, except as the total rated life and the mean lumens per watt therein specified, may be modified by the provisions of Section II, 3 (i) (below), and by Section II, 2 (d), (page 8). The conformity of a group of lamps with the inherent quality guarantee is determined by correcting the average life of the group from the mean efficiency at which the lamps operate during the life-performance test to the mean efficiency upon which the guaranteed life is based.

(h) METHOD OF COMPUTATION.—The individual lamps shall be tested at voltages (or currents) corresponding to equal initial efficiencies and the average number of hours' life to burn out determined for the group of lamps. The mean efficiency throughout life of any group of lamps shall be determined as the quotient of the total lumen hours and watt hours of the group when so tested. The average life obtained on test shall be corrected from the computed mean efficiency throughout life to the mean lumens per watt specified in the Manufacturers' Schedules of Commercial Ratings Section IV. Obtaining the mean efficiency as the quotient outlined in the preceding paragraph is identical with a determination of it as the average of the mean efficiencies throughout life of the individual lamps the mean efficiency of each lamp being weighted in proportion to the life of the lamp.

(i) REJECTION FOR FAILURE TO MEET GUARANTEED INHERENT QUALITY.—Any group of lamps, provided such group is represented by at least five lamps on life-performance test, may be rejected if the average hours' life of the group, when corrected to the mean lumens per watt throughout life specified in the Manufacturers' Schedules of Commercial Ratings, Section IV (or as may be modified by Section II, 2 (d)), falls below the guaranteed life by more than the life tolerance specified in Table 2, life tolerances, for the number of test lamps averaged.

TABLE 2.—*Life tolerances*<sup>1</sup>

Number of lamps averaged	Allowable per cent variation from guaranteed life	Number of lamps averaged	Allowable per cent variation from guaranteed life	Number of lamps averaged	Allowable per cent variation from guaranteed life
250 and above-----	5	24-20-----	12	9-----	19
249-100-----	6	19-18-----	13	8-----	20
99-55-----	7	17-16-----	14	7-----	21
54-45-----	8	15-14-----	15	6-----	23
44-35-----	9	13-12-----	16	5-----	25
34-30-----	10	11-----	17		
29-25-----	11	10-----	18		

<sup>1</sup> On account of the natural and inherent variations in individual lamp performance, the average test results of a small number of test samples can not be depended upon to indicate exactly the average for the larger quantity from which the test samples were taken. The tables of allowable variations are devised in accordance with the observed accuracy of lamp-testing methods and the observed variations in lamp performance.

(j) MEASUREMENT OF LUMENS.—Life-test lamps shall be measured for lumens and amperes (or volts) at their rated volts (or amperes) at reasonable intervals during the test. Unless otherwise mutually agreed, these intervals of measurement shall be chosen so that the majority of the lamps comprising the test lot will be measured at least twice after the initial measurement.

(k) DETERMINATION OF LUMEN MAINTENANCE.—The measure of lumen maintenance for an individual lamp shall be its mean lumens throughout the test expressed as a percentage of its initial lumens. The measure of lumen maintenance for a group of lamps shall be the mean lumens in per cent of average initial lumens and shall be determined by averaging the above percentages for the individual lamps, the percentage for each individual lamp being weighted in proportion to the life of the lamp. A simple and practical method of determining the desired mean lumens in per cent of average initial lumens for a group of lamps is to average, with equal weight, all readings on individual lamps representing (that is, taken at the mid-points of) successive equal test intervals.

(l) GUARANTEED LUMEN MAINTENANCE.—The guaranteed lumen maintenance of a group of lamps is expressed by the mean lumens in per cent of average initial lumens specified in Manufacturers' Schedules of Commercial Ratings, Section IV, except as modified by paragraph (m).

(m) REJECTION FOR FAILURE TO MEET GUARANTEED LUMEN MAINTENANCE.—When tested in accordance with the foregoing test specifications, any group of lamps may be rejected, provided such group is represented on life-performance test by at least five lamps, and provided the mean lumens in per cent of average initial lumens, as above derived, falls below the per cent specified in the Manufacturers' Schedules of Commercial Ratings, Section IV, by more than the tolerance specified in Table 3 below for the number of lamps tested.

TABLE 3.—*Lumen maintenance tolerances*<sup>1</sup>

Number of lamps tested	Allowable variation in per cent mean lumens of average initial lumens	Number of lamps tested	Allowable variation in per cent mean lumens of average initial lumens
100 and above.....	1	24-10.....	3
99-25.....	2	9-5.....	4

<sup>1</sup> On account of the natural and inherent variations in individual lamp performance, the average test results of a small number of test samples can not be depended upon to indicate exactly the average for the larger quantity from which the test samples were taken. The tables of allowable variations are devised in accordance with the observed accuracy of lamp-testing methods and the observed variations in lamp performance.

(n) GUARANTEED LIFE.—In addition to conforming with the quality guaranties above stated, the lamps furnished under this specification are further guaranteed to give an average total life not less than the total life specified in Section IV, Manufacturers' Schedules of Commercial Ratings as modified by paragraph (i), when tested at, or corrected to, the initial rated lumens per watt specified in Section IV, or as may be modified by Section II, 2 (d).

(o) METHOD OF COMPUTATION.—The individual lamps shall be tested at voltages (or currents) corresponding to equal initial efficiencies and the average number of hours life to burn out determined for the group of lamps. The average life obtained on test shall be corrected from the initial test efficiency to the rated initial lumens per watt specified in Section IV, Manufacturers' Schedules of Commercial Ratings.

(p) REJECTION FOR DEFICIENT LIFE.—Any group of lamps, provided such group is represented by at least five lamps on life-performance test, may be rejected if the average life of the group, when corrected to the rated initial lumens per watt specified in Section IV, Manufacturers' Schedules of Commercial Ratings (or as it may be modified by Section II, 2 (d)) falls below the guaranteed life by more than the life tolerance specified in paragraph (i) above for the number of test lamps averaged.

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