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EPA Technical Report

Comparative Analysis of GM Inertia Weight Distributions MY75-MY81

by

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Introduction:

General Motors has claimed that the change from 250 pound dyno inertia increments to 125 pound intervals has penalized their fuel economy results relative to the 1975 test procedure. EPA contends that this would only happen if a manufacturer's fleet were biased in such a way that the new test weights were higher than the old test weights. GM's July 27, 1979 petition presented data on a fleet of eleven cars to support their claim of .6mpg penalty due to "all" test procedure changes since 1975. The one noteworthy difference in the test conditions for this program was that nine of the eleven moved to the higher inertia weight. The other two remained the same. None moved to a lower inertia as would have occurred for an unbiased fleet.

EPA's analysis indicates that GM's weight reduction program resulted in a fleet of vehicles that were more often tested at inertia increments below the actual vehicle weight. However, these reductions in vehicle weight do not translate to real world fuel economy improvements of equal magnitude.

This paper summarizes the analysis of these inertia weight versus loaded test weight differences for GM and other major manufacturers. The data were derived from the certification data in which over 12,500 data entries were considered from 1974 to 1980.

Discussion of Analysis:

Two essential parameters were available for 5421 of the 12,500 certification entries. Curb weight and inertia class for the EPA test were used to calculate the loaded test weight and weight difference, DEL_WT. The DEL_WT is the value of curb weight plus 300 pounds minus the value of the inertia test setting. Hence, a positive value for DEL_WT means that the vehicles' actual loaded weight exceeds the inertia simulated for the test. Therefore, the fuel economy measured during the test will likely overstate the real world fuel economy.

The statistical summary of the DEL_WT data are shown on Tables A through E and on Figures 1 to 4. Individual plots were made of DEL_WT versus inertia weight for each manufacturer and for each year. The one observation that was readily seen from these plots was the tendency for GM's DEL_WT values to be biased positive at inertia values of 3500 pounds or less. Their data for inertia values over 4000 pounds are more equally distributed.

Tables A through E show how many data points fell on the positive and negative sides of the inertia values for each test year. These data were stratified above and below the inertia of 3875 pounds and plotted on Figures 1, 2, and 3 to illustrate how the smaller inertia classes are biased to the positive side. All the domestics have one or more occurrences of this positive bias for some specific model years such as Chrysler in 1975. However, GM's bias is consistently positive and is the largest both in numbers and average DEL_WT, as shown on Figure 4. Chrysler and AMC data indicate DEL_WT averages that are generally negative. The use of smaller inertia increments appears to decrease this average. This reduction should therefore minimize the potential for understating the CAFE data for these manufacturers.

These figures show several other noteworthy characteristics. First, when all inertia weights are used (Figure 3), the overall distributions appear equally balanced. However, the bias becomes more pronounced at the lighter inertia values, where the advantage of a change from a higher inertia to a lower inertia is maximized. When the 125 pound inertia increments were implemented for 1979 and 1980 test years, the data for each strata assumes a balanced pattern.

Figure 4 shows that the overall average DEL_WT generally got closer to zero, except for the "OTHER" category, which encompasses all non-domestic manufacturers. In fact, the overall averages for 1979 and 1980 exceeded -70 pounds! This should be theoretically impossible since no individual DEL_WT should have exceeded 62.5 pounds. If it did, the vehicle would be tested at the next inertia setting.

This anomally was investigated with Certification engineers and the explanation was found (see attached memo). In 1979, Certification issued a policy that allowed any manufacturer whose estimated loaded vehicle weight was close to being in the next higher test weight to elect to test at the higher weight. This policy avoided the problems of having to retest vehicles whose actual production weight exceeded the limits on the estimated weight class. Hence, a significant number of manufacturers have elected to do this. The impact of this option is to offset the DEL_WT data by 62 to 125 pounds, thus causing the observed negative bias. However, this is a self imposed bias rather than the result of the new inertia increments.

Conclusions/Recommendations:

Vehicle inertia and curb weight data indicate that the smaller inertia classes for GM were biased to the positive side (actual weight greater than test weight).

The use of smaller inertia increments tends to recenter the distributions for all inertias to eliminate the biases, while at the same time

provides incentives for even a small weight reduction which can be reflected in the test conditions.

GM's test fleet would likely receive a lower (but more representative) overall CAFE under the smaller inertia test increments, but only because of the biased conditions under the broader inertia increments.

APPENDIX

TABLE A - DISTRIBUTION OF DEL_WT FOR AMC DATA (1974-80)

TEST YR	1974		1975		1976		1977		1978		74-78		1979		1980		79-80		ALL	
INERTIA CLASS	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
2000																				
2250																				
2375																				
2500													2	0			2	0	2	0
2625																				
2750					2	0	2	0	3	0	7	0							7	0
2875													2	0	1	0	3	0	3	0
3000	1	0	10	2	9	7	5	6	9	3	34	18	0	4	1	1	1	5	35	23
3125													1	0			1	0	1	
3250													0	2	1	0	1	2	1	2
3375													1	0	0	1	1	1	1	1
3500	0	2	28	7	25	19	8	18	6	9	67	55	1	5			1	5	68	6
3625																				
3750													1	1			1	1	1	1
3875															0	1	0	1	0	1
4000	1	0	4	0	3	4	5	11	1	7	14	22	0	1			0	1	14	2
4250													0	2			0	2	0	2
4500	0	5	3	2	0	16	1	6	4	5	8	34			0	1	0	1	8	3
4750													0	2			0	2	0	2
5000									0	1	0	1							0	1
5250																				
5500																				
6000																				
N	2	-7	45	-11	39	-46	21	-41	23	-25	130	-130	8	17	3	4	11	-21	141	-151
TOTAL	9		56		85		62		48		260		25		7		32		292	
AVG. ΔWT:	-81		33		-51		-67		-16				-70		-23					

TABLE B - DISTRIBUTION OF DEL_WT FOR CHRYSLER DATA (1974-80)

TEST YR	1974		1975		1976		1977		1978		74-78		1979		1980		79-80		ALL	
INERTIA	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
CLASS																				
2000																				
2250							1	0			1	0							1	0
2375													1	0			1	0	1	0
2500							17	3	5	8	22	11	2	2	1	2	3	4	25	15
2625													2	1	2	6	4	7	4	7
2750							0	4	0	2	0	6			0	3	0	3	0	9
2875															1	2	1	2	1	2
3000			7	0	0	1					7	1							7	1
3125																				
3250																				
3375																				
3500			31	0	5	1	9	0	9	0	57	1	1	0			1	0	58	1
3625													1	1	0	1	1	2	1	2
3750													2	4	1	3	3	7	3	7
3875													1	5			1	5	1	5
4000	2	2	28	16	27	45	32	39	24	17	113	114	6	4	6	4	12	8	125	122
4250													5	5	2	11	7	16	7	16
4500	0	2	37	19	20	23	20	28	5	29	82	101	2	4	1	3	3	7	85	108
4750													0	1	1	2	0	3	0	3
5000	0	2	25	5	15	10	6	19	5	7	51	43	2	0	0	2	2	2	53	45
5250															0	1	0	1	0	1
5500	0	1	8	19	1	7	2	15	0	1	11	43	1	0			1	0	12	43
6000																				
N	2	7	136	59	71	87	87	103	48	64	344	320	26	27	15	40	41	67	385	387
TOTAL	9		195		158		190		112		664		53		55		108		772	
AVG. ΔWT	-126		+35		-36		-47		-49		—		-6		-35		—		—	

TABLE C - DISTRIBUTION OF DEL. WT FOR FORD DATA (1974-80)

TEST YR.	1974		1975		1976		1977		1978		74-78		1979		1980		79-80		ALL	
INERTIA CLASS	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
2000											11	0					1	0	12	0
2250																	1	1	1	1
2375																				
2500																	1	0	1	0
2625																				
2750					15	0					51	0					1	1	52	1
2875																	1	0	1	0
3000											128	64					11	12	139	76
3125																	3	8	3	8
3250																	2	4	2	4
3375																	0	1	0	1
3500											65	100					3	8	68	108
3625																	1	7	1	7
3750																	1	5	1	5
3875																	4	3	4	3
4000			54								148	115					9	4	157	119
4250																	9	15	9	15
4500											133	71					8	13	141	84
4750																	2	0	2	0
5000											93	93					4	4	97	97
5250																	1	2	1	2
5500											52	45					1	2	53	47
6000																				
N			433		23						1168						154		1322	
TOTAL			247	186	181						680	488			11		64	90	744	578
AVG. ΔWT	60		40		7		27		-9		—				-10		—		—	

+DEL WT = ACTUAL WEIGHT GREATER THAN TEST WEIGHT

−DEL WT = " " LESS " " " "

TABLE D - DISTRIBUTION OF DEL_WT FOR GM DATA (1974-1980)

TEST YR	1974		1975		1976		1977		1978			74-78			1979		1980			79-80		ALL	
INERTIA CLASS	+	−	+	−	+	−	+	−	+	−		+	−		+	−	+	−		+	−	+	−
2000																							
2250			24	2	8	1	7	0	2	0		41	3									41	3
2375															3	0	1	0		4	0	4	0
2500			0	1			0	6	0	9		0	16		0	5				0	5	0	21
2625																							
2750			8	0								8	0		1	0				1	0	9	0
2875															6	0	3	1		9	1	9	1
3000	0	1	28	10	26	3	13	0	13	2		80	16		3	7	1	1		4	8	84	24
3125															0	6				0	6	0	6
3250															1	0				1	0	1	0
3375															0	2				0	2	0	2
3500	1	0	23	10	10	8	44	8	41	8		119	34		3	0	0	1		3	1	122	35
3625															10	4	1	4		11	8	15	8
3750															3	3	2	6		5	9	5	9
3875															2	10	1	6		3	16	3	16
4000	0	1	68	31	38	36	45	28	33	22		184	118		16	13	5	11		21	24	205	142
4250															0	6	3	7		3	13	3	13
4500	14	3	46	46	32	39	41	11	27	21		160	120		5	8	4	4		9	12	169	132
4750															0	4	1	3		1	7	1	7
5000	6	3	36	26	13	27	3	20	4	12		62	88		0	1	1	2		1	3	63	91
5250															0	2	0	1		0	3	0	3
5500	3	3	20	5	4	5	2	7	1	2		30	22				1	0		1	0	31	22
6000									3	0		3	0									3	0
N	35		380		250		235		201			1104			124		71			195		1296	
TOTAL	24	11	249	131	131	119	155	80	124	77		687	417		53	71	24	47		77	118	760	536
AVG. ΔWT.	+73		+34.		−37.		+69.		+31.						−19.		−20.					—	

\+ DEL_WT = ACTUAL WEIGHT GREATER THAN TEST WEIGHT

− DEL_WT = " " LESS " " "

TABLE E. - AVERAGE DEL_WT BY MFR FROM 1974-1980.

YEAR	1	2 1974	3 1975	4 1976	5 1977	6 1978	7 1979	8 1980	9	10	11	12	13
MFR	ITEM												
AMC	N	9	56	85	62	48	28	7					
	$\bar{X}$	-81	33	-51	-67	-16	-70	-23					
	SD	148	93	170	155	168	103	87					
CHRY	N	9	196	158	190	112	53	55					
	$\bar{X}$	-126	35	-36	-47	-49	-6	-35					
	SD	145	164	161	154	149	93	123					
FORD	N	36	433	323	237	139	110	44					
	$\bar{X}$	60	40	7	27	-9	-12	-40					
	SD	151	148	148	181	168	121	80					
GM	N	35	388	250	235	201	124	71					
	$\bar{X}$	73	34	-37	69	31	-19	-20					
	SD	121	129	178	183	174	110	124					
OTHERS	N	48	510	348	309	240	180	103					
	$\bar{X}$	33	10	-23	-42	-7	-71	-73	← SEE POLICY MEMO 4/24/79 ON INERTIA INTERVAL AND CLASS DETERMINATION				
	SD	108	116	110	120	117	70	61					
ALL	N	137	1575	1164	1033	740	492	280					
	$\bar{X}$	32	28	-21	-3	-4	-38	-46					
	SD	139	135	149	166	154	102	99					

N = NUMBER OF DATA POINTS

$\bar{X}$ = MEAN VALUE OF DEL_WT FOR ALL IW

SD = STANDARD DEVIATION OF DEL.WT DATA

DEL_WT = [(CW + 300) - ETW]

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FIGURE 1.

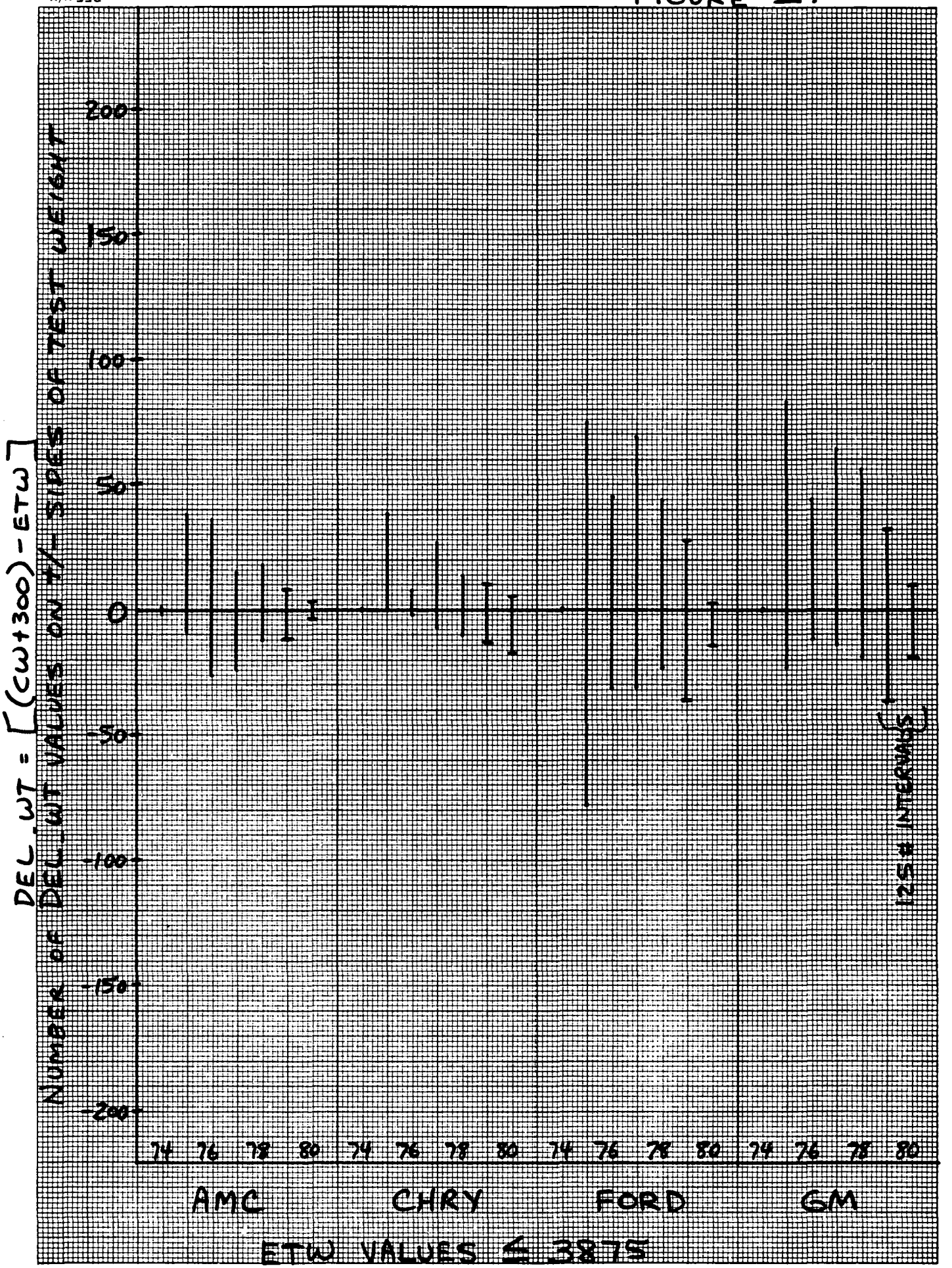

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FIGURE 2.

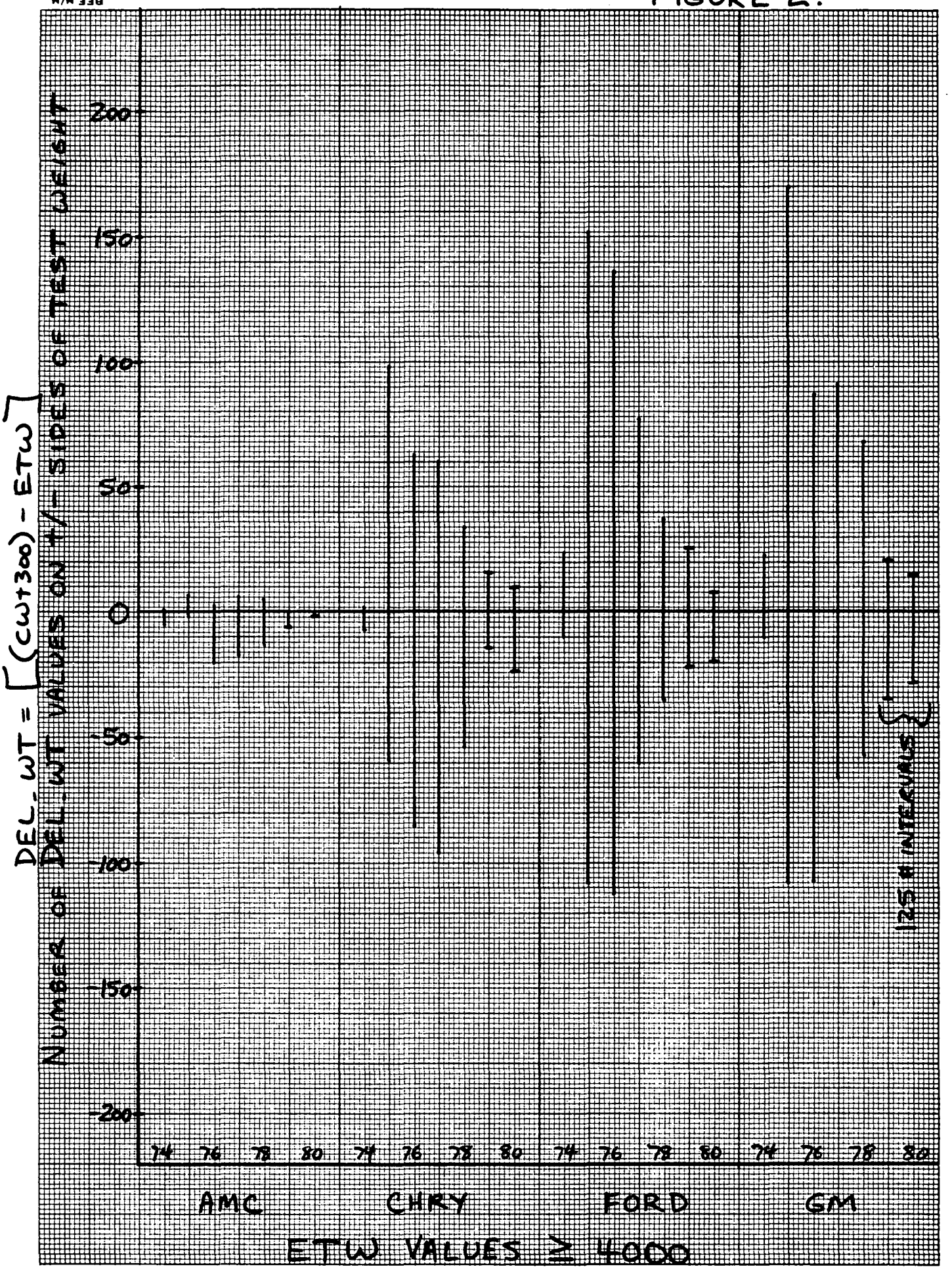

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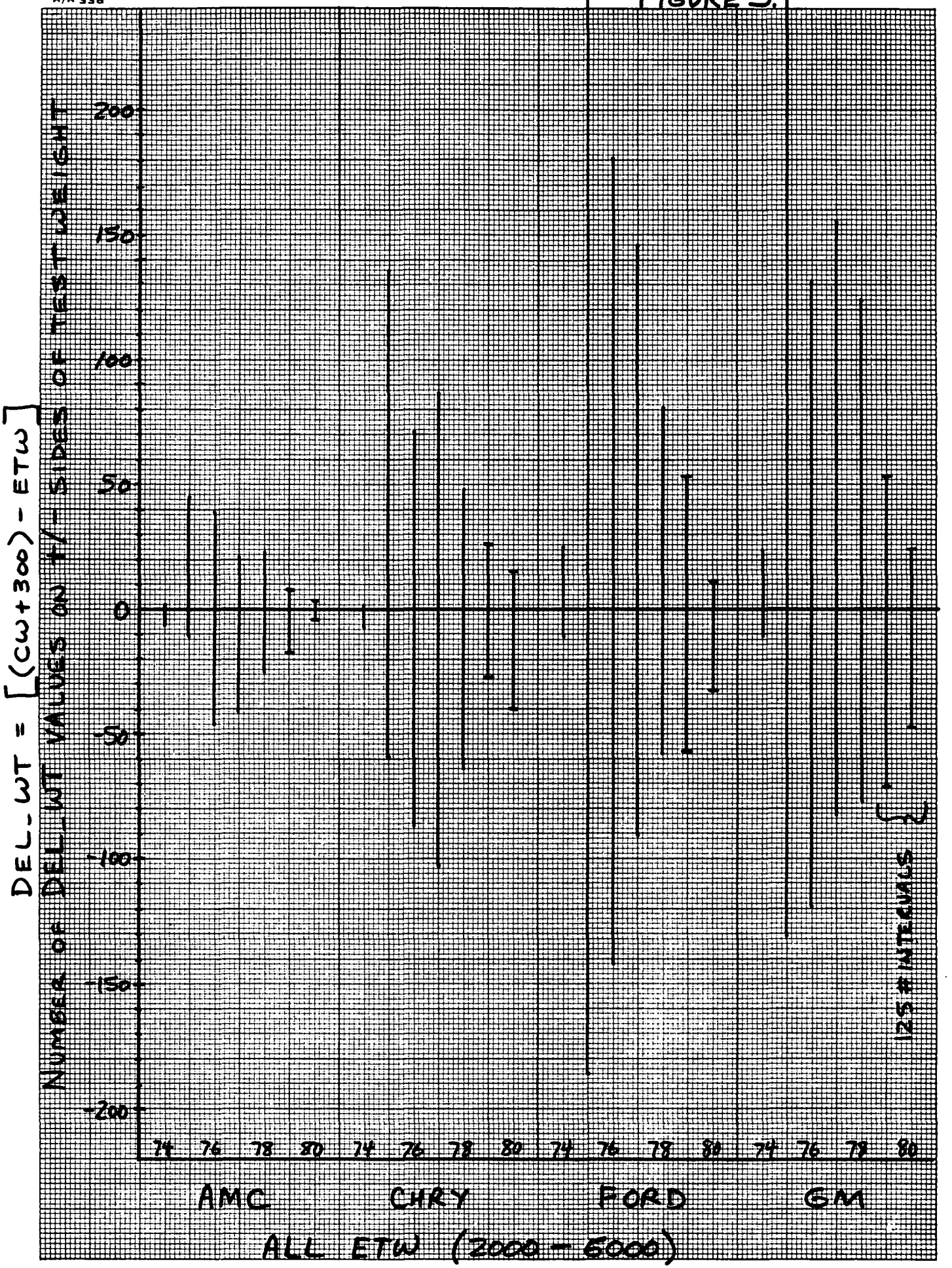
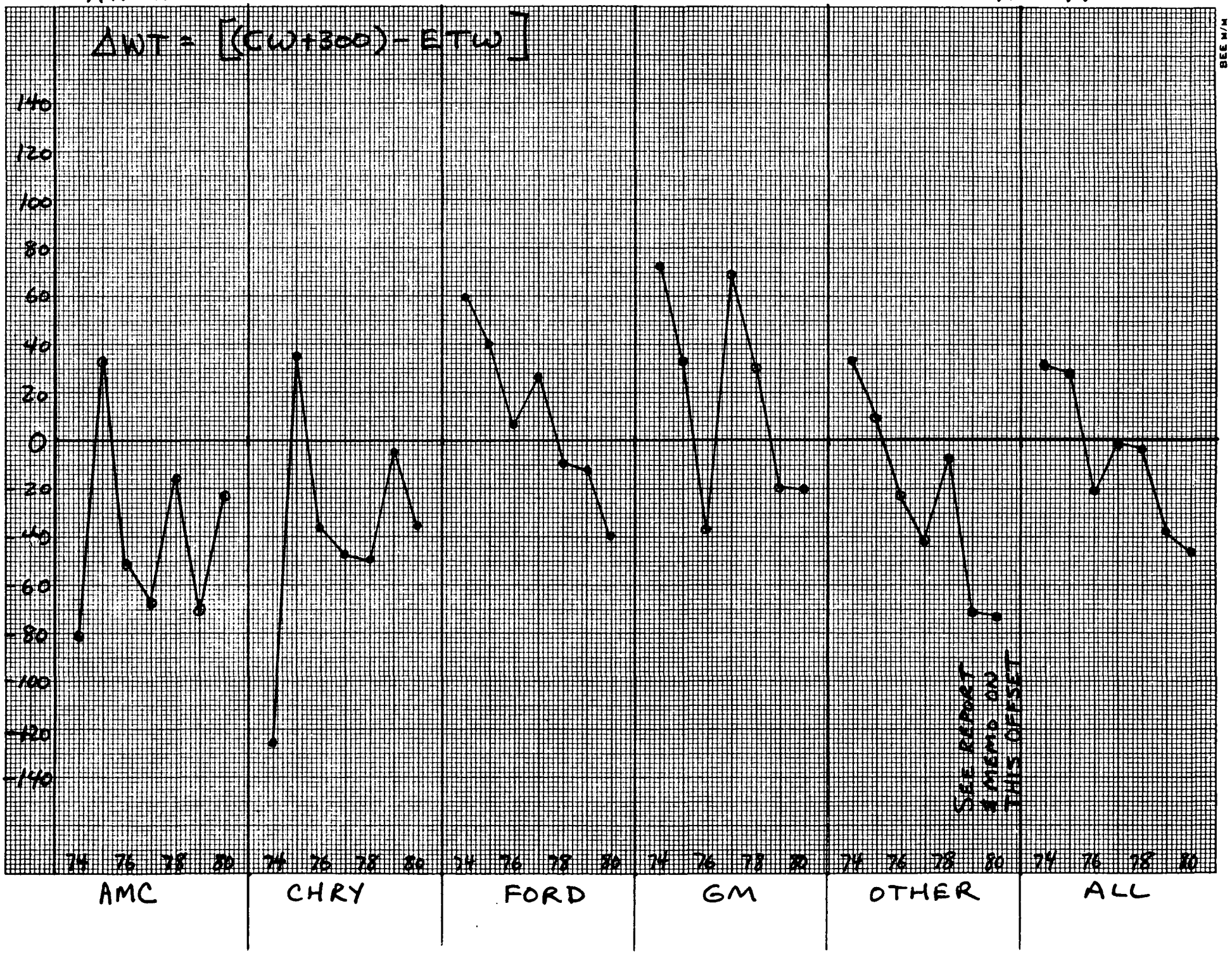
FIGURE 3.



AVERAGE ΔWT BY TEST YEAR FOR MFRS. FIGURE 4.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DATE: April 24, 1979

SUBJECT: Policy for Handling Test Weight Intervals in Certification

FROM: R. E. Harrington, Director
Certification Division

TO: All Certification Branch Members

With the modification of the light duty vehicle and light-duty truck test procedures to incorporate equivalent test weights within inertia weight classes, several operating and policy questions have arisen which need clarification and resolution in order to promote consistent interpretation and inplementation among the certification teams and the Fuel Economy Group. This memorandum will serve to formally state those policy decisions and clarify the operational implementation of this regulatory change. At some time in the future, we intend to formally communicate these policy decisions and operating guidelines to the industry via an advisory circular. Until such time, you should feel free to informally share this guidance with your respective manufacturers.

As in the past, manufacturers will provide their best estimate for vehicle weights. In selecting test vehicles, EPA will specify equivalent test weights consistent with the declared loaded vehicle weight of the vehicles.

The regulations [40 CFR 86.080-26(a)(2)] explicitly allow a manufacturer to test a vehicle at the next higher equivalent test weight if the estimated loaded vehicle weight is within 100 pounds of being included in the next higher inertia weight class. However, under the authority of 40 CFR 86.079-27 ("Special Test Procedures"), manufacturers will be allowed to similarly test any vehicle at the next higher equivalent test weight even if not within 100 pounds of being included in the next higher inertia weight class.

If, due to a change in design intent, a loaded vehicle weight changes, the manufacturer must correct his application either via an update (prior to certification) or a running change (after certification). If the loaded vehicle weight increases to the extent that a test vehicle selection would change or a correctly selected but already tested vehicle would be appropriately tested at a higher equivalent test weight, manufacturers will be required to emission test to determine certification compliance. Unless the certification team has identified some unusual circumstance which would suggest the need for a new emission-data vehicle, for a properly selected vehicle only a back-to-back test would be necessary to appropriately redetermine compliance. Therefore, even before initial certification, back-to-back testing will be allowed to account for a change in design intent. Of course, if a new vehicle configuration would be selected as a result of a design change (e.g., a different "B" vehicle), then a new 4,000-mile emission-data (before initial certification) or running change (after initial certification) vehicle would be required.

If the manufacturer determines that due to slippage from design intent, production vehicle weights have changed to the extent that the appropriate equivalent test weight has changed, the manufacturer must correct his application via a running change. If the corrected equivalent test weight is lower, no running change test will be required. If the equivalent test weight increases by only one category, running change testing would only be considered in those cases where the original emission-data vehicle marginally passed. In these instances, the need for testing should be considered on a case-by-case basis by evaluating the expected impact of the weight change (that is, the vehicle's emission sensitivity to weight change and consequently the likelihood that it would fail standards if retested). If the production slippage results in an increase of more than one equivalent test weight category, running change testing would be more frequently expected, but again evaluated on a case-by-case basis as to the likelihood that the vehicle would fail if retested at the higher equivalent test weight. In cases where the production weight increased such that the vehicle was appropriately tested in a higher inertia weight class, testing will usually be required unless the manufacturer has previously opted to voluntarily test at an equivalent test weight in the higher inertia weight class.

With respect to carryover consideration, if the vehicle has been tested at a higher test weight in a previous year and the request for carryover is to represent a vehicle at a lower test weight, carryover will not be jeopardized. If the converse is true (request to carryover from a lower to a higher test weight), carryover will be jeopardized. Prior to EPA granting carryover, the manufacturer will have to present evidence demonstrating that the increase in weight will not significantly affect emission levels.

As is our current practice, requests for carryover, running change approvals, etc. must be coordinated with the Fuel Economy Group so that they may assure compliance with the fuel economy regulations.

For your information, it is our current understanding that SEA testing will be conducted according to the vehicle weight estimates provided in the manufacturer's certification application. Additionally, for the time being (probably at least through the 1980 model year), MSED will only consider inertia weight classes when determining if production vehicles are covered by the certificate (that is, weight changes from one equivalent test weight to another will not be cause for enforcement action as long as the intertia weight class has not changed).