

MIL-R-2728C
 5 December 1977
 SUPERSEDING
 MIL-R-2728B
 8 November 1961
 (See 6.4)

MILITARY SPECIFICATION

REFLECTOR, LIGHT; PARABOLIC, SEARCHLIGHT

This specification is approved for use by all Departments and agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers parabolic reflectors for searchlights.

1.2 Classification. Reflectors shall be of the following sizes as specified (see 6.2.1). (These sizes are ratings based on serviceable reflector area, and are not overall dimensions.)

12 inches
 24 inches

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

PPP-B-576 - Box, Wood, Cleated, Veneer, Paper Overlaid.
 PPP-B-585 - Boxes, Wood, Wirebound.
 PPP-B-591 - Boxes, Shipping, Fiberboard, Wood-Cleated.
 PPP-B-601 - Boxes, Wood, Cleated-Plywood.
 PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
 PPP-B-636 - Boxes, Shipping, Fiberboard.
 PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple Wall.

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MIL-P-116 - Preservation-Packaging, Methods of.
 MIL-S-901 - Shock Tests; H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
 MIL-L-10547 - Liners, Case, and Sheet, Overwrap; Water-Vaporproof or Waterproof, Flexible.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
 MIL-STD-129 - Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, G. F. Earl, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

UNITED STATES POSTAL SERVICE
Postal Regulations.

(Application for copies should be addressed to the United States Postal Service, 475 L'Enfant Plaza West S.W., Washington, DC 20260.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Sample for first article inspection. Prior to beginning production, a sample shall be examined and tested as specified in 4.3 (see 6.3).

3.2 Material. Material shall be at the option of the contractor, but shall be so selected as to meet all corrosion-resisting (see 4.6.8) and performance requirements set forth herein. Reclaimed materials shall be used to the maximum extent possible.

3.3 Design. Reflector shall be of uniform thickness, and of such thickness as may be necessary to produce a rigid construction. Irregularities in thickness due to roughness of the back or convex surface are not considered detrimental. The concave surface, when finished, shall be a mathematically true paraboloid, designed for a point focus with central focal axis perpendicular to the plane of the paraboloid reflective surface.

3.3.1 The reflector shall withstand high-impact shock as specified in MIL-S-901 (see 4.6.11).

3.4 Dimensions. Dimensions shall conform to table I and figure 1.

TABLE I. Weight and dimensions.^{5/}

Nominal size	Dimensions			Weight		Angle
	B ^{1/}	J ^{2/}	H ^{3/}	Minimum	Maximum	K ^{4/}
<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inch</u>	<u>Pounds</u>	<u>Pounds</u>	<u>Degrees</u>
12	12.6	5.75	0.082	--	--	90
24	25.6	9.70	.188	24	32	125

^{1/}Tolerance minus 1/2 percent.

^{2/}Tolerance plus or minus 2 percent.

^{3/}Tolerance plus 10 percent, minus 20 percent.

^{4/}Tolerance plus or minus 5 degrees.

^{5/}See figure 1.

3.5 Finish. The concave reflective surface shall be optically polished or so finished as to produce an optically efficient first surface reflector. The quality of the polished surface shall be judged principally by the efficiency as a reflector (see 3.6).

3.5.1 Reflectors having scratches that are so fine that they show a smooth edge and no structure between the edges when examined with a 10-power magnifier will be permitted. The reflecting surface may be the same metal as the blank structure, or may be a separate composition. The finished reflective surface shall, however, in either case, be inseparable from the metal blank and shall, in effect, be amalgamated or alloyed with the blank. The reflective surface, in addition to being corrosion-resisting to an extent equal to the metal blank, shall resist tarnish or oxidation from the contact with gases and fumes encountered in shipboard service, among which are flue gas and the gas generated by the arc of the light source of a searchlight where the arc is used.

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3.6 Reflectance. The specular reflectance of the reflective surface shall be not less than 63 percent for light from an incandescent tungsten lamp at a color temperature of 2848 kelvin (K), and there shall be no appreciable selective absorption of colors of the white light spectrum between 4,000 and 7,000 Angstroms (A). (Narrow dips, not exceeding 10 percent of the average between these limits shall be allowed.)

3.7 Temperature. The metal from which the reflector is formed shall be of such characteristic as to have a low linear coefficient of expansion, and shall show no distortion which will alter the efficiency of a reflected beam of light under service conditions more than five percent within a temperature range of 0°C to 150°C. Normal optical characteristics shall be taken as those found at 23°C. Construction shall be such as to withstand any forces induced internally through specified temperatures without damage or permanent distortion of the reflector.

3.8 Marking. Each reflector shall be plainly marked at the edge on the reflective surface, with maker's name or registered trademark, serial number, rated focal length and nominal size. Marking shall occupy an area not greater than 1-inch by 2-inches, and shall extend inward from the edge not more than 1 inch. Marking shall indicate the bottom of the reflector as determined by the beam pattern test specified in 4.6.3. The optical and geometrical center of the reflective surface shall be indicated by a spot not greater than 0.0625-inch diameter indented permanently in the reflector surface. The back of the reflector shall be marked in large figures with the actual weight of the reflector.

3.9 Measurements. When the metal blank is rough on the convex surface, the dimension "H" shall be the minimum measured thickness through the base of the depression, and the tolerance specified shall be on this measurement. The roughness shall not exceed a tolerance of plus 50 percent of the thickness "H".

3.10 Workmanship. Parts shall be free from blemishes, deformations, and other defects which would affect the serviceability or performance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of the examination and tests specified in 4.6 through 4.6.11. Production shall not be started until the contractor has furnished evidence that the sample has passed the first article tests.

4.3.1 Test report. The contractor shall prepare a first article test report in accordance with the data ordering document included in the contract or order (see 6.2.2).

4.4 Sampling for quality conformance inspection.

4.4.1 Lot. For purposes of sampling, a lot shall consist of all reflectors of the same size offered for delivery at one time.

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4.4.2 Sampling for group A examination and tests. A random sample of reflectors shall be selected in accordance with table II from each lot and subjected to each of the group A examination and tests specified in 4.5.1.

TABLE II. Sampling for group A examination and tests AQL (approx.) = 1.5 percent defective.

Number of reflectors in lot	Number of reflectors in sample	Number of equipments nonconforming on any group A examination and tests
		Rejection number
2 to 8	6	1
9 to 15	8	1
16 to 25	10	1
26 to 40	13	1
41 to 65	17	1
66 to 110	22	2
111 to 180	28	2
181 to 300	35	2
301 to 500	45	3
501 and over	55	4

4.4.3 Sampling for group B tests. A random sample of reflectors shall be selected in accordance with table III from each lot and subjected to each of the group B tests specified in 4.5.2.

TABLE III. Sampling for group B tests.

Number of reflectors in lot	Number of reflectors in sample	Number of equipments nonconforming on any group B tests
		Rejection number
2 to 8	3	1
9 to 15	4	1
16 to 25	5	1
26 to 40	6	1
41 to 65	8	1
66 to 110	10	1
111 to 180	13	2
181 to 300	17	2
301 to 500	22	3
501 and over	28	3

4.4.4 Sampling for group C tests. A sample number of reflectors shall be selected in accordance with table IV from the end of each month's production and shall be subjected to the group C tests.

TABLE IV. Sampling for group C tests.

Number of reflectors in 1 month's production	Number of reflectors for group C tests
65 and under	1
66 to 300	2
301 to 800	3

4.5 Inspection.

4.5.1 Group A examination and tests. Each of the sample reflectors selected in accordance with table II shall be subjected to the examination and each of the tests specified below, and the results of the examination and each test compared with specification requirements. Failure to conform to the specification requirements for any group A examination and test shall be counted as a defect and the reflector shall be rejected. If the number of such nonconforming reflectors in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

<u>Group A examination and tests</u>	<u>Reference</u>
Screen pattern	4.6.1
Focal point	4.6.2
Beam pattern	4.6.3
Surface and dimensional examination	4.6.4

4.5.2 Group B tests. Each of the sample reflectors selected in accordance with table III shall be subjected to each of the tests specified below, and the results of each test compared with specification requirements. Failure to conform to the specification requirements for any group B test shall be counted as a defect and the reflector shall be rejected. If the number of such nonconforming reflectors in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

<u>Group B tests</u>	<u>Reference</u>
Color selection	4.6.5
Reflecting efficiency	4.6.6

4.5.3 Group C tests. Each of the sample reflectors selected in accordance with table IV shall be subjected to each of the tests specified below, and the results of each test compared with specification requirements. In the event of any failure to conform to the specification requirements for any group C tests, the contractor shall correct the cause of failure on future production units and repair the deficiency in any reflectors not yet shipped.

<u>Group C tests</u>	<u>Reference</u>
Temperature changes	4.6.7
Staining	4.6.10
Shockproofness	4.6.11

4.6 Tests.

4.6.1 Screen pattern. The reflector shall be held at room temperature long enough to assure a sensibly uniform temperature throughout the mass of the metal. It shall be placed in a jig with a diaphragm, the opening of which equals the nominal size shown in table I. The jig for the reflector shall be constructed so that the front edge of the reflector bears on eight shims equally spaced and the reflector shall be restrained by spring pressure buttons opposite the shims. The reflection of straight horizontal and vertical lines shall be photographed. The line width shall be 3/8 inch, forming 2-1/4 inch squares or smaller on a flat surface of sufficient area to furnish a complete reflected pattern on the mirror. The distance between the vertex of the reflector and the screen shall be five times the focal length of the individual reflector. Under these conditions, no line shall depart along its entire length from a straight line, measured in a horizontal direction, by more than 3.2 percent for the 12-inch size and 4.3 percent for the 24-inch size of its horizontal distance from the center of the photograph.

4.6.2 Focal point. With the reflector mounted as specified in 4.6.1 a light beam 1 inch in diameter, collimated to parallelism shall be projected on the reflector, parallel to the focal axis. The reflected beam from any and all parts of the reflective surface shall pass through the focal center of the reflector, condensed to a point at the focal center. (A composite photograph, with plate surface substantially parallel to the focal axis in any and all planes across the plane of the mirror surface shall show all of these points falling within a sphere not to exceed the diameter shown in table V.) This shall be the limits permitted for the spherical aberration of the reflector. The photographic plate shall be placed

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so that the center of the focal sphere is substantially in coincidence with the center of the emulsion surface of the photographic plate, and the exposure shall be such to insure that the entire pattern is seen.

TABLE V. Sphere diameter.

Nominal reflector size	Sphere diameter maximum
<u>Inches</u>	<u>Inch</u>
12	3/16
24	4/32

This test shall be made on not less than two diameters, 90 degrees apart, and the measurement shall be made of the photographic images with prints from the several plates superimposed. In making these images the plates shall be set at the true focal point, and the mirror rotated about its focal axis. One plate shall be made on each diameter with the light moved at uniform speed across the diameter.

4.6.3 Beam pattern test. The reflector shall be mounted as specified in 4.6.1. A horizontal beam shall be projected from a light source at the focal point against a vertical screen at least 100 feet away. The size of the light source in any direction normal to the axis of the reflector shall not exceed 2 mm. The screen shall be marked with circles having diameters equal to the nominal size of the reflector under test. The reflector shall be adjusted in the mount about the axis to determine the orientation that produces the nearest approach to a circular cross section of the beam. The beam shall be symmetrical as specified in 4.6.1 and 4.6.2. The pattern shall not show the presence of narrow bright streamers of light projected outside the main beam.

4.6.4 Examination shall be made to determine compliance with the requirements of this specification, including workmanship and general dimensions.

4.6.5 Color selection in reflection. The reflective surface shall be essentially non-color selective in the region 7,000 to 4,200 A. The general trend of the specular spectral reflectance shall rise from the blue to red end of the spectrum and shall be not less than 60 percent at 4,200 A, nor less than 65 percent at 7,000 A and with this plotted line as the average, shall not fall more than 10 percent below this line at any point within the limits of 4,200 and 7,000 A.

4.6.6 Reflective efficiency. The reflective efficiency of the mirror shall be determined by the absorption of light of a reflected collimated beam or other suitable source, and the loss of light in the process of reflection determined. Sufficient readings shall be made to determine the average reflective efficiency of the reflector in the completed form, the figures to include surface dispersion, and the reflective efficiency of the reflective surface. The determination shall be made in the same manner as specified in 4.6.3 except a photocell, corrected by means of suitable filters to have a light response similar to the human eye, shall be employed instead of photographic equipment. The aperture over the photocell should be slightly larger than the sphere diameter maximum listed in table V.

4.6.7 Temperature changes. The completed reflector shall be tested for mechanical distortion resulting from expansion and contraction under temperature changes. The reflector shall be brought to a temperature of 0°C.; then the temperature of the reflector shall be raised to 150°C. It shall be cooled by natural radiation and convection to room temperature. This procedure shall be repeated five times. The reflector shall then be submitted to the screen test (see 4.6.1), the focal point test (see 4.6.2), and the reflective efficiency test (see 4.6.6), and these data shall show no change in characteristics of the reflector within the 3 percent personal error permitted in making optical data. Polishing of the reflective surface to remove any possible contamination of the reflecting surface incident to the handling of the reflector shall be done before making the observations.

4.6.8 Salt-water corrosion. The entire reflecting surface shall be polished with a polishing preparation to produce a clean reflecting surface, and the reflector shall be submitted to a salt spray of 20 percent commercially pure sodium chloride and distilled water, for 100 hours. At the end of this time no evidence of corrosion, or permanent effect of deterioration of the reflective surface shall be visible. The reflective surface shall be polished with a polishing compound, and shall show no change in characteristics as specified in 4.6.1, 4.6.2 and 4.6.6.

4.6.9 Eight-hour operating run. Reflector shall be polished and installed in a search-light, and operated for 8 consecutive hours with the arc or standard light source with which it shall be used. No cleaning or polishing shall be done during this period. The beam at 100 feet shall indicate a well-defined spot equivalent to the image of the light source. The shape, diameter, and definition of this spot shall not change except as modified by the crater of the carbon, during this run. No indication shall be present of the mirror distortion affecting the beam characteristics. After completing the 8-hour operating run, the reflector after cooling to room temperature naturally shall be cleaned and polished with a preparation to remove contamination of the surface incident to this test, and the results of the tests specified in 4.6.1, 4.6.2 and 4.6.6 shall show with allowance of the usual 3 percent for personal error the same as found for the new reflector.

4.6.10 Staining. Reflector shall be thoroughly polished on the reflective surface with a cleaning preparation, and subjected to 1 hour in concentrated washed and dried hydrogen sulfide gas (H_2S). At the end of this time the reflector shall be removed, and any stains appearing on the reflective surface shall be readily and completely removable with a cleaning material. Thus cleaned the reflector shall be tested as specified in 4.6.1, 4.6.2 and 4.6.5 to the same extent as required for the new reflector, with allowances of the usual 3 percent for personal error in testing.

4.6.11 Shock. Reflector shall be tested for class III. (high impact) shockproofness in accordance with MIL-S-901. The classification of the shock test shall be grade A, class 1, type C.

4.7 Inspection of preparation for delivery. Preservation-packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PRESERVATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements.)

5.1 Preservation-packaging. Preservation-packaging shall be level A or C as specified (see 6.2.1).

5.1.1 Level A. The reflector(s) shall be individually unit protected method III in accordance with MIL-P-116. Unit containers shall conform to PPP-B-636 class domestic with selection of variety and grade at the contractor's option. The special requirements for maximum weight and dimensions for the box selected shall apply.

5.1.2 Level C. Preservation-packaging of reflectors shall afford protection against corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The contractor's normal retail or wholesale preservation-packaging methods may be utilized when such meets the requirements of this level.

5.2 Packing. Packing shall be level A, B or C as specified (see 6.2.1).

5.2.1 Level A. Reflectors packaged as specified in 5.1 shall be packed in containers conforming to anyone of the following specifications at the option of the contractor.

<u>Specification</u>	<u>Classification</u>
PPP-B-576	Class 2
PPP-B-585	Class 3 use
PPP-B-591	Overseas type
PPP-B-601	Overseas type
PPP-B-621	Class 2
PPP-B-636	Class weather - resistant
PPP-B-640	Class 2

5.2.1.1 Closure, case liners and gross weight. Shipping containers shall be closed, strapped or banded in accordance with the applicable container specification or appendix thereto. Unless otherwise specified (see 6.2.1), shipping containers shall have case liners conforming to MIL-L-10547. Case liners for fiberboard boxes conforming to PPP-B-636 and PPP-B-640 may be omitted provided all center and edge seams and the manufacturer's joint are sealed and waterproofed with pressure sensitive tape in accordance with the applicable fiberboard box specification. Method V closure shall apply for PPP-B-636 boxes. Fiberboard boxes shall be reinforced with pressure-sensitive reinforced, filament tape or nonmetallic banding in lieu of steel strapping. The gross weight of wood or wood-created boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification.

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5.2.2 Level B. Reflectors packaged as specified in 5.1 shall be packed in containers conforming to any one of the following specifications at the option of the contractor:

<u>Specification</u>	<u>Classification</u>
PPP-B-576	Class 1
PPP-B-585	Class 1 or 2 use
PPP-B-591	Domestic type
PPP-B-601	Domestic type
PPP-B-621	Class 1
PPP-B-636	Class domestic
PPP-B-640	Class 1

Shipping containers shall be closed in accordance with the applicable box specification or appendix thereto. The gross weight of wood or wood-created boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable fiberboard box specification. When specified (see 6.2.1), unit fiberboard boxes (see 5.1.1) may be used as the shipping container.

5.2.3 Level C. Reflectors packaged as specified in 5.1 shall be packed in containers, at the lowest rates, in a manner which will insure acceptance by common carrier and will afford protection against physical or mechanical damage during direct shipment from the supply source to the first receiving activity for immediate use. This level in general shall conform to the Uniform Freight Classification Ratings, Rules and Regulations or other carrier regulations as applicable to the mode of transportation.

5.3 Cushioning, dunnage and wrapping materials.

5.3.1 Level A preservation-packaging, level A and B packing. Use of all types of loose-fill materials for applications such as cushioning, filler, stuffing and dunnage for material destined for shipboard use is prohibited.

5.3.2 Level C preservation-packaging and packing. Unless otherwise specified in the contract or order, use of all types of loose-fill materials for applications such as cushioning, filler, stuffing and dunnage for material destined for shipboard use is prohibited. When approved for use by the contract or order, unit packages and containers (interior and exterior) shall be marked or labeled as follows:

"CAUTION

Contents cushioned etc. with loose-fill material.
Not to be taken aboard ship.
Remove and discard loose-fill material before shipboard storage.
If required, recushion with cellulosic material bound fiber, fiberboard, or transparent flexible cellular material."

5.4 Marking. In addition to any special marking required by the contract or order (see 6.2.1), interior packages and exterior shipping containers shall be marked for shipment in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Reflectors are intended for use with the following equipment:

- (a) 12-inch incandescent and high intensity searchlights.
- (b) 24-inch high intensity arc searchlights.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Size required (see 1.2).
- (c) Preservation and packaging level required (see 5.1).
- (d) Packing level required (see 5.2).
- (e) When shipping containers are to have case liners other than as specified (see 5.2.1.1).
- (f) When unit fiberboard boxes are used as shipping containers (see 5.2.2).
- (g) Special marking required (see 5.4).

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6.2.2 Data requirements. When this specification is used in a procurement which invokes the provision of the "Requirements for Data" of the Armed Services Procurement Regulations (ASPR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the ASPR are not invoked in a procurement, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

<u>Paragraph</u>	<u>Data requirement</u>	<u>Applicable DID</u>	<u>Option</u>
4.3.1	Report, first article inspection	UDI-T-23450	-----

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the procuring/purchasing activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item procured to this specification. This does not apply to specific data which may be required for each procurement regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.

6.4 Changes from previous issue. The symbol "#" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
 Army - ME
 Navy - SH
 Air Force - 99
 Review interest:
 GS

Preparing activity:
 Navy - SH
 (Project 6210-0496)

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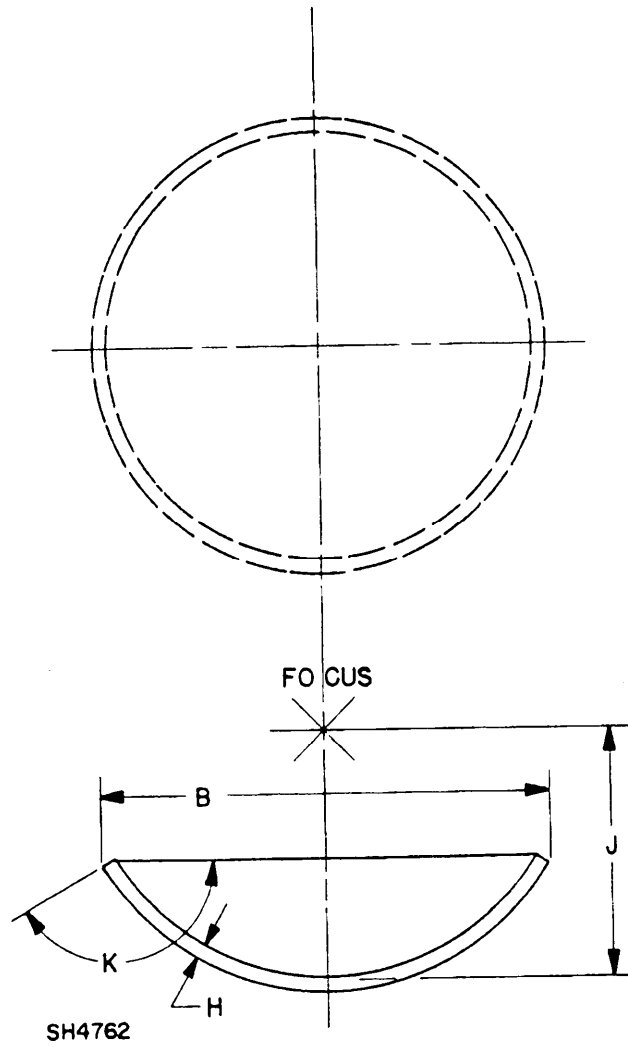


FIGURE 1. Reflector.

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