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SURFACE VEHICLE RECOMMENDED PRACTICE

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Submitted for recognition as an American National Standard

(R) MEASURING THE RADIUS OF CURVATURE OF CONVEX MIRRORS

1. ***Scope***—The SAE Recommended Practice is intended for use in measuring the radius of curvature (ROC) of spherical convex mirrors.

2. ***References***—There are no referenced publications specified herein.

3. ***Apparatus***—The apparatus shall consist of a linear spherometer (see Figure 1) with two fixed posts of equal height and ends so constructed that only point contact is made with the mirror. The distance between the two posts, referred to as the chord length, should be known to ±0.02 mm (0.001 in). A center probe is located midway between the fixed posts on the line running through the contact points of the posts. It should also make only point contact with the mirror. The center probe should be capable of vertical movement and be attached to a gauge which can display the linear displacement of the probe in units not larger than 0.002 mm (0.0001 in).

   Optionally, a third post may be placed rearward of the center probe (see Figure 1) to provide stability and facilitate easier measurement. It should be the same distance from the center probe as the two outside posts and the same height as the outside posts.

3.1 Chord Length for Automotive Applications—For automotive applications, the gauge shall have a chord length long enough to permit ROC to be calculated to within 2.5% of the average ROC of the mirror. In addition, to allow surface variation to be detected, the chord length shall not be any longer than that required to calculate ROC to within 1.0% of the average ROC. Tables 1 and 2 list the range of ROC that can be measured within these requirements for gauges with various chord lengths. Table 1 gives values for a metric gauge which reads in units of 0.002 mm and Table 2 gives values for an English gauge which reads in units of 0.0001 in. A gauge with the chord length listed in the first column should be used to measure any mirror with a ROC within the range listed in the second column. For gauges with other chord lengths or mirrors with other ROC, see Appendix A.

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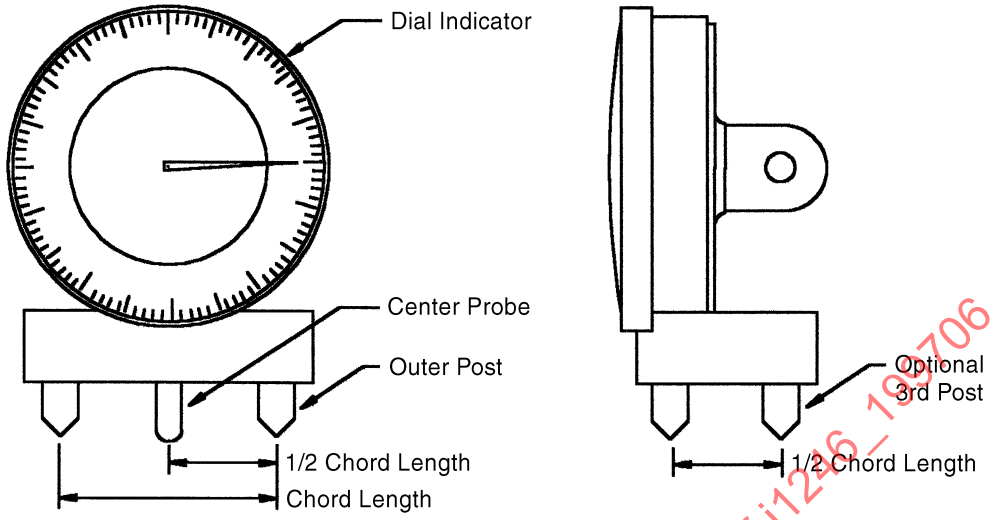

FIGURE 1—SCHEMATIC OF MEASURING APPARATUS

**TABLE 1—CHORD LENGTHS REQUIRED TO DETERMINE ROC ±1.0 TO ±2.5%
(CENTER PROBE UNITS = 0.002 MM)**

Gauge with Chord Length	Measures Mirrors with ROC
25.00 mm	391 to 977 mm
37.50 mm	879 to 2197 mm
50.00 mm	1563 to 3906 mm
62.5 mm	2441 to 6104 mm
75.00 mm	3516 to 8789 mm

**TABLE 2—CHORD LENGTHS REQUIRED TO DETERMINE ROC ±1.0 TO ±2.5%
(CENTER PROBE UNITS = 0.0001 IN)**

Gauge with Chord Length	Measures Mirrors with ROC
1.000 in	12.5 to 31.3 in
1.500 in	28.1 to 70.3 in
2.000 in	50.0 to 125.0 in
2.500 in	78.1 to 195.3 in
3.000 in	112.5 to 281.3 in

4. Procedure

4.1 Radius of Curvature at One Location—The spherometer shall be placed on a flat surface such as an optical flat accurate to at least 76 x 10^{-5} mm (3 x 10^{-5} in) over 13 mm (0.5 in) longer than the chord length and the gauge shall be set to zero. The spherometer shall then be placed on the mirror such that the device is normal to the surface (all fixed posts are in contact with the mirror) and the displacement of the center probe read. Radius is defined by Equation 1:

$$R = \frac{C^2}{8H} + \frac{H}{2} \qquad \text{(Eq. 1)}$$

where:

R = Radius of Curvature (ROC)
C = Chord Length
H = Displacement of Center Probe

4.2 Radius of Curvature of a Mirror—Radius of curvature of a mirror shall be defined as the average of at least ten readings taken over the surface of the mirror. The readings shall consist of: two readings at the center of the mirror, one parallel and one perpendicular to the longitudinal axis of the mirror; four readings along the perimeter of the mirror with the spherometer placed parallel to and 3.0 mm (0.12 in) from the edge; and four readings at the same locations along the perimeter of the mirror with the gauge placed perpendicular to the edge and with the outer post 3.0 mm (0.12 in) from the edge. (See Figure 2.)

For mirrors with an area greater than 200 cm^2 (31 in^2), readings shall be taken in addition to those prescribed such that there is at least one reading for each 20 cm^2 (3.0 in^2) of surface area. These additional readings shall be taken at enough locations to obtain an accurate average of the radius of curvature over the entire surface.

The chord length of the gauge used shall be reported with the results of any ROC reading.

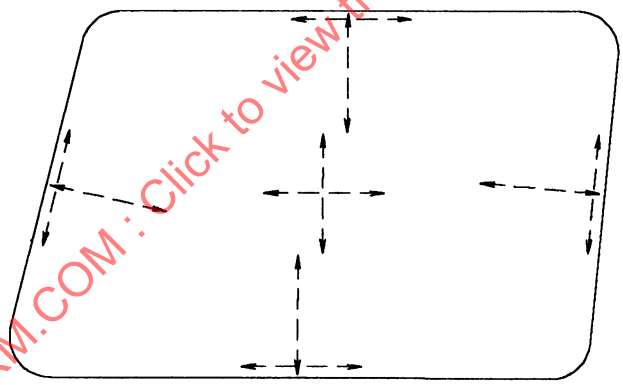

FIGURE 2—MEASUREMENT LOCATIONS

5. Notes

5.1 Marginal Indicia—The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE DRIVER VISION STANDARDS COMMITTEE

APPENDIX A

FACTORS IN SELECTING THE APPROPRIATE CHORD LENGTH

A.1 Radius of curvature (ROC) is calculated using the displacement of the center post relative to the outer posts. The ROC is actually the radius of a circle on which the tips of the three posts would fall. Any variation in the surface between the posts will not be detected. Therefore, gauges with shorter chord lengths give a truer indication of surface variation. Longer chord lengths can mask variation and lead to inaccurate measurement of ROC. A chord length should be selected which is short enough to include any expected variations in the surface.

Chord length will also determine the precision of the calculated radius of curvature. Longer chord lengths will give a more precise ROC. In Table A1, the ROC listed in the first column cannot be calculated more precisely than plus or minus the values in the adjacent columns. For example, a 1000 mm radius of curvature mirror can only be determined to within ±12 mm using 38.1 chord length gauge or to within ±5 mm using 62.25 chord length gauge.

TABLE A1—EFFECT OF CHORD LENGTH ON DETERMINING RADIUS OF CURVATURE (CENTER PROBE CAN BE READ ±0.002 mm)

ROC	Chord Length 38.10 mm	Chord Length 62.25 mm
1000 mm	±12	±5
1500 mm	±24	±10
2000 mm	±44	±16

To determine the minimum chord length required to attain a given level of precision, use Equation A1:

$$C \cong 2 \cdot R \cdot \sqrt{\frac{2 \cdot \Delta H}{\Delta R}} \qquad \text{(Eq. A1)}$$

where:

R = Radius of Curvature (ROC)
C = Chord Length
ΔH = Precision in Measuring Center Probe Displacement
ΔR = Precision in Calculating ROC