SAE International™

SURFACE VEHICLE INFORMATION REPORT

SAE J1759

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Superseding J1759 OCT2000

SAE Hose Measurement Study

1. ***Scope***—The Measurement of Coolant Hose task group conducted a round-robin study to determine the measuring capability of automotive suppliers and users to measure Inside Diameter (ID), Outside Diameter (OD), Wall Thickness (Wall) and wall thickness variation of hose using traditional measuring devices and techniques. Seven companies (five suppliers and two end users) participated in this testing. Based upon the round-robin study this information report will detail procedures, test measuring devices, results and recommendations.

1.1 **Rationale**—This document has been reaffirmed to comply with the SAE 5-Year Review policy.

2. ***References***

2.1 **Applicable Publications**—The following publication forms a part of this specification to the extent specified herein.

2.1.1 AIAG PUBLICATIONS—Available from Automotive Industry Action Group, Suite 200, 26200 Lahser Road, Southfield, MI 48034-7100, Tel: 248-358-3570, www.aiag.org.

(MSA) Manual-Measurement Systems Analysis Manual

3. ***Procedure***—The following procedures were employed in the round-robin study:

3.1 Two (2) sets of hoses were checked; there were 10 samples in each set.

3.2 One end of each hose was marked for measurement. The attribute was taken from 6.4 mm (0.250 in) to 25.4 mm (1.000 in) from the end of the hose.

NOTE—All measurements were made using inch measuring units due to the lack of adequate metric equipment).

3.3 Three (3) people repeated each measurement three (3) times at each testing location.

3.4 The data were recorded on forms supplied with the samples.

3.5 Hose samples and measuring devices were brought to equilibrium for 24 h in a controlled environment of 23 °C ± 2 °C and relative humidity of 50% +5%.

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4. *Attributes*

4.1 Procedure—All of the samples and measuring devices were forwarded to the seven participants in order. The form for recording the measurements was also included. After taking the measurements, the data were sent to the chairman of the Measurement of Coolant Hose task group for analysis.

The attributes of ID, OD, Wall Thickness, and Wall thickness variation were measured as follows:

4.1.1 INSIDE DIAMETER—The ID of the sample hoses was measured with step gages. Two sets of gages were provided that were centered around the target of each of the hose ID's; one set included diameter steps in increments of 0.05 mm (0.002 in) and the other 0.1 mm (0.004 in). The gages were inserted dry with a steady rotating motion and not causing more than an increase of 0.13 mm (0.005 in) in the OD when measured with a pi tape.

4.1.2 OUTSIDE DIAMETER—The OD was measured by two methods:

4.1.2.1 *Method 1*—A plug which had an OD the same as the maximum specified ID of the hose to be measured was inserted into the hose. The OD was measured by means of pi tape. (The plug was provided for this test with diameter steps graduated in 0.25 mm (0.010 in) increments).

4.1.2.2 *Method 2*—The OD was measured by means of calipers. Find the largest OD and record; take another reading 90 degrees ± 15 degrees from the first and record. The average of the two readings was recorded and used as the OD of the hose.

(Calipers were provided for this test)

4.2 Wall Thickness—The wall thickness was measured with calipers. Four (4) readings were taken, starting with the thinnest spot on the hose and rotating 90 degrees for each of the following three (3) measurements. An average of the four (4) numbers was recorded as the wall thickness.

4.3 Wall Thickness Variation—The Wall Thickness Variation was calculated using the first wall thickness recorded in 4.2. A second measurement was taken at the thickest location of the wall measurement and recorded. The difference between the two readings was recorded as the Wall Thickness Variation.

5. ***Results*—**The Gage R & R calculation is based upon the Automotive Industry Action Group Measurement Systems Analysis (MSA) manual.

The Results of this study were as follows in Figures 1 to 17:

6. ***Recommendations*—**The results of this study have shown that traditional measuring devices and techniques are not capable of meeting the required 10% Gage R&R as suggested in the AIAG MSA automotive standards.

It is the consensus of the SAE Coolant Hose Committee that new gaging methods must be found and implemented before current hose measurement can be validated between companies. The SAE Coolant Hose Committee urges the membership jointly or individually to develop measuring devices and techniques which will conform to the AIAG MSA Automotive Gage R & R target of 10%.

5/13/92 MEDIAN VS AVERAGE TOLERANCE FOR GAGE ERROR

CHARACTERISTIC	GAGE/METHOD	R&R MEDIAN	ACTUAL MEDIAN	R&R AVERAGE	ACTUAL AVERAGE
I.D.	.002 W/1.75	41.860	.013	67.730	.020
I.D.	.004 W/1.75	33.880	.010	44.457	.013
I.D.	.002 W/.725	16.190	.005	20.650	.006
I.D.	.004 W/.725	21.170	.006	26.375	.008
O.D.	PI TAPE W/1.75	62.310	.025	73.354	.029
O.D.	CALIPERS W/1.75	38.865	.016	43.437	.017
O.D.	PI TAPE W/.725	56.760	.023	66.834	.027
O.D.	CALIPERS W/.725	66.465	.027	67.470	.027
WALL	CALIPERS W/1.75	28.465	.011	42.418	.017
WALL	CALIPERS W/.725	44.440	.018	49.538	.020
CONCENTRICITY	CALIPERS W/1.75	61.200	.024	61.050	.024
CONCENTRICITY	CALIPERS W/.725	78.985	.032	75.088	.030

The characteristic "concentricity" is the wall variation.

NOTE—1 in = 25.4 mm
1 lb/ft = 1.49 kg/m
1 psi = 6.9 kPa

FIGURE 1—MEDIAN VERSUS AVERAGE TOLERANCE FOR GAGE ERROR USING PLUG GAGE FOR ID, Pi TAPE AND CALIPERS FOR OD AND CALIPERS FOR WALL THICKNESS AND WALL VARIATION

5/13/92 SUMMARY SAE HOSES I.D.

COMPANY	DIM.	GAGE USED	REPEAT. % OF TOL.	ACTUAL TOL. USED	REPROD. % OF TOL.	ACTUAL TOL. USED	GAGE R & R	ACTUAL TOTAL TOL. USED	SPEC. TOL.
A-1	I.D.	.002 S/P 1.750	10.27	.003	22.35	.007	32.62	.010	.030
B-1	I.D.	.002 S/P 1.750	7.68	.002	7.62	.002	15.30	.005	.030
C-1	I.D.	.002 S/P 1.750	7.39	.002	97.17	.029	104.56	.031	.030
D-1	I.D.	.002 S/P 1.750	4.39	.001	37.47	.011	41.86	.013	.030
E-1	I.D.	.002 S/P 1.750	16.14	.005	1.64	.000	17.78	.005	.030
F-1	I.D.	.002 S/P 1.750	.29	.000	130.06	.039	130.34	.039	.030
G-1	I.D.	.002 S/P 1.750	.50	.000	131.15	.039	131.65	.039	.030
		AVERAGE:	6.666		61.066		67.730		
A-2	I.D.	.004 S/P 1.750	11.70	.004	1.02	.000	12.72	.004	.030
B-2	I.D.	.004 S/P 1.750	5.60	.002	15.42	.005	21.01	.006	.030
C-2	I.D.	.004 S/P 1.750	19.20	.006	50.57	.015	69.77	.021	.030
D-2	I.D.	.004 S/P 1.750	11.40	.003	22.48	.007	33.88	.010	.030
E-2	I.D.	.004 S/P 1.750	8.47	.003	2.17	.001	10.63	.003	.030
F-2	I.D.	.004 S/P 1.750	.88	.000	101.56	.030	102.44	.031	.030
G-2	I.D.	.004 S/P 1.750	1.48	.000	59.26	.018	60.75	.018	.030
		AVERAGE:	8.390		36.069		44.457		
A-1	I.D.	.002 S/P .725	6.38	.002	9.81	.003	16.19	.005	.030
B-1	I.D.	.002 S/P .725	5.76	.002	2.21	.001	7.97	.002	.030
C-1	I.D.	.002 S/P .725	10.28	.003	4.20	.001	14.48	.004	.030
D-1	I.D.	.002 S/P .725	5.02	.002	2.38	.001	7.41	.002	.030
E-1	I.D.	.002 S/P .725	14.38	.004	4.80	.001	19.18	.006	.030
F-1	I.D.	.002 S/P .725	.51	.000	43.55	.013	46.06	.014	.030
G-1	I.D.	.002 S/P .725	3.99	.001	29.27	.009	33.26	.010	.030
		AVERAGE:	6.617		13.746		20.650		
A-2	I.D.	.004 S/P .725	13.43	.004	3.13	.001	16.56	.005	.030
B-2	I.D.	.004 S/P .725	0.00	0.000	14.40	.004	14.40	.004	.030
C-2	I.D.	.004 S/P .725	19.54	.006	7.63	.002	21.17	.006	.030
D-2	I.D.	.004 S/P .725	7.44	.002	1.46	.000	8.89	.003	.030
E-2	I.D.	.004 S/P .725	14.54	.004	17.81	.005	32.35	.010	.030
F-2	I.D.	.004 S/P .725	1.89	.001	45.87	.014	47.75	.014	.030
G-2	I.D.	.004 S/P .725	2.71	.001	40.67	.012	43.38	.013	.030
		AVERAGE:	8.507		18.710		26.357		

NOTE—1 in = 25.4 mm
1 lb/ft = 1.49 kg/m
1 psi = 6.9 kPa

FIGURE 2—MEASUREMENT OF HOSE ID USING 0.05 mm (0.002 in) AND 0.1 mm (0.004 in) STEPPED PLUG GAGES

5/13/92 SUMMARY SAE HOSES O.D.

COMPANY	DIM.	GAGE USED	REPEAT. % OF TOL.	ACTUAL TOL. USED	REPROD. % OF TOL.	ACTUAL TOL. USED	GAGE R & R	ACTUAL TOTAL TOL. USED	SPEC. TOL.
A-1	O.D.	PI TAPE 1.750	23.60	.009	37.99	.015	61.59	.025	.040
B-1	O.D.	PI TAPE 1.750	7.61	.003	77.28	.031	84.89	.034	.040
C-1	O.D.	PI TAPE 1.750	35.95	.014	22.26	.009	58.22	.023	.040
D-1	O.D.	PI TAPE 1.750	31.75	.013	8.12	.003	39.88	.016	.040
E-1	O.D.	PI TAPE 1.750	37.43	.015	24.88	.010	62.31	.025	.040
F-1	O.D.	PI TAPE 1.750	2.36	.001	131.57	.053	133.94	.054	.040
G-1	O.D.	PI TAPE 1.750	69.71	.028	2.94	.001	72.65	.029	.040
		AVERAGE:	29.773		43.577		73.354		
A-2	O.D.	CALIPERS 1.750	22.60	.009	21.13	.008	43.73	.017	.040
B-2	O.D.	CALIPERS 1.750	31.99	.013	1.88	.001	33.87	.014	.040
C-2	O.D.	CALIPERS 1.750	34.74	.014	23.41	.009	58.16	.023	.040
D-2	O.D.	CALIPERS 1.750	17.94	.007	6.87	.003	24.81	.010	.040
E-2	O.D.	CALIPERS 1.750	33.61	.013	.38	.000	34.00	.014	.040
F-2	O.D.	CALIPERS 1.750							
G-2	O.D.	CALIPERS 1.750	62.12	.025	3.93	.002	66.05	.026	.040
		AVERAGE:	33.833		9.600		43.437		
A-1	O.D.	PI TAPE .725	10.06	.004	9.38	.004	19.43	.008	.040
B-1	O.D.	PI TAPE .725	5.82	.002	105.13	.042	110.95	.044	.040
C-1	O.D.	PI TAPE .725	24.24	.010	28.01	.011	52.25	.021	.040
D-1	O.D.	PI TAPE .725	87.15	.035	19.88	.008	107.30	.043	.040
E-1	O.D.	PI TAPE .725	52.46	.021	30.79	.012	83.25	.033	.040
F-1	O.D.	PI TAPE .725	24.54	.010	13.36	.005	37.90	.015	.040
G-1	O.D.	PI TAPE .725	30.99	.012	25.78	.010	56.76	.023	.040
		AVERAGE:	33.609		33.190		66.834		
A-2	O.D.	CALIPERS .725	34.33	.014	53.97	.022	88.29	.035	.040
B-2	O.D.	CALIPERS .725	22.99	.009	29.91	.012	52.90	.021	.040
C-2	O.D.	CALIPERS .725	57.56	.023	11.18	.004	68.74	.027	.040
D-2	O.D.	CALIPERS .725	43.75	.018	20.44	.008	64.19	.026	.040
E-2	O.D.	CALIPERS .725	38.22	.015	6.64	.003	44.86	.018	.040
F-2	O.D.	CALIPERS .725							
G-2	O.D.	CALIPERS .725	33.18	.013	52.66	.021	85.84	.034	.040
		AVERAGE:	38.338		29.133		67.470		

NOTE—1 in = 25.4 mm
1 lb/ft = 1.49 kg/m
1 psi = 6.9 kPa

FIGURE 3—MEASUREMENT OF HOSE OD USING Pi TAPE AND CALIPERS

5/13/92

SUMMARY SAE HOSES CONCENTRICITY

COMPANY	DIM.	GAGE USED	REPEAT. % OF TOL.	ACTUAL TOL. USED	REPROD. % OF TOL.	ACTUAL TOL. USED	GAGE R & R	ACTUAL TOTAL TOL. USED	SPEC. TOL
A	CONCEN.	CALIPERS 1.750	44.60	.018	27.62	.011	72.22	.029	.040
B	CONCEN.	CALIPERS 1.750	10.72	.004	32.82	.013	43.54	.017	.040
C	CONCEN.	CALIPERS 1.750	59.94	.024	3.18	.001	63.12	.025	.040
D	CONCEN.	CALIPERS 1.750	15.69	.006	43.61	.017	59.30	.024	.040
E	CONCEN.	CALIPERS 1.750	38.88	.016	1.03	.000	39.91	.016	.040
F	CONCEN.	CALIPERS 1.750							.040
G	CONCEN.	CALIPERS 1.750	86.22	.034	1.98	.001	88.21	.035	.040
		AVERAGE:	42.675		18.373		61.050		
A	CONCEN.	CALIPERS .725	42.05	.017	27.32	.011	69.37	.028	.040
B	CONCEN.	CALIPERS .725	18.87	.008	10.09	.004	28.97	.012	.040
C	CONCEN.	CALIPERS .725	48.17	.019	58.48	.023	106.65	.043	.040
D	CONCEN.	CALIPERS .725	82.97	.033	35.46	.014	118.43	.047	.040
E	CONCEN.	CALIPERS .725	36.99	.015	1.52	.001	38.51	.015	.040
F	CONCEN.	CALIPERS .725							.040
G	CONCEN.	CALIPERS .725	76.19	.030	12.41	.005	88.60	.035	.040
		AVERAGE:	50.873		24.213		75.088		

NOTE—1 in = 25.4 mm
1 lb/ft = 1.49 kg/m
1 psi = 6.9 kPa

FIGURE 4—MEASUREMENT OF HOSE CONCENTRICITY (WALL VARIATION) USING CALIPERS

5/13/92

SUMMARY SAE HOSES WALL

COMPANY	DIM.	GAGE USED	REPEAT. % OF TOL.	ACTUAL TOL. USED	REPROD. % OF TOL.	ACTUAL TOL. USED	GAGE R & R	ACTUAL TOTAL TOL. USED	SPEC. TOL.
A	WALL	CALIPERS 1.750	23.24	.009	3.46	.001	26.70	.011	.040
B	WALL	CALIPERS 1.750	9.56	.004	15.59	.006	25.15	.010	.040
C	WALL	CALIPERS 1.750	21.62	.009	8.61	.003	30.23	.012	.040
D	WALL	CALIPERS 1.750	18.41	.007	7.13	.003	25.55	.010	.040
E	WALL	CALIPERS 1.750	6.94	.003	99.39	.040	106.33	.043	.040
F	WALL	CALIPERS 1.750							
G	WALL	CALIPERS 1.750	31.10	.012	9.45	.004	40.55	.016	.040
		AVERAGE:	18.478		23.938		42.418		
A	WALL	CALIPERS .725	29.32	.012	10.96	.004	40.28	.016	.040
B	WALL	CALIPERS .725	6.63	.003	38.44	.015	45.07	.018	.040
C	WALL	CALIPERS .725	18.50	.007	25.31	.010	43.81	.018	.040
D	WALL	CALIPERS .725	11.39	.005	58.46	.023	69.85	.028	.040
E	WALL	CALIPERS .725	7.26	.003	55.68	.022	62.94	.025	.040
F	WALL	CALIPERS .725							
G	WALL	CALIPERS .725	34.72	.014	.57	.000	35.28	.014	.040
		AVERAGE:	17.970		31.570		49.538		

Number in parenthesis represents actual amount of tolerance attributed to gage and technique error.

10% gage error is maximum acceptable standard for most customers.

Repeatability: The variation in measurement obtained when one operator uses the same gage for measuring the identical characteristic of the same part.

Reproducibility: The variation in the average of measurements made by different operators using the same gage when measuring identical characteristics of the same parts.

NOTE—1 in = 25.4 mm
1 lb/ft = 1.49 kg/m
1 psi = 6.9 kPa

FIGURE 5—MEASUREMENT OF HOSE WALL THICKNESS USING CALIPERS

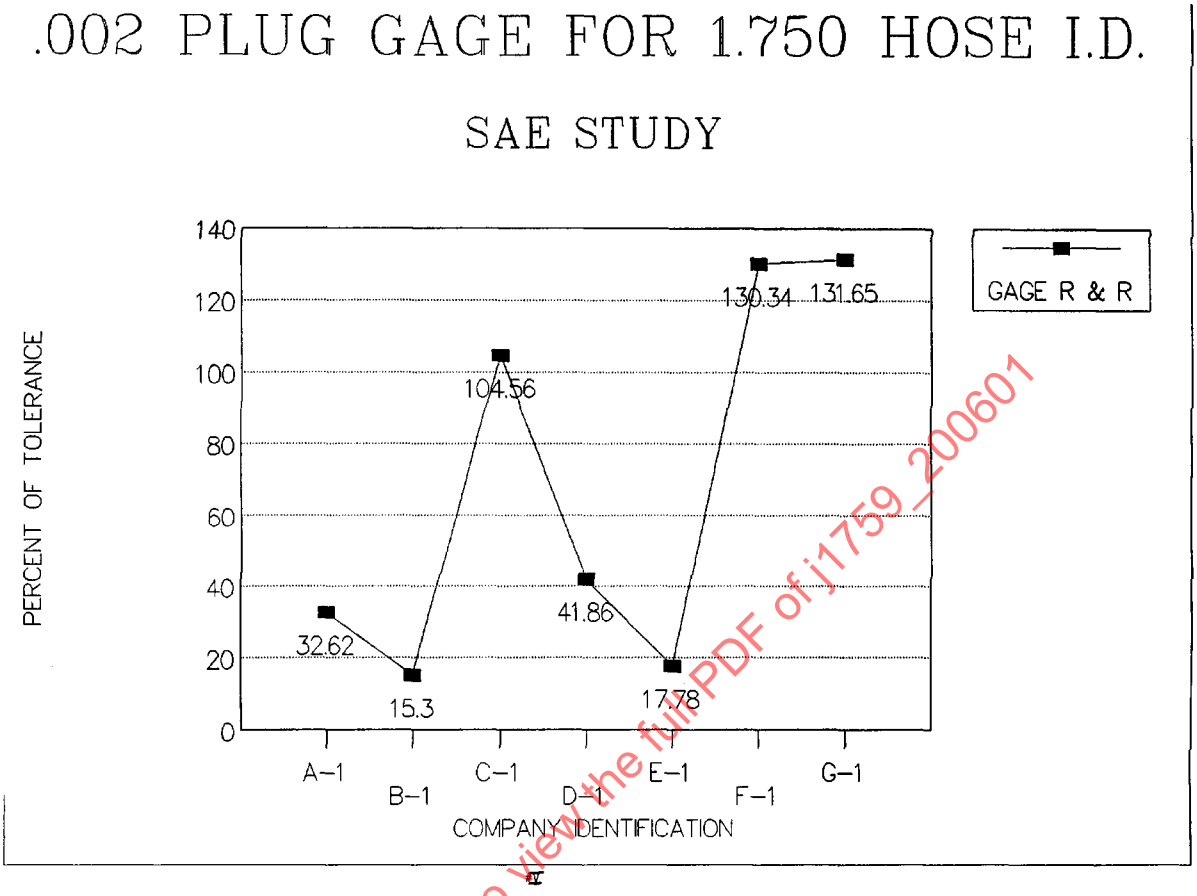

FIGURE 6—GRAPH OF 44.5 mm (1.75 in) HOSE ID GAGE R & R DATA FROM FIGURE 2 USING 0.05 mm (0.002 in) STEPPED PLUG GAGES

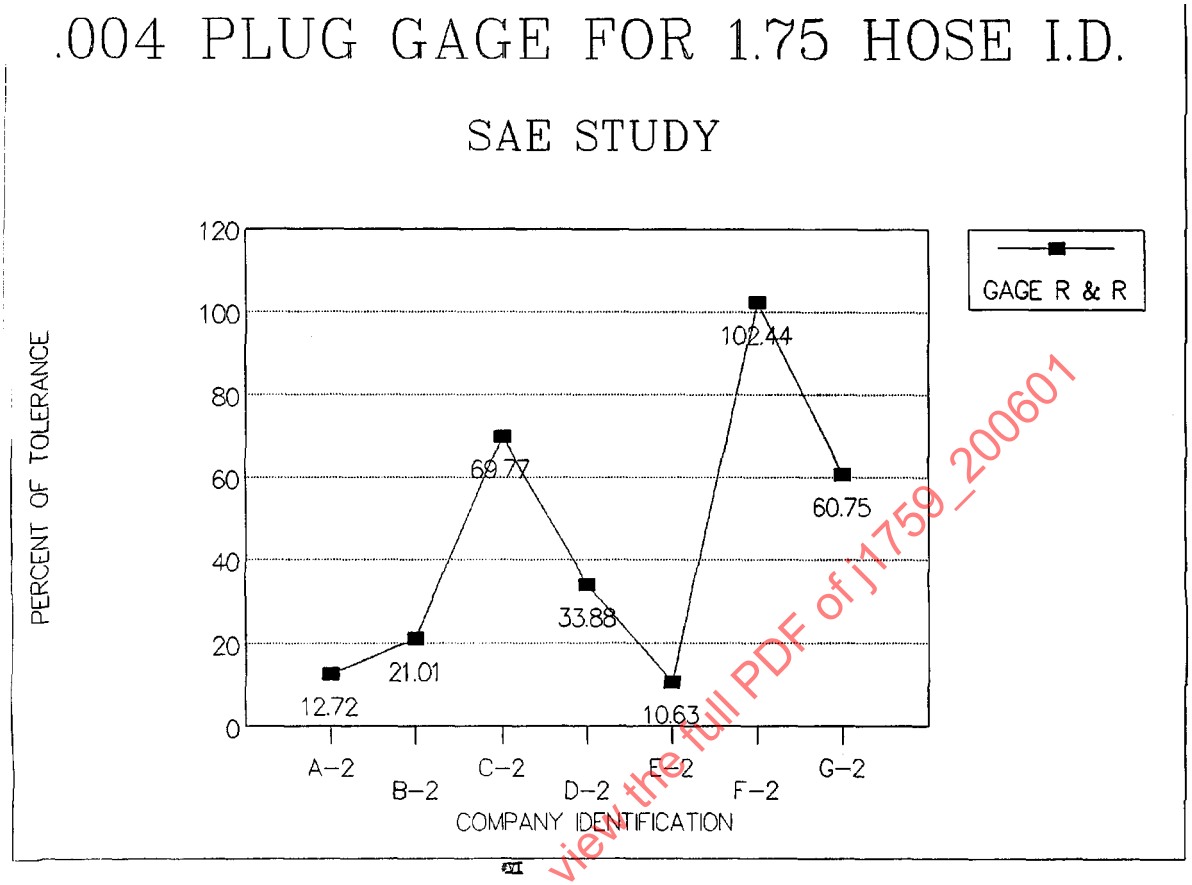

FIGURE 7—GRAPH OF 44.5 mm (1.75 in) HOSE ID GAGE R & R DATA FROM FIGURE 2 USING 0.10 mm (0.004 in) STEPPED PLUG GAGES

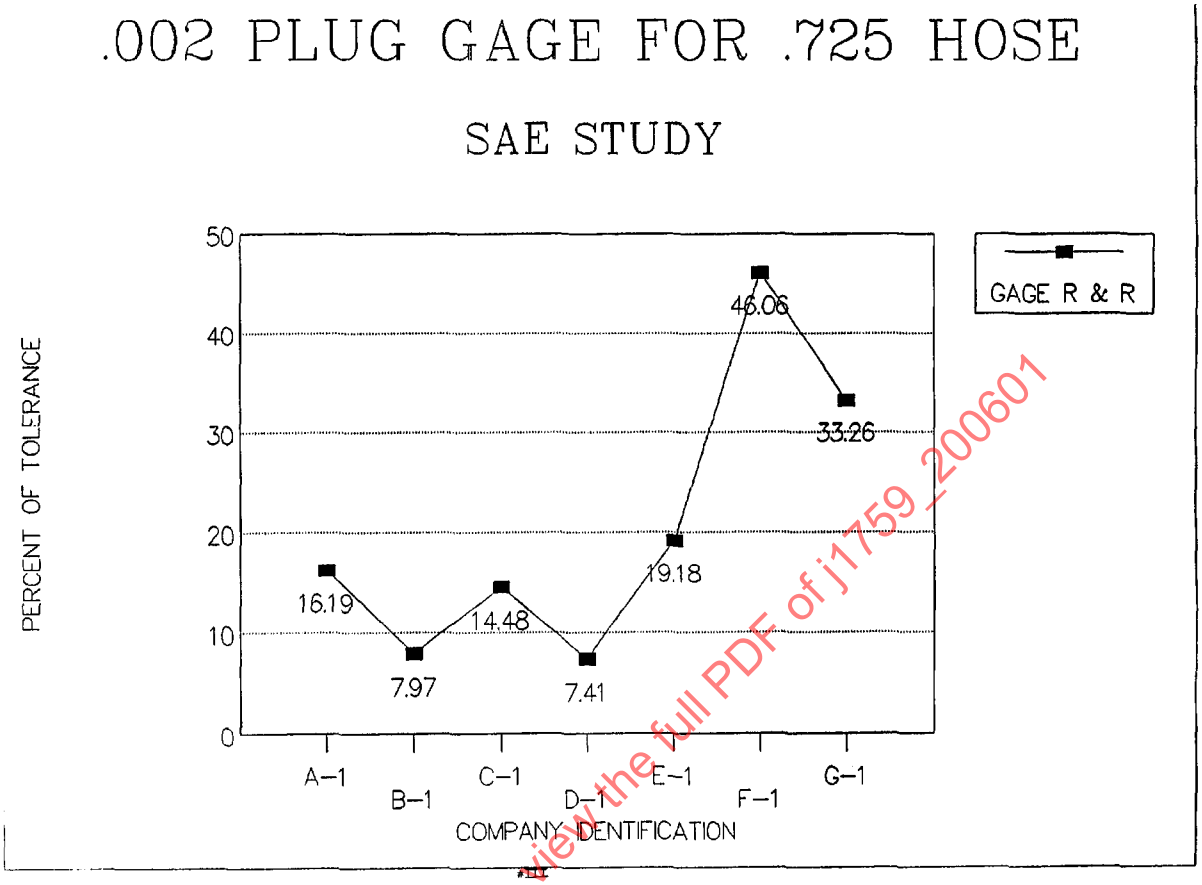

FIGURE 8—GRAPH OF 18.4 mm (0.725 in) HOSE ID GAGE R & R DATA FROM FIGURE 2 USING 0.05 mm (0.002 in) STEPPED PLUG GAGES

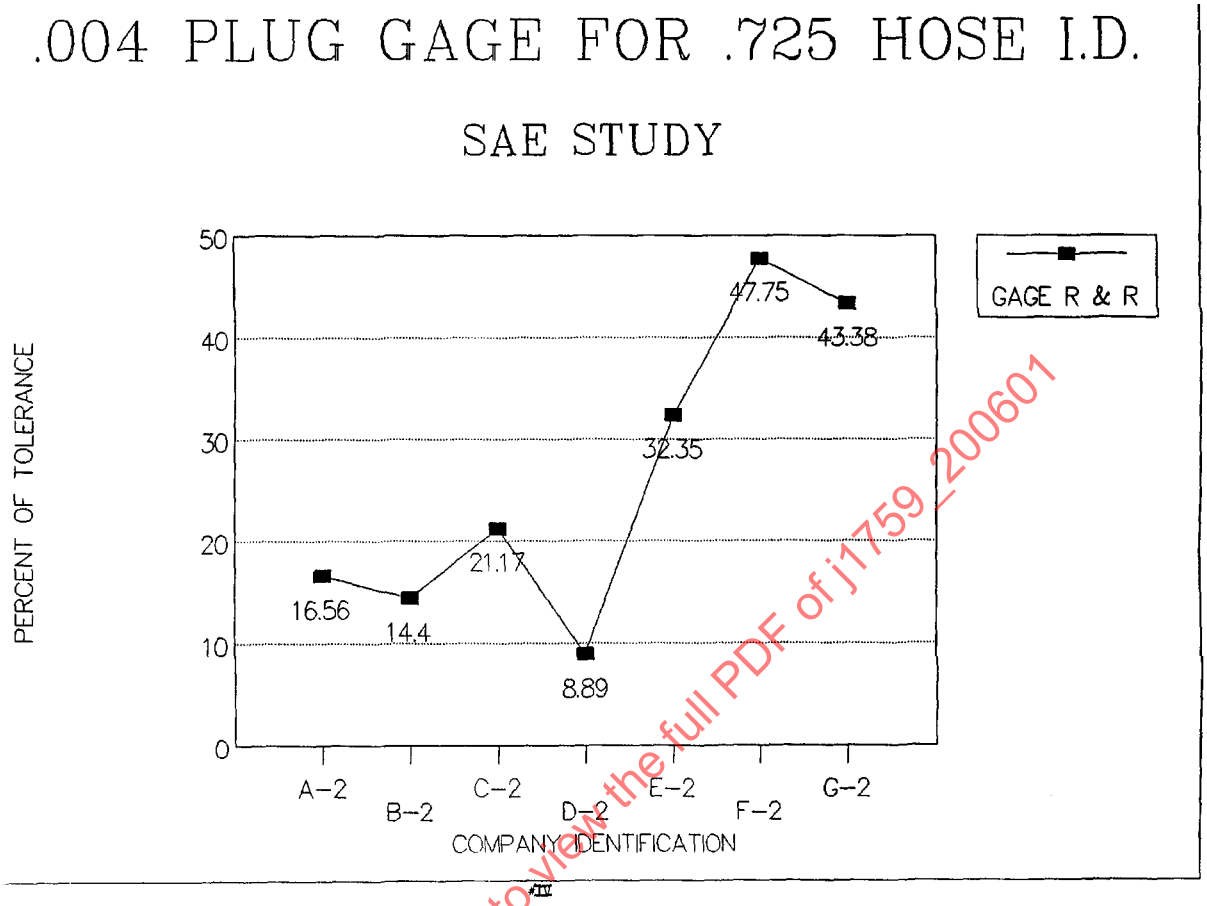

FIGURE 9—GRAPH OF 18.4 mm (0.725 in) HOSE ID GAGE R & R DATA FROM FIGURE 2 USING 0.1 mm (0.004 in) STEPPED PLUG GAGES

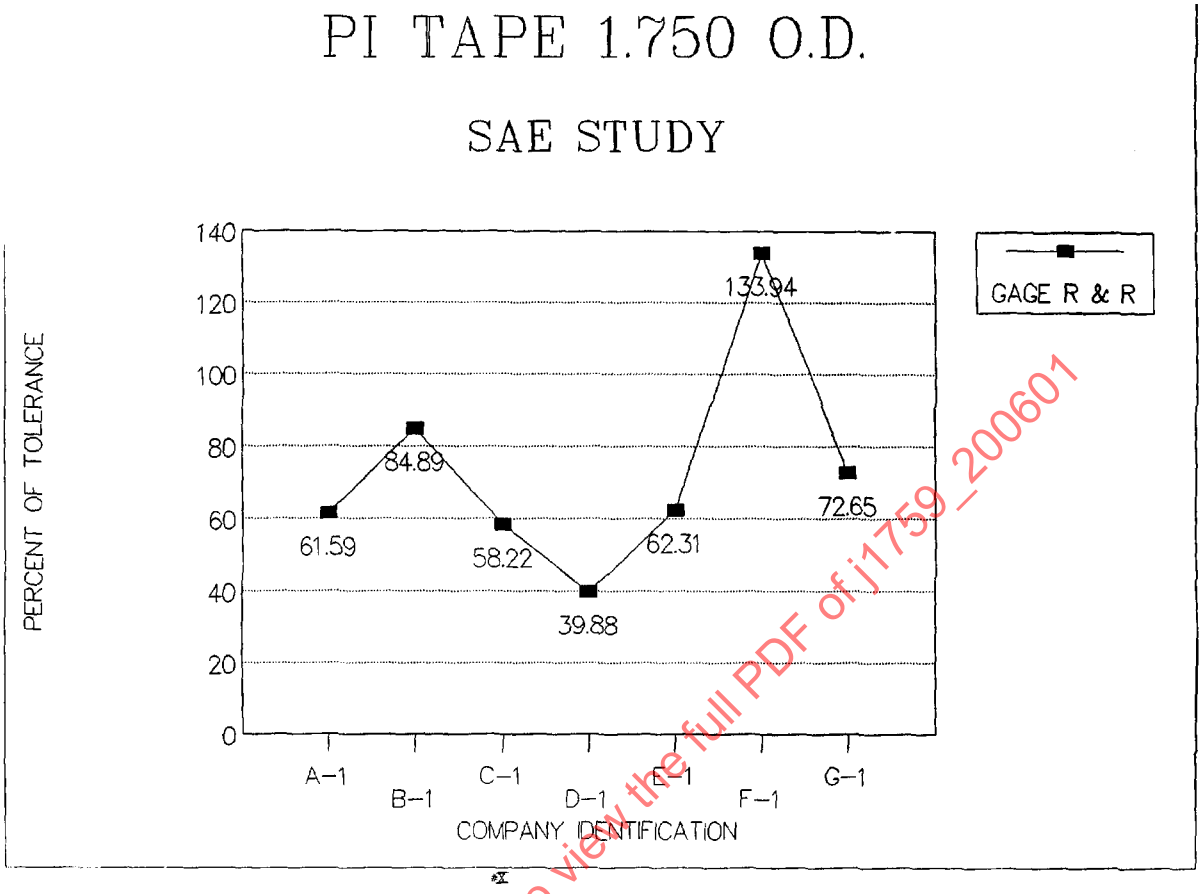

FIGURE 10—GRAPH OF 44.5 mm (1.75 in) HOSE OD GAGE R & R DATA FROM FIGURE 3 USING Pi TAPE

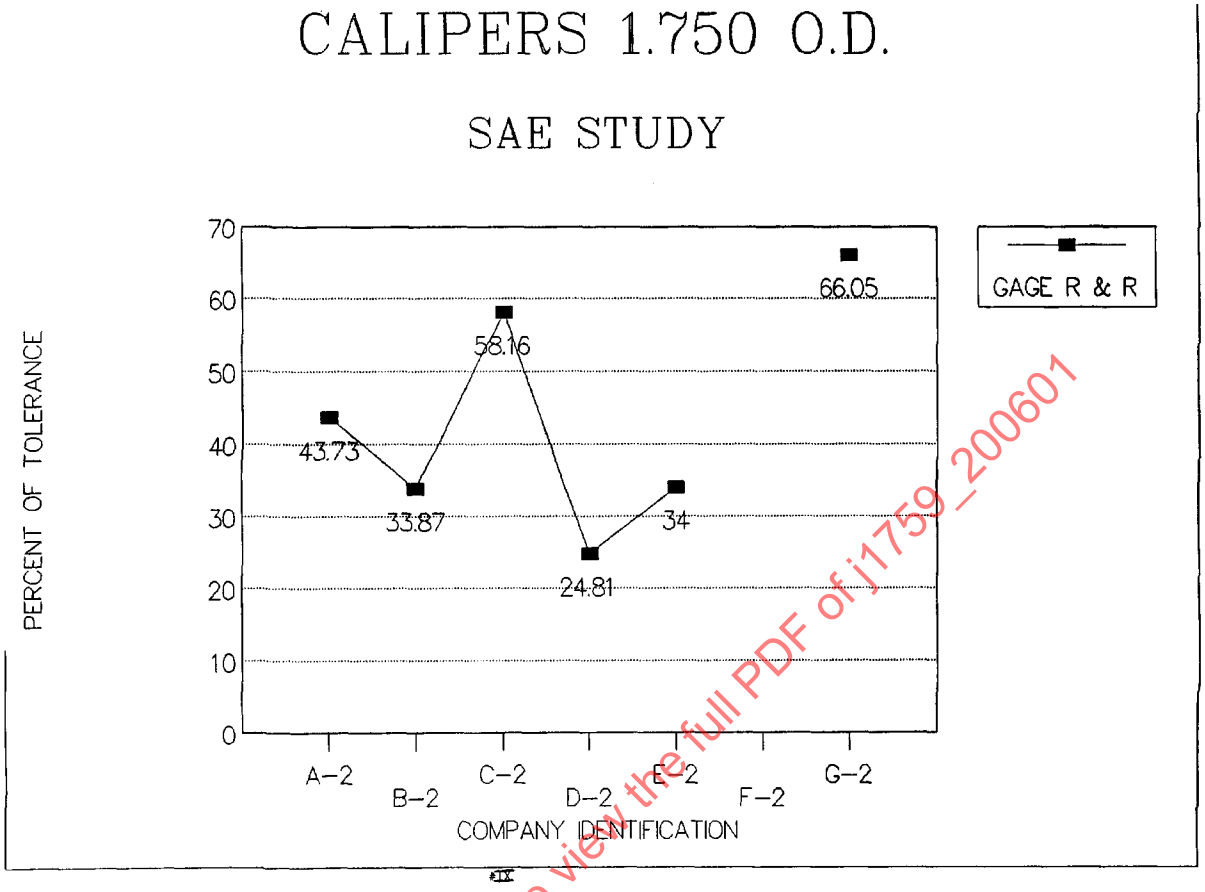

FIGURE 11—GRAPH OF 44.5 mm (1.75 in) HOSE OD GAGE R & R DATA FROM FIGURE 3 USING CALIPERS

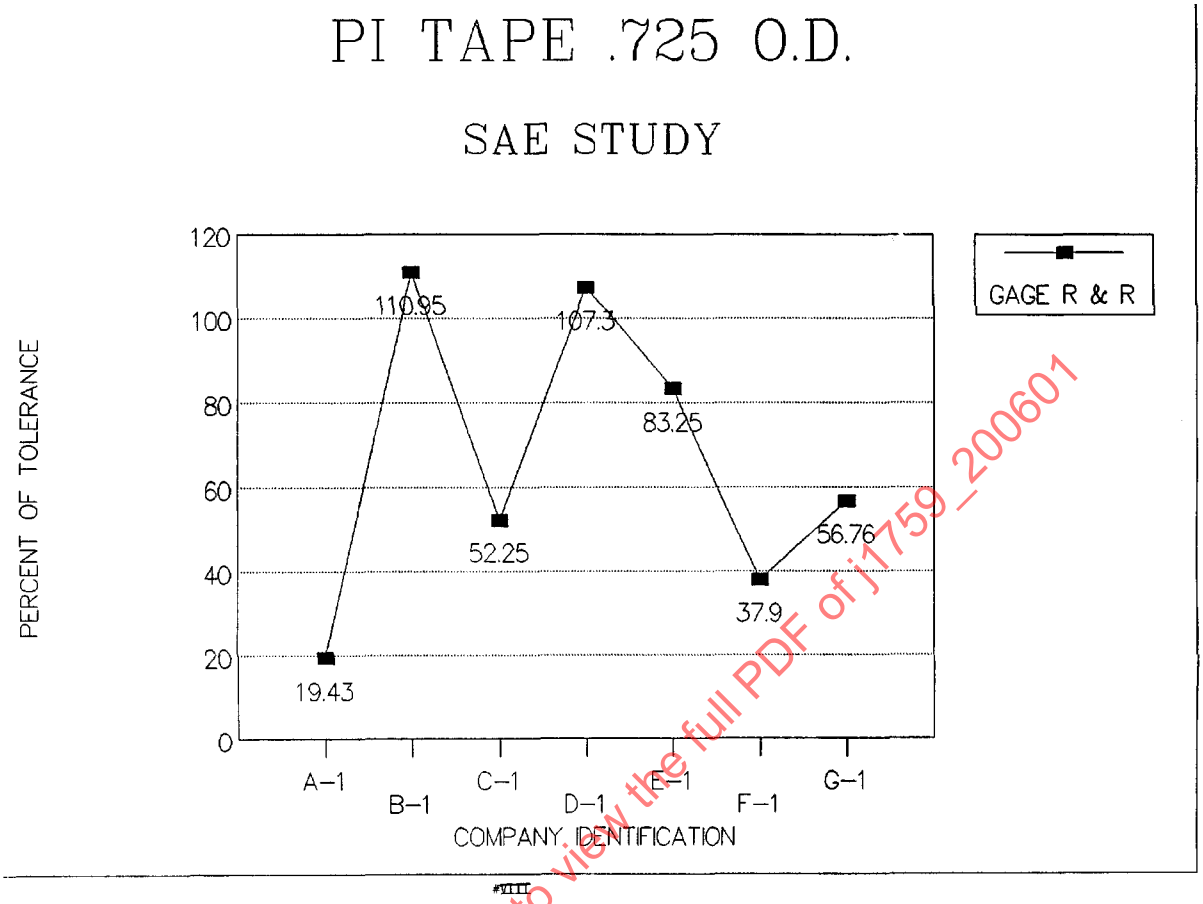

FIGURE 12—GRAPH OF 18.4 mm (0.725 in) HOSE OD GAGE R & R DATA FROM FIGURE 3 USING Pi TAPE

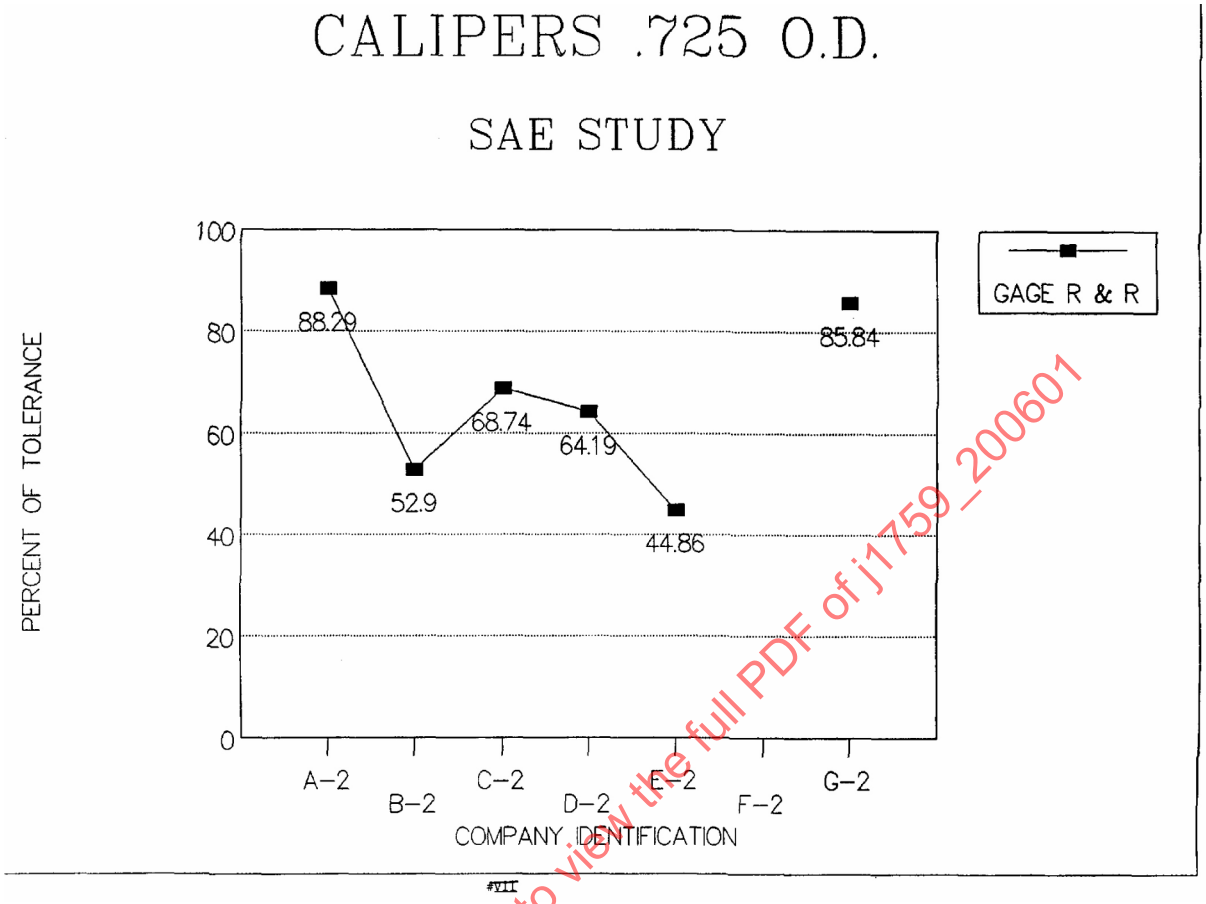

FIGURE 13—GRAPH OF 18.4 mm (0.725 in) HOSE OD GAGE R & R DATA FROM FIGURE 3 USING CALIPERS