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RECOMMENDED STANDARD FOR OCCUPATIONAL & EDUCATIONAL EYE & FACE PROTECTION

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RECOMMENDED STANDARD FOR OCCUPATIONAL AND EDUCATIONAL EYE AND FACE PROTECTION

1.0 Scope and Purpose.

1.1 Scope. This standard shall apply to all occupational and educational operations or processes which are potentially hazardous to the head, face, eyes, or neck of a worker, excluding those relating to x-rays, gamma rays, high-energy particulate radiations, lasers, or masers.

1.2 Purpose. The purpose of this standard is to describe the performance requirements for various types and/or classes of eye and face protective devices when subjected to the appropriate tests; to describe the procedures, methods and equipments for testing the attributes of eye and face protective devices; and to provide a guide for selection of the proper safety equipment for different working conditions and a guide for the proper usage, cleaning, maintenance, and storage of protective devices.

2.0 Terminology.

2.1 In this standard, the use of the word "shall" indicates a mandatory requirement.

3.0 Definitions.

3.1 Specific Definitions.

Absorptive Lens	-	A filter lens designed to attenuate the effect of glare, reflective and stray light. In this standard, it refers to shades 1.7 through 3.0.
Anthropomorphic Head*	-	A dummy head with external dimensions equivalent to a percentage of the population of human heads.
Bevel	-	The shape of the edge of a lens used to prevent chipping or to achieve mechanical fit.
Cover Cup Goggle	-	A cup goggle designed to fit over vision correcting spectacles.
Cover Lens (Cover Circle)	-	A removable colorless disc that covers the filter lens and protects it from weld spatter, pitting or scratching when used in a helmet, hood or goggle.
Cover Plate	-	A removable colorless pane that covers the filter lens and protects it from weld spatter, pitting or scratching when used in a helmet, hood or goggle.
Cup Goggle	-	An eye protector consisting of two lenses mounted in cups supported by a flexible nosebridge and headband.
Diopter	-	A unit of measure used in optical measurements and having the following meanings when used in this standard:

*1. "Stereometric Measurements of Dummy Master Models," Final Report by Baylor University for Department of Transportation, National Highway Traffic Safety Administration, Contract No. DOT-HS-186-2-292, December 1972.

2. "Anthropometric Golden Shell Models and Their Designation by Stereometric Measurements," by V. G. Radovich and Dr. R. E. Herron, SAE Report No. 740116, February 1974.

Information concerning anthropomorphic heads can also be obtained from Alderson Research Laboratories, 390 Ludlow Street, P.O. Box 1271, Stanford, Connecticut 06904 and Humanoids Systems Division of Alderson Biotechnology Corporation, 5250 El Segundo Blvd., Hawthorne, CA 90250.

When referring to Prismatic Power: one thirty-second (1/32) of the angular deviation (in minutes) of a light ray due to its passage through a refractive medium with nonparallel surfaces (e.g., 1/16 diopter is equivalent to an angular deviation of 2 minutes; 1/8 diopter, an angular deviation of 4 minutes).

When referring to Refractive Power: the reciprocal of the focal length in meters (e.g., 1/16 diopter is equivalent to a focal length of 16 meters).

When referring to Radius of Curvature: the reciprocal of the radius of curvature in meters (e.g., 6.00 diopter is equivalent to a radius of curvature of 1/6 meter).

Disinfection - The act or process of destroying organisms that may cause disease.

Face Shield - A device supported in front of the face to protect the eye, face, forehead, chin and neck.

Filter Lens (Filter Circle) - A removable disc in the eyecup of a goggle that absorbs varying proportions of the ultraviolet, visible, and infrared rays according to the composition and density of the filter lens.

Filter Plate - A removable plate used in a helmet, hood or goggle which absorbs varying proportions of the ultraviolet, visible, and infrared rays according to the composition and density of the plate.

Glabella - The most anterior point in the mid-sagittal plane on the forehead between the eyebrows as determined by palpation and visual inspection.

Goggle - An eye protector fitting the contour of the face and held in position by a headband or suitable means.

Haze - The fraction of the total transmitted light from a normally incident beam which is not transmitted in a straight line.

Headband - That part of the goggle, helmet or hood suspension consisting of a supporting band that circles the head either partially or completely.

Infrared Radiation - Electromagnetic energy with wavelengths starting at 750 nanometers.

Lens - The transparent substance through which the wearer of the eye protector looks.

Luminous Transmittance - Visible transmittance corrected by the photopic spectral luminous efficiency of the human eye.

Nanometer - 10^{-9} meters (abbreviated as nm).

Opaque - Device having ultraviolet, luminous and infrared transmittances less than the lower bound of that required of a shade #14 filter (i.e., Luminous Transmittance < 0.00016%, Infrared Transmittance <0.3%, and Ultraviolet Transmittance <0.05% at 313, 334, and 365 nm and <0.1% at 405 nm).

Plano Lens - A lens with surfaces that are not curved or that are curved but neutralize each other. Such a lens has nominally no refractive power.

Prismatic Power - A measure of the nonparallelism of two faces of a lens normally expressed in diopters (1/16 diopter is equivalent to an angular deviation of 2 minutes of a light ray after passing through a lens).

Protector - A device that provides protection from potential injurious hazard. A dust protector has indirect fine screen ventilation and a close seal to the face. A chemical splash protector has indirect ventilation, a close seal to the face and chemical inertness. An impact protector is resistant to impacting particles. A welding and cutting protector possesses specific transmittance properties and resistance to heat. A molten metal protector is resistant to hot objects and has specific transmittance properties.

Refractive Power	- A measure of the amount that a lens focuses light rays, normally expressed in diopters. (A 1/16 diopter lens has a focal length of 16 meters.)
Safety Spectacle	- An eye protector patterned after prescription spectacle eyewear but made of sufficient strength to withstand appropriate tests in this standard.
Side Shield	- A device attached firmly to a spectacle lens frame to protect the eye from side exposure.
Striae	- An imperfection in optical glass consisting of distinct streaks of transparent material having a slightly different refractive index from the body of the glass caused by improper mixing of ingredients during manufacture.
Ultraviolet Radiation	- Electromagnetic energy with wavelengths from 200 to 400 nanometers.
Visible Light	- Electromagnetic energy with wavelengths from 400 to 750 nanometers.

4.0 Attributes of Eye and Face Protective Devices.

4.1 Specific Attributes.

4.1.1 Dimensions. Eye and face protective devices shall be designed with dimensions which provide direct and, in some cases, lateral protection. The effectiveness of the device depends in part upon its ability to form adequate shielding of vulnerable areas to protect them from the hazardous environment.

4.1.2 General Characteristics. Manufacturers of eye and face protective devices shall strive to make their devices comfortable and attractive so that they will be readily accepted by the user. Protectors have no effectiveness until they are worn.

4.1.3 Marking. It is recognized that no one protector will provide protection for all hazardous environments. Therefore, certain attributes must be labeled on some devices to identify their intended usage.

4.1.4 Optical Quality. Viewing regions of protectors shall not distort normal vision.

4.1.5 Prismatic Power. The faces of a plano lens shall be parallel to within strict tolerances.

4.1.6 Definition. Resolution shall not be highly affected by protective lenses.

4.1.7 Refractive Power. The eye shall not have to refocus substantially after putting on a device with a protective plano lens.

4.1.8 Transmittance. The transmittance properties of lenses shall be within tolerances dependent upon the hazard.

4.1.9 Opacity. For some hazards, regions of protectors shall have less transmittance than that of a shade #14 filter lens.

4.1.10 Haze. The amount of light scattered by a plano lens shall be minimized.

4.1.11 Impact Resistance. Protectors shall be able to withstand low speed, high mass impact and high speed, low mass impact.

4.1.12 Mechanical Strength. The supporting mechanism of protectors shall be sufficiently durable for the hazards to which it will be exposed.

4.1.13 Water Absorption. Protectors shall not absorb large amounts of water.

4.1.14 Disinfection. Protectors shall be constructed of materials which can be cleaned and disinfected so that illness and disease will not be spread by their usage.

4.1.15 Corrosion Resistance. Protectors shall be designed to withstand corrosive effects of humidity, heat, and salt associated with the working environment and the worker's perspiration.

4.1.16 Abrasion Resistance. Protectors shall be designed to withstand abrasive wear caused by handling.

4.1.17 Heat Deformation. Certain protectors, because of their exposure to particular hazards, shall be able to substantially retain their shape when subjected to heat and loading.

4.1.18 Resistance to Hot Materials. Certain protectors, because of their exposure to particular hazards, shall be able to resist penetration by hot objects.

4.1.19 Flame Resistance. Protectors shall be made of materials which will be resistant to burning.

4.1.20 Reaction to Chemicals. Certain protectors, because of their exposure to particular hazards, shall be resistant to the attack of various chemicals.

4.1.21 Resistance to Dusts. Certain protectors, because of their exposure to particular dusty environments, shall provide adequate protection to the wearer from dusts.

4.1.22 Susceptibility to Fogging. Certain protectors shall be vented, made of non-fog materials, and/or coated in such a manner to prevent fogging of the viewing portion of the protector while worn.

5.0 General Types of Eye and Face Protectors. Within the confines of this standard, the identifiable eye and face devices are included in this section.

5.1 Spectacles.

5.1.1 Clear lenses, without sideshields (Figure 5.1.1-1)

5.1.2 Clear lenses, with sideshields (Figures 5.1.2-1 and 5.1.2-2)

5.1.3 Filter lenses, without sideshields

5.1.4 Filter lenses, with sideshields

5.2 Cup and Cover Cup Goggles.
(Covers only eyes and immediate surrounding area)

5.2.1 Dust

5.2.2 Chemical Splash

5.2.3 Impact (Figures 5.2.3-1 and 5.2.3-2)

5.2.4 Welding and Cutting (Figures 5.2.4-1 and 5.2.4-2)

5.2.5 Molten Metal

5.3 Facial Goggles.
(Includes flexible fitting and cushioned fitting goggles)

5.3.1 Dust

5.3.2 Chemical Splash

5.3.3 Impact (Figure 5.3.3-1)

5.3.4 Welding and Cutting (Figure 5.3.4-1)

5.3.5 Molten Metal

5.4 Face Shields.
(Protects the front and part of the side of the head.)

5.4.1 Chemical Splash (Figure 5.4.1-1)

5.4.2 Impact (Figure 5.4.1-1)

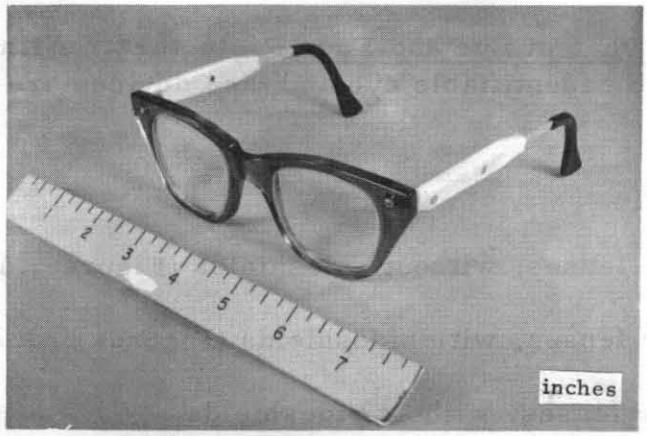

FIGURE 5.1.1-1. PLASTIC FRAME SAFETY SPECTACLES WITH CLEAR LENSES AND WITHOUT SIDESHIELDS

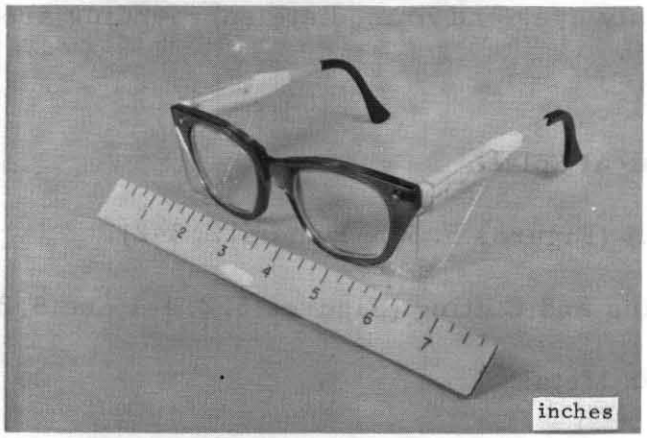

FIGURE 5.1.2-1. PLASTIC FRAME SAFETY SPECTACLES WITH CLEAR LENSES AND WITH FLAT-FOLD SIDESHIELDS

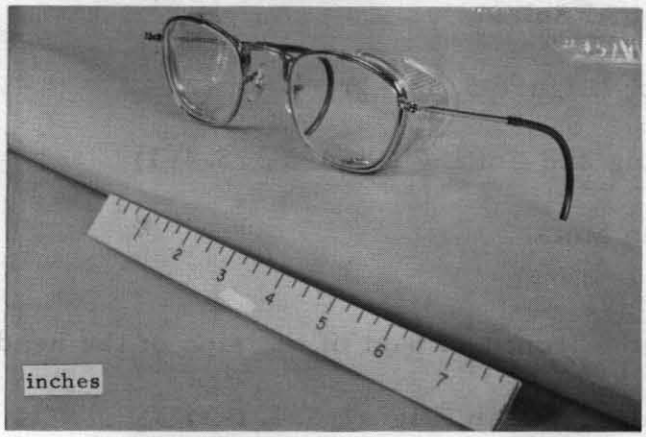

FIGURE 5.1.2-2. METAL FRAME SAFETY SPECTACLES WITH CLEAR LENSES AND WITH CUP-TYPE SIDESHIELDS

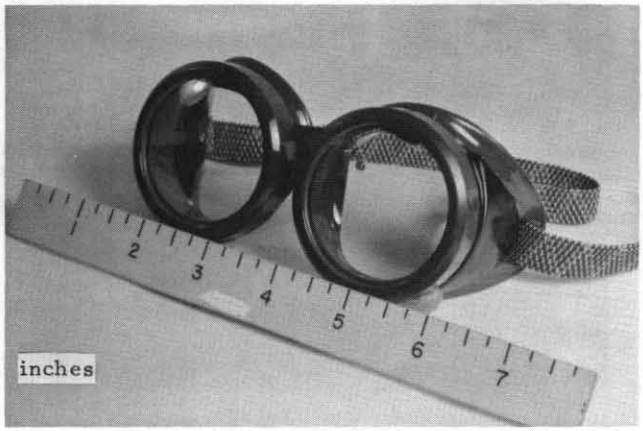

FIGURE 5.2.3-1. CUP GOGGLE FOR IMPACT PROTECTION

FIGURE 5.2.3-2. COVER CUP GOGGLE FOR IMPACT PROTECTION

FIGURE 5.2.4-1. CUP GOGGLE FOR WELDING AND CUTTING PROTECTION

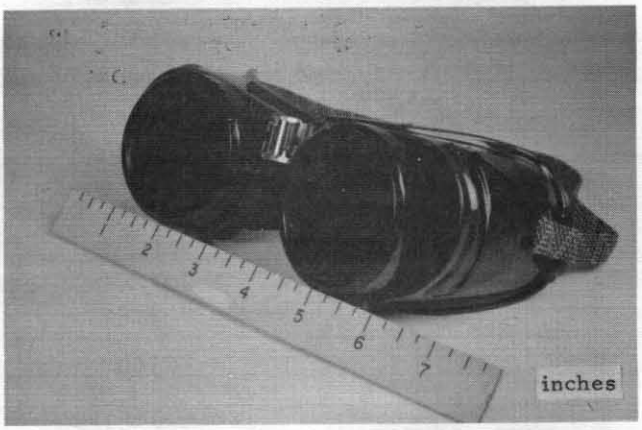

FIGURE 5.2.4-2. COVER CUP GOGGLE FOR WELDING AND CUTTING PROTECTION

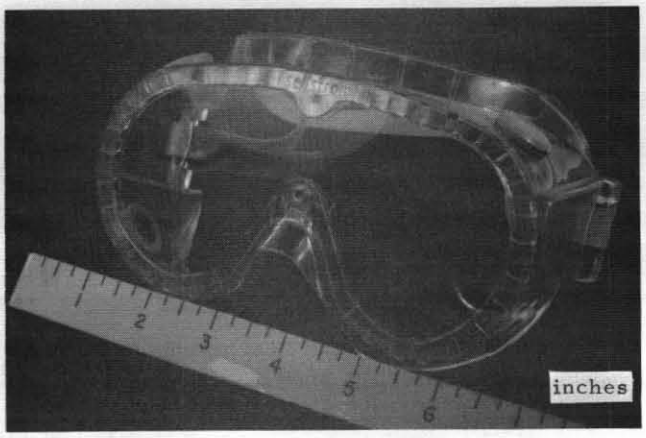

FIGURE 5.3.3-1. FACIAL GOGGLE FOR IMPACT PROTECTION

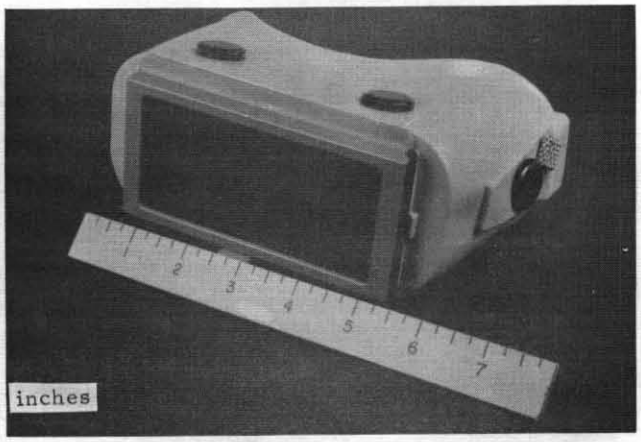

FIGURE 5.3.4-1. FACIAL GOGGLE FOR WELDING AND CUTTING PROTECTION

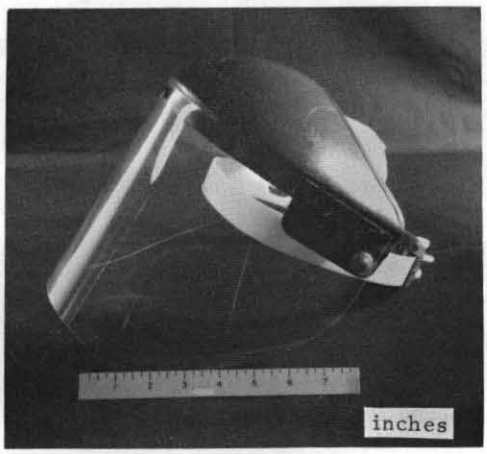

FIGURE 5.4.1-1. FACESHIELD FOR CHEMICAL SPLASH AND IMPACT PROTECTION

5.4.3 Welding and Cutting

5.4.4 Molten Metal

5.5 Welding Helmets.
(Protects the front and part of the side of the head.) (Figure 5.5-1)

5.6 Visitor's Spectacles.
(Designed for visitors and inspectors of working environments) (Figure 5.6-1)

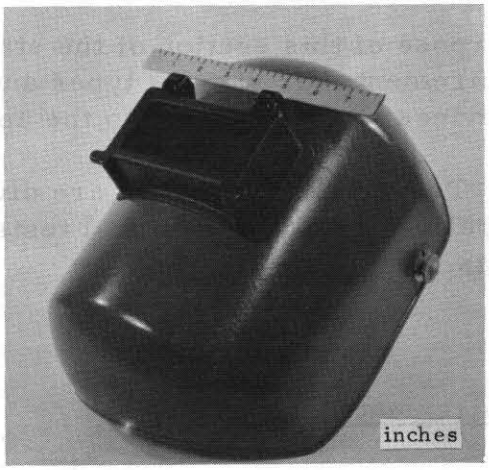

FIGURE 5.5-1. WELDING HELMET

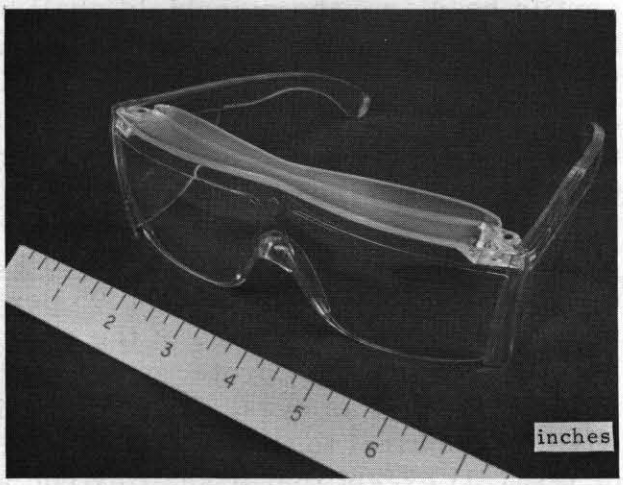

FIGURE 5.6-1. VISITOR'S SPECTACLES

6.0 Performance Requirements for Various Protectors.

6.1 Purpose. The purpose of this section of the standard is to describe the performance requirements for various types and/or classes of eye and face protective devices when subjected to the appropriate tests.

6.2 Test Categories. Tests in this standard are divided into four basic categories: general requirements, optical tests, mechanical tests and additional tests.

6.3 Test Criteria.

6.3.1 General Requirements.

6.3.1.1 Dimensions.

6.3.1.1.1 Minimum Requirements for Sideshields. On the 95 percentile headform, the sideshield shall be positioned so that no portion of the eye extends beyond any of its edges when viewed in the manner described in Section 7.4.1.1.1. A 1.0 mm (0.04 in.) diameter rod shall not be able to directly pass between the sideshield and frame to any point behind the lens. (See Figure 6.3.1.1.1-1)

6.3.1.1.2 Minimum Requirements for Eye and Face Protectors. At no time shall any portion of the 95 percentile anthropomorphic head between the base of the chin and the top of the head extend beyond a protector which is designed to protect the face as well as eyes. Side protection requirements shall be identical to that for sideshields (i.e., Section 6.3.1.1.1) except that it shall extend at least up to the top of the head and down to the base of the chin. Side protection for welding helmets shall extend to a vertical line back of the ears.

6.3.1.1.3 Maximum Ventilation Opening Criteria. Ventilation openings shall exclude the 1.0 mm (0.04 in.) diameter rod.

6.3.1.1.4 Field of Vision Criteria. The entire periphery of the ellipse shall be able to be outlined when the test described in Section 7.4.1.1.4 is performed on each eye and the results are combined.

6.3.1.2 Marking Criteria.

6.3.1.2.1 Manufacturer's Identification. All lenses, frames and portions of eye protectors which can be disassembled shall bear a permanent manufacturer's identification mark.

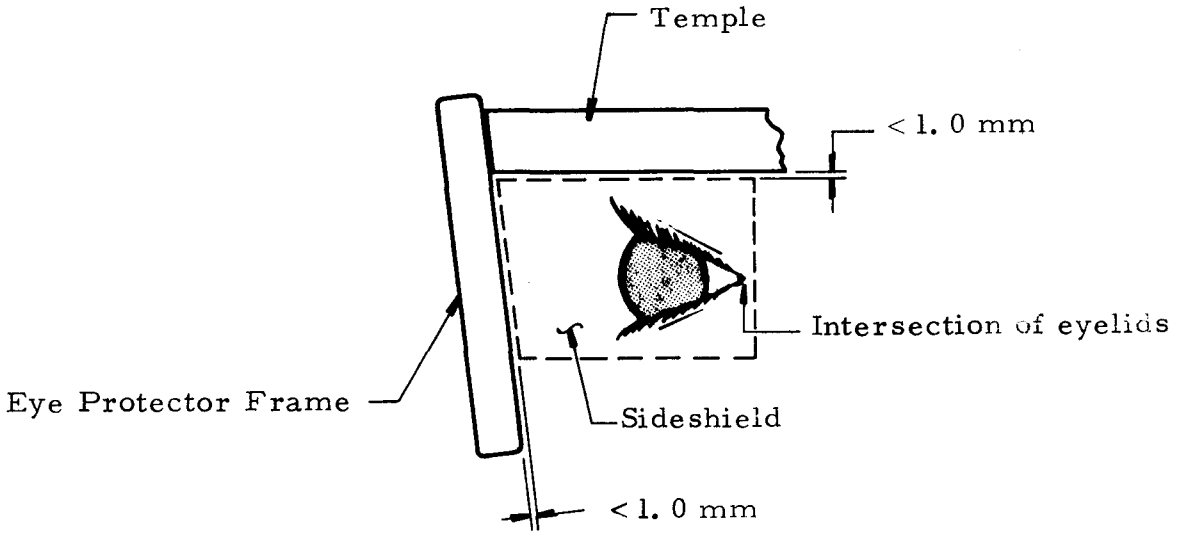

FIGURE 6. 3. 1. 1. 1-1. SIDESHIELD POSITION

6.3.1.2.2 Shade Number. All absorptive and filter lenses intended for hazards in the visible, ultraviolet and infrared spectra shall have their shade number permanently marked on them in such a manner that they do not interfere with the vision of the wearer.

6.3.1.2.3 Luminous Shade Designation. All shaded lenses intended for protection in the visible region only shall be permanently labeled "Lt", "Md", or "Dk" denoting respectively Light, Medium or Dark.

6.3.1.2.4 Impact Strength Grade. All lenses, frames and portions of eye protectors which can be disassembled shall be permanently labeled with the impact strength grade number (i.e., I, II or III).

6.3.1.2.5 Dust, Chemical Splash and Molten Metal Designation. Protectors designed to withstand dust, chemical splash, and/or molten metal shall be labeled respectively "D", "C", and/or "M".

6.3.1.2.6 Sequence of Marking. The sequence of marking, read as when reading the English language (left to right, then top to bottom), shall be as follows:

(1) Manufacturer's identification
(2) Shade
(3) Impact strength grade
(4) Dust
(5) Chemical splash
(6) Molten metal.

Thus a protector that is produced by a manufacturer with manufacturer's identification AA and which has a shade number 14, impact strength I, and can be used in areas where there is molten metal shall be labeled in the sequence AA14IM. (Note that $^{AA14}_{IM}$ and other forms are also acceptable since the proper sequence, according to normal English language reading habits, is preserved.)

6.3.1.2.7 Additional Information.

6.3.1.2.7.1 Mandatory Information. Each manufacturer shall supply literature with each eye protector distributed which explains to the user the following:

- Proper cleaning procedure
- Work environment(s) for which the protector is intended. (Note: for chemical exposure, the categories shall be weak acids, strong acids, weak alkalies, strong alkalies, organic solvents.)
- Work environment(s) for which the protector is not intended. (Note: for chemical exposure the categories shall be weak acids, strong acids, weak alkalies, strong alkalies, organic solvents.)
- Conditions under which lenses and/or protectors should be replaced.

6.3.1.2.7.2 Optional Information. The manufacturer may provide additional information for convenience. Some other useful information is as follows:

- Materials in eye protector components.
- Other, including disinfection procedures.

6.3.2 Optical Test Criteria.

6.3.2.1 Optical Quality. All lenses shall be made of material suitable for opthalmic use and both surfaces of the lenses shall be well polished and free from visible surface defects. The lenses shall be free from striae, bubbles, waves and other visible defects and flaws which would impair their optical quality.

6.3.2.2 Prismatic Power. Tolerances for all plano lenses shall be 1/16 diopter (i.e., 2 minutes angular deviation) except for cover plates and filter plates which shall be 1/8 diopter (i.e., 4 minutes angular deviation).

6.3.2.3 Definition. The high contrast resolving power chart pattern 20 of the National Bureau of Standards Special Publication 374 shall be clearly resolvable when viewed through the test lens and telescope.

6.3.2.4 Refractive Power. The refractive power shall not exceed plus or minus 1/16 diopter and the difference in refractive power of any two meridians shall not exceed 1/16 diopter.

6.3.2.5 Ultraviolet, Luminous and Infrared Transmittances. Tolerances for transmittances of shaded materials shall be as given in Table 6.3.2.5-I. If two filter lenses are required in a

TABLE 6.3.2.5-I. TRANSMITTANCES AND TOLERANCES IN TRANSMITTANCE OF VARIOUS SHADES OF ABSORPTIVE LENSES, FILTER LENSES, AND PLATES

Shade Number	Optical Density			Luminous Transmittance			Maximum Infrared Transmittance	Maximum Spectral Transmitrance in the Ultraviolet and Violet			
	Maximum	Standard	Minimum	Maximum Percent	Standard Percent	Minimum Percent	Percent	313 nm Percent	334 nm Percent	365 nm Percent	405 nm Percent
1.5	0.26	0.214	0.17	67	61.5	55	25	0.2	0.8	25	65
1.7	0.36	0.300	0.26	55	50.1	43	20	0.2	0.7	20	50
2.0	0.54	0.429	0.36	43	37.3	29	15	0.2	0.5	14	35
2.5	0.75	0.643	0.54	29	22.8	18.0	12	0.2	0.3	5	15
3.0	1.07	0.857	0.75	18.0	13.9	8.50	9.0	0.2	0.2	0.5	6
4.0	1.50	1.286	1.07	8.50	5.18	3.16	5.0	0.2	0.2	0.5	1.0
5.0	1.93	1.714	1.50	3.16	1.93	1.18	2.5	0.2	0.2	0.2	0.5
6.0	2.36	2.143	1.93	1.18	0.72	0.44	1.5	0.1	0.1	0.1	0.5
7.0	2.79	2.571	2.36	0.44	0.27	0.164	1.3	0.1	0.1	0.1	0.5
8.0	3.21	3.000	2.79	0.164	0.100	0.061	1.0	0.1	0.1	0.1	0.5
9.0	3.64	3.429	3.21	0.061	0.037	0.023	0.8	0.1	0.1	0.1	0.5
10.0	4.07	3.857	3.64	0.023	0.0139	0.0085	0.6	0.1	0.1	0.1	0.5
11.0	4.50	4.286	4.07	0.0085	0.0052	0.0032	0.5	0.05	0.05	0.05	0.1
12.0	4.93	4.714	4.50	0.0032	0.0019	0.0012	0.5	0.05	0.05	0.05	0.1
13.0	5.36	5.143	4.93	0.0012	0.00072	0.00044	0.4	0.05	0.05	0.05	0.1
14.0	5.79	5.571	5.36	0.00044	0.00027	0.00016	0.3	0.05	0.05	0.05	0.1

protector, they shall be supplied and replaced in pairs and shall have the same luminous transmittance within 20 percent of the lens with the lower luminous transmittance. [1] All shaded lenses intended for protection in the visible region only shall have a percent luminous transmittance in one of the three ranges shown in Table 6.3.2.5-II.

6.3.2.6 Opacity. An item shall be considered opaque if its transmittance is less than that for a shade #14 (i.e., Luminous Transmittance <0.00016%, Infrared Transmittance <0.3%, and Ultraviolet Transmittance <0.05% at 313, 334, and 365 nm and <0.1% at 405 nm, see Table 6.3.2.5-I). All portions of welding and cutting protective devices other than the lenses shall be opaque as well as all welding and cutting protective partitions.

6.3.2.7 Haze. Plastic lenses of all types shall not exhibit more than six percent haze.

6.3.3 Mechanical Test Criteria.

6.3.3.1 In-Frame Drop Ball Test Criteria. No lens edge shall be chipped. No lens shall be shattered or displaced from the frame eye. No portion of the frame or sideshield shall be cracked or broken.

6.3.3.2 Out of Frame Drop Ball Test Criteria. The lens shall not chip or fracture.

6.3.3.3 Out of Frame Breakage Pattern Test Criteria - Glass Only. The lens shall break predominately with radial cracks with a minor tendency toward concentric cracks. The lens shall not show any tendency to break with the lines of cleavage parallel to the surface since this indicates an unsatisfactory heat treatment. (See Figures 6.3.3.3-1 and 6.3.3.3-2.)

6.3.3.4 Out of Frame Penetration Test Criteria - Plastic Only. The lens shall not be pierced through from the impact.

6.3.3.5 Ballistic Impact Test Criteria. All lenses and sideshields shall pass the Grade I requirement (see Table 6.3.3.5-I) of this test. After being tested, no lens edge shall be chipped and no lens shall be shattered or displaced from the frame eye. Also, no portion of the frame or sideshield shall be cracked or broken.

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[1] Clear lenses shall not transmit less than 89 percent of the incident luminous radiation.

TABLE 6.3.2.5-II. CRITERIA FOR LUMINOUS SHADE DESIGNATION

Marking	Designation	Percent Luminous Transmittance
Lt	Light	50 ± 7
Md	Medium	24 ± 5
Dk	Dark	14 ± 4

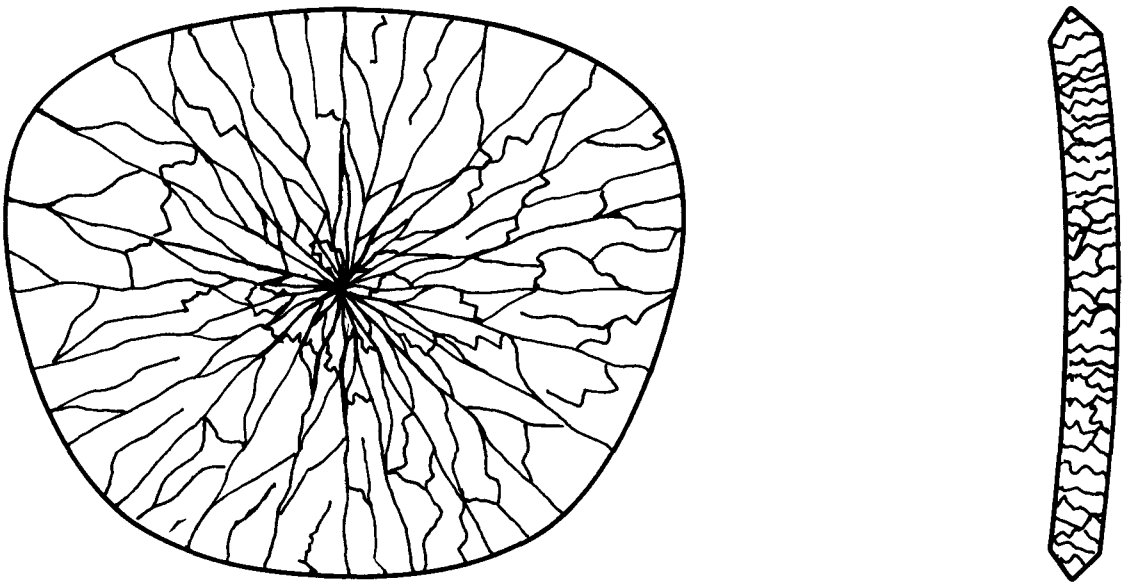


FIGURE 6. 3. 3. 3-1. BREAKAGE PATTERN FOR PROPERLY HEAT TREATED LENS

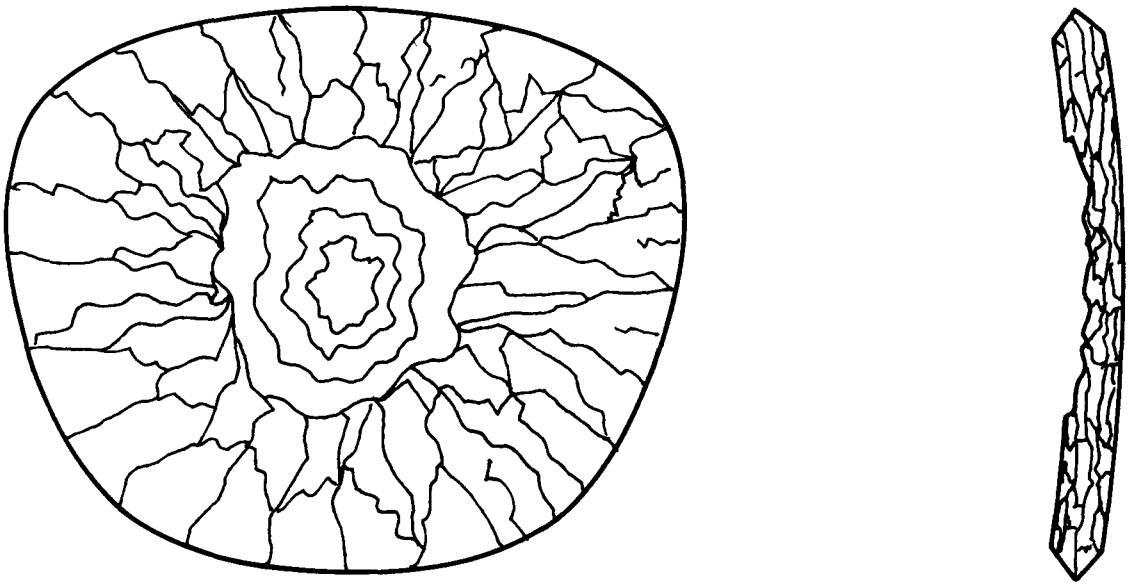


FIGURE 6. 3. 3. 3-2. BREAKAGE PATTERN FOR IMPROPERLY HEAT TREATED LENS

TABLE 6.3.3.5-I. IMPACT TEST PARAMETERS FOR GRADING OF MATERIALS

Ball Diameter	Weight	Ballistic Velocity (m/sec)	Drop Height	Gradations
25 mm (1.00 in)	68.1 gm (2.4 oz.)		1.25 m (50 in)	Grade I, II, III
4.8 mm (0.188 in)	0.4 gm (.01 oz.)	11 + 4 - 0		Grade I
4.8 mm (0.188 in)	0.4 gm (.01 oz.)	50 ± 3		Grade II
4.8 mm (0.188 in	0.4 gm (.01 oz.)	100 ± 5		Grade III

6.3.3.6 Flat Transverse Test Criteria. Upon removal of the load no deformation shall be apparent in the frame.

6.3.3.7 Edge Transverse Test Criteria. After the test is completed, no deformation shall be apparent in the frame.

6.3.3.8 Strength of Joints Criteria. After the test is completed, the frame shall not have any visible joint fracture.

6.3.4 Additional Test Criteria.

6.3.4.1 Water Absorption Criteria. The amount of water absorbed by each component shall not exceed five percent by weight.

6.3.4.2 Disinfection Criteria. The eye and face protective devices shall show no signs of deterioration or discoloration.

6.3.4.3 Corrosion Resistance Criteria. The eye and face protective devices shall have no more than a slight degree of corrosion. An unacceptable degree of corrosion is when the device is rendered not usable for its intended purpose as a result of the corrosion.

6.3.4.4 Abrasive Wear Criteria. After being tested, a lens shall not have more than a 10 percent decrease in luminous transmittance as determined by the procedure specified in Section 7.4.2.5.2.

6.3.4.5 Heat Deformation Criteria. Before and after the test, the retaining ring and the cup shall fit in a snug but not tight manner. The maximum deviation from the original dimensions shall not exceed the following: For dimensions (A) and (B), 1/2 percent, and for dimension (D), 5 percent (see Figure 6.3.4.5-1).

6.3.4.6 Penetration of Hot Solid Criteria. The lens shall not be pierced through.

6.3.4.7 Flammability Criteria. The test specimen average burning rate shall not be greater than 7.6 centimeters per minute (3 inches per minute).

6.3.4.8 Resistance to Chemicals.

6.3.4.8.1 General Purpose Chemical Protector Test Criteria. After being tested, the protector shall be able to qualify as a Grade I impact protector (see Table 6.3.3.5-I).

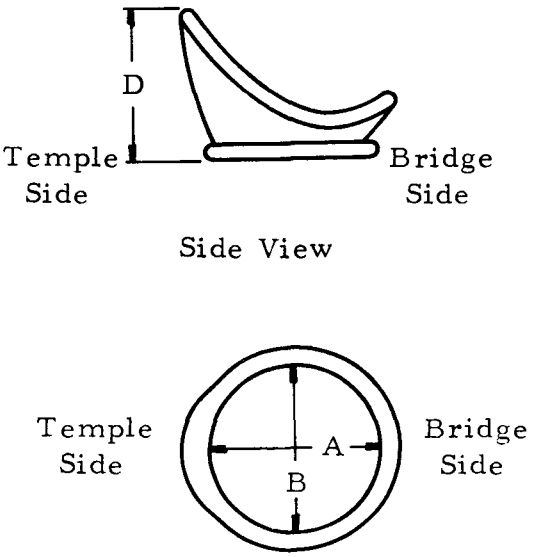


FIGURE 6.3.4.5-1. DIMENSIONS TO BE MEASURED IN HEAT DEFORMATION TEST

Note: Chemical protectors shall have indirect ventilation and form a close seal to the face.

6.3.4.8.2 Special Purpose Chemical Protector Test Criteria. After being tested, the protector shall not have more than a 10 percent decrease in luminous transmittance. The protector shall also be able to qualify as a Grade I impact protector.

Note: Chemical protectors shall have indirect ventilation and form a close seal to the face.

7.0 Testing Requirements for Various Protectors

7.1 Purpose. The purpose of this section of the standard is to describe the procedures, methods and equipments for testing the attributes of eye and face protective devices.

Table 7.1-I indicates the required tests for each eye and face protective device.

7.2 Intent of Tests. The intent of the tests in this standard is to provide a means of examining the attributes of eye and face protective equipment.

7.3 Testing Order. To complete the testing procedure outlined below, fourteen to eighteen (i.e., depending upon required tests, see Table 7.1-I) complete protectors and five lenses of each design or type are needed. When applicable, eye and face protectors shall be subjected to the following test order.

7.3.1 General Requirements Examinations. Any convenient order; nondestructive; eleven complete samples. (Note: Only one of these protectors is to be used for the Field of Vision Test, Section 7.4.1.1.4.)

7.3.2 Optical Tests. Any convenient order, nondestructive; ten complete samples used in general requirements examinations excluding one protector used for Field of Vision Test, Section 7.4.1.1.4.

7.3.3 Mechanical Tests.

7.3.3.1 In-Frame Drop Ball Test; semi-destructive; ten complete samples used in optical tests.

7.3.3.2 Ballistic Impact Test; semi-destructive; ten complete samples used in drop ball test on lenses in their frames.

7.3.3.3 Flat Transverse Test; semi-destructive; three of ten complete samples used in ballistic tests.

7.3.3.4 Edge Transverse Test; semi-destructive; three complete samples used in flat transverse test.

7.3.3.5 Strength of Joints; destructive; three complete samples used in edge transverse test.

7.3.3.6 Out of Frame Drop Ball Test; semi-destructive; five unused lenses.

TABLE 7.1-I. REQUIRED TESTS FOR VARIOUS PROTECTORS

NOTE: There are six basic categories of protective devices in this matrix, (1) spectacles, (2) cup and cover cup goggles, (3) facial goggles, (4) face shields, (5) welding helmets, and (6) visitor's spectacles.

Each category has some or all of the following basic attributes:

Dust - indirect fine screen ventilation and close seal to face.
Chemical splash - indirect ventilation, close seal to face and chemical inertness.
Impact - resistant to impacting particles.
Welding & Cutting - specific transmittance properties and resistance to heat.
Molten Metal - resistance to hot objects and, in some instances, specific transmittance properties.

			EYE AND FACE PROTECTIVE DEVICES																				
			Spectacles					Cup and Cover Cup Goggles					Facial Goggles					Face Shields					
General Test Categories	Testing Standard Code No.	Tests	Clear lenses w/o sideshields	Clear lenses with sideshields	Filter lenses w/o sideshields	Filter lenses with sideshields		Dust	Chemical splash	Impact	Welding & cutting	Molten metal	Dust	Chemical splash	Impact	Welding & cutting	Molten metal	Chemical splash	Impact	Welding & cutting	Molten metal	Welding Helmets	Visitor's Spectacles
Dimensions	7.4.1.1.1	Minimum requirements for sideshields		X		X		X	X	X	X	X	X	X	X	X	X						X
	7.4.1.1.2	Minimum requirements for eye and face protectors																X	X	X	X	X	
	7.4.1.1.3	Maximum ventilation opening		X		X		X	X	X	X	X	X	X	X	X	X						
	7.4.1.1.4	Field of vision	X	X	X	X		X	X	X			X	X	X			X	X				X
Marking	7.4.1.2	Manufacturer's identification	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.1.2	Shade number			X	X					X					X				X		X	
	7.4.1.2	Luminous Shade Designation										X					X				X		
	7.4.1.2	Impact strength grade	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.1.2	Dust, chemical splash, and molten metal designation						X	X			X	X	X			X	X			X		
	7.4.1.2	Sequence of marking	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.1.2	Additional information	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Optical Tests	7.4.2.1	Optical quality	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.2.2	Prismatic power	X	X	X[1]	X[1]		X	X	X	X[1]	X[1]	X	X	X	X[1]	X[1]	X	X	X[1]	X[1]	X[1]	X
	7.4.2.3	Definition	X	X	X[1]	X[1]		X	X	X	X[1]	X[1]	X	X	X	X[1]	X[1]	X	X	X[1]	X[1]	X[1]	X
	7.4.2.4	Refractive power	X	X	X[1]	X[1]		X	X	X	X[1]	X[1]	X	X	X	X[1]	X[1]	X	X	X[1]	X[1]	X[1]	X
	7.4.2.5	Ultraviolet, luminous and infrared transmittance			X	X					X					X				X		X	
	7.4.2.6	Opacity									X					X				X		X	
	7.4.2.7	Haze[2]	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mechanical Tests	7.4.3.1	In-frame drop ball test	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.3.2	Out-of-frame drop ball test	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.3.3	Out-of-frame breakage pattern test - glass only	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.3.4	Out-of-frame penetration test - plastic only	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.3.5	Ballistic impact test	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.3.6	Flat transverse	X	X	X	X																	X
	7.4.3.7	Edge transverse	X	X	X	X																	X
	7.4.3.8	Strength of joints[3]	X	X	X	X																	X
Additional Tests	7.4.4.1	Water absorption[2]	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.4.2	Disinfection	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.4.3	Corrosion resistance	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.4.4	Abrasive wear[4]	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.4.5	Heat deformation						X	X	X	X	X											
	7.4.4.6	Penetration of hot solid[4]									X	X				X	X			X	X	X	
	7.4.4.7	Flammability	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	7.4.4.8	Resistance to chemicals							X					X				X					

(1) All clear lenses and all shades up to and including shade #4.
(2) Plastic only.
(3) Frames with metal bridge only.
(4) Outermost lenses only.

NOTE: It is conceivable that a protector can qualify in more than one category of eye and face protective devices. For example, one can create a combination face shield and facial goggle. To qualify for both areas, the device shall pass all relevant tests for each category. That is, it shall pass the tests for the appropriate facial goggle type and the appropriate face shield type.

7.3.3.7 Out of Frame Breakage Pattern Test; destructive; five lenses (if made of glass) used in drop ball test of lenses without the frames.

7.3.3.8 Out of Frame Penetration Test; semi-destructive; five lenses (if made of plastic) used in drop ball test of lenses without the frame.

7.3.4 Additional Tests - three to seven (i.e., depending upon required tests) additional complete protectors.

One of the complete protectors mentioned above shall undergo the following testing order:

7.3.4.1 Water Absorption Test

7.3.4.2 Disinfection Test

7.3.4.3 Corrosion Resistance Test

The remaining complete protectors shall undergo the following tests, one protector for each test:

7.3.4.4 Abrasive Wear

7.3.4.5 Flammability Tests

7.3.4.6 Heat Deformation Test - if applicable

7.3.4.7 Penetration of Hot Solid - if applicable

7.3.4.8 Resistance to Chemicals - two tests if applicable

7.4 Test Procedures. Unless otherwise specified, tests shall be conducted at a temperature of 240°C ± 6°C (75°F ± 10°F).

7.4.1 General Requirement Tests.

7.4.1.1 Dimensions.

7.4.1.1.1 Minimum Requirement Test for Sideshields. Eye protectors with sideshields shall be placed on a 95 percentile anthropomorphic head, in the normal wearing position. During the test, the observer shall sight (with one eye open and one eye closed or blocked) perpendicular to the direction of vision of the anthropomorphic head and shall examine the periphery of the sideshield. Attempts shall also be made to pass without forcing a 1.00 mm (0.04 in.) diameter rod directly between the sideshield and frame to any point behind the lens.

7.4.1.1.2 Minimum Requirement Test for Eye and Face Protectors. Protectors designed to protect the face as well as eyes shall be placed on a 95 percentile anthropomorphic head in the normal wearing position. The observer shall face the dummy head and shall sight (with one eye open and one eye closed or blocked) along lines parallel to the line of sight of the dummy head, around the entire periphery of the eye and face protector. He shall then sight perpendicular to the line of sight of the dummy head and examine the protector for side protection.

7.4.1.1.3 Ventilation Opening Test. Attempts shall be made to pass without forcing a 1.00 mm (0.04 in.) diameter rod through ventilation openings.

7.4.1.1.4 Field of Vision Test. An ellipse with the foci and center shown in Figure 7.4.1.1.4-1 shall be cut out of a piece of wood 0.64 cm (1/4 in.) to 1.27 cm (1/2 in.) thick and shall be supported with its major axis horizontal and its minor axis vertical. A 95 percentile anthropomorphic head shall be placed facing the ellipse such that the eyes of the headform are 1.00 m from the ellipse. The horizontal component of the perpendicular bisection of the interpupillary distance of the headform shall be in line with the center of the ellipse as shown in Figure 7.4.1.1.4-2. The protector shall be placed on the dummy head in the normal wearing position with the lenses removed. One end of a straight and rigid tube or rod with a diameter no greater than 0.64 cm (1/4 in.) and at least 1.8 m long shall be placed against the center of each eye (one at a time) of the dummy head. The free end of the tube or rod shall be moved along the periphery of the ellipse or eye frame, whichever boundary interferes first.

7.4.1.2 Marking. Protectors shall be visually examined to insure that they contain, when applicable, the following information:

- Manufacturer's Identification--see Section 6.3.1.2.1
- Shade Number--see Section 6.3.1.2.2
- Luminous Shade Designation--see Section 6.3.1.2.3
- Impact Strength Grade--see Section 6.3.1.2.4
- Dust, Chemical Splash and Molten Metal Designation--see Section 6.3.1.2.5
- Sequence of Marking--see Section 6.3.1.2.6
- Additional Information--see Section 6.3.1.2.7

7.4.2 Optical Tests. All lenses shall be cleaned with soap and water, rinsed, and dried prior to conducting each optical test.

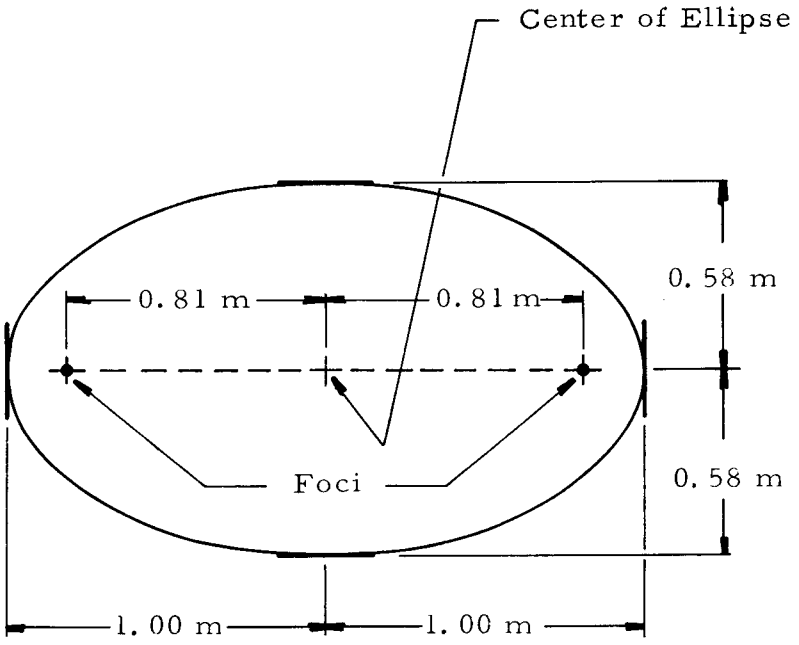


FIGURE 7.4.1.1.4-1. ELLIPSE FOR FIELD OF VISION TEST

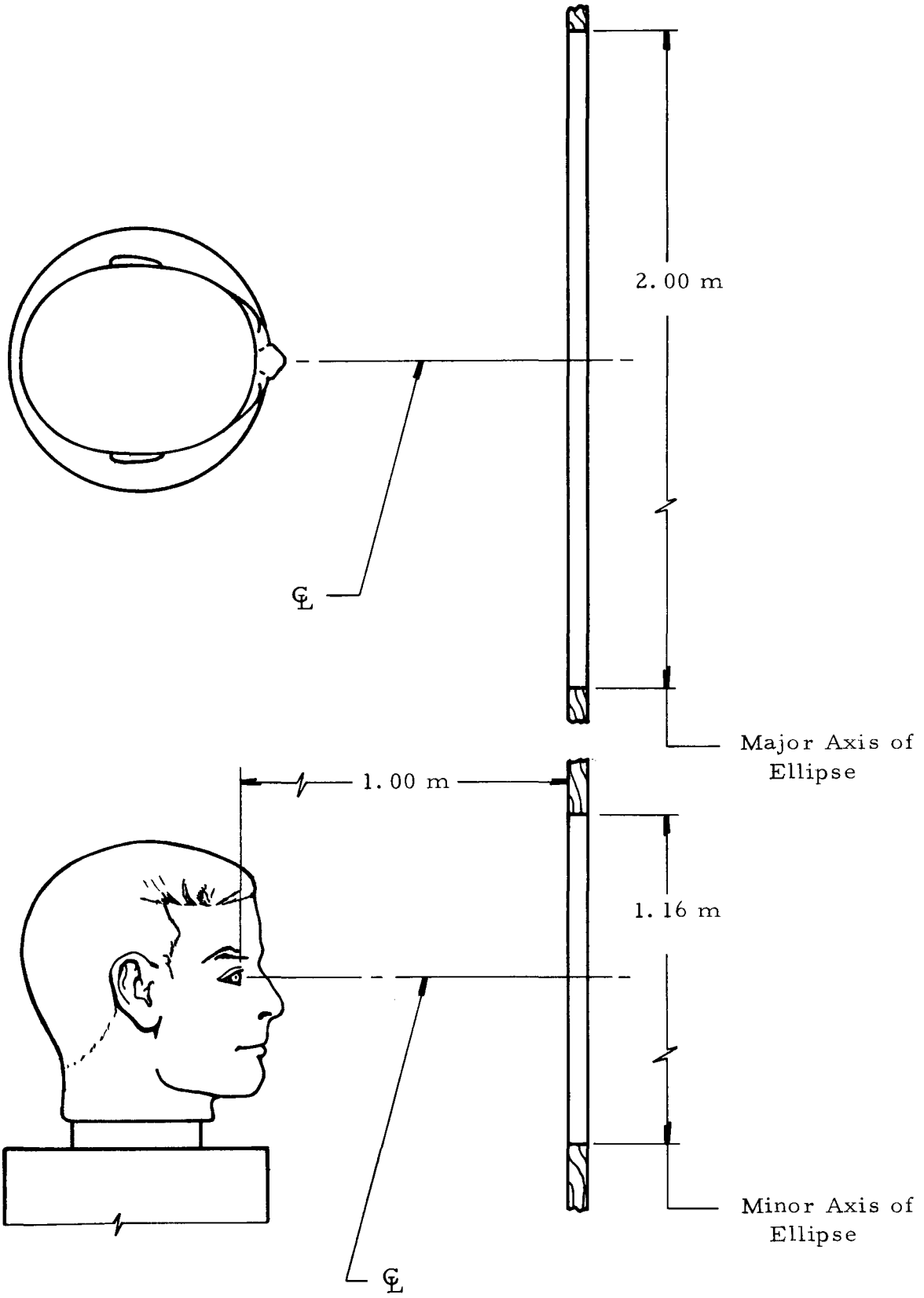


FIGURE 7.4.1.1.4-2. POSITION OF ANTHROPOMORPHIC HEAD

7.4.2.1 Optical Quality. All lenses shall be visually examined for polished surfaces and visible surface defects.

7.4.2.2 Prismatic Power. Plano lenses shall be tested for prismatic power by use of an instrument such as a Vertometer or Lensometer, modified to furnish the accuracy required, or a telescope. If a telescope is used, it shall be 8X to 25X with an effective aperture of 19 mm (0.75 in.) and equipped with cross hairs in the focal plane of the ocular. A whole or part of an anthropomorphic head or accurate reproduction of the whole or part of the head sufficient to accommodate the viewing portion of the eye protector in the normal wearing position shall be modified so that the objective lens of the telescope is centered where the eye would normally be and the optical axis of the telescope points in the direction the eye would if it were looking straight ahead. The telescope mounted in place as described above shall be focused on an illuminated target, placed at a distance of 12.2 m (35 ft) from the telescope objective, comprising a central dot and concentric circles whose outer edges are 12.7 (0.5 in.) and 25.4 mm (1.0 in.) in diameter and which are drawn on white paper using permanent black ink. The telescope shall be aligned, with no lens in front of the objective, so that the image of the central dot falls on the intersection of the cross hairs. The eye protector whose lens is to be tested shall then be mounted on the 95 percentile head in their normal wearing position. Protector headbands which interfere with the telescope shall be positioned to support the lens but not interfere with the telescope. The essential criterion is that the lenses be placed in their normal wearing position. If the intersection point of the cross hairs falls without the image of the inner circle, the prismatic power exceeds 1/16 prism diopter. If the intersection point of the cross hairs falls without the image of the outer circle, the prismatic power exceeds 1/8 prism diopter.

In protective devices where the light rays pass through more than one lens before entering the eye and the lenses are not permanently attached to one another, each lens shall be tested individually.

7.4.2.3 Definition. The lens shall be tested for refractive power by any suitable instrument such as a vertometer, lensometer, or telescope. If a telescope is used, it shall be 8X to 25X with an effective aperture of 19 mm (0.75 in.) and shall be mounted in the manner as described in the prismatic power test. Without the eye protector in place, the telescope shall be focused

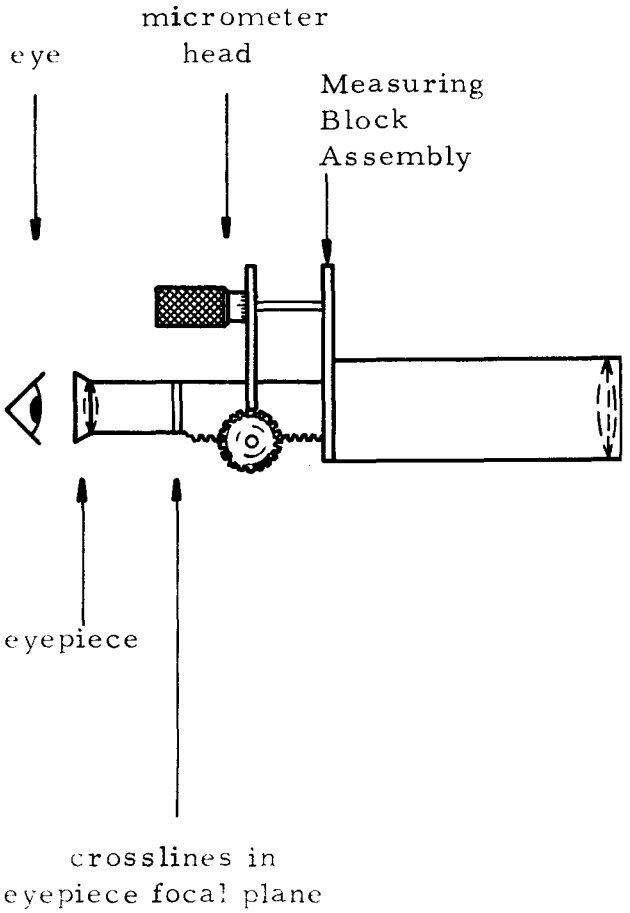
on the high-contrast resolving power chart pattern 20 of the National Bureau of Standards Special Publication 374. To test a lens, the protector with lens in place shall be put on the 95 percentile head in the manner described in Section 7.4.2.2, and the telescope brought to the sharpest possible focus.

In protective devices where the light rays pass through more than one lens before entering the eye and the lenses are not permanently attached to one another, each lens shall be tested individually.

7.4.2.4 Refractive Power. The same setup as that used in the definition test shall be used for this test except that the anthropomorphic head or reproduction shall be capable of being rotated about the optic axis of the telescope so that the refractive power of more than one meridian can be measured. Prior to conducting the test, the telescope shall be calibrated by successively locating the position of best focus of the number 20 pattern first with no lens in front of the telescope objective lens, and then with a standard lens of +1/16 diopter, and then a standard lens of -1/16 diopter, placed directly in front of the objective lens so that the optical center of the standard lenses align with the optical center of the telescope objective lens. These positions shall be marked by scratches on the draw tube or by other suitable means such as the micrometer and measuring block assembly described below. The eye protector shall then be mounted on the 95 percentile anthropomorphic head or reproduction and brought to the best possible focus. If the position of best focus falls outside the index marks, the refractive power is in excess of 1/16 diopter.

If +1/16 and -1/16 diopter lenses are not available, +1/16 and +1/8 diopter (or -1/16 and -1/8 diopter) lenses shall be used. Scribe lines shall be placed on the draw tube after focusing with and without the calibration lenses and then a linear extrapolation shall be made from the positions of the scribe lines to determine the focusing positions of +1/16 and -1/16 diopter lenses. If more accuracy is desired, the micrometer and measuring block assembly shown in Figure 7.4.2.4-1 shall be used in place of the scribe lines to indicate positions of best focus. (Note: The micrometer shall be mounted either on the draw tube or on the telescope barrel, whichever is more convenient.)

In protective devices where the light rays pass through more than one lens before entering the eye and the lenses are not permanently attached to one another, each lens shall be tested individually.



Note: The micrometer shall be mounted either on the draw tube or on the telescope barrel, whichever is more convenient. (Figure shows the micrometer mounted on the draw tube.)

FIGURE 7.4.2.4-1. TELESCOPE WITH MICROMETER AND BLOCK ASSEMBLY

7.4.2.5 Ultraviolet, Luminous and Infrared Transmittance. The ultraviolet, luminous (total visible) and infrared transmittance of lenses of all types shall be determined by any standard method recognized as suitable by the National Bureau of Standards. The following methods are suggested.

7.4.2.5.1 Ultraviolet Transmittance Plastic and Glass. The source of radiant energy for determining the ultraviolet spectral transmittance shall be a quartz mercury arc or other source emitting an intense spectrum. The intense emission lines of the quartz mercury arc at 313, 334, 365, and 405 nm are conveniently distributed and well adapted for making these measurements. If other sources are used, the wavelengths closest to the above values of the mercury arc may be used. Suitable detectors for this test shall be photomultiplier tubes or other photo detectors which are sensitive to ultraviolet light and which are capable of measuring an ultraviolet transmittance of 0.05 percent. A wavelength dispersive monochrometer or suitable filters shall be used to isolate the appropriate wavelengths.

7.4.2.5.2 Luminous Transmittance - Plastic and Glass. The standard source of radiant energy used in the measurement of the luminous transmittance of lenses shall be a projection-type lamp No. T-8 (or other high-powered gas filled tungsten-filament incandescent lamp) operated at the color temperature (2854K) corresponding to Commission Internationale de 'Eclairage (CIE) Source A. The luminous transmittance shall be determined by one of the following means:

7.4.2.5.2.1 Photometrically by an observer having normal vision, as determined by recognized color vision chart tests such as those employing pseudoisochromatic plates.

7.4.2.5.2.2 With a physical photometer consisting of a thermopile (or other radiometer) and a luminosity solution having a spectral transmittance curve which coincides closely with the luminous-efficiency curve of the average eye. *

7.4.2.5.2.3 By measuring the spectral transmittance and calculating the luminous transmittance through the use of

*IES Lighting Handbook, Fourth Edition, Illuminating Engineering Society, 345 E. 47th St., New York, 10017, p. 1-3.

published data on the spectral radiant energy of CIE Source A and the relative luminous efficiency of the average eye.

7.4.2.5.3 Infrared Transmittance - Plastic and Glass. The same standard source of radiant energy used in determining the transmittance of luminous radiation shall be used also in the measurement of the transmittance of the total infrared radiation. One of the following methods shall be used for determining the total infrared transmittance:

7.4.2.5.3.1 By observing the infrared spectral-energy distribution curves of a gas-filled lamp, with and without the lens placed before the entrance slit of a spectrophotometer, and integrating the area under each of the two curves between the spectral limits of 750 and 4,000 nm.

7.4.2.5.3.2 By observing the integrated transmittance with a physical radiometer (i.e., a thermopile) covered with a deep red filter which has a high and uniform transmittance through the infrared spectrum and transmits less than 0.5 percent of the luminous radiation.

7.4.2.6 Opacity. The same apparatus used for ultraviolet, luminous and infrared transmittance measurements shall be used for opacity measurements. An item shall be considered opaque if its transmittance is less than that for a shade #14 (i.e., Luminous Transmittance <0.00016%, Infrared Transmittance <0.3%, and Ultraviolet Transmittance <0.05% at 313, 334, and 365 nm and <0.1% at 405 nm, see Table 6.3.2.5-I).

Welding helmet bodies, welding goggle frames and welding partitions shall be tested for opacity.

7.4.2.7 Haze. The test for percent haze shall be in accordance with Federal Test Method Number 406, 26.1-1966 ("American Standard Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways") or a reliable alternative method.

One reliable alternative method shall be to make two similar circular apertures in approximately 1.6-mm (1/16 in.) thick metal plates of a size smaller than the effective detecting surface of a photoelectric cell which is filter corrected to have the same luminous-efficiency curve of the average eye (i.e., "y" curve corrected or photopic corrected). The

photoelectric cell shall be placed directly behind one aperture (A) as shown in Figure 7.4.2.7-1. The detecting device - aperture combination shall then be positioned at a distance directly in front of aperture (B) such that the solid angle (i.e., α) subtended at the center of aperture (B) by aperture (A) is approximately $\pi/1296$ (i.e., $\pi r^2/\ell^2 = \pi/1296$, see Figure 7.4.2.7-2). A concentrated filament Tungsten lamp mounted in front of a reflector whose voltage is regulated within ±5% of set initial value and whose intensity is adjustable shall be mounted behind aperture (B) in such a manner that the light falls on the aperture and regions in its vicinity and does not illuminate the surrounding area (a suitable shield with exit port is allowable). The whole apparatus shall be placed in a darkened room or chamber while the test is being performed. The test shall be performed by placing the same area of the test lens* in front of aperture (A) and noting the difference in voltage reading on the detector-amplifier combination compared to that taken when no light is present, and then in front of aperture (B) and noting the difference in voltage reading compared to that taken when no light is present.

Three sets of haze readings shall be made on each lens tested, the values of haze for each calculated, and then the average of the three haze calculations made to arrive at average haze. Percent haze shall be calculated as follows:

$$\% \text{ haze} = \left(\frac{T_d}{T_{TOT}}\right)(100) = \left(\frac{T_{TOT} - T_{\parallel}}{T_{TOT}}\right)(100)$$

$$\% \text{ haze} = \left(\frac{T_A - T_B}{T_A}\right)(100)$$

where T_d = diffuse light transmittance

$T_{TOT} = T_A$ = total light transmittance

$T_{\parallel} = T_B$ = parallel light transmittance.

Before conducting the haze test on test samples, the apparatus shall be calibrated by using the apparatus to calculate the

*A felt tip marker may be used to outline the general area under investigation but care must be taken to assure that this border is not positioned in a manner which could change the results of the test. Measuring the distance from an edge of the lense to the edge or center of the area being examined would also be acceptable.

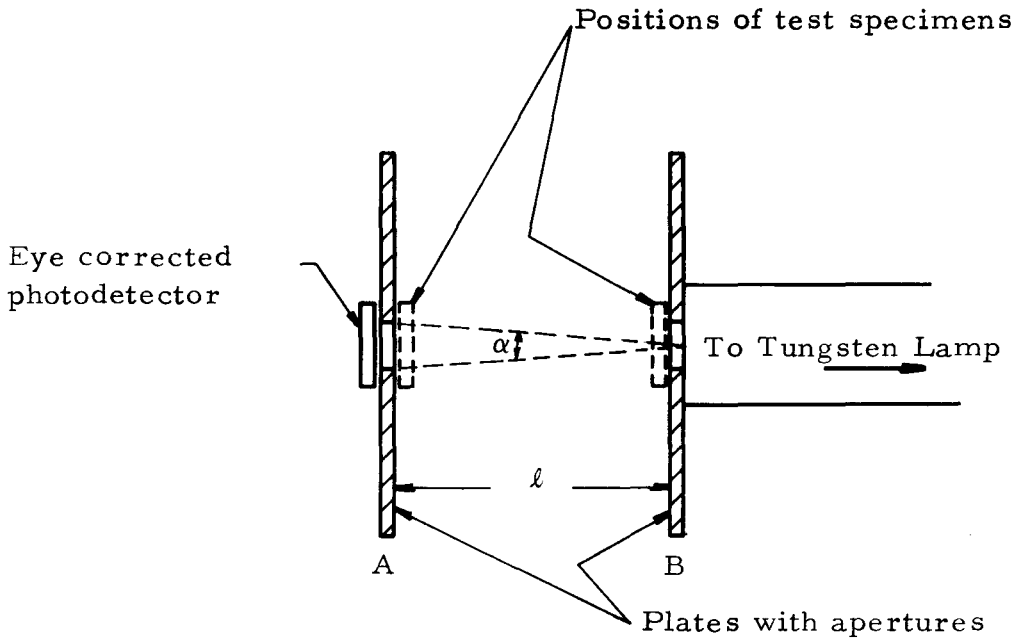


FIGURE 7.4.2.7-1. HAZE TEST APPARATUS

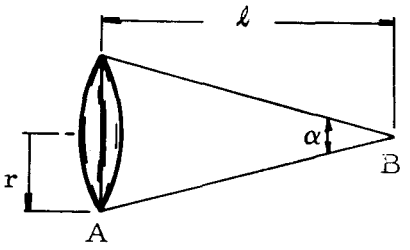


FIGURE 7.4.2.7-2. SUBTENDED ANGLE CALCULATION

average haze of a haze standard* with 5% haze (or 6% haze). Average haze calculated shall be 5% ± 0.25% (or 6% ± 0.30%) for the apparatus to be acceptable. If the result is unacceptable, the apparatus shall be examined for sources of error such as fluctuating lamp intensity, stray light, etc. If none are found, then the aperture separation distance shall be varied until an acceptable value of average haze is obtained when measuring the value of haze of the haze standard. Both apertures shall be the same size, and at no time shall the specimen being tested be smaller than the apertures. Only flat lenses shall be tested in this manner. Curved lenses shall be tested for haze according to Federal Test Method 406, 26.1-1966, or other method suitable for curved lenses which produce an accuracy of 5% or better.

7.4.3 Mechanical Tests

7.4.3.1 In-Frame Drop Ball Test. All lenses (except welding cover plates) and sideshields shall be subjected to this test. The drop ball test shall be conducted with the eye protector mounted on a 95 percentile anthropomorphic head with a hardness of 40 ± 10 durometer measured at the glabella, in their normally worn position (see Figure 7.4.3.1-1). A 25.4-mm (1.0 in.) diameter steel ball weighing approximately 68.1 grams (2.4 ounces) shall be dropped 127 cm (50 in.) from rest onto the lens such that it impacts within a circular area of 15.9-mm (5/8 in.) diameter centered directly in front of the eye. The support block for the anthropomorphic head shall then be rotated 90 degrees and sideshields shall be impacted directly above the intersection of the eyelids (see Figure 6.3.1.1.1-1). Each protector shall be impacted once in front of each eye and once on each sideshield.

7.4.3.2 Out-of-Frame Drop Ball Test. All lenses (except welding cover plates) and sideshields shall be subjected to this test. The support shall consist of a wooden block made from pine with a washer of neoprene rubber packing of 40 ± 5 durometer reading, 3.2 mm (1/8 in.) thick, glued to the support block perpendicular to the grain. (See Figure 7.4.3.2-1.) A circular hole with dimensions 5 mm (0.2 in.) less than the periphery of the lens or 38.1 mm (1.5 in.) in diameter, whichever is smaller, shall be made through the washer and at least 38.1 mm (1.5 in.) into the wooden block. The

*Gardner Laboratories haze standard or any other haze standard which is traceable to the National Bureau of Standards is suitable.

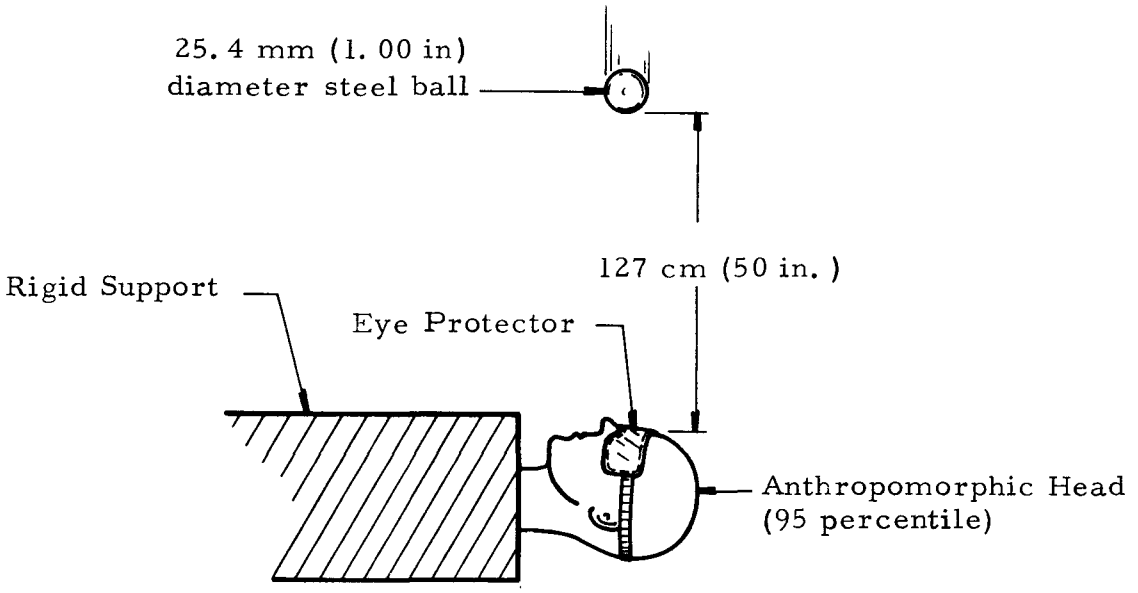


FIGURE 7.4.3.1-1. IN-FRAME DROP BALL TEST

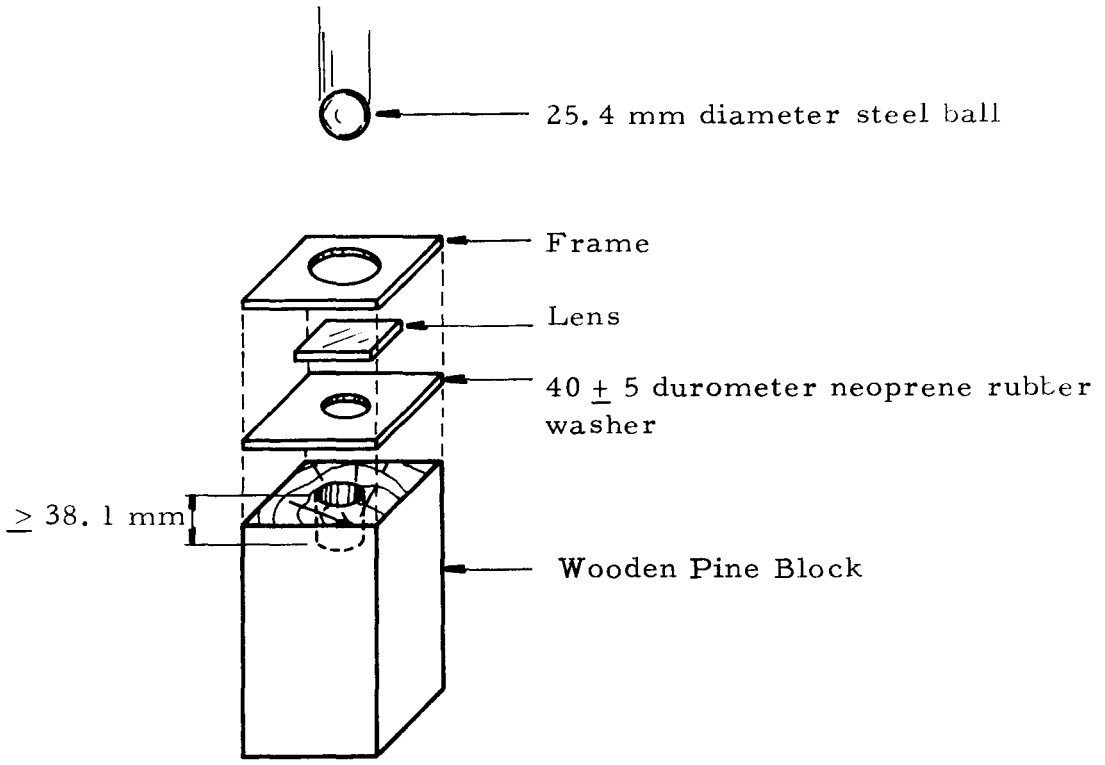


FIGURE 7.4.3.2-1. OUT-OF-FRAME DROP BALL TEST - ESSENTIAL COMPONENTS

point of the lens farthest from its perimeter shall be centered on the hole in the block. Lenses shall be restrained to prevent lateral motion. The support block shall be curved if necessary to allow for the perimeter of curved lenses to rest uniformly on the neoprene rubber surface. A 25.4 mm (1.00 in.) diameter steel ball, weighing approximately 68.1 grams (2.4 ounces), shall be dropped 127 cm (50 in.) from rest onto the lens such that it impacts a circular area of 15.9-mm (5/8 in.) diameter centered at the point of the lens farthest from its periphery.

7.4.3.3 Out-of-Frame Breakage Pattern Test - Glass Only. All glass lenses (except welding cover plates) and sideshields shall be subjected to this test. The lens shall be supported in the same manner as that for the out-of-frame drop ball test (see Section 7.4.3.2). Commencing with a 25.4-mm (1.00 in.) diameter steel ball weighing approximately 68.1 grams (2.4 ounces) dropped 127 cm (50 in.) onto the point of the lens farthest from its periphery, the drop ball size and/or height shall be increased until the glass lens breaks. The breakage pattern shall then be examined.

7.4.3.4 Out-of-Frame Penetration Test - Plastic Only. All plastic lenses and sideshields shall be subjected to this test. The lens shall be supported in the same manner as that for the out-of-frame drop ball test (see Section 7.4.3.2). A pointed projectile consisting of a Singer number 25, size 135 × 17 needle, fastened into a holder approximately 44.3 grams (1.56 ounces) in weight and 25.4 cm (10.0 in.) to 101.6 cm (40.0 in.) in length, shall be freely dropped, pointed downward, from a height of 127 cm (50 in.) onto the lens impacting a circular area of 15.9-mm (5/8 in.) diameter centered on the point of the lens farthest from its periphery. The projectile shall be guided, but not restricted, in its fall by being dropped through a tube extending to within 10 cm (3.9 in.) of the lens. The holder shall be of materials and design that will not deform substantially upon impact and thus absorb part of the impact energy. Phenolic or aluminum are suitable materials for the holder.

7.4.3.5 Ballistic Impact Test. All protectors shall be subjected to this test. The end of the gun barrel of a gun capable of propelling a 4.8-mm (0.188 in.) diameter steel ball at velocities of 11 + 4 - 0 m/sec, 50 ± 3 m/sec and/or 100 ± 5 m/sec shall be placed no less than 25.4 cm (10 in.) nor more than 50.8 cm (20 in.) from the eye of a 95 percentile anthropomorphic head with a hardness of 40 ± 10 durometers

measured at the glabella.* A detecting system consisting of two lamps opposite two photodiodes spaced 12.7 cm (5 in.) to 25.4 cm (10 in.) apart and a suitable time interval counter accurate to within 1 microsecond† shall be mechanically aligned and electrically connected so that the projectile will start the counter and then stop the counter as it travels toward the dummy head. (See Figure 7.4.3.5-1.) The velocity (m/sec) can be calculated by dividing the photodiode spacing (meters) by the time interval (seconds). Eye protectors shall be mounted on a 95 percentile anthropomorphic head in their normally worn positions (welding cover plates shall be removed). The gun shall be aimed at the center of the eye of the anthropomorphic head, facing the gun, when the lenses of the eye protectors are tested; at the intersection of the eyelids of the eye (see Figure 6.3.1.1.1-1) of the anthropomorphic head, 90 degrees rotated from facing the gun, when the side protectors of the device are tested.

7.4.3.6 Flat Transverse Test. Each frame shall contain lenses during the test. One lens container shall be laid flat on a firm, level support with the outer surface of the lens downward, so that the lens container and one-half of the bridge project beyond the edge of the support. A holding clamp shall be placed over the supporting lens container and shall be fastened to the firm base. A 454-gm (16 oz.) weight shall be attached to the outermost portion of the frame for one minute. (See Figure 6.4.3.6-1.) The frame shall then be removed and examined.

7.4.3.7 Edge Transverse Test. Each frame tested shall contain the lenses and shall have the right lens container held vertically in one hand and the lower edge of the left lens container (as worn) pressed against one of the platforms of an equal arm balance having a weight of 2.27 kilograms (5 lb) on the other platform. (See Figure 7.4.3.7-1.) The pressure shall be increased until the weight is balanced and shall remain in this position for one minute. The frame shall then be removed and examined.

7.4.3.8 Strength of Joints Test - Metal Frame Spectacles Only. Only frames with metal bridges shall be subjected to this test.

*A suitable propulsion system can be made by muzzle loading a 0.22 caliber Benjamin high compression air pistol model #132, with a rifled 8-in. long barrel.

†A suitable counter would be one with characteristics similar to a Computer Measurements Company Time Interval Meter Model 915.

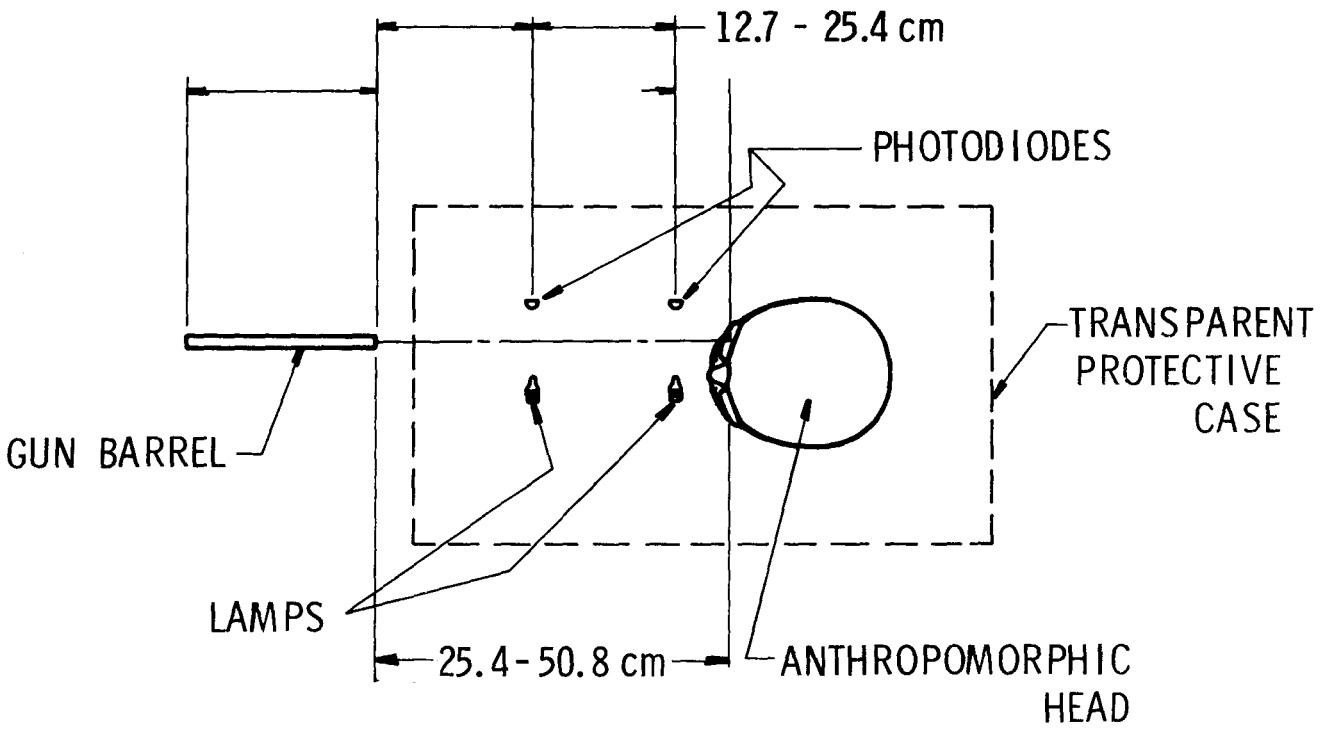


FIGURE 7.4.3.5-1. TOP VIEW OF BALLISTIC TEST APPARATUS

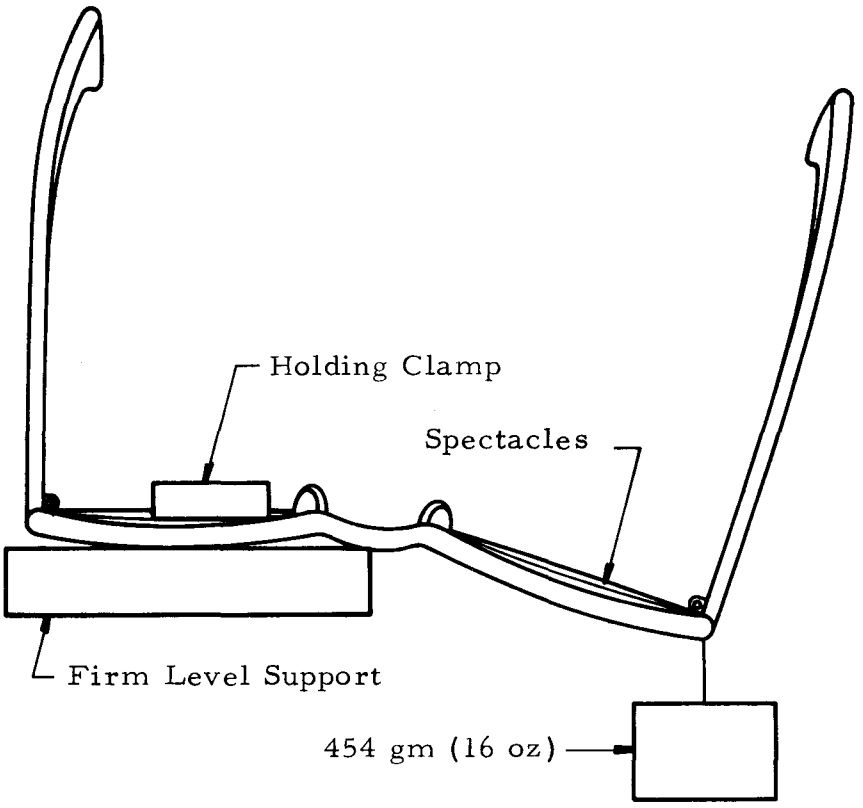


FIGURE 7.4.3.6-1. FLAT TRANSVERSE TEST - ESSENTIAL COMPONENTS

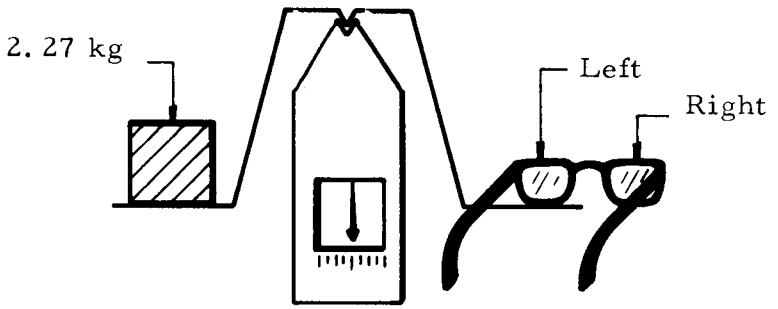


FIGURE 7.4.3.7-1. EDGE TRANSVERSE TEST - ESSENTIAL COMPONENTS

Frames with upper-brace (brow) bars shall have the brace bar cut before performing the test. The lens containers with lenses in place shall be gripped, one in each hand, with the thumbs bearing on the outer surface near the bridge and the fingers on the inner surface of the lenses near the junction of the bridge and lens container. The frames shall then be slowly bent, the direction of motion being in a plane perpendicular to the surface of the lenses, until the outer surfaces of the lenses face each other, the outer ends of the frame touching. The frame shall then be bent back to its original shape and a careful examination made for fracture in the joints. See Figures 7.4.3.8-1 and 7.4.3.8-2.

7.4.4 Additional Tests

7.4.4.1 Water Absorption Test. Only plastic parts shall be tested for water absorption. All lenses shall be removed from the frames and the protector shall be disassembled to the farthest extent practicable. Only completely plastic regions of the components, non-plastic portions removed with tools if necessary, shall be subjected to the water absorption test specified in Procedure A of Test Method No. 7031 of Federal Test Methods Standard 406. The percent change in weight of each disassembled plastic component of the eye protector shall be determined from this test. In no instance shall the component tested be so small that its conditioned weight will be less than 1 gram.

7.4.4.2 Disinfection Test. All eye and face protective devices shall be subjected to this test. Each protector shall be thoroughly cleaned in soap (or detergent) and water, completely rinsed, carefully dried with a lint-free towel, immersed in a disinfecting hypochlorite solution for 10 minutes, removed and examined. This same item shall then undergo the same procedure using a disinfecting phenol solution and then a disinfecting quaternary ammonium compound solution. The disinfecting test shall be conducted with solution temperatures of 24°C ± 6°C (75°F ± 10°F). All of the above solutions shall be at the proper concentrations for disinfection as specified by the disinfectant manufacturer.

Suitable disinfecting solutions are:

- Hypochlorite - Clorox at manufacturer's recommended disinfecting concentration which is 3/4 cup clorox per gallon of water.

- Phenol - Lysol at manufacturer's recommended disinfecting concentration which is 2-1/2 tablespoons per gallon of water.

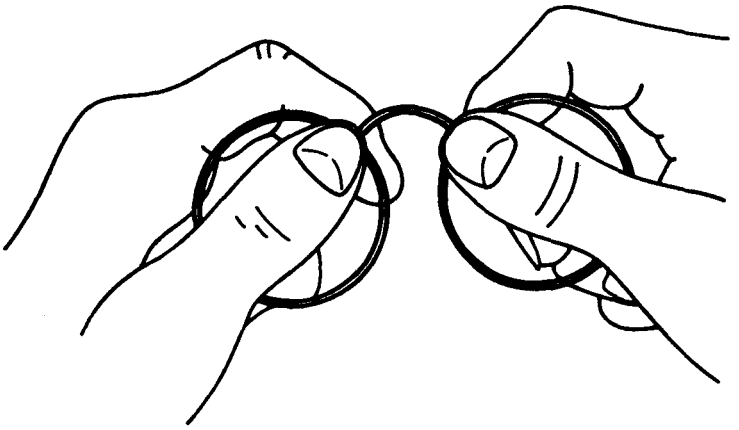


FIGURE 7. 4. 3. 8-1. METHOD OF HOLDING FRAMES FOR TESTING JOINTS

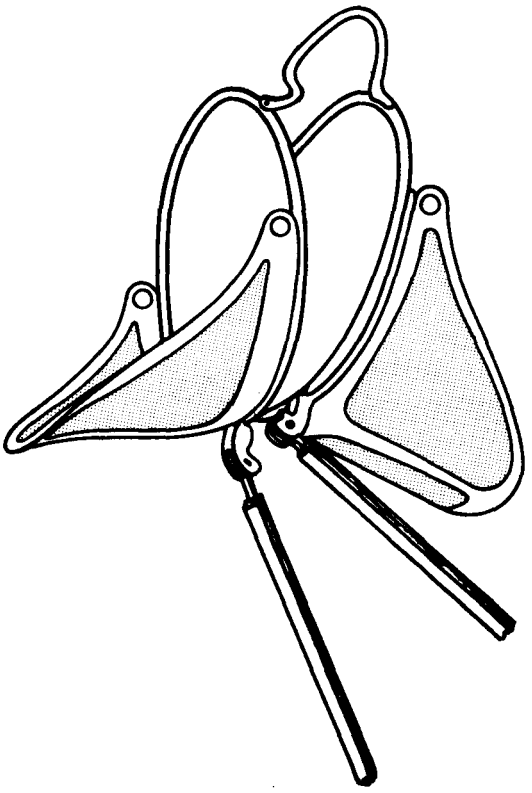


FIGURE 7. 4. 3. 8-2. APPEARANCE OF FRAME AFTER BENDING

- Quaternary Ammonium Compound - Hyamine 3500 Germicide Concentrate (1 part in 1000 parts water).

7.4.4.3 Corrosion Resistance. All types of eye and face protective devices shall be subjected to this test. The eye protector, completely assembled, shall be tested in accordance with the requirements of USA Standard Method of Salt Spray (Fog) Testing, Z118.1-1966 (ASTM B117-64), or the latest revision thereof. The protector shall be supported or suspended so that the outermost region of the viewing surface shall be between 15 and 30 degrees from the vertical and facing upward and preferably parallel to the principal direction of horizontal flow of fog through the chamber. The exposure time of each protector shall be 48 hours.

7.4.4.4 Abrasive Wear Test. This test shall be performed on all types of lenses in eye and face protective devices. A total of 1600 gm of 150 grit (powder) carborundum abrasive shall be dropped in eight 200 gm quantities on a lens placed at a 45° angle with its outer surface upward (see Figure 7.4.4.4-1). The abrasive shall fall on less than a 25.4 mm (1.0 in.) diameter circular area centered above the normal position of the eye behind the lens at a flow rate of 200 gm + 50 gm - 15 gm per minute. The abrasive shall be guided to within 5.1 cm (2.0 in.) to 7.6 cm (3.0 in.) of the center of the impact area of the lens by means of a straight tube at least 55.8 cm (22 in.) long with an internal diameter of 9.5 mm (3/8 in.). A mechanism to stop the flow of the abrasive shall be positioned 63.5 cm (25 in.) above the lens and a flow adjusting mechanism shall be positioned within 17.8 cm (7 in.) above the stop control mechanism. A funnel may be used above the flow rate control mechanism. If a funnel is used, its base shall be positioned within 17.8 cm (7 in.) above the stop control mechanism. Before conducting the test, at least 1600 gm of the abrasive shall be allowed to flow through the tube to control the flow. When conducting the test, the 200 gm quantities of abrasive shall be allowed to come to rest behind the stop clamp before it is released. The abrasive shall be dry and shall not be allowed to be used for more than 1000 cycles. Luminous transmittance measurements (see Section 7.4.2.5.2) shall be made before the abrasive wear test in the center of the impact area of the lens. The luminous transmittance shall be measured after the abrasive wear test in the most highly affected area of the lens, as determined by the largest percent decrease in luminous transmittance, i.e.,

$$\frac{\text{initial lum. trans.} - \text{final lum. trans.}}{\text{initial lum. trans.}} \times 100$$

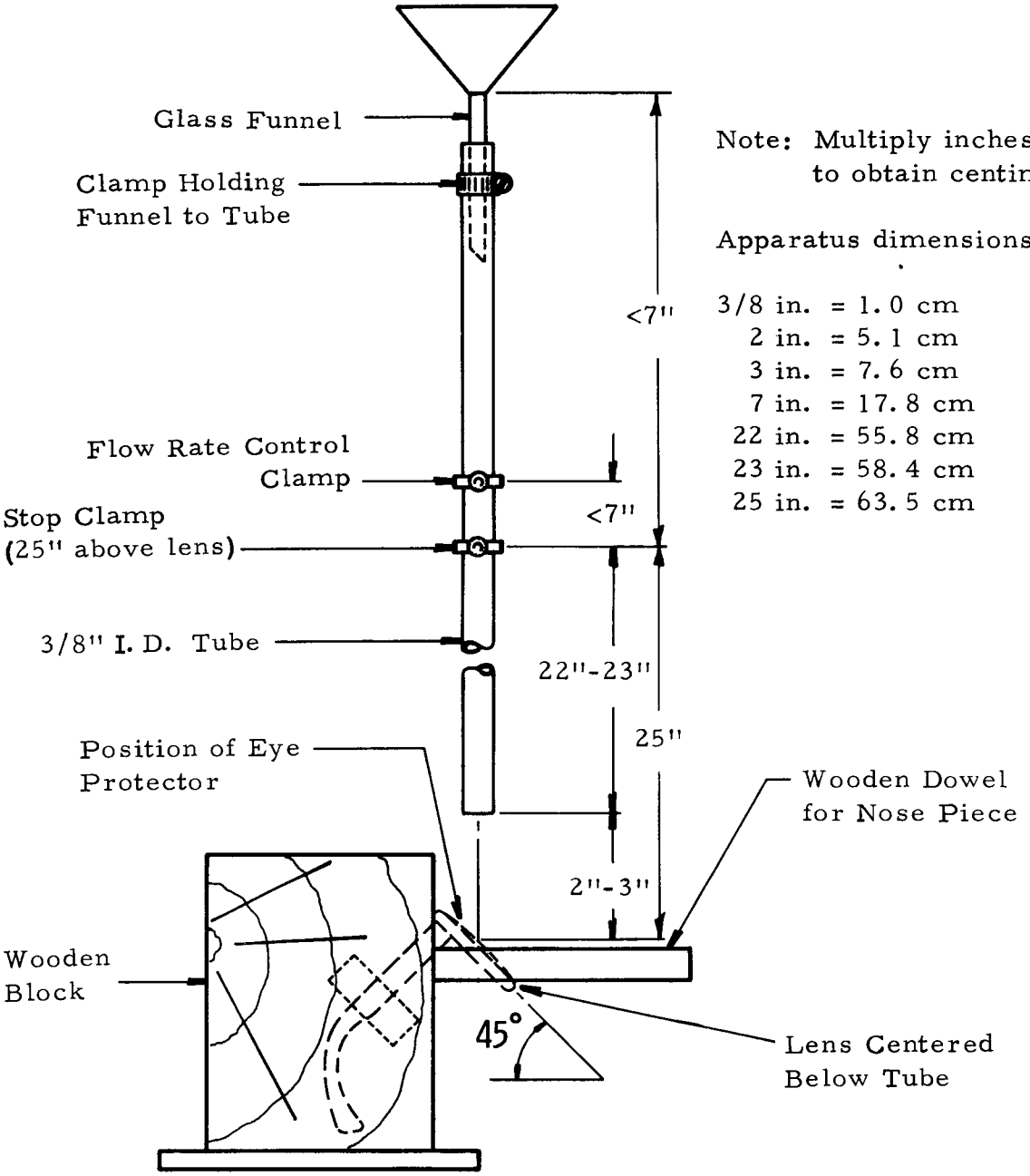


FIGURE 7.4.4.4-1. ABRASIVE WEAR TEST APPARATUS

7. 4. 4. 5 Heat Deformation Test. All cup and cover cup goggles shall be subjected to this test. Eyecup goggles shall be tested for heat deformation by mounting the eyecup with lenses and retaining ring in place, on a wooden block with a weight as shown in Figure 7. 4. 4. 5-1, and placing the whole assembly in a forced draft oven for 1 hour. The temperature of the oven shall be maintained at 65. 6 ± 3°C (150°F) for chipper's models and dust and splash models, and at 82 ± 3°C (180°F) for welder's and cutter's models. After 1 hour, the assembly shall be removed from the oven and allowed to cool. The weight shall then be removed. Dimensions (A), (B) and (D) (Figure 6. 3. 4. 5-1) shall be measured and the percent change in dimensions, i. e.,

$$\frac{\text{initial dim - final dim}}{\text{initial dim}} \times 100, \text{ shall be determined.}$$

The eyecup shall be mounted on the wooden block with the facial edge of the cup down and the lens horizontal. The bridge side shall be fastened to the block by means of a piece of wire placed through the hole used for the hose strap. The eyecup shall rest on the edge of the block, which has a 4. 8 mm (3/16 in.) radius. A 680-gm weight shall be suspended from the eyecup by means of a piece of wire, one end of which is attached to the weight and the other end fastened to the temple-side headstrap hole by means of a small pin placed through a loop in the wire (Figure 7. 4. 4. 5-1).

7. 4. 4. 6 Penetration of Hot Solid Test. Cover plates, cover circles, and shaded goggles and faceshields with shade #5 and higher shall be subjected to this test. A 6. 4-mm (1/4 in.) diameter steel ball shall be preheated to 1030 ± 10°C (1886°F) in a furnace and, as rapidly as possible, dropped through a funnel made out of an insulating material (alumina fire brick is suitable) with dimensions specified in Figure 7. 4. 4. 6-1, and onto the lens positioned on a support such that the ball is free to drop completely through the lens if it should penetrate. The hot ball shall remain on the lens for 2 minutes before the lens is removed and examined.

7. 4. 4. 7 Flammability Test. All materials except glass and metal shall be subjected to this test. Three strips 12. 7 cm (5. 0 in.) × 1. 27 cm (0. 5 in.) shall be cut from the thinnest section of the lens and from the frame and/or body of the protector. [If a specimen of this size cannot be made from the protector, then a section at least 2. 54 cm (1. 0 in.) long shall be used.] The material shall be tested by inserting one end of the strip

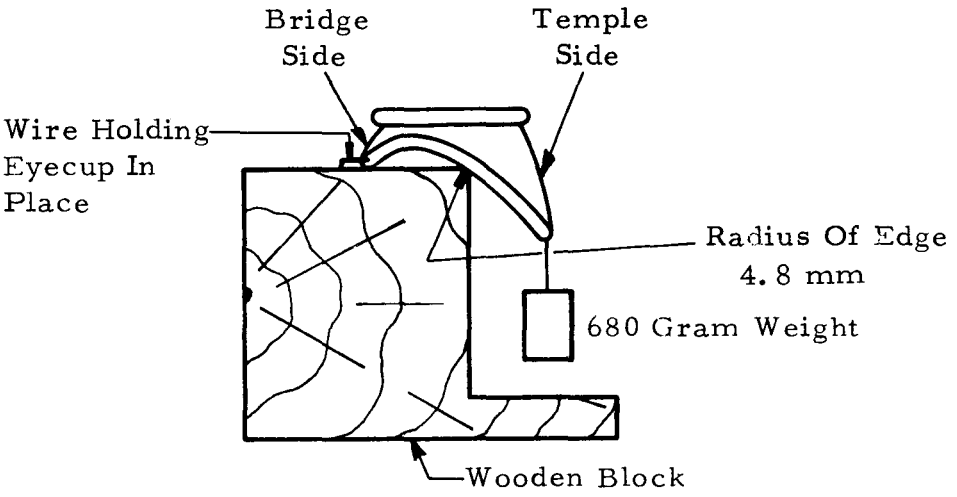
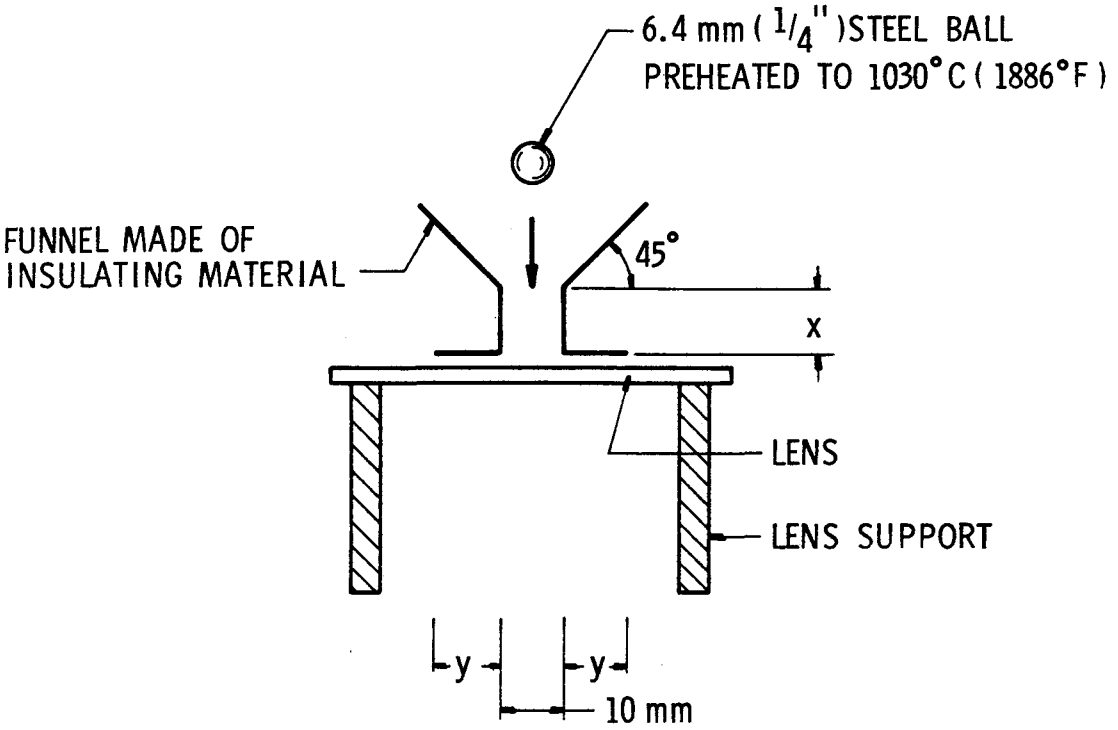


FIGURE 7.4.4.5-1. APPARATUS FOR HEAT DEFORMATION TEST



$10\ mm \leq x \leq y$

$10\ mm \leq y \leq 20\ mm$

FIGURE 7.4.4.6-1. ESSENTIAL COMPONENTS FOR PENETRATION OF HOT SOLID TEST

into the hottest region (i. e., at the tip of the innermost flame) of a blue-flame Bunsen burner with a 12. 7 cm (0. 5 in.) high flame. The strip shall be inclined at 45 degrees with the longest dimension horizontal. After 10 seconds, the flame shall be removed and measurement of the burning rate shall commence. The rate of propagation in cm/min for each specimen shall be recorded and then averaged.

7. 4. 4. 8 Resistance to Chemicals. There are five basic categories of chemicals whose effect on eye protectors is examined in this test: weak acids, strong acids, weak alkalies, strong alkalies, and organic solvents. The reagents used in this test shall be chemically pure, or greater purity. The preparation of reagents given below are for approximately 1-liter quantities and the percentages are by weight. Solutions for each of the above five categories are as follows:

- Weak Acids:

  Acetic acid (5 percent). Add 48 milliliters (50. 5 g) of glacial acetic acid (sp. gr. 1. 05) to 955 milliliters of water.

  Hydrogen peroxide solution (3 percent), or USP 10 volume). Add 98 milliliters (108 g) of commercial grade (100 volume or 28 percent) hydrogen peroxide to 901 milliliters of water.

- Strong Acids:

  Sulfuric acid (30 percent). Slowly add 199 milliliters (366 g) of H_2SO_4 (sp. gr. 1. 84) to 853 milliliters of water.

  Nitric acid (10 percent). Add 108 milliliters (153 g) of HNO_3 (sp. gr. 1. 42) to 901 milliliters of water.

  Hydrochloric acid (10 percent). Add 239 milliliters (283 g) of HCI (sp. gr. 1. 19) to 764 milliliters of water.

- Weak Alkalies:

  Sodium carbonate solution (2 percent). Add 55 grams of $Na_2CO_3 \cdot 10H_2O$ to 964 milliliters of water.

  Sodium chloride solution (10 percent). Add 107 grams of NaC 1 to 964 milliliters of water.

- Strong Alkalies:

  Sodium hydroxide solution (10 percent). Dissolve 11 grams of NaOH in 998 milliliters of water.

- Organic Solvents:

  Acetone.

  Carbon tetrachloride, commercial concentration.

  Heptane. Commercial grade, boiling range 90° to 100°C.

All of the above solutions shall be maintained at 23°C ± 1.1°C (73.4°F ± 2.0°F) prior to immersion of the protector.

7.4.4.8.1 General Purpose Chemical Protector Test. Prior to testing, the protector shall be cleaned with soap and water and dried with a lint-free towel. The entire protector designed for use in chemical environments shall be submerged for 1 minute in each of the solutions and in the order given in Section 7.4.4.8. Immediately after removal from each solution, the protector shall be wiped with absorbent cotton or suitable absorbing material. The protector shall remain outside of the solutions for one minute between each immersion cycle. After immersion in all of the above solutions and after being cleaned in soap and water and dried with a lint-free towel, the protector shall be subjected to the in-frame drop ball test (see Section 7.4.3.1) and ballistic impact test (see Section 7.4.3.5) needed to qualify as a grade I impact protector.

Note: Chemical protectors shall have indirect ventilation and form a close seal to the face.

7.4.4.8.2 Special Purpose Chemical Protector Test. Prior to testing, the protector shall be cleaned with soap and water and dried with a lint-free towel. For a chemical protector to qualify as a special purpose protector for any of the above five categories, it shall be able to withstand test in Section 7.4.4.8.1 above. Another identical chemical protector shall have its luminous transmittance (see Section 7.4.2.5.2) measured within a 25.4-mm (1.00 in.) diameter circle centered at the projected image of the eye on the lens. The protector shall then be subjected to a 48-hour submersion to the chemicals,

temperature, and order for the chemicals for the particular category being tested. The protector shall be washed with soap and water and dried with a lint-free towel between submersions. The protector shall remain out of solution for 1 hour before submergence in a new solution. After the protector has been exposed to all of the solutions in the particular category for which it is being tested, it shall be cleaned with soap and water and dried with a lint-free towel. The luminous transmittance shall be determined in the same area as that before the test. The lens shall not have more than a 10-percent decrease in luminous transmittance in this area. The protector shall then be subjected to the in-frame drop ball test (see Section 7. 4. 3. 1) and ballistic impact test (see Section 7. 4. 3. 5) needed to qualify it as a grade I impact protector.

Note: Chemical protectors shall have indirect ventilation and form a close seal to the face.

8.0 Guide for Users of Various Protectors

8.1 Purpose. The purpose of this section of the standard is to provide information to users and dispensers of eye and face protective devices so that they will be able to choose the proper safety equipment for different working conditions. This section of the standard also describes the procedure for proper usage, cleaning, maintenance, and storage of protective devices.

8.2 Selection of Protective Devices versus Hazards.

8.2.1 Table 8.2.1-I is a guide for selection from which one can determine which protectors are applicable for various hazards.

8.2.2 Table 8.2.2-I is a guide for selection from which one can determine which shade number filters are applicable for various hazards involving intense radiation.

8.3 Marking. All eye and face protective devices shall be labeled in the manner described in Sections 6.3.1.2.1 through 6.3.1.2.7. Knowledge of the meaning of the marking by the user is recommended.

8.4 Usage, Maintenance, Storage and Cleaning and Disinfection Procedures.

8.4.1 Usage. Protectors are personal items and shall be for the individual and exclusive use of the person to whom they are issued. If circumstances require reissue, the protectors shall be thoroughly cleaned and disinfected.

Since protectors are personal items, upon issue of each item to an individual, it shall be fitted and adjusted for maximum comfort to the wearer.

8.4.2 Maintenance.

8.4.2.1 It is essential that the lenses of protectors be kept clean. Continuous vision through dirty lenses can cause eye fatigue and become a contributory factor to accidents. Daily cleaning of eye protectors is recommended.

8.4.2.2 Pitted or scratched lenses shall be replaced immediately since they seriously reduce protection.

8.4.2.3 Slack, worn-out, sweat-soaked, knotted, or twisted headbands which do not hold the eye protector in proper position shall be replaced.

TABLE 8.2.1-I. RECOMMENDED METHODS OF EYE AND FACE PROTECTION FOR VARIOUS HAZARDS

NOTE: There are six basic categories of protective devices in this matrix, (1) spectacles, (2) cup and cover cup goggles, (3) facial goggles, (4) face shields, (5) welding helmets, and (6) visitor's spectacles.

Each category has some or all of the following basic attributes:

Dust - indirect fine screen ventilation and close seal to face.
Chemical splash - indirect ventilation, close seal to face and chemical inertness.
Impact - resistant to impacting particles.
Welding & Cutting - specific transmittance properties and resistance to heat.
Molten Metal - resistance to hot objects and, in some instances, specific transmittance properties.

"XX" denotes that the attribute for which the protector is designed should be adequate for a particular hazard (e.g., impact).

"X" denotes that the protector must be designed for more than one attribute for a particular hazard (e.g., impact and dust) or, two protectors, one for each attribute, should be used.

	SUITABLE EYE AND FACE PROTECTIVE DEVICES																				
	Spectacles				Cup and Cover Cup Goggles					Facial Goggles					Face Shields						
Hazards	Clear lenses w/o sideshields	Clear lenses with sideshields	Filter lenses w/o sideshields	Filter lenses with sideshields	Dust	Chemical splash	Impact	Welding & cutting	Molten metal	Dust	Chemical splash	Impact	Welding & cutting	Molten metal	Chemical splash	Impact	Welding & cutting	Molten metal	Welding Helmets	Visitor's Spectacles*1
Acids & Caustics (burns, splashes, fumes)											XX				XX					
Babbitting		XX					X		X			X		X		X		X		
Chemicals (splash, glass breakage)		XX				XX					XX				XX					
Chipping (flying particles)		XX					XX					XX				XX				
Compressed Air (30 PSI or less*2)					X		X			X		X								
Dusts					XX					XX										
Furnace Operations (glare, heat, molten metal)			XX	XX					XX					XX						
Glare - harmless			XX	XX																XX
Glare - harmful (infrared and ultraviolet)				XX				XX					XX			XX			XX	
Grinding - light (buffing, machining, flying particles)					X		X			X		X								
Grinding - heavy (flying particles, sparks)					X		X			X		X								
Hand and Power Tools	XX	XX					XX					XX				XX				
Machine Shop Operations (flying particles)		XX					XX					XX				XX				
Molten Metals (heat, glare, sparks, splash)				XX			X		X			X		X		X		X		
Riveting		XX					XX					XX								
Sand Blasting										X		X								
Steam Boiler Operations		XX					XX					XX				XX				
Welding, Cutting, Burning - Acetylene (sparks, harmful rays, molten metal, flying part)			XX	XX				XX					XX				XX			
Welding - Electric Arc (sparks, molten metal, harmful rays)								XX					XX						XX	
Welding - Spot and Butt (sparks, flying particles)		XX		XX			X		X			X		X		X		X		
Welding - adjacent to				XX				XX					XX				XX		XX	
Woodworking (dust)					X		X			X		X								
Woodworking (flying particles)		XX					XX					XX				XX				

*1 Protection for plant visitors should depend upon their exposure to particular hazards.

*2 Maximum allowable pressure given in paragraph 1910.242(b) of the Occupational Safety and Health Act, Federal Register, June 3, 1974.

TABLE 8.2.2-1. APPROPRIATE FILTER LENSES FOR WELDING AND CUTTING OPERATIONS

(a) Governed by Amperage*

FILTER LENS SHADE NUMBERS FOR VARIOUS WELDING AND CUTTING OPERATIONS

Type of Operation	Shade Number
Resistance welding and for protection against stray light from nearby welding and cutting	Clear or filters up to No. 2
Torch brazing or soldering	3 to 4
Light oxygen cutting and gas welding (to ⅛ in.)	4 or 5
Oxygen cutting, medium gas welding (⅛ to ½ in.) and arc welding up to 30 amps	5 or 6
Heavy gas welding (over ½ in.) and arc welding and cutting from 30 to 75 amps	6 or 8
Arc welding and cutting from 75 to 200 amps	10
Arc welding and cutting from 200 to 400 amps	12
Arc welding and cutting exceeding 400 amps	14

NOTE: Flash goggles should be worn under all arc-welding helmets, particularly for gas-shielded metal arc welding.

Adapted from *Welding Handbook*, 5th ed. American Welding Society.

*Reproduced from the Accident Prevention Manual for Industrial Operations, 5th Edition.

(b) Governed by Electrode Diameter†

WELDING OPERATION	SHADE NUMBER
Shielded Metal-Arc Welding – 1/16, 3/32, 1/8, 5/32 inch electrodes	10
Gas-Shielded Arc Welding (Nonferrous) – 1/16, 3/32, 1/8, 5/32 inch electrodes	11
Gas-Shielded Arc Welding (Ferrous) – 1/16, 3/32, 1/8, 5/32 inch electrodes	12
Shielded Metal-Arc Welding – 3/16, 7/32, 1/4 inch electrodes	12
– 5/16, 3/8 inch electrodes	14
Atomic hydrogen welding	10-14
Carbon arc welding	14
Soldering	2
Torch Brazing	3 or 4
Light Cutting, up to 1 inch	3 or 4
Medium Cutting, 1 inch to 6 inches	4 or 5
Heavy Cutting, 6 inches and over	5 or 6
Gas Welding (Light) up to 1/8 inch	4 or 5
Gas Welding (Medium) 1/8 inch to 1/2 inch	5 or 6
Gas Welding (Heavy) 1/2 inch and over	6 or 8

NOTE: In gas welding or oxygen cutting where the torch produces a high yellow light, it is desirable to use a filter or lens that absorbs the yellow or sodium line in the visible light of the operation.

†Reproduced from USAS Z49.1, Safety in Welding and Cutting, 1967.

8.4.2.4 The wearer shall not alter the protector in any manner since this may cause reduced protection.

8.4.3 Storage. To prolong the life of eye protectors, they shall be placed in suitable cases or containers between periods of use. Storage containers shall be clean and free of dust.

8.4.4 Cleaning and Disinfection Procedures. Protectors showing need for extensive cleansing shall be disassembled to the extent possible without tools, prior to the cleaning and disinfection procedures. Defective parts shall be replaced with new ones.

8.4.4.1 Cleaning. When necessary, protectors shall be cleaned in soap (or detergent) and water, completely rinsed and dried with a clean, lint-free towel.

8.4.4.2 Disinfection. When necessary, protectors shall be disinfected in the manner specified by the manufacturer of the protector or according to the following procedure. The protector shall be thoroughly cleaned in soap (or detergent) and water, completely rinsed, carefully dried with a clean, lint-free towel, immersed in a suitable disinfecting solution at room temperature for 10 minutes and removed. It shall then either be dried in air or dried with a clean, lint-free towel. Protectors shall not be rinsed after disinfection since this might remove the residual affect. Suitable disinfecting solutions are:

Hypochlorite - e.g., Clorox at manufacturer's recommended disinfecting concentration which is 3/4 cup Clorox per gallon of water.

Phenol - e.g., Lysol at manufacturer's recommended disinfecting concentration which is 2-1/2 tablespoons per gallon of water.

Quaternary Ammonium Compound - e.g., Hyamine 3500 germicide concentrate (1 part in 1000 parts water).

8.5 Contact Lenses.

8.5.1 Usage. The following rules shall apply to the wearer of contact lenses.

8.5.1.1 At no time shall contact lenses be used as substitutes for eye protection.

8.5.1.2 The contact lens wearer shall be known to all who may be called upon to tend to his needs in case of an accident and shall be recorded in the company personnel files. In case of accident, the medical attendant shall be informed that the injured person is a contact lens wearer.

8.5.1.3 Means for removal of contact lenses shall always be readily available. Appropriate means for removal shall be those specified by a practicing opthalmologist.

8.5.1.4 Wearing of contact lenses in hazardous environments during the adaptation period shall not be allowed unless approved by the physician fitting the lenses.

8.5.1.5 A person wearing contact lenses shall not be allowed to work in areas where there is extensive exposure to fumes, smoke, dust or fine particles and, in some cases, chemicals and molten metal unless approved by a practicing opthalomologist.

8.5.1.6 The contact lens wearer shall have a suitable means of cleaning and storing his contact lenses and a reliable pair of opthalmic eyeglasses immediately available.