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NATIONAL AERONAUTICAL ESTABLISHMENT

LABORATORY TECHNICAL REPORT

LTR - ST - 974

RELATIONSHIP BETWEEN THE AIMING PLANE AND THE SEATING PLANE OF 5-¾ INCH DIAMETER SAE HEADLAMPS

(PART 3)

COLIN MacKENZIE

RAPPORT TECHNIQUE DE LABORATOIRE

ÉTABLISSEMENT AÉRONAUTIQUE NATIONAL

17 FEBRUARY 1978

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NATIONAL AERONAUTICAL ESTABLISHMENT

ÉTABLISSEMENT AÉRONAUTIQUE NATIONAL

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DIAG.

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REPORT
RAPPORT

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RELATIONSHIP BETWEEN THE AIMING PLANE AND THE SEATING PLANE OF 5-3/4 INCH DIAMETER SAE HEADLAMPS (Part 3)

SUBMITTED BY
PRÉSENTÉ PAR J. A. Dunsby
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Relationship Between the Aiming Plane and the Seating Plane of 5-3/4 inch diameter SAE Headlamps

(Part 3)

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1.0 INTRODUCTION

It has been noted that many people when changing headlamps assume that because the original headlamp was properly aimed, the replacement will also be aimed properly if the headlamp aiming adjustments were not altered during replacement. For SAE headlamps, the photometric aim relative to the aiming plane is controlled during manufacture. For installation in a vehicle the aiming plane is then used as a reference by mechanical aiming devices. When changing headlamps the only physical reference points are the seating pads which form the seating plane, so the relationship between the seating plane and the aiming plane of the original and replacement lamps determines the change in aim of the replacement lamp.

Accordingly, as an adjunct to the photometric scan measurements being carried out on market samples of headlamps (references 9, 10 & 11), a suitable jig was constructed to permit measurements to determine the angular deviation between the aiming and seating planes for these headlamps.

This report describes and tabulates the measurements and results on ninety-three headlamps having NAE sample numbers ranging from 206 to 302. The results obtained from similar measurements on earlier sampled SAE headlamps [LTR-ST.695 (NAE Nos.141-162) and LTR-ST.749 (NAE Nos. 181 to 205), References 7 and 8 respectively] are included in Appendix A.

2.0 DEFINITIONS

Type 1 Sealed Beam Unit

A 5-3/4 inch diameter unit having a single filament and used in a four-lamp system to provide the principal portion of the upper beam.

Type 2 Sealed Beam Unit

A 5-3/4 inch diameter unit having two filaments and used in a four-lamp system to provide the lower beam and the

secondary portion of the upper beam.

Mechanically Aimable Sealed Beam Unit

A unit having three pads on the face of the lens forming a mechanical aiming plane used to adjust and inspect the aim of the unit when installed on the vehicle.

Aiming Plane

A plane through the three aiming pads on the face of the lens.

Seating Plane

A plane through the three seating pads on the back of the unit.

3.0 EQUIPMENT AND PROCEDURE

The headlamps were mounted on a machined ring (seating plane ring) with the seating plane parallel to the surface table. Another machined ring (aiming plane ring) was mounted on the headlamp aiming pads and held in position by the aiming plane ring guides, anti-rotation pin and tension bands (figures 1 and 2). The aiming plane ring has a polar co-ordinate grid in its center for obtaining angular readings. A Starrett 0.0001 inch dial indicator was used to take readings on the top of the aiming plane ring (figures 2 and 3). Starting at the zero degree position on the aiming plane ring, (top of the headlamp) the headlamp assembly was rotated against the 'V' guide and the maximum and minimum readings and the angular position of each were recorded (Tables VI to X).

To calibrate the measuring system, the aiming plane ring was placed on the seating plane support and measurements were taken every ten degrees (Tables XI and XII). The average of three measurements was used to determine the errors caused by the dimensional tolerances of the seating plane support, aiming plane ring, and the surface plate. Figure 4 is a graphical representation of the average readings. The measured readings were then corrected using these error values.

4.0 RESULTS

Tables I to V tablulate the headlamp identification and calculated results obtained from the measured data tabulated on the experiment result sheets (Tables VI to X). Equations 1, 2 and 3 from figure 5 were used to calculate the results. Figures 6(a) to 6(e) are polar vector plots of the headlamp aiming plane-seating plane deviations using results from Tables I to V.

The headlamps were separated by type and manufacturer and the aiming deviations at 60 feet were plotted on figures 11 and 12.

The notation used for conversion from the polar coordinate measuring system to a rectangular coordinate system to facilitate the use of a pre-programmed mini-computer for further computations is shown in figure 7.

Using equations 4, 5 6 and 7 from figures 7 and 8 the mean deviations for different headlamp types were calculated and are shown on polar vector plots (figures 9 and 10) and Table XIII.

Figures 13 and 14 are the SAE dimensional specifications for the headlamps (taken from reference 1).

Figure 15 shows the different headlamp configurations used in North American cars equipped with round headlamps.

5.0 REFERENCES

1. SAE J571c - Dimensional Specifications for Sealed Beam Headlamp Units.
2. SAE J579b - Sealed Beam Headlamp Units for Motor Vehicles.
3. SAE J580b - Sealed Beam Headlamp.
4. SAE J599c - Lighting Inspection Code.
5. SAE J600a - Headlamp Testing Machines.
6. SAE J602b - Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units.

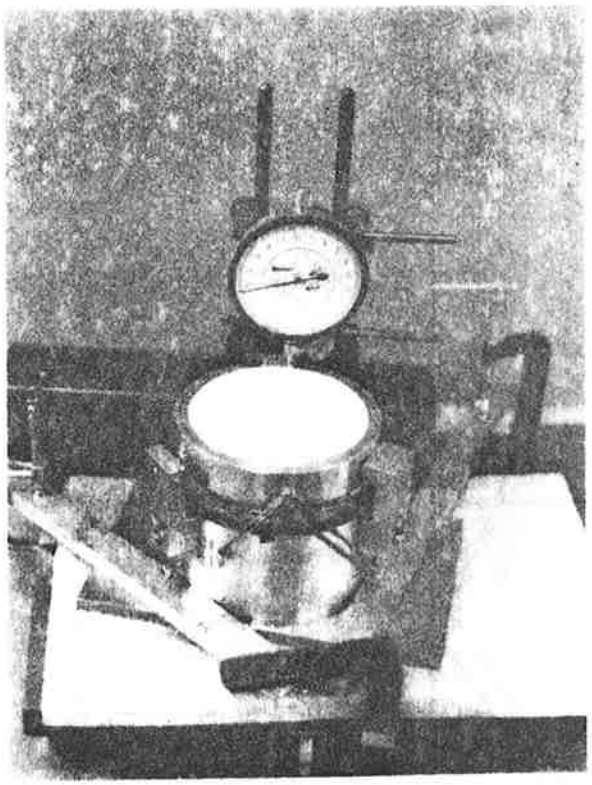
7. MacKenzie, C. W. - Relationship Between the Aiming Plane and the Seating Plane of 5-3/4 inch diameter SAE Headlamps. NRC NAE LTR-ST.695, February 1974.

8. MacKenzie, C. W. - Relationship Between the Aiming Plane and the Seating Plane of 5-3/4 inch diameter SAE Headlamps (Part 2). NRC NAE LTR-ST.749, January 1975.

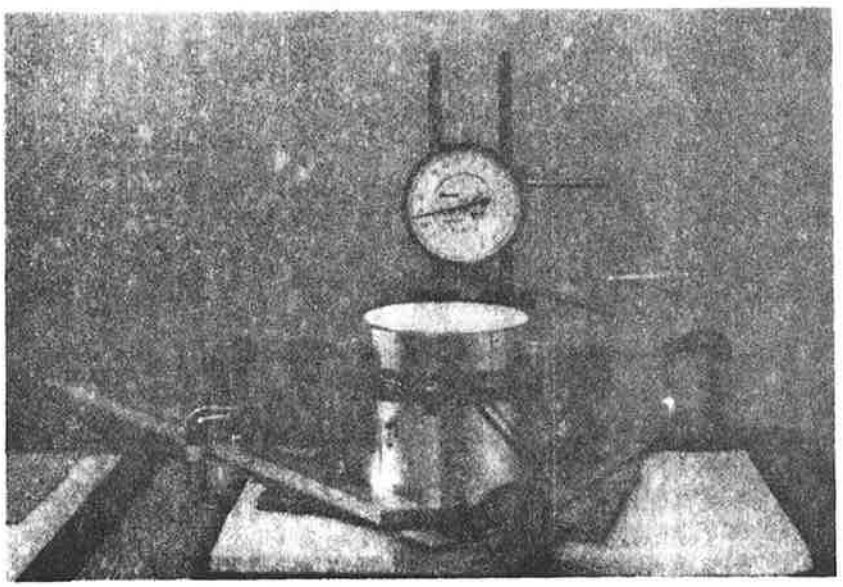
9. Harrison, A. L. - Measured Illumination Characteristics of the General Electric Experimental Headlamps for SAE J579b and J582a. NRC NAE LTR-ST.782, July 1975.

10. Harrison, A. L. - Measured Illumination Characteristics of the 1974 Headlamps: Part 1 - The SAE Headlamps. NRC NAE LTR-ST.783, July 1975.

11. Harrison, A. L. - Measured Illumination Characteristics of the 1975 Headlamps. NRC NAE LTR-ST.845, March 1976.

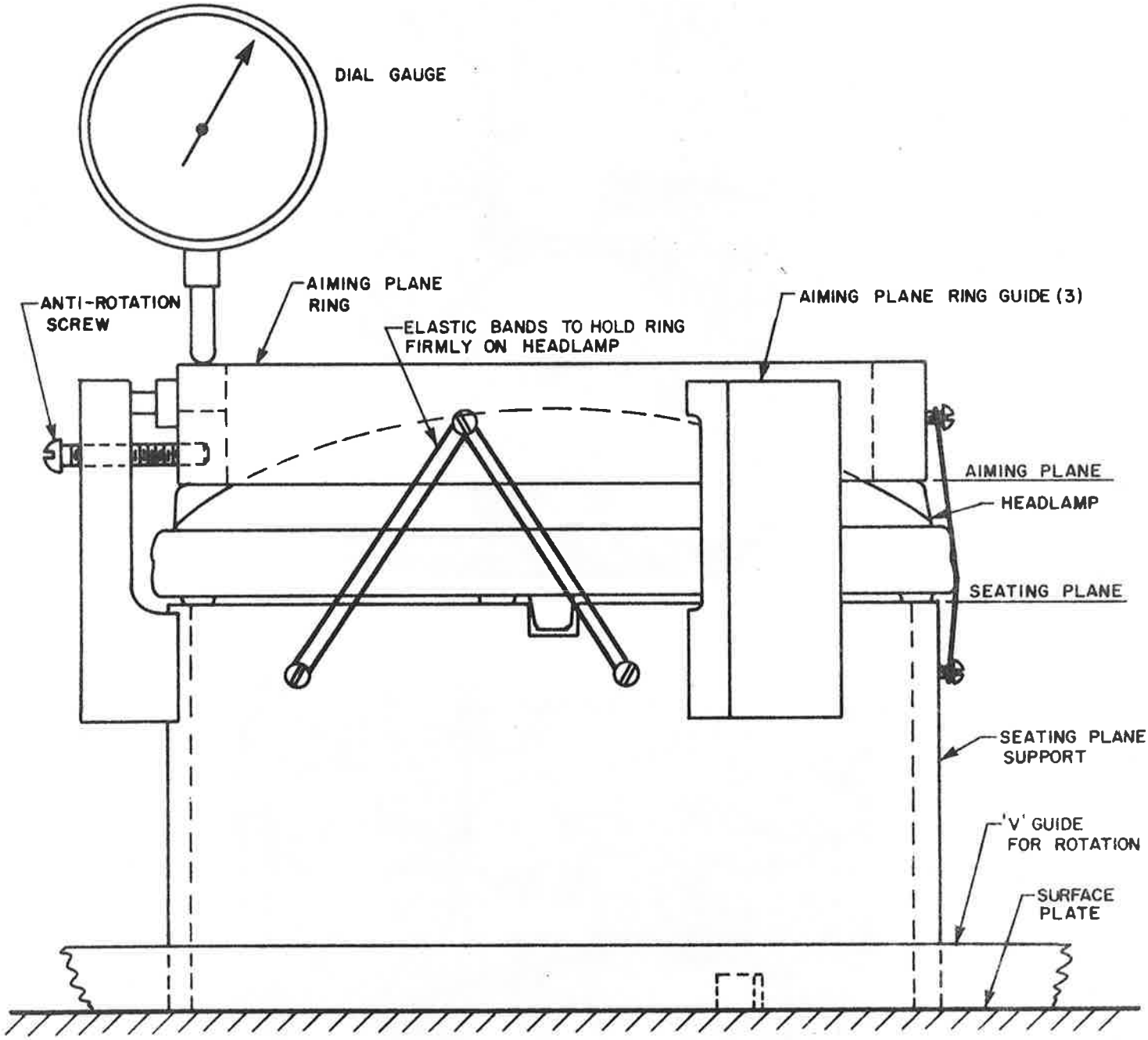


(a)



(b)

FIG. 1 GENERAL TEST ARRANGEMENT



NOTE:
THE SEATING PLANE SUPPORT IS REVERSIBLE TO ACCOMMODATE BOTH TYPE I AND TYPE 2 HEADLAMPS.

FIG. 2 SCHEMATIC OF TEST ARRANGEMENT

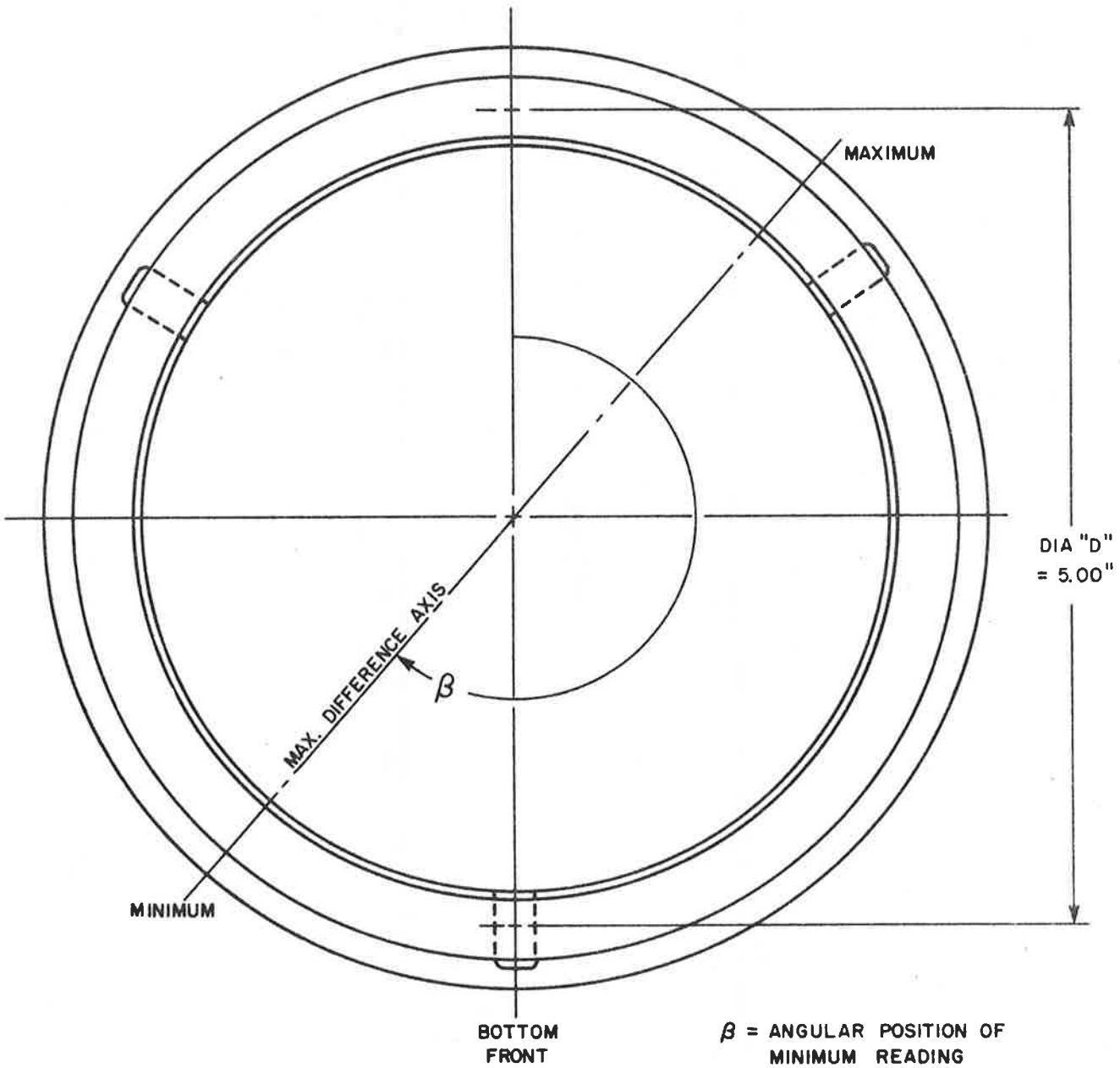


FIG. 3 PLAN VIEW - AIMING PLANE RING AND HEADLAMP

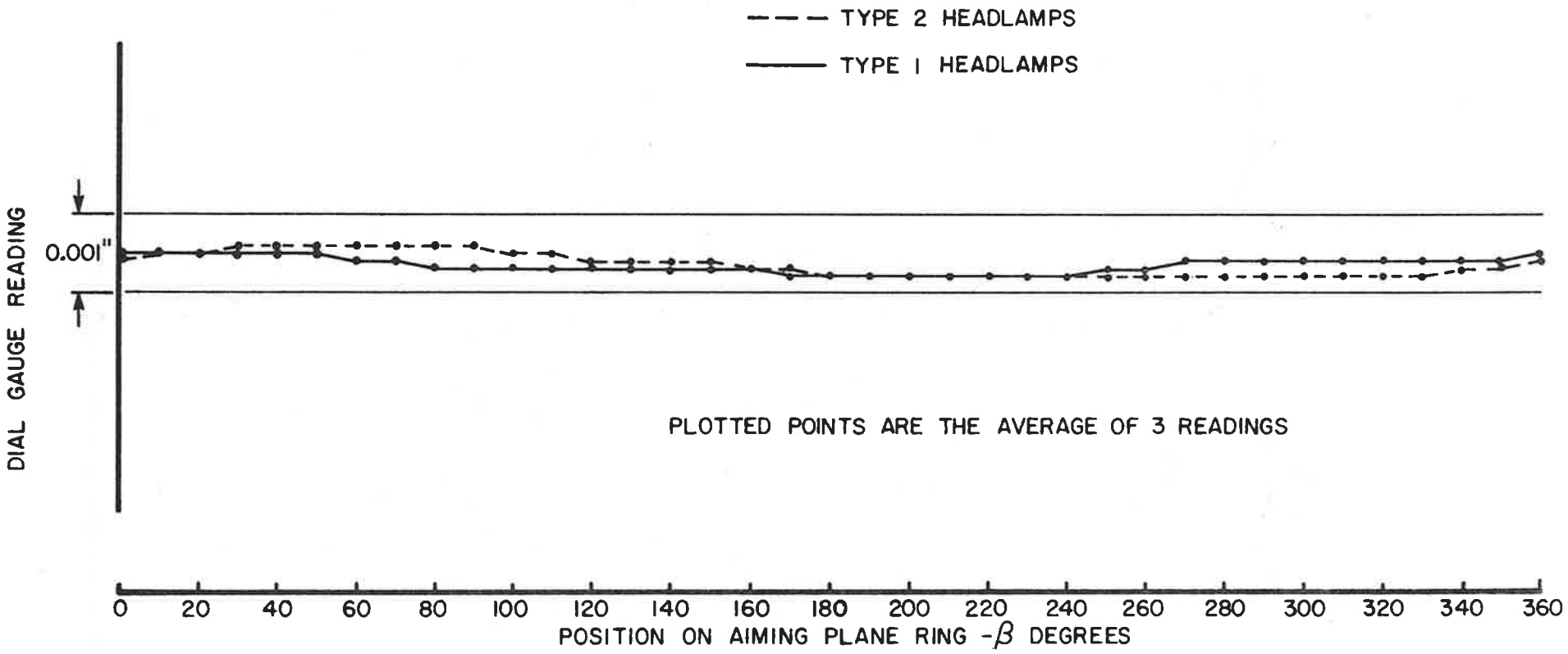
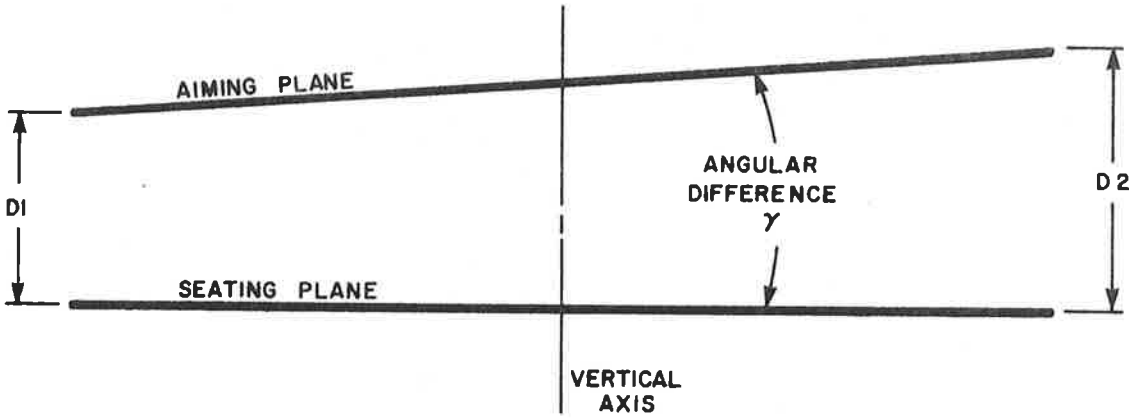


FIG. 4 CALIBRATION OF MEASURING SYSTEM

D1 = CORRECTED MINIMUM READING
D2 = CORRECTED MAXIMUM READING
} MEASURED AT MAX. DIFFERENCE AXIS

DIA "D" = DIAMETER AT WHICH READINGS WERE TAKEN (5.00 inches)



equation 1 $\frac{D2 - D1}{DIA\ "D"} = \text{Tan}\ \gamma$

equation 2 $\text{Tan}\ \gamma \times 720"$ = RESULTANT DEVIATION AT 60 FT. (inches)

equation 3 $\text{Tan}\ \gamma \times 300"$ = RESULTANT DEVIATION AT 25 FT. (inches)

FIG. 5 CALCULATION OF ANGULAR DIFFERENCE AND RESULTANT DEVIATION

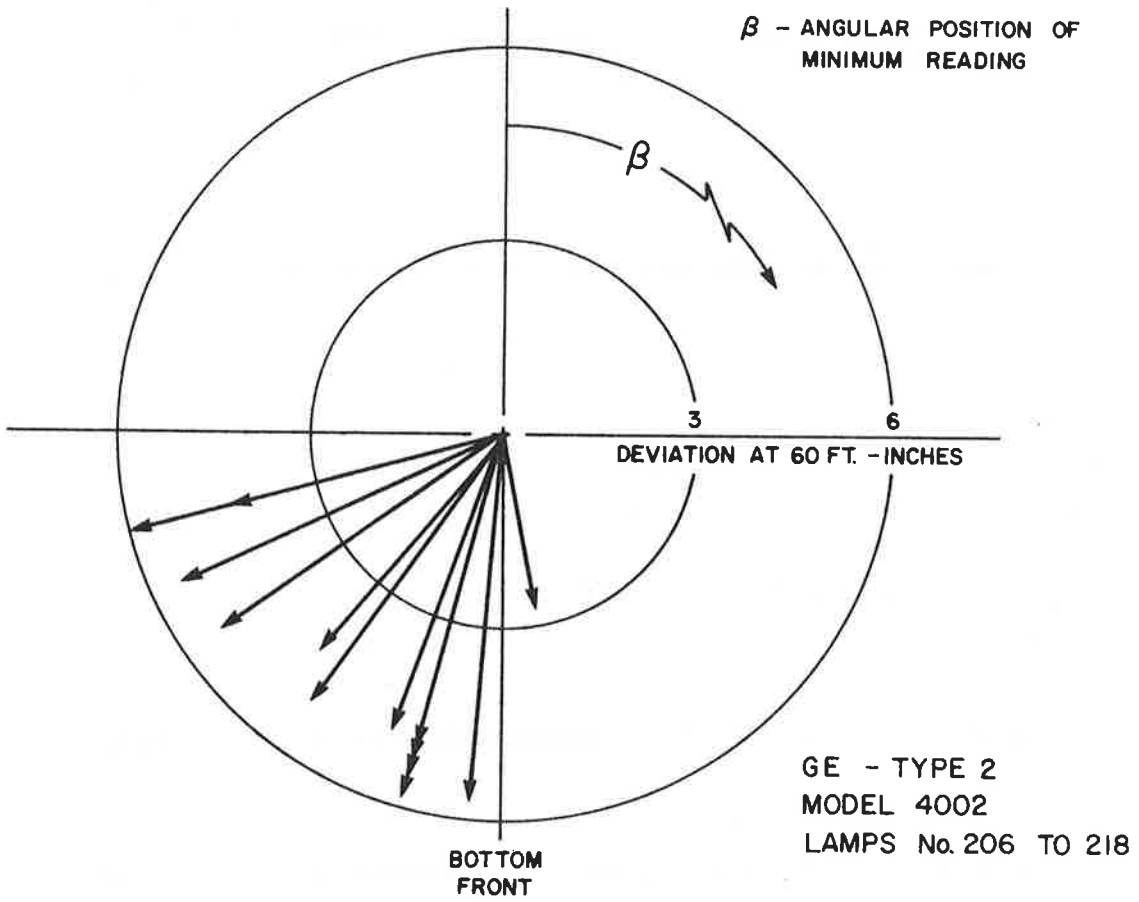


FIG. 6(a) POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE DEVIATION

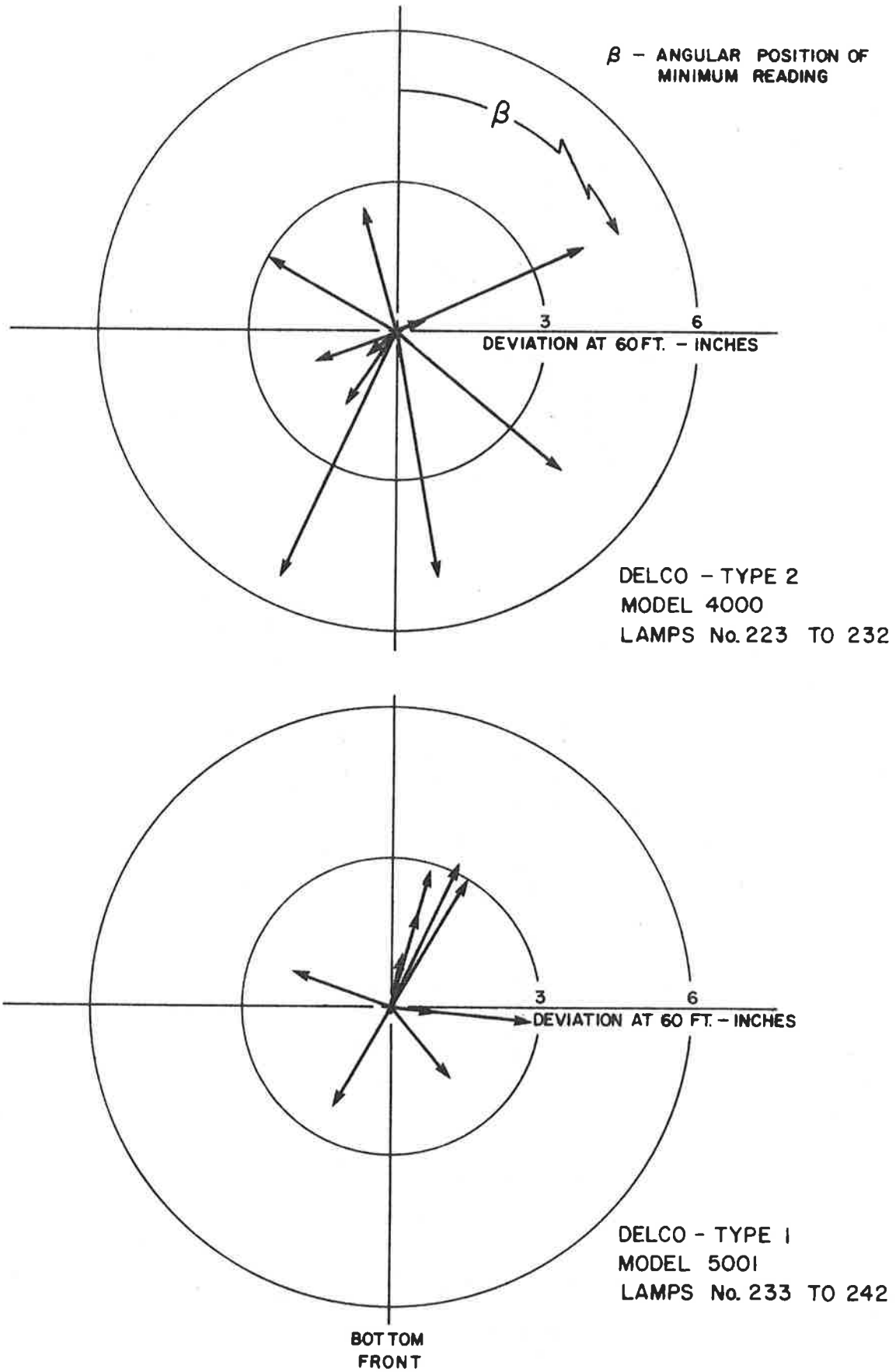


FIG. 6 (b) POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE – SEATING PLANE DEVIATION

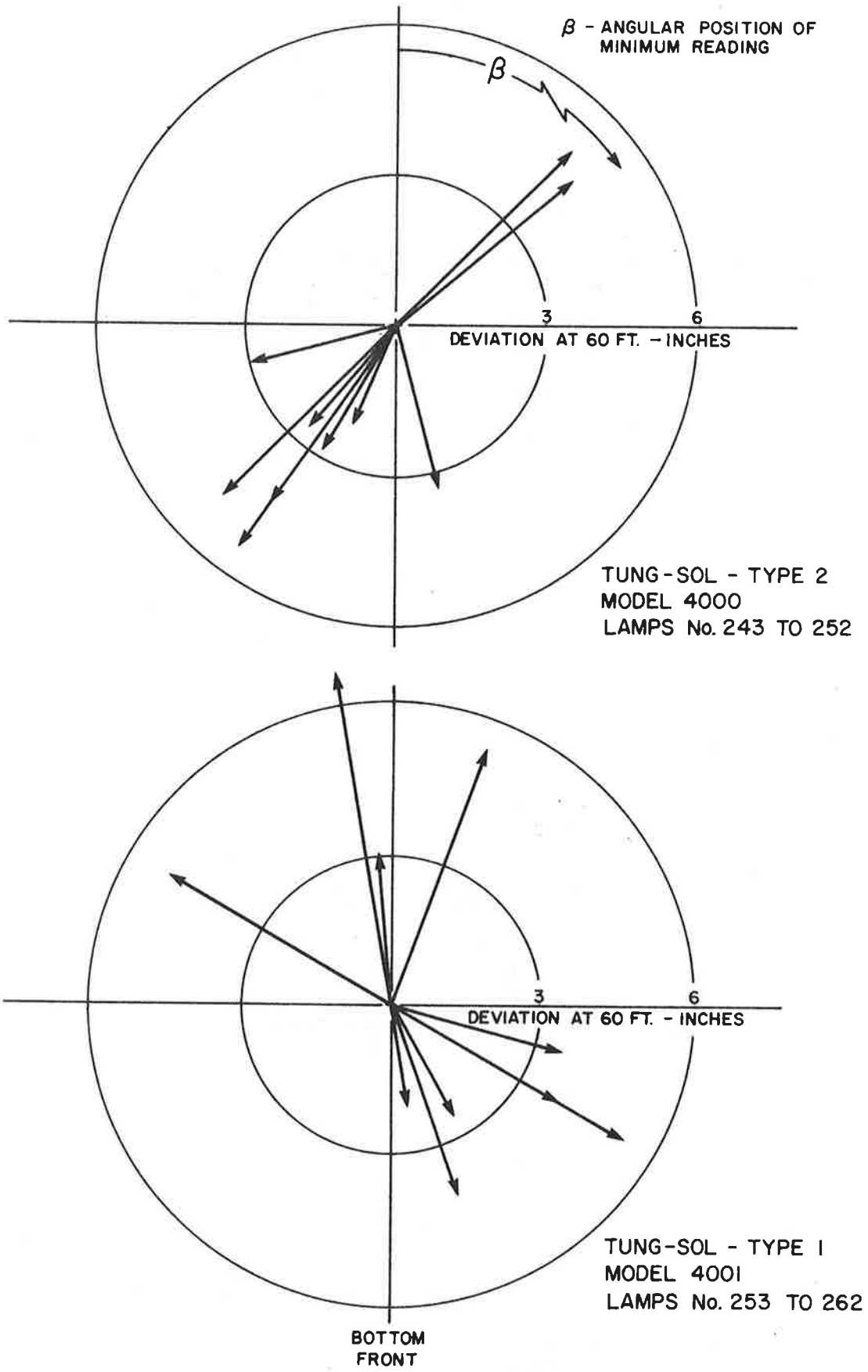


FIG. 6 (c) POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE DEVIATION

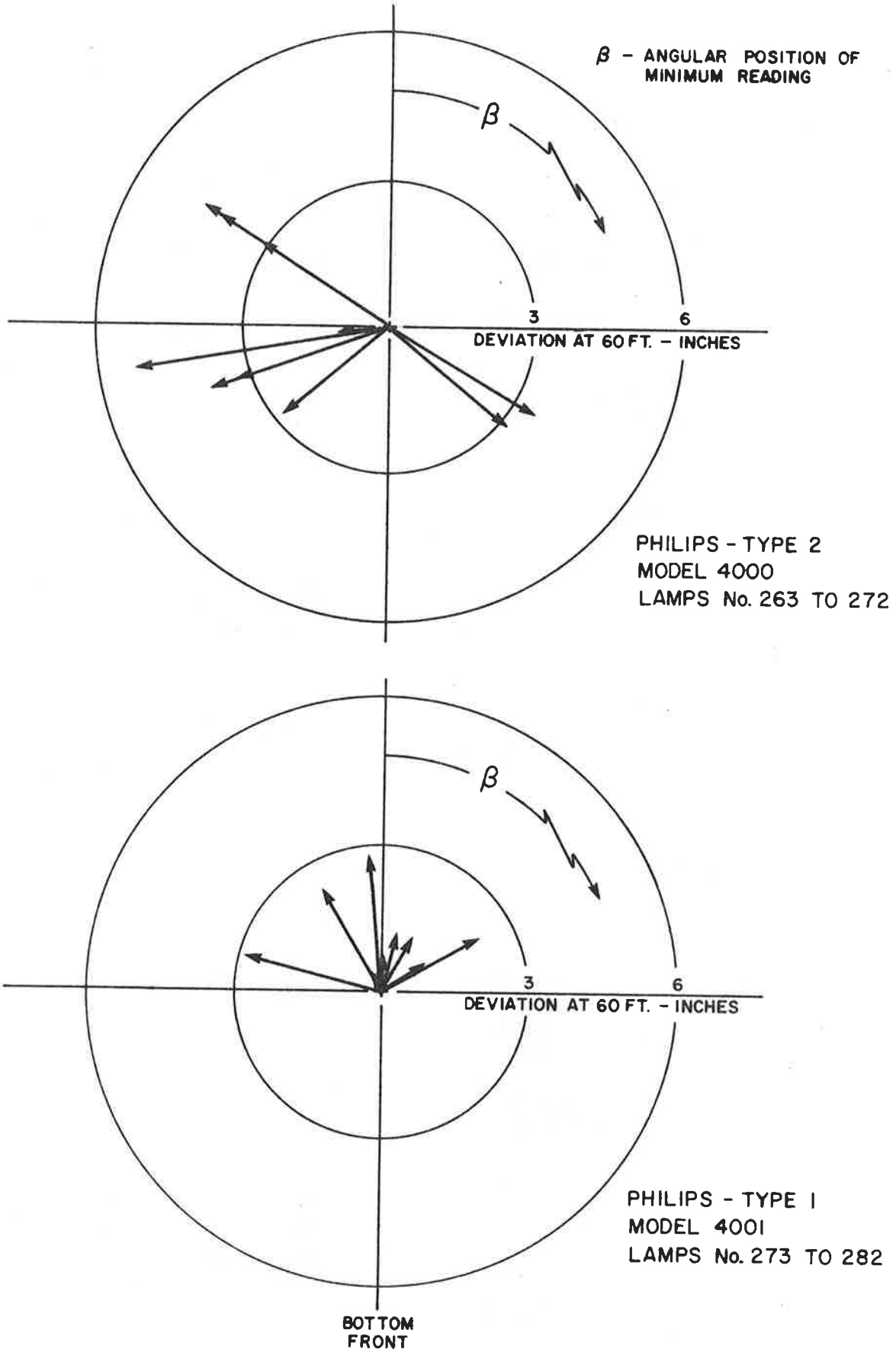


FIG. 6 (d) POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE DEVIATION

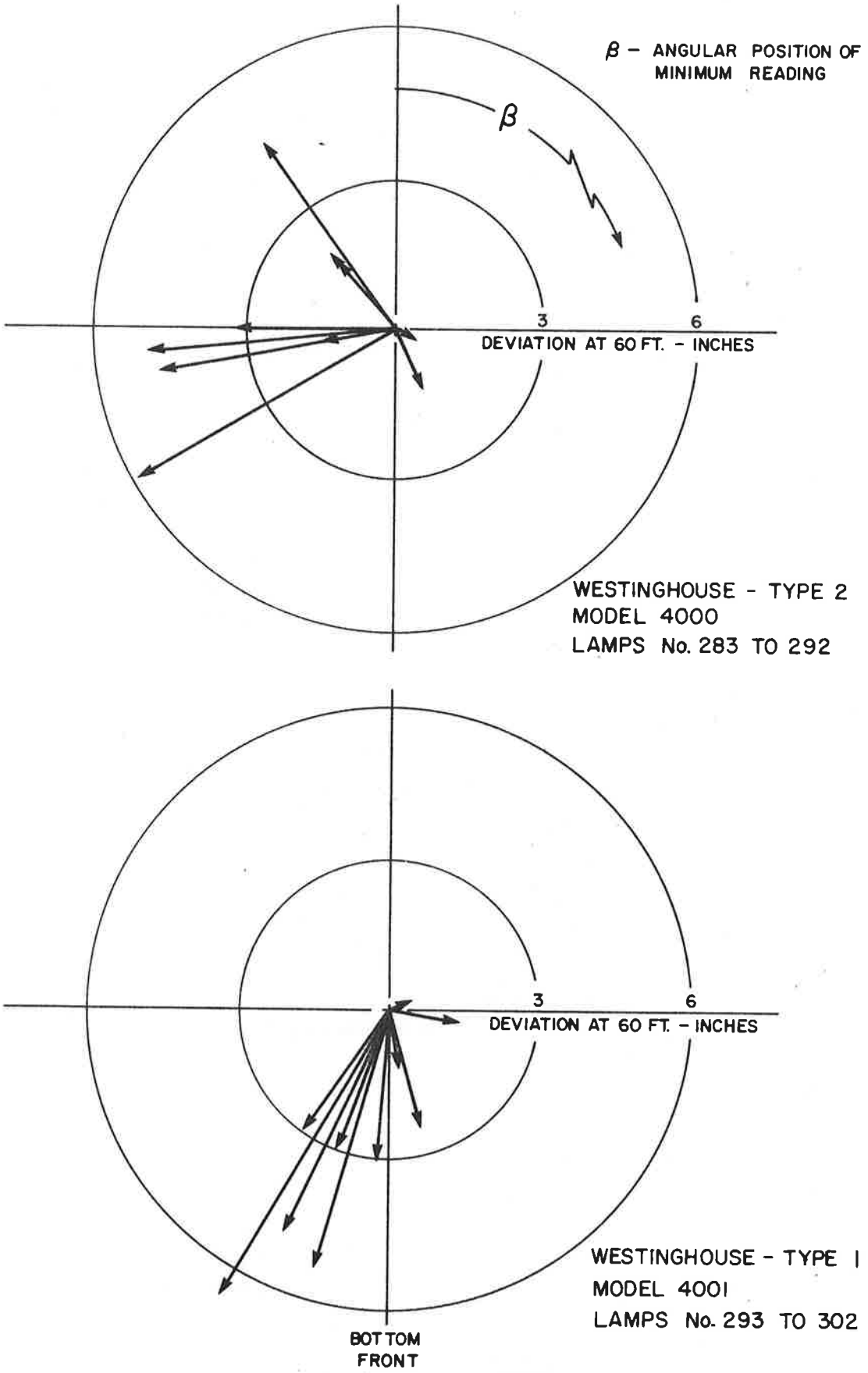
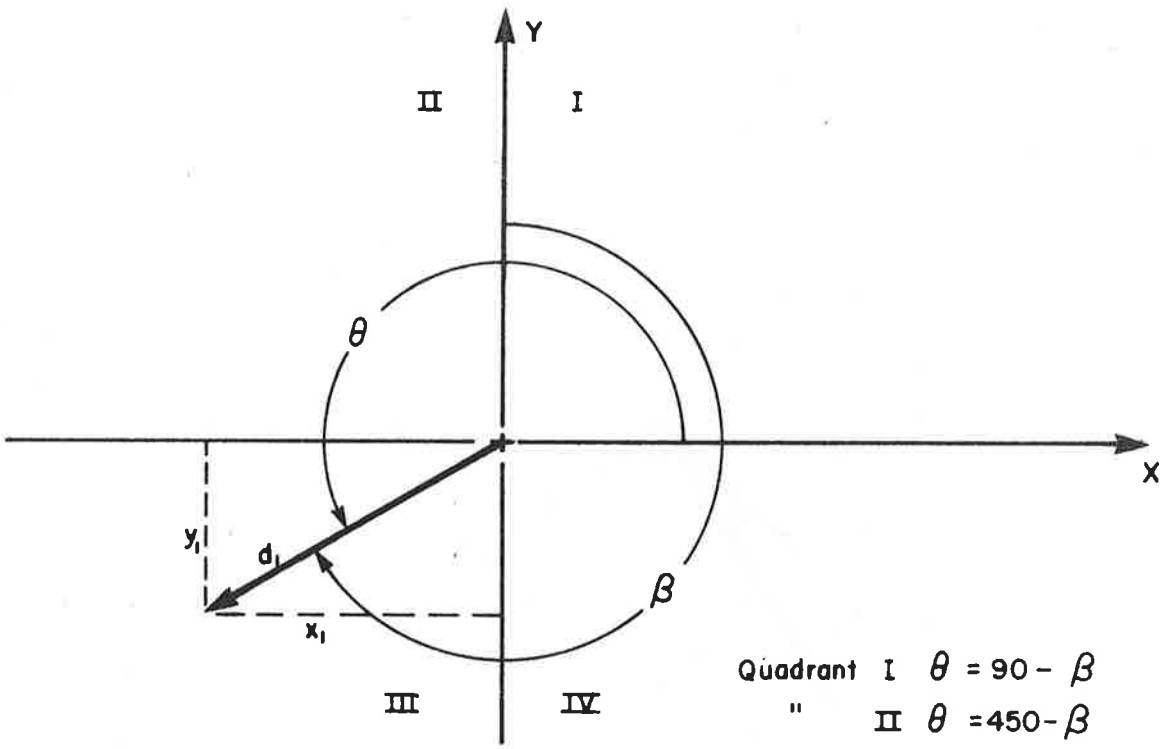


FIG. 6(e) POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE DEVIATION



Quadrant I $\theta = 90 - \beta$

" II $\theta = 450 - \beta$

" III $\theta = 450 - \beta$

" IV $\theta = 450 - \beta$

β – angle as measured

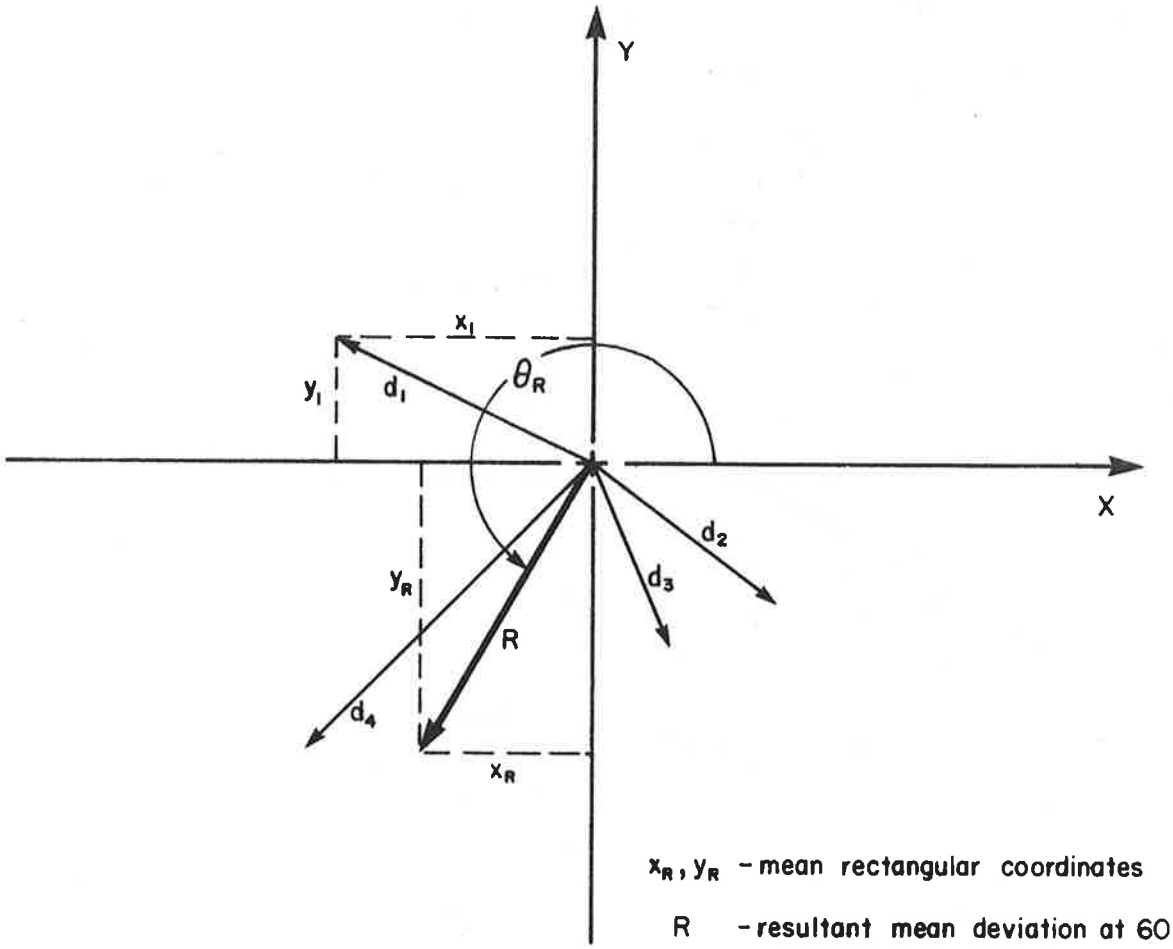
θ – standard angular notation

d_1 – deviation at 60 ft. (inches)

equation 4 $x = d (\cos \theta)$

equation 5 $y = d (\sin \theta)$

FIG. 7 NOTATION FOR CONVERSION FROM THE POLAR COORDINATE MEASURING SYSTEM TO A RECTANGULAR COORDINATE SYSTEM



x_R, y_R – mean rectangular coordinates

R – resultant mean deviation at 60 ft. (inches)

θ_R – resultant angle

$d_{1 \to n}$ – deviation at 60 ft. (inches)

n = 10 except for GE model 4002 where n = 13

equation 6 $x_R = \overline{x_1, x_2, \ldots x_n}$

equation 7 $y_R = \overline{y_1, y_2, \ldots y_n}$

FIG. 8 NOTATION FOR CALCULATION OF THE MEAN DEVIATION FOR EACH HEADLAMP TYPE

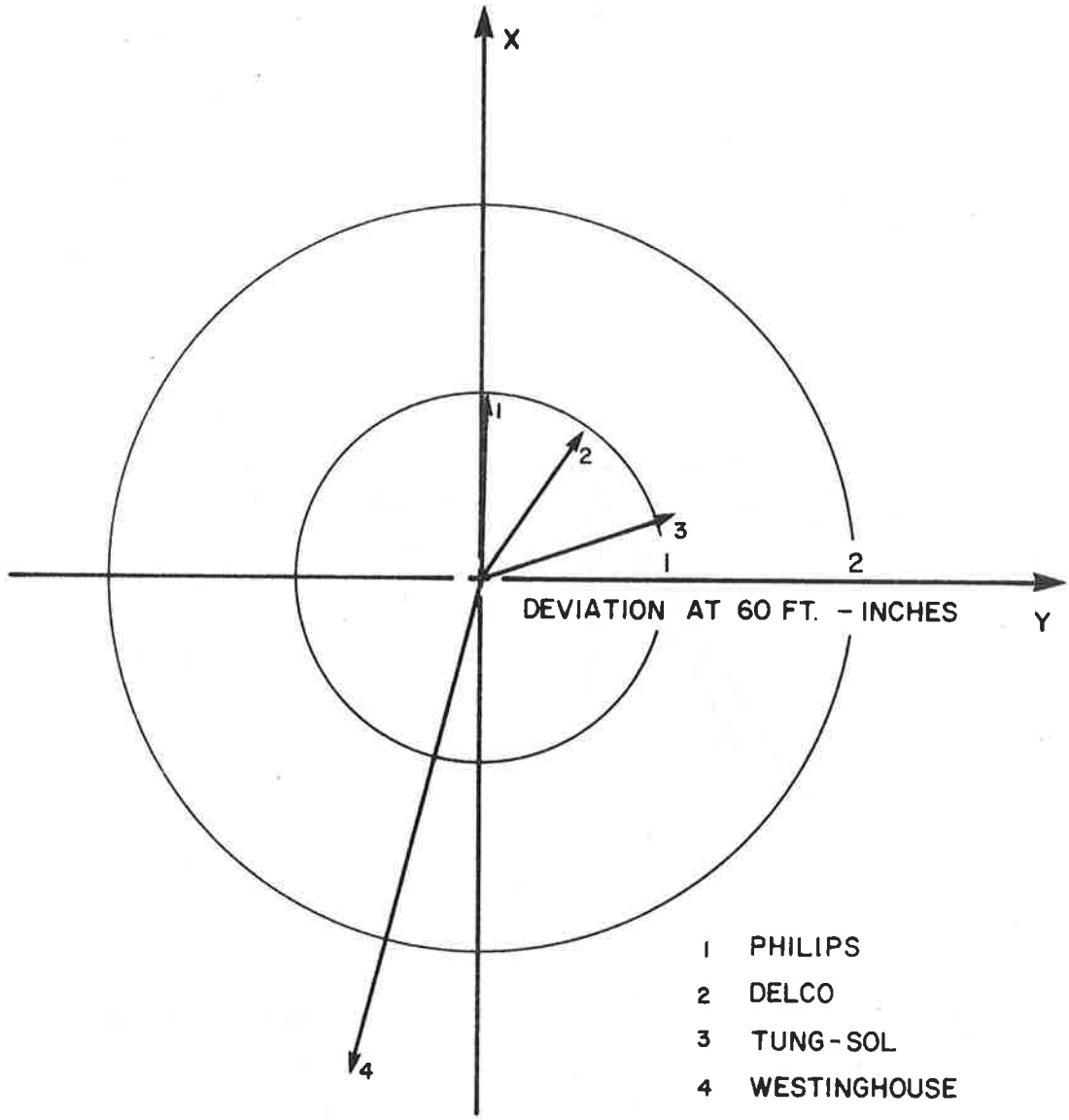


FIG. 9 POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE MEAN DEVIATIONS (TYPE I HEADLAMPS)

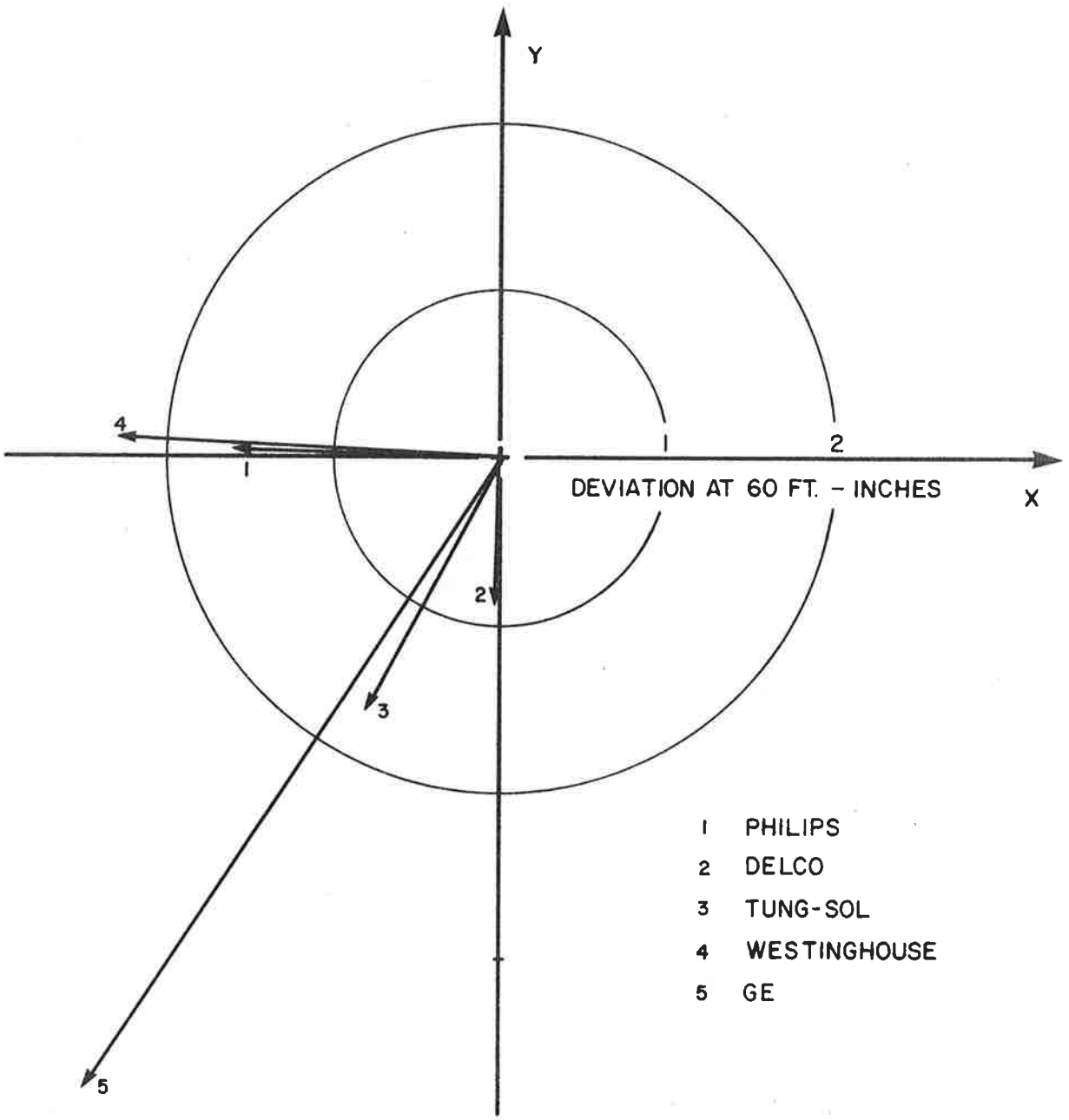
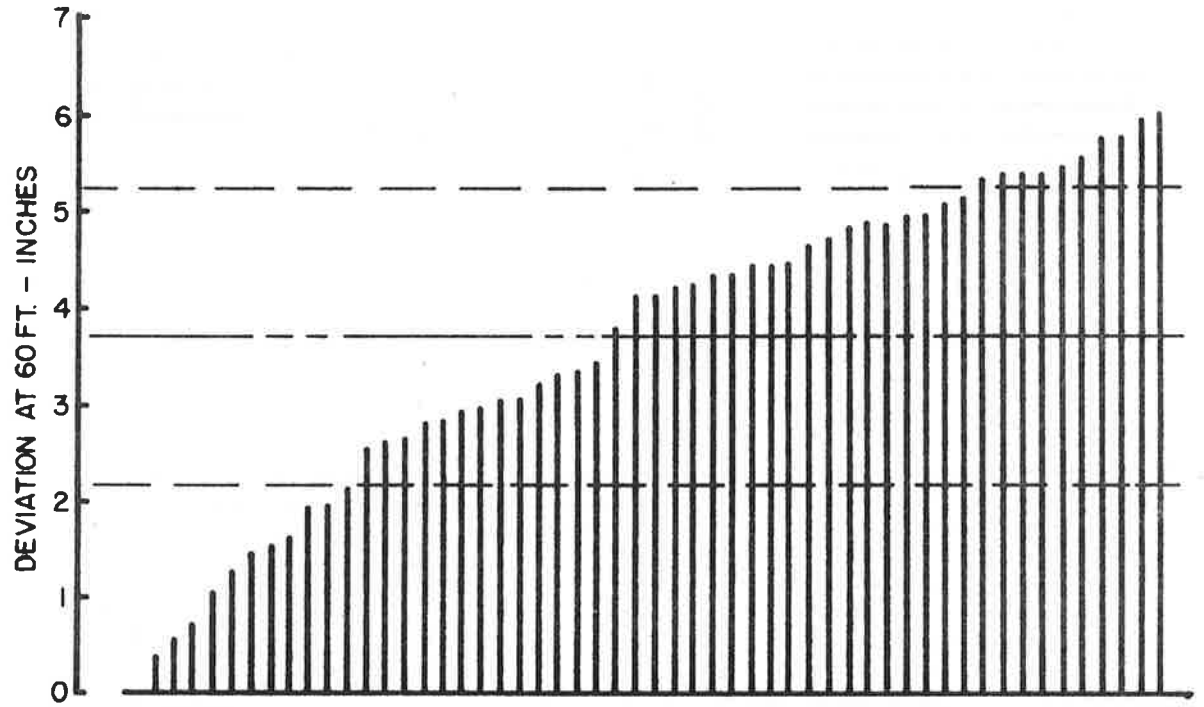
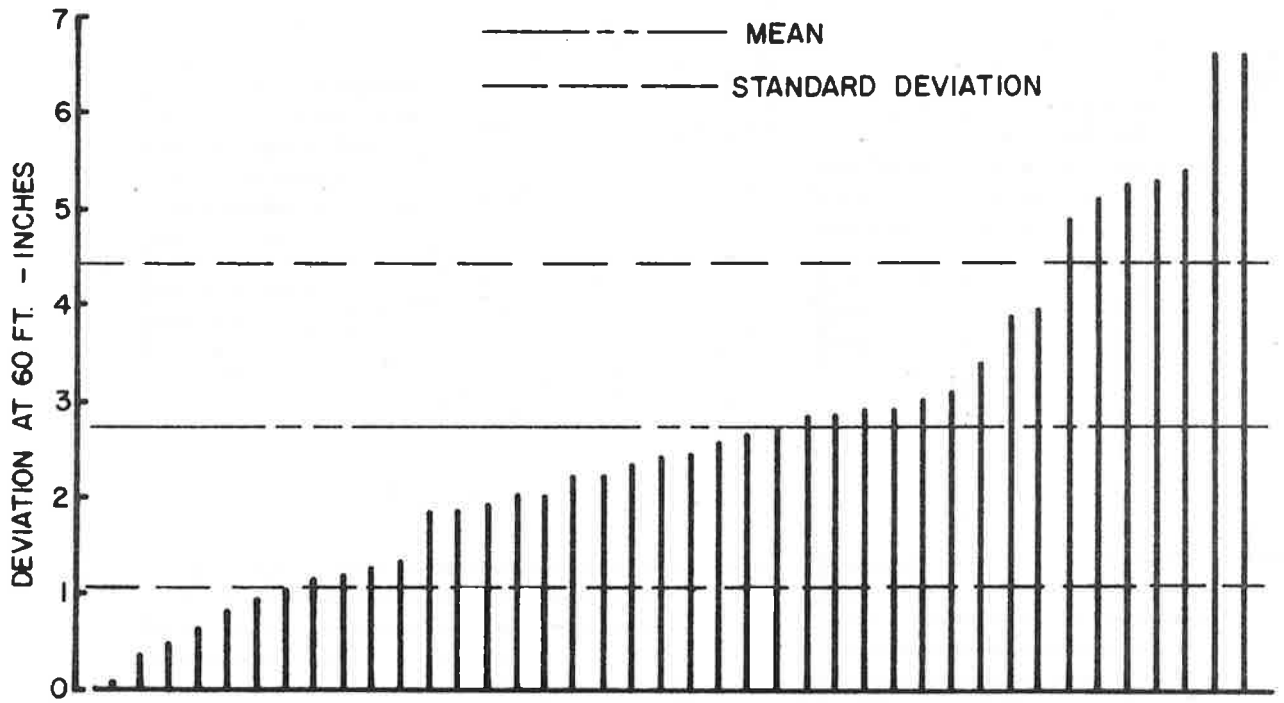


FIG. 10 POLAR VECTOR PLOT OF THE HEADLAMP AIMING PLANE - SEATING PLANE MEAN DEVIATIONS (TYPE 2 HEADLAMPS)



(a) TYPE 2 HEADLAMPS



(b) TYPE 1 HEADLAMPS

FIG. 11 AIMING DEVIATION DISTRIBUTION AT 60 FT.

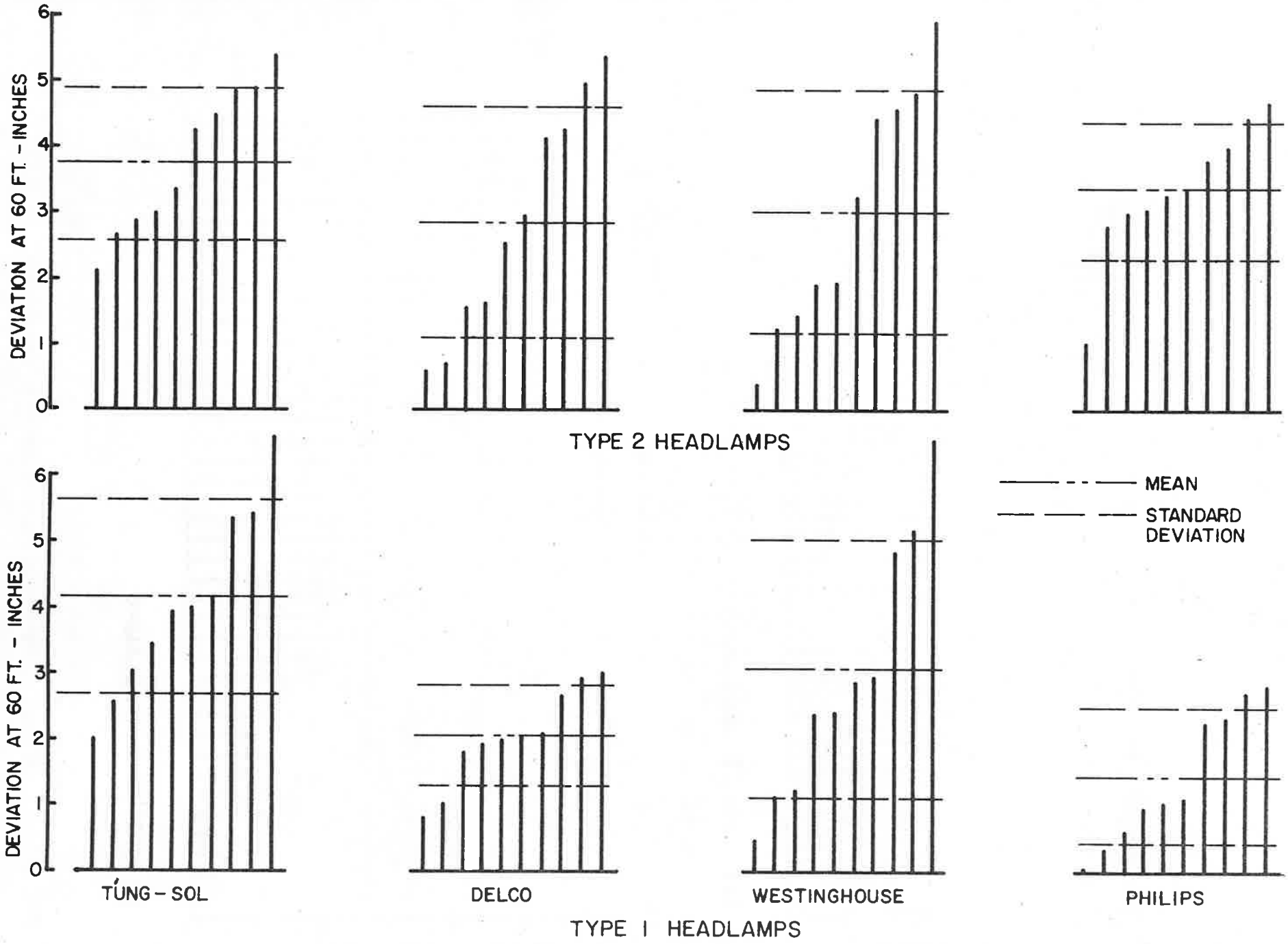


FIG. 12 (a) AIMING DEVIATION DISTRIBUTION AT 60 FT. BY HEADLAMP MAKE

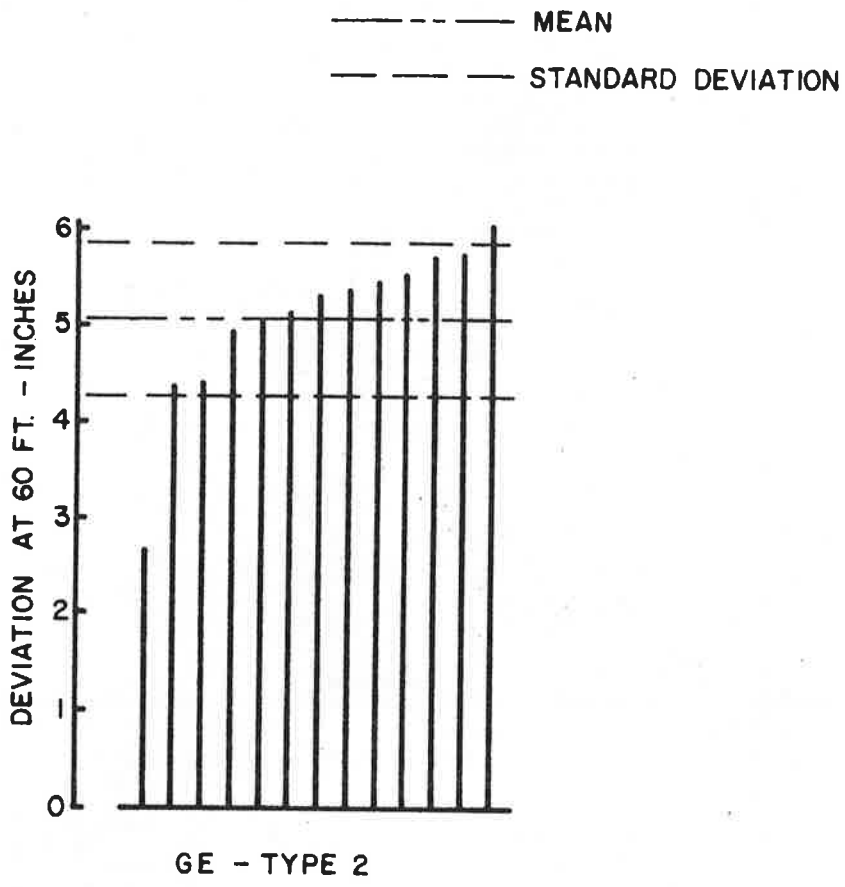
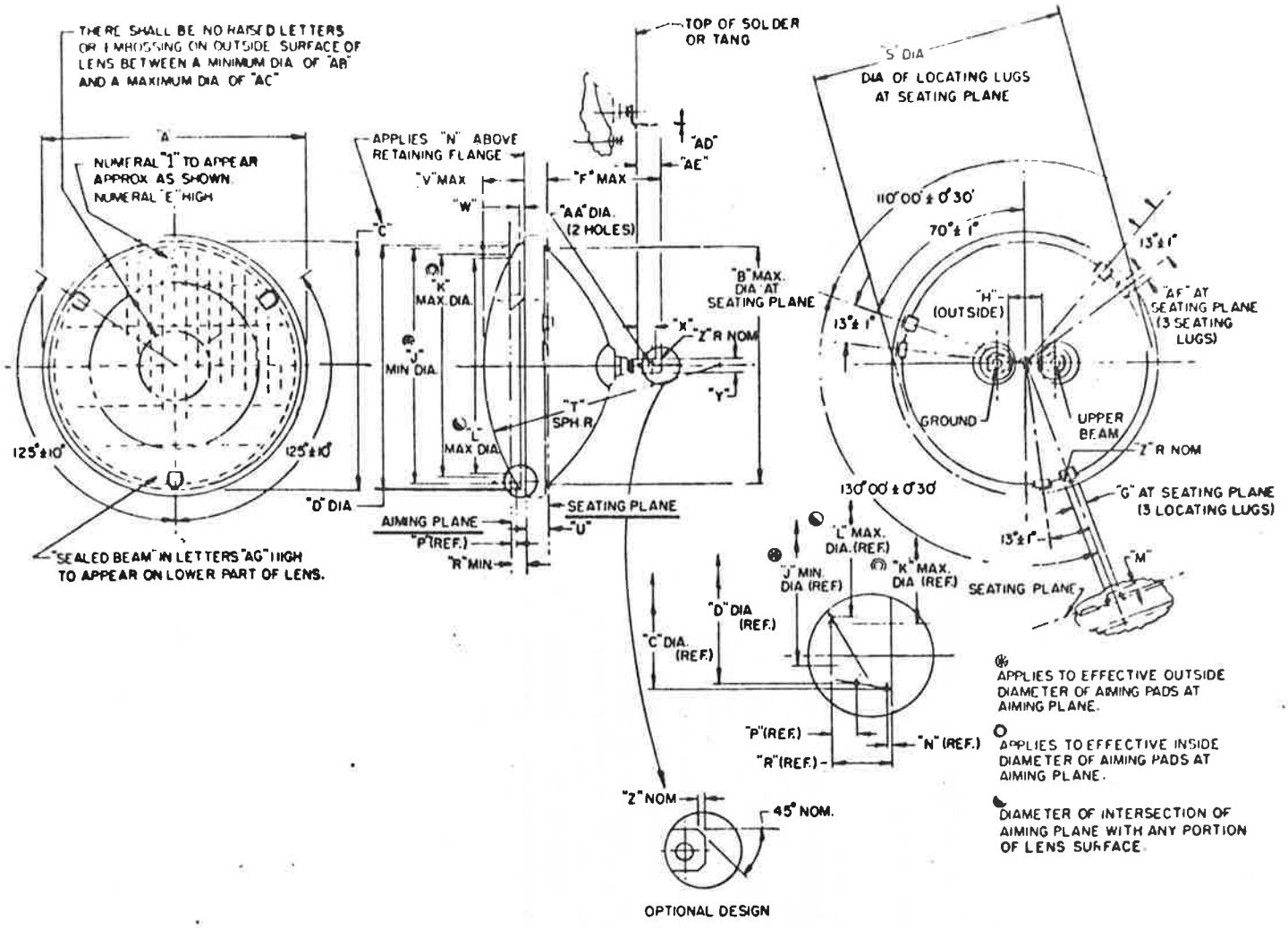

MEAN
STANDARD DEVIATION
DEVIATION AT 60 FT. - INCHES
0
1
2
3
4
5
6
GE - TYPE 2

FIG. 12 (b)



DIMENSIONS

Letter	In	mm	Letter	In	mm
A	$5.700^{+0.000}_{-0.100}$	$144.78^{+0}_{-2.54}$	T	5.06 ±0.12	128.52±3.04
B	5.120	130.04	U	0.500±0.040	12.70±1.01
C	$5.355^{+0.000}_{-0.030}$	$136.01^{+0}_{-0.76}$	V	0.92	23.36
D	5.280–5.340	134.11–135.63	W	$0.078^{+0.062}_{-0.000}$	$1.98^{+1.57}_{-0}$
E	1/4±1/32	6.35±0.79	X	$0.345^{+0.060}_{-0.000}$	$8.76^{+1.52}_{-0}$
F	2.60	66.04	Y	$0.304^{+0.016}_{-0.000}$	$7.72^{+0.40}_{-0}$
G	0.312±0.010	7.92±0.25	Z	0.06	1.52
H	$0.670^{+0.035}_{-0.000}$	$17.01^{+0.88}_{-0}$	AA	$0.120^{+0.010}_{-0.000}$	$3.04^{+0.25}_{-0}$
J	5.060	128.52	AB	1.50	38.10
K	4.57	116.07	AC	3.60	91.44
L	4.53	115.06	AD	0.030±0.002	0.76±0.05
M	$0.100^{+0.050}_{-0.000}$	$2.54^{+1.27}_{-0}$	AE	$0.535^{+0.000}_{-0.070}$	$13.58^{+0}_{-1.77}$
N	0.030	0.76	AF	0.31 ±0.12	7.87±3.04
P	0.165	4.19	AG	5/32±1/32	3.96±0.79
R	0.320	8.12			
S	$5.440^{+0.000}_{-0.040}$	$138.17^{+0}_{-1.01}$			

FIG. 13 TYPE I SEALED BEAM HEADLAMP UNIT
(REF. 1)

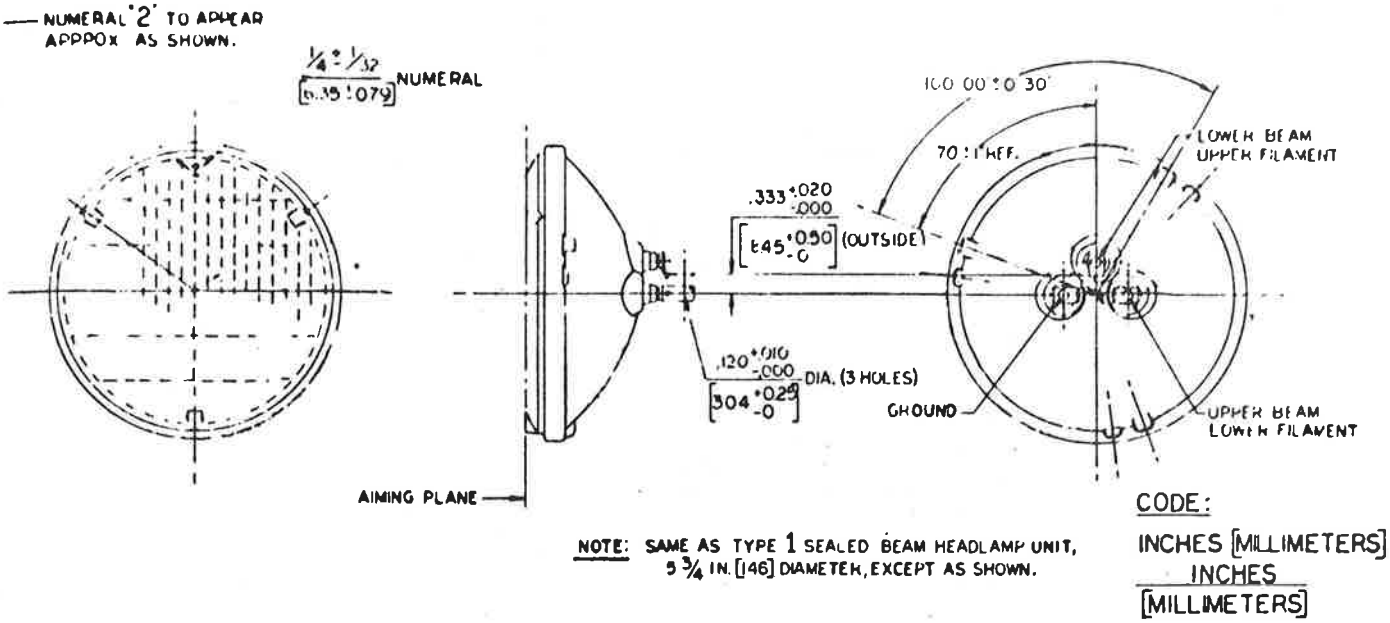
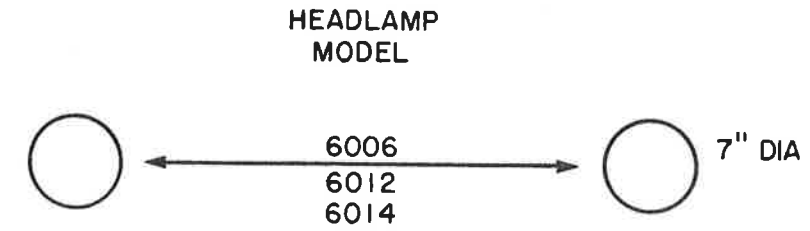
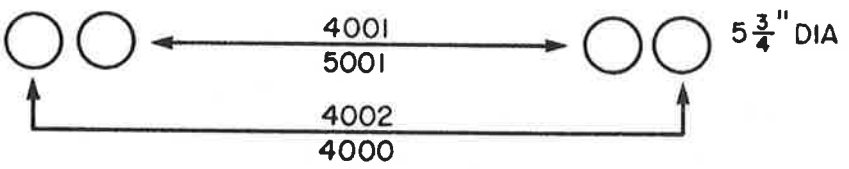


FIG. 14 TYPE 2 SEALED BEAM HEADLAMP UNIT

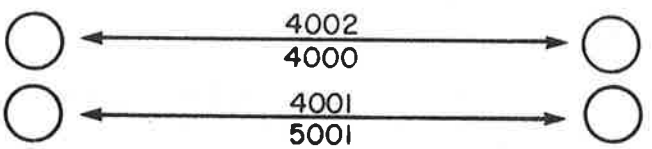
(REF. 1)



TWO HEADLAMP CARS



(a)



(b)

FOUR HEADLAMP CARS

Types 6006, 6012, 6014, 4002, and 4000 are dual filament lamps.

FIG. 15 HEADLAMP CONFIGURATIONS

TABLE I

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Type	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 206	GE	4002	2	0.478	6.005	2.502
207	GE	4002	2	0.458	5.760	2.400
208	GE	4002	2	0.212	2.664	1.110
209	GE	4002	2	0.423	5.314	2.214
210	GE	4002	2	0.393	4.939	2.058
211	GE	4002	2	0.437	5.486	2.286
212	GE	4002	2	0.429	5.386	2.244
213	GE	4002	2	0.402	5.054	2.106
214	GE	4002	2	0.456	5.731	2.388
215	GE	4002	2	0.348	4.378	1.824
216	GE	4002	2	0.441	5.544	2.310
217	GE	4002	2	0.351	4.406	1.836
218	GE	4002	2	0.407	5.112	2.130

TABLE II

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Type	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 223	Delco	4000	2	0.123	1.541	0.642
224	Delco	4000	2	0.340	4.277	1.782
225	Delco	4000	2	0.129	1.627	0.678
226	Delco	4000	2	0.398	4.997	2.082
227	Delco	4000	2	0.236	2.966	1.236
228	Delco	4000	2	0.057	0.720	0.300
229	Delco	4000	2	0.430	5.400	2.250
230	Delco	4000	2	0.330	4.147	1.728
231	Delco	4000	2	0.047	0.590	0.246
232	Delco	4000	2	0.203	2.549	1.062
233	Delco	5001	1	0.248	3.110	1.296
234	Delco	5001	1	0.215	2.707	1.128
235	Delco	5001	1	0.177	2.218	0.924
236	Delco	5001	1	0.159	2.001	0.834
237	Delco	5001	1	0.237	2.981	1.242
238	Delco	5001	1	0.166	2.088	0.870
239	Delco	5001	1	0.084	1.051	0.438
240	Delco	5001	1	0.146	1.829	0.762
241	Delco	5001	1	0.158	1.944	0.810
242	Delco	5001	1	0.068	0.850	0.354

TABLE III

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Type	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 243	Tung-sol	4000	2	0.342	4.291	1.788
244	Tung-sol	4000	2	0.389	4.882	2.034
245	Tung-sol	4000	2	0.238	2.995	1.248
246	Tung-sol	4000	2	0.213	2.678	1.116
247	Tung-sol	4000	2	0.389	4.882	2.034
248	Tung-sol	4000	2	0.269	3.384	1.410
249	Tung-sol	4000	2	0.170	2.131	0.888
250	Tung-sol	4000	2	0.358	4.493	1.872
251	Tung-sol	4000	2	0.430	5.400	2.250
252	Tung-sol	4000	2	0.227	2.851	1.188
253	Tung-sol	4001	1	0.165	2.074	0.864
254	Tung-sol	4001	1	0.203	2.549	1.062
255	Tung-sol	4001	1	0.320	4.018	1.674
256	Tung-sol	4001	1	0.427	5.371	2.238
257	Tung-sol	4001	1	0.413	5.184	2.160
258	Tung-sol	4001	1	0.314	3.946	1.644
259	Tung-sol	4001	1	0.531	6.667	2.778
260	Tung-sol	4001	1	0.244	3.067	1.278
261	Tung-sol	4001	1	0.433	5.443	2.268
262	Tung-sol	4001	1	0.277	3.485	1.452

TABLE IV

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Type	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 263	Philips	4000	2	0.085	1.066	0.444
264	Philips	4000	2	0.246	3.096	1.290
265	Philips	4000	2	0.358	4.493	1.872
266	Philips	4000	2	0.229	2.880	1.200
267	Philips	4000	2	0.304	3.816	1.590
268	Plilips	4000	2	0.264	3.312	1.380
269	Philips	4000	2	0.246	3.096	1.290
270	Philips	4000	2	0.273	3.427	1.428
271	Philips	4000	2	0.330	4.147	1.728
272	Philips	4000	2	0.377	4.738	1.974
273	Philips	4001	1	0.030	0.374	0.156
274	Philips	4001	1	0.050	0.634	0.264
275	Philips	4001	1	0.076	0.950	0.396
276	Philips	4001	1	0.227	2.851	1.188
277	Philips	4001	1	0.006	0.072	0.030
278	Philips	4001	1	0.092	1.152	0.480
279	Philips	4001	1	0.222	2.794	1.164
280	Philips	4001	1	0.099	1.238	0.516
281	Philips	4001	1	0.180	2.261	0.942
282	Philips	4001	1	0.190	2.390	0.996

TABLE V

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Type	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 283	Westing-house	4000	2	0.358	4.493	1.872
284		4000	2	0.385	4.838	2.016
285	"	4000	2	0.101	1.267	0.528
286	"	4000	2	0.154	1.930	0.804
287	"	4000	2	0.374	4.694	1.956
288	"	4000	2	0.157	1.973	0.822
289	"	4000	2	0.473	5.947	2.478
290	"	4000	2	0.117	1.469	0.612
291	"	4000	2	0.032	0.403	0.168
292	"	4000	2	0.256	3.211	1.338
293	"	4001	1	0.235	2.952	1.230
294	"	4001	1	0.111	1.397	0.582
295	"	4001	1	0.040	0.504	0.210
296	"	4001	1	0.427	5.371	2.238
297	"	4001	1	0.392	4.925	2.052
298	"	4001	1	0.231	2.909	1.212
299	"	4001	1	0.197	2.477	1.032
300	"	4001	1	0.528	6.638	2.766
301	"	4001	1	0.096	1.210	0.504
302	"	4001	1	0.194	2.434	1.014

National Research Council Canada / Conseil national de recherches Canada

TABLE VI

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

Date 7 April '75

Name C. MacKenzie

EXPERIMENTAL RESULTS

HEADLAMP NAE No.	HEADLAMP IDENT.			MEASURED DATA					CALCULATED DATA				
	MAKE	MODEL	SOLD BY	MAX. READING	MIN. READING	ANGULAR POS. (deg.)	CORRECTED MAX.	CORRECTED MIN.	MAX. – MIN.	DEVIATION ANGLE	DEVIATION AT 60' (in.)	DEVIATION AT 25' (in.)	
206	GE	4002	GE	.1879	.1458	255	.1875	.1458	.0417	.4778	6.0048	2.5020	
207	↓	↓	↓	.1987	.1584	195	.1984	.1584	.0400	.4584	5.7600	2.4000	
208				.1860	.1675	170	.1859	.1674	.0185	.2120	2.6640	1.1100	
209				.2002	.1630	195	.1999	.1630	.0369	.4228	5.3136	2.2140	
210				.1990	.1604	200	.1987	.1604	.0343	.3930	4.9392	2.0580	
211				.1889	.1504	245	.1885	.1504	.0381	.4366	5.4864	2.2860	
212				.1909	.1531	235	.1905	.1531	.0374	.4286	5.3856	2.2440	
213				.1927	.1572	215	.1923	.1572	.0351	.4022	5.0544	2.1060	
214				.1972	.1571	185	.1969	.1571	.0398	.4561	5.7312	2.3880	
215				.1756	.1448	255	.1752	.1448	.0304	.3484	4.3776	1.8240	
216				.2000	.1612	195	.1997	.1612	.0385	.4412	5.5440	2.3100	
217				.1916	.1606	220	.1912	.1606	.0306	.3506	4.4064	1.8360	
218	GE	4002	GE	.2002	.1644	195	.1999	.1644	.0355	.4068	5.1120	2.1300	

National Research Council Canada / Conseil national de recherches Canada

TABLE VII

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

Date 21 FEB. '75

Name C. MACKENZIE

EXPERIMENTAL RESULTS

HEADLAMP NAE No.	HEADLAMP IDENT.			MEASURED DATA			CALCULATED DATA						
	MAKE	MODEL	SOLD BY	MAX. READING	MIN. READING	ANGULAR POS. (deg.)	CORRECTED MAX.	CORRECTED MIN.	MAX. – MIN.	DEVIATION ANGLE	DEVIATION AT 60' (in.)	DEVIATION AT 25' (in.)	
223	DELCO	4000	GM	.0721	.0610	215	.0717	.0610	.0107	.1226	1.5408	.6419	
224				.0339	.0044	130	.0339	.0042	.0297	.3403	4.2768	1.7820	
225				.0767	.0650	250	.0763	.0650	.0113	.1295	1.6273	.6781	
226				.0372	.0025	170	.0371	.0024	.0347	.3976	4.9968	2.0820	
227				.0720	.0512	300	.0718	.0512	.0206	.2361	2.9664	1.2360	
228				.0337	.0283	230	.0333	.0283	.0050	.0573	.7200	.3000	
229				.0432	.0053	205	.0428	.0053	.0375	.4297	5.4000	2.2500	
230				.0595	.0311	65	.0595	.0307	.0288	.3300	4.1472	1.7280	
231				.0587	.0550	70	.0587	.0546	.0041	.0470	.5904	.2460	
232		4000		.0640	.0463	345	.0639	.0462	.0177	.2028	2.5488	1.0620	
233		5001		.0563	.0350	25	.0563	.0347	.0216	.2475	3.1104	1.2960	
234				.0590	.0405	15	.0590	.0402	.0188	.2154	2.7072	1.1280	
235				.0487	.0330	210	.0484	.0330	.0154	.0765	2.2176	.9240	
236				.0363	.0225	290	.0362	.0223	.0139	.1593	2.0016	.8340	
237				.0396	.0192	30	.0396	.0189	.0207	.2372	2.9808	1.2420	
238				.0436	.0290	95	.0434	.0289	.0145	.1662	2.0880	.8700	
239				.0304	.0234	10	.0304	.0231	.0073	.0837	1.0512	.4380	
240				.0520	.0392	140	.0518	.0391	.0127	.1455	1.8288	.7618	
241				.0349	.0217	15	.0349	.0214	.0135	.1547	1.9440	.8100	
242	DELCO	5001	GM	.0505	.0445	95	.0503	.0444	.0059	.0676	.8496	.3540	

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TABLE VIII

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

Date 21 FEB. '75

Name C. MacKENZIE

EXPERIMENTAL RESULTS

HEADLAMP NAE No.	HEADLAMP IDENT.			MEASURED DATA					CALCULATED DATA			
	MAKE	MODEL	SOLD BY	MAX. READING	MIN. READING	ANGULAR POS. (deg.)	CORRECTED MAX.	CORRECTED MIN.	MAX. – MIN.	DEVIATION ANGLE	DEVIATION AT 60' (in.)	DEVIATION AT 25' (in.)
243	TUNG-SOL	4000	TUNG-SOL	.0432	.0130	215	.0428	.0130	.0298	.3415	4.2912	1.7880
244	↓	↓	↓	.0511	.0176	45	.0511	.0172	.0339	.3885	4.8816	2.0340
245				.0379	.0167	255	.0375	.0167	.0208	.2383	2.9952	1.2480
246				.0574	.0384	220	.0570	.0384	.0186	.2131	2.6784	1.1160
247				.0475	.0132	225	.0471	.0132	.0339	.3885	4.8816	2.0340
248				.0288	.0053	165	.0287	.0052	.0235	.2693	3.3840	1.4100
249				.0271	.0119	205	.0267	.0119	.0148	.1696	2.1312	.8880
250				.0597	.0289	50	.0597	.0285	.0312	.3575	4.4928	1.8720
251				.0445	.0066	215	.0441	.0066	.0375	.4297	5.3999	2.2499
252		4000		.0625	.0423	210	.0621	.0423	.0198	.2269	2.8512	1.1880
253		4001		.0418	.0272	170	.0416	.0272	.0144	.1650	2.0736	.8639
254		↓		.0341	.0163	150	.0339	.0162	.0177	.2028	2.5488	1.0620
255				.0597	.0317	160	.0595	.0316	.0279	.3197	4.0176	1.6740
256				.0475	.0101	120	.0473	.0100	.0373	.4274	5.3712	2.2380
257				.0664	.0301	300	.0659	.0299	.0360	.4125	5.1840	2.1600
258				.0354	.0079	120	.0352	.0078	.0274	.3140	3.9456	1.6440
259				.0615	.0154	350	.0615	.0152	.0463	.5305	6.6672	2.7780
260				.0399	.0188	355	.0399	.0186	.0213	.2441	3.0672	1.2780
261	↓	↓	↓	.0535	.0160	20	.0535	.0157	.0378	.4331	5.4432	2.2680
262	TUNG-SOL	4001	TUNG-SOL	.0337	.0094	105	.0335	.0093	.0242	.2773	3.4848	1.4520

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TABLE IX

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

Date 21 FEB. '75

Name C. MacKENZIE

EXPERIMENTAL RESULTS

HEADLAMP NAE No.	HEADLAMP IDENT.			MEASURED DATA					CALCULATED DATA				
	MAKE	MODEL	SOLD BY	MAX. READING	MIN. READING	ANGULAR POS. (deg.)	CORRECTED MAX.	CORRECTED MIN.	MAX. – MIN.	DEVIATION ANGLE	DEVIATION AT 60' (in.)	DEVIATION AT 25' (in.)	
263	PHILIPS	4000	PHILIPS	.0225	.0147	265	.0221	.0147	.0074	.0848	1.0656	0.4440	
264	↑	↑	↑	.0327	.0114	130	.0327	.0112	.0215	.2464	3.0960	1.2900	
265				.0408	.0094	325	.0406	.0094	.0312	.3575	4.4928	1.8720	
266				.0362	.0158	230	.0358	.0158	.0200	.2292	2.880	1.2000	
267				.0391	.0122	250	.0387	.0122	.0265	.3037	3.8160	1.5900	
268				.0472	.0238	250	.0468	.0238	.0230	.2636	3.3120	1.3800	
269				.0548	.0331	325	.0546	.0331	.0215	.2464	3.0960	1.2900	
270				.0605	.0369	120	.0605	.0367	.0238	.2727	3.4272	1.4280	
271			↓	.0462	.0172	325	.0460	.0172	.0288	.3300	4.1472	1.7280	
272		4000		.0374	.0041	260	.0370	.0041	.0329	.3770	4.7376	1.9740	
273		4001		.0353	.0329	350	.0353	.0327	.0026	.0298	.3744	.1560	
274		↑		.0214	.0173	0°	.0214	.0170	.0044	.0504	.6336	.2640	
275				.0178	.0115	55	.0178	.0112	.0066	.0756	.9504	.3960	
276				.0208	.0011	285	.0207	.0009	.0198	.2269	2.8512	1.1880	
277				.0190	.0187	65	.0190	.0185	.0005	.0057	.0720	.0300	
278				.2012	.1935	15	.2012	.1932	.0080	.0917	1.1520	.4800	
279				.0356	.0164	355	.0356	.0162	.0194	.2223	2.7936	1.1640	
280				.0193	.0110	30	.0193	.0107	.0086	.0985	1.2384	.5160	
281	↓	↓	↓	.0263	.0108	60	.0268	.0106	.0157	.1799	2.2607	.9420	
282	PHILIPS	4001	PHILIPS	.0170	.0005	330	.0169	.0003	.0166	.1902	2.3904	.9960	

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TABLE X

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

Date 13 March '75

Name C. MacKenzie

EXPERIMENTAL RESULTS

HEADLAMP NAE No.	HEADLAMP IDENT.			MEASURED DATA					CALCULATED DATA				
	MAKE	MODEL	SOLD BY	MAX. READING	MIN. READING	ANGULAR POS. (deg.)	CORRECTED MAX.	CORRECTED MIN.	MAX. – MIN.	DEVIATION ANGLE	DEVIATION AT 60' (in.)	DEVIATION AT 25' (in.)	
283	WESTING-HOUSE	4000	WESTING-HOUSE	.1837	.1521	265	.1833	.1521	.0312	.3575	4.4928	1.8720	
284	↓	↓	↓	.1892	.1552	260	.1888	.1552	.0336	.3850	4.8384	2.0160	
285				.1791	.1702	155	.1790	.1702	.0088	.1008	1.2672	.5280	
286				.1749	.1613	320	.1747	.1613	.0134	.1536	1.9296	.8040	
287				.1849	.1521	325	.1847	.1521	.0326	.3736	4.6944	1.9560	
288				.1714	.1575	320	.1712	.1575	.0137	.1570	1.9728	.8221	
289				.1605	.1188	240	.1601	.1188	.0413	.4733	5.9472	2.4782	
290				.1603	.1497	260	.1599	.1497	.0102	.1169	1.4688	.6120	
291				.1633	.1607	120	.1633	.1605	.0028	.0321	.4032	.1680	
292		4000		.1783	.1556	270	.1779	.1556	.0223	.2555	3.2112	1.3380	
293		4001		.1786	.1578	185	.1783	.1578	.0205	.2349	2.9520	1.2300	
294		↓		.1500	.1402	100	.1498	.1401	.0097	.1112	1.3974	.5822	
295				.1221	.1187	70	.1220	.1185	.0035	.0401	.5040	.2100	
296				.1538	.1162	195	.1535	.1162	.0373	.4274	5.3710	2.2379	
297				.1900	.1555	205	.1897	.1555	.0342	.3919	4.9248	2.0520	
298				.1839	.1634	200	.1836	.1634	.0202	.2315	2.9091	1.2121	
299				.1845	.1670	215	.1842	.1670	.0172	.1971	2.4768	1.0320	
300	↓	↓	↓	.1977	.1513	210	.1974	.1513	.0461	.5283	6.6384	2.7660	
301				.1550	.1464	170	.1548	.1464	.0084	.0963	1.2096	.5040	
302	WESTING-HOUSE	4001	WESTING-HOUSE	.1761	.1590	165	.1759	.1590	.0169	.1937	2.4336	1.0140	

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TABLE XI

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. _____

types 4001 & 5001

Date 21 Feb.'75

Name C.MacKenzie

CALIBRATION OF MEASURING SYSTEM

Position On Ring	Reading 1	Reading 2	Reading 3	Cal. Average Error	Pos. On Ring	Reading 1	Reading 2	Reading 3	Cal. Average Error
0	.0507	.0507	.0507	.0003	180	.0504	.0504	.0504	0
10	.0507	.0507	.0507	.0003	190	.0504	.0504	.0504	0
20	.0507	.0507	.0507	.0003	200	.0504	.0504	.0504	0
30	.0507	.0507	.0507	.0003	210	.0504	.0504	.0504	0
40	.0507	.0507	.0507	.0003	220	.0504	.0504	.0504	0
50	.0507	.0507	.0506	.0003	230	.0504	.0504	.0504	0
60	.0506	.0506	.0506	.0002	240	.0504	.0505	.0504	0
70	.0506	.0506	.0505	.0002	250	.0505	.0505	.0504	.0001
80	.0505	.0505	.0504	.0001	260	.0505	.0506	.0504	.0001
90	.0505	.0505	.0504	.0001	270	.0506	.0506	.0505	.0002
100	.0505	.0505	.0504	.0001	280	.0506	.0506	.0505	.0002
110	.0505	.0505	.0504	.0001	290	.0506	.0506	.0505	.0002
120	.0505	.0505	.0504	.0001	300	.0506	.0506	.0505	.0002
130	.0505	.0505	.0504	.0001	310	.0506	.0506	.0505	.0002
140	.0505	.0505	.0504	.0001	320	.0506	.0506	.0505	.0002
150	.0505	.0505	.0504	.0001	330	.0506	.0506	.0505	.0002
160	.0505	.0505	.0504	.0001	340	.0506	.0506	.0505	.0002
170	.0504	.0504	.0504	.0	350	.0506	.0506	.0505	.0002
					360	.0507	.0507	.0506	.0003

National Research Council Canada / Conseil national de recherches Canada

TABLE XII

NATIONAL AERONAUTICAL ESTABLISHMENT

STRUCTURES AND MATERIALS LABORATORY

Experiment No. TYPE 4000 & 4002

Date 13 March '75

Name C. MacKenzie

CALIBRATION OF MEASURING SYSTEM

Position On Ring	Reading			Cal. Average Error	Pos. On Ring	Reading			Cal. Average Error			
	1	2	3			1	2	3				
0	.0506	.0506	.0506	.0002	180	.0504	.0505	.0504	0			
10	.0507	.0507	.0507	.0003	190	.0504	.0504	.0504	0			
20	.0508	.0507	.0507	.0003	200	.0504	.0504	.0504	0			
30	.0508	.0508	.0508	.0004	210	.0504	.0504	.0504	0			
40	.0508	.0508	.0508	.0004	220	.0504	.0504	.0504	0			
50	.0508	.0508	.0508	.0004	230	.0504	.0504	.0504	0			
60	.0508	.0508	.0508	.0004	240	.0504	.0504	.0504	0			
70	.0508	.0508	.0508	.0004	250	.0504	.0504	.0504	0			
80	.0508	.0508	.0508	.0004	260	.0504	.0504	.0504	0			
90	.0508	.0508	.0508	.0004	270	.0504	.0504	.0504	0			
100	.0507	.0507	.0507	.0003	280	.0504	.0504	.0504	0			
110	.0506	.0507	.0507	.0003	290	.0504	.0504	.0504	0			
120	.0506	.0506	.0506	.0002	300	.0504	.0504	.0504	0			
130	.0506	.0506	.0506	.0002	310	.0504	.0504	.0504	0			
140	.0506	.0506	.0506	.0002	320	.0504	.0504	.0504	0			
150	.0506	.0506	.0506	.0002	330	.0504	.0504	.0504	0			
160	.0505	.0505	.0505	.0001	340	.0505	.0505	.0505	.0001			
170	.0505	.0505	.0505	.0001	350	.0505	.0505	.0505	.0001			
					360	.0506	.0606	.0506	.0002			

TABLE XIII

NAE Lamp No.	type	resultant mean deviation at 60ft.	standard deviation	x coordinate mean	y coordinate mean	vector magnitude	angle θ_R (degrees)
206 to 218	2	5.060	0.869	-2.500	-3.813	4.560	123.24
223 to 232	2	2.881	1.757	-0.002	-0.895	0.895	269.88
233 to 242	1	2.078	0.741	0.530	0.804	0.963	56.57
243 to 252	2	3.799	1.124	-0.818	-1.555	1.757	242.24
253 to 262	1	4.180	1.457	1.039	0.374	1.104	19.80
263 to 272	2	3.407	1.034	-1.602	0.071	1.604	177.48
273 to 282	1	1.472	1.023	1.010	0.985	0.985	89.45
283 to 292	2	3.023	1.871	-2.337	0.102	2.339	177.49
293 to 302	1	3.082	1.975	-0.677	-2.672	2.756	255.77

Note: All dimensions are given in inches except where noted.

TABLE I (FROM LTR-ST 695)

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Sold By	Angular Difference (degrees)	Resultant Error At 60 ft. (in.)	Resultant Error At 25 ft. (in.)
NAE 141	GE	4001	GE	0.371	4.66	1.94
143	GE	4002	Atlas	0.331	4.16	1.73
144	Philips	4002	Philips	0.091	1.15	0.48
145	GE	4001	Atlas	0.324	4.07	1.70
146	GE	4000	GE	0.207	2.60	1.08
147	GE	4001	Atlas	0.221	2.78	1.16
148	GE	4002	Atlas	0.157	1.98	0.82
149	GE	4001	Atlas	0.208	2.62	1.09
150	GE	4002	Atlas	0.309	3.89	1.62
152	GE	4000	Ford	0.330	4.14	1.73
153	GE	4001	Ford	0.234	2.94	1.23
154	GE	4000	Ford	0.356	4.48	1.86
155	GE	4000	GE	0.385	4.84	2.02
156	GE	4001	GE	0.185	2.33	0.97
157	GE	4001	GE	0.249	3.12	1.30
158	GE	4000	GE	0.331	4.16	1.73
159	GE	4000	GE	0.197	2.47	1.03
160	GE	4001	GE	0.155	1.95	0.81
161	GE	4000	GE	0.321	4.04	1.68
162	GE	4001	GE	0.093	1.16	0.49

Note:

Model 4000 - dual beam (plus 25)- type 2

" 4001 - single beam - type 1

" 4002 - dual beam - type 2

TABLE I (FROM LTR-ST 749)

HEADLAMP IDENTIFICATION AND CALCULATED RESULTS

Headlamp No.	Headlamp Identification			Relationship Between "Aiming" and "Seating" Planes		
	Make	Model	Sold By	Angular Difference (degrees)	Resultant Deviation At 60 ft. (in.)	Resultant Deviation At 25 ft. (in.)
NAE 181	GE	4000	GE	0.461	5,798	2.416
182	GE	4001	GE	0.283	3.560	1.484
183	GE	4000	GE	0.487	6.117	2.549
184	GE	4001	GE	0.154	1.932	0.805
185	GE	4000	GE	0.106	1.337	0.557
186	GE	4001	GE	0.133	1.671	0.696
187	GE	4000	GE	0.111	1.395	0.581
188	GE	4001	GE	0.302	3.792	1.580
189	GE	4000	GE	0.643	8.079	3.366
190	GE	4001	GE	0.123	1.293	0.539
191	GE	4000	GE	0.452	5.681	2.367
192	GE	4001	GE	0.112	1.409	0.587
193	GE	4000	GE	0.318	3.996	1.665
194	GE	4001	GE	0.335	4.214	1.756
195	GE	4000	GE	0.392	4.926	2.052
196	GE	4001	GE	0.134	1.685	0.702
197	GE	4000	GE	0.112	1.409	0.587
198	GE	4001	GE	0.199	2.499	1.041
199	GE	4000	GE	0.458	5.754	2.398
200	GE	4000	GE	0.469	5.899	2.458
201	GE	4000	GE	0.465	5.841	2.433
202	GE	4000	GE	0.214	2.688	1.120
203	GE	4002	GE	0.498	6.262	2.610
204	GE	4002	GE	0.330	4.141	1.726
205	GE	4002	GE	0.371	4.664	1.943

Note:

Model 4000 - dual beam (plus 25) - type 2

" 4001 - single beam - type 1

" 4002 - dual beam - type 2