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FRONTAL CRASH RESPONSES: Steering Column and Intrusion Analysis

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16. Abstract

Research and compliance testing of steering assemblies has shown that new columns perform at or near their full energy absorbing potential. Accident data analysis, however, indicates that the EA units seldom exhibit compression which utilizes their full capability. The cause of the discrepancy between the test results and the accident data is unknown, although a number of explanations have been offered. Each accident is unique, however, and the column behavior in the varied accident modes is difficult to assess.

The crash matrix of the Frontal Crash Responses program provided an opportunity to examine the steering column performance under a variety of frontal crash configurations. The analysis of this report was initiated with the objective of documenting the amount and nature of steering column and instrument panel intrusion for selected matrix tests. Static and photographic measurement methods were employed in documenting the steering column and instrument panel intrusion.

The results show significant differences between dynamic motions and residual displacements. They also show column performance being dependant upon both the vehicle and the crash configuration. The effect of these results on unrestrained occupant response is included in the analysis. It is recommended that the steering column documentation methodology described in the report be extended to additional vehicles and crash configurations.

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Research and compliance testing of steering assemblies have shown that new columns perform at or near their full energy absorbing potential. Accident data analysis, however, indicates that the EA units seldom exhibit compression of over four inches -- only half or less of their designed capacity for energy absorption. These findings are not inconsistent with the findings of other researchers who have found no correlation between injury severity and steering assembly performance in both laboratory testing and accident analysis. The cause for the discrepancy between the test results and the accident data is unknown. It has been postulated that crash induced damage to the steering column and/or occupant non-axial loading may be possible causes. Each accident is unique, however, and the column behavior in the varied accident modes is difficult to assess. The crash matrix of the Frontal Crash Responses program provided an opportunity to examine the steering column performance under a variety of frontal crash configurations. The analysis of this report was initiated with the objective of documenting the amount and nature of steering column and instrument panel intrusion for selected matrix tests.

The steering column performance from thirteen 30 mph ΔV crash tests of Celebrity, Omni, Accord, and Fuego vehicles was analyzed using static measurements, photographic film analysis, and dummy measurement responses. The procedures described in the analysis provide a methodology for documenting intrusion and steering column dynamic performance in crash testing. In addition, a limited post-test comparison of the Omni, Accord, and Fuego columns was made with that of a VW Golf which had experienced a 30 mph ΔV oblique barrier collision. Among the conclusions were the following:

- The importance of measuring steering column motion was clearly demonstrated. Significant differences between dynamic motions and residual displacements measured post-test were observed.

- Although the magnitude of intrusion of the steering column into the occupant compartment did not correlate with unrestrained driver contact velocity, the time occurrence of steering column intrusion was found to be a critial factor in determining unrestrained driver contact velocity.

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- Unrestrained driver contact velocities estimated both with and without steering column intrusion indicated that considerably higher contact velocities can occur with intrusion.

- Post-test examination of the steering assemblies appeared to indicate that limitation of column motion due to firewall intrusion is feasible in production steering column designs.

- The column performance was dependant upon not only the vehicle, but also the crash configuration.

- The maximum upward movement of the column was less than six inches.

- Hybrid III chest deflection measurements in offset frontal tests were unreasonably low, likely due to the deflection measurement sensitivity to off-axis loading conditions.

The analysis indicated that two factors may be significant in explaining the discrepancy between test results and accident data. They are 1.) the effect of crash configuration on steering column dynamic performance, and 2.) the effect of column intrusion timing on unrestrained driver contact velocity. The following recommendations are made for future steering assembly efforts:

- Apply the static measurement and photographic film analysis methodology developed in this study to other production vehicles and crash configurations to better characterize steering column intrusion and its effect on occupant contact velocities.

- Identify existing and/or develop new ways of mounting steering assemblies in vehicles which reduce column motion during typical crashes.

- Establish steering column performance requirements to be effective over ranges of intrusion, contact velocity, and column angular motion, as determined from crash test results on vehicles with improved column mounting designs.

- Utilize Hybrid III chest acceleration rather than chest deflection to assess injury severity from off-axis steering assembly chest impacts until the Hybrid III deflection criterion has been extended to the off-axis loading condition.

1.0 INTRODUCTION

In the 1950's, the steering assembly was identified as the leading cause of injury in motor vehicle accidents. This is a reflection of the high percentage of accidents with frontal principal force directions, and the location of the steering assembly relative to the driver. In an effort to reduce the number of serious and fatal injuries produced by the steering assembly, considerable research has been conducted by private industry, and U.S. and foreign governments. This research led to the development of energy absorbing (EA) steering assembies, and Motor Vehicle Safety Standards (MVSS) 203 and 204. MVSS 203 and 204 established performance requirements for the steering column energy absorption and rearward displacement into the occupant compartment, respectively.

MVSS 203 and 204 have been cost effective in reducing fatal and serious injuries. It has been estimated that 1300 fatalities and 23,000 serious injuries are prevented annually, and that the rearward displacement of the column into the occupant compartment has been reduced by 81% (1). This has been accomplished for only a few dollars life-time cost of the vehicle. Despite the improved column performance, the steering assembly continues to be the leading cause of serious injuries to the motor vehicle occupant. Accident data indicate that the highest ranking "body to vehicle" contacts in frontal crashes are the chest and abdomen into the steering column (2,3). The harm associated with steering column contact accounts for over 25% of the total societal costs due to motor vehicle accidents. The injuries which are observed in the accident environment suggest that the forces which are required to compress the EA units frequently are seriously injurious to the driver.

Research and compliance testing of steering assemblies have shown that new columns perform at or near their full EA potential. Accident data analysis (4), however, indicates that the EA units seldom exhibit compression of over four inches -- only half or less of their designed capacity for energy absorption. These findings are not inconsistent

with the findings of other researchers (5-7), who have found no correlation between injury severity and steering assembly performance in both laboratory testing and accident analysis. Although EA units do not appear to be more effective in any particular crash condition, there are indications that they function better in distributed loading frontal crashes than in frontal crashes with concentrated loadings (4).

The cause for the discrepancy between the test results and the accident data is unknown. It has been postulated that crash induced damage to the steering column and/or occupant non-axial loading may be possible causes. Each accident is unique, however, and the column behavior in the varied accident modes is difficult to assess. Since most of the accident data regarding steering column performance is from unrestrained occupants, it is not easy to differentiate the column damage induced by occupant interaction versus structural intrusion effects. The crash matrix of the Frontal Crash Responses program provided an opportunity to examine the steering column performance under a variety of frontal crash configurations. The analysis of this report was initiated with the objective of documenting the amount and nature of steering column and instrument panel intrusion for selected matrix tests. The rationale for the selection, documentation approach, and results are discussed in this report.

2.0 APPROACH

The crash matrix of the SRL-98 Frontal Crash Responses project (Table 1) was conducted to accomplish several objectives. Those objectives were to:

- evaluate the ability of the Part 572 and Hybrid III dummies to detect events of the crash which would be expected to produce injury to the unrestrained occupant,
- obtain crash pulses, intrusion measurements, and occupant responses for vehicles in typical crash modes for use in analytic studies, and,

TABLE 1

Frontal Crash Test Matrix

Test Number	Subject Vehicle	Delta V	Crash Partner	Crash Mode	SUBJECT VEHICLE				CRASH PARTNER			
					Driver Dummy	Passenger Dummy	Driver Restraint	Passenger Restraint	Driver Dummy	Passenger Dummy	Driver Restraint	Passenger Restraint
840926	Celebrity	30	FRB	FF	HIII	P572	UR	UR	NA	NA	NA	NA
841004	Celebrity	30	FRB	FF	P572	HIII	UR	UR	NA	NA	NA	NA
841011	Fiero	30	FRB	FF	HIII	P572	UR	UR	NA	NA	NA	NA
841018	Fiero	30	FRB	FF	P572	HIII	UR	UR	NA	NA	NA	NA
841114	Honda	30	Honda	FF	HIII	P572	UR	UR	P572	HIII	UR	UR
841129	Fuego	30	Fuego	FF	HIII	P572	UR	UR	P572	HIII	UR	UR
841218	Omni	30	Omni	FF	HIII	P572	UR	UR	P572	HIII	UR	UR
850219	Honda	30	Fuego	FF	HIII	HIII	UR	UR	HIII	HIII	UR	UR
850228	Omni	30	Celebrity	FF	HIII	HIII	R	UR	HIII	HIII	R	R
850315	Omni	20	Celebrity	FF	HIII	HIII	R	UR	HIII	HIII	UR	R
850326	Honda	30	Celebrity	FF	HIII	HIII	R	UR	HIII	HIII	UR	R
850402	Honda	30	Concord	FF	HIII	HIII	R	UR	HIII	HIII	UR	R
850410	Omni	30	Concord	FF	HIII	HIII	R	UR	HIII	HIII	UR	R
850510	Fuego	30	Celebrity	FF	HIII	HIII	R	UR	HIII	HIII	UR	R
850731	Fuego	30	Fuego	OF	HIII	NONE	R	NA	HIII	HIII	UR	R
850524	Omni	30	Omni	OF	HIII	NONE	R	NA	HIII	HIII	UR	R
850724	Honda	30	Honda	OF	HIII	NONE	R	NA	HIII	HIII	UR	R
850807	Honda	30	Fuego	OF	HIII	HIII	R	UR	HIII	HIII	R	UR
850814	Omni	30	Celebrity	OF	HIII	NONE	R	NA	HIII	NONE	R	NA
850425	Honda	30	Pole	CTR	HIII	HIII	R	UR	NA	NA	NA	NA
850614	Omni	30	Pole	CTR	HIII	HIII	R	UR	NA	NA	NA	NA
850621	Fuego	30	Pole	CTR	HIII	HIII	R	UR	NA	NA	NA	NA
850912	Honda	30	Pole	OF	HIII	NONE	R	NA	NA	NA	NA	NA
851031	Omni	30	Pole	OF	HIII	NONE	R	NA	NA	NA	NA	NA
850910	Fuego	30	Pole	OF	HIII	NONE	R	NA	NA	NA	NA	NA
850918	Fuego	30	FLCB	FF	HIII	NONE	R	NA	NA	NA	NA	NA
850628	Rabbit	30	FLCB	FF	HIII	HIII	R	R	NA	NA	NA	NA
850717	Rabbit	30	FLCB	FF	HIII	HIII	R	R	NA	NA	NA	NA
851106	Omni/Omni FF Repeat of Test 841218											

- determine the performance of production vehicle steering columns, instrument panels, and other components relative to occupant survival.

Evaluation of the Part 572 and Hybrid III dummies in the unrestrained environment was the subject of the Vehicle Research and Test Center Report Number SRL-98-1, Frontal Crash Responses: Part 572 Versus Hybrid III Dummy Response Evaluation. The steering column performance is the subject of this report. The performance was examined through static measurements, photographic film analysis, and dummy measurement responses. The intrusion measurements were also examined in conjunction with the column performance. The remaining objectives are being completed by the NHTSA R&D Office of Crashworthiness Research.

2.1 Matrix Test Selection

Prior to selecting specific tests from the test matrix for the analysis, a full matrix of variables which were thought likely to influence the steering column and intrusion behavior was considered. For the subject vehicle being analyzed, these factors were weight and stiffness. The factors considered for the object being struck were type, weight, stiffness, and engagement. The velocity was not considered to be a variable since most of the subject vehicle ΔV's were 30 mph. A matrix of these factors amounts to a total of forty-four different cells as shown in Figure 1. For the small vehicle portion of the subject vehicle analysis matrix, configurations which might be expected to bracket the intrusion severity levels can be selected. A small amount of intrusion would be expected in the small, stiff car when struck full frontally by a small, soft car. A large amount of intrusion would be expected for the small, soft car when struck by a large, stiff car in an offset engagement. Neither of these configurations were represented in the crash matrix, however, so the differences found in the ensuing analysis may not represent steering column and intrusion extremes which would occur in the accident environment.

Figure 1 - Steering Column Performance and Intrusion Analysis Factor Matrix

Struck Object Type	Struck Object Engagement	Struck Object Weight	Struck Object Stiffness	Subject Vehicle Stiffness	Subject Vehicle Weight	Vehicle								Narrow Pole		Barrier
						Full Frontal				Offset Frontal				Center	Offset	Full Frontal
						Small		Large		Small		Large		Large	Large	Large
						Soft	Stiff	Soft	Stiff	Soft	Stiff	Soft	Stiff	Rigid	Rigid	Rigid
Small		Soft											X			
		Stiff				X										
Large		Soft														
		Stiff														

The distribution of tests relative to the analysis factors is shown in Figure 2. The crash matrix vehicles were selected on the basis of load cell data from rigid barrier tests. The Omni and Accord were selected as being small, soft vehicles, and the Fuego was selected as a small, stiff vehicle. As shown in Figure 3, however, the compartment response differences for full frontal car-to-car engagements were slight. For the large cars, the Celebrity was the soft vehicle, while the Concord was the stiffer one.

Two measurement methods (static and photographic) were employed in documenting the steering column and instrument panel intrusion. These methods are described in detail below. The static measurements documented the compartment intrusion at the firewall and cowl. The photographic analysis required removal of the right front passenger dummy, and documented the steering column dynamic motion. Those tests which are circled in Figure 2 had both the static and photographic analysis conducted. Passenger occupant response data was required in preference to the photographic information of the steering column behavior in many of the tests. The static measurements were collected in four of those cases, and are indicated in Figure 2 with an underscore. As illustrated in Figure 2, emphasis was given to the offset crash tests since the greatest amount of intrusion and steering column motion was expected for those tests.

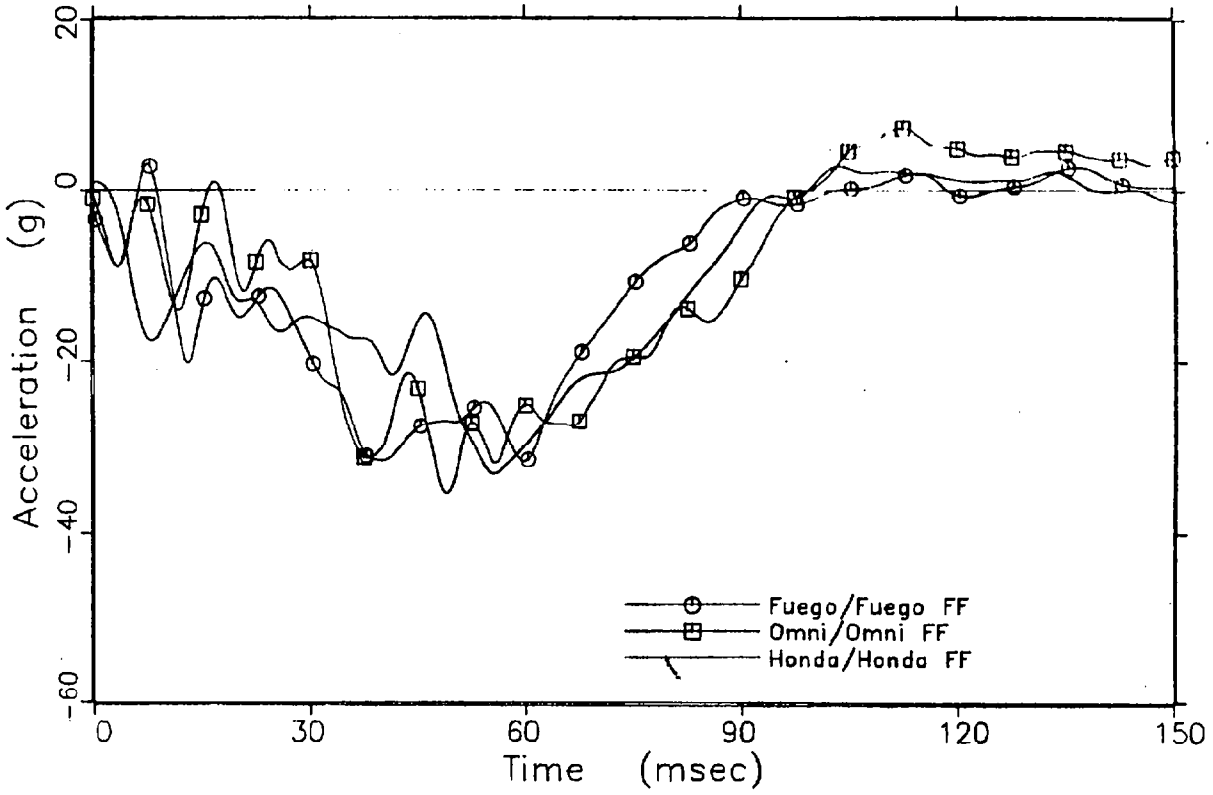
2.2 Static Measurement Procedure

Each of the vehicles included in the analysis had a series of pre-test measurements taken. Prior to the test, the instrument panel was removed, and a matrix of reference dimensions was made. The reference dimensions were made from either the rear tail light opening or the rear bumper. The points were located at four inch increments from the centerline of the vehicle at five elevations (Figure 4). The top two elevations (A and B) were located on the cowling (where the instrument panel was attached). The next two levels (C and D) were on the firewall, and the fifth level (E) was near the firewall/toeboard juncture. Following the crash test, these points were again located

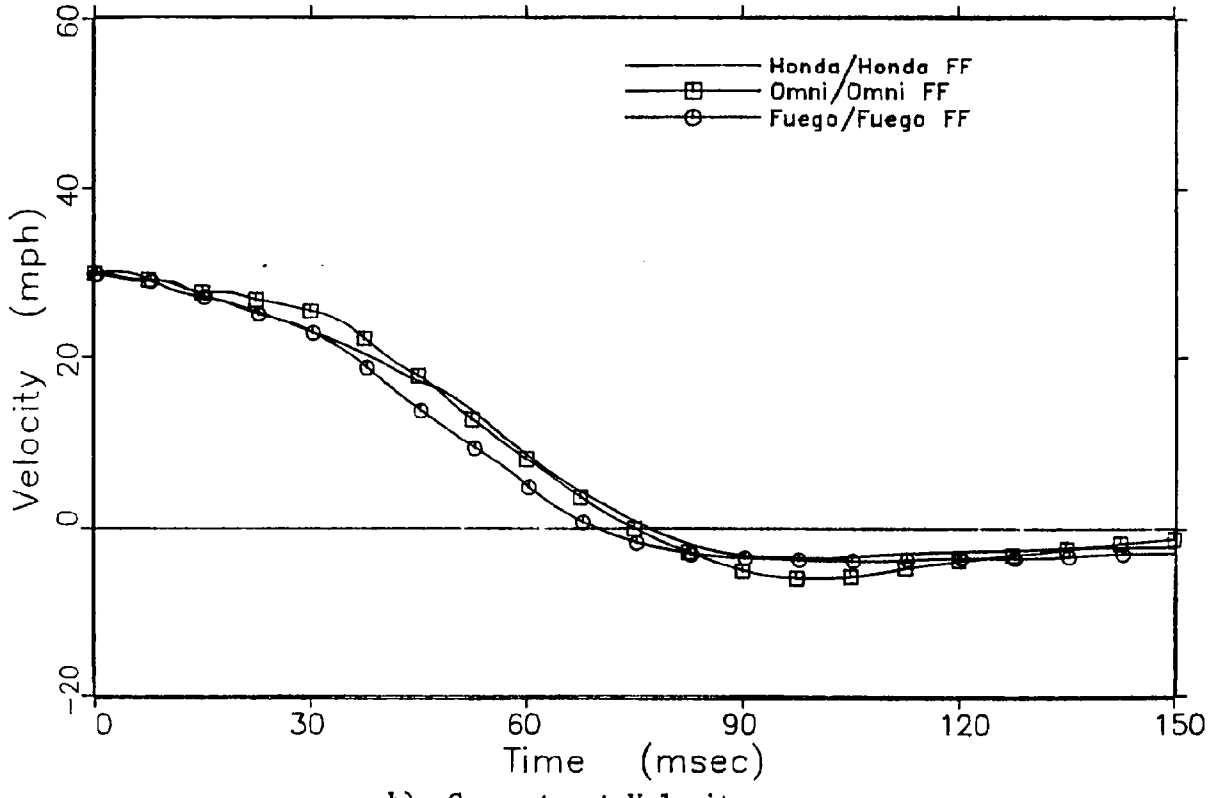
Figure 2 - Crash Test Distribution Relative to Analysis Factors

Struck Object Type / Struck Object Engagement / Struck Object Weight / Struck Object Stiffness / Subject Vehicle Stiffness / Subject Vehicle Weight		Vehicle								Narrow Pole		Barrier
		Full Frontal				Offset Frontal				Center	Offset	Full Frontal
		Small		Large		Small		Large		Large	Large	Large
		Soft	Stiff	Soft	Stiff	Soft	Stiff	Soft	Stiff	Rigid	Rigid	Rigid
Small	Soft	841114 851106	850219	850228 850326	850402 850410	850524 850724	850807	850814*		850425 850614	850917 851031	841011 841018 840628 850717
	Stiff		841129	850510			850731			850621	850911	850918
Large	Soft											840926 841004
	Stiff											

* Steering column and intrusion analysis conducted on both vehicles



a) Compartment Acceleration



b) Compartment Velocity

FIGURE 3 -- Small Vehicle Stiffness Comparison

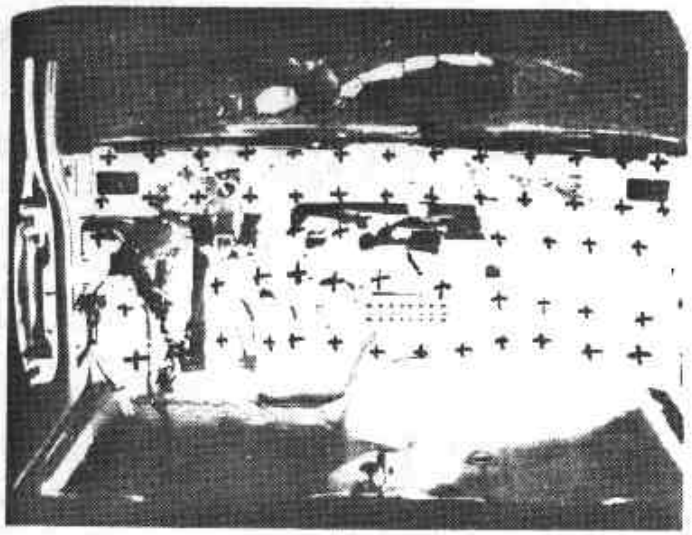


FIGURE 4 -- Static Intrusion Measurement Locations

from the rear reference to determine the amount of rearward displacement. A vertical displacement of the points relative to ground occurred in some of the crash tests, but no attempt was made to record it. These vertical displacements were caused by a collapse of the occupant compartment floorpan, and did not represent a localized intrusion.

2.3 Film Analysis Procedure

A number of the crash tests in the matrix had restrained drivers, and passenger data which was not critical to the objectives of the testing. For those tests (circled in Figure 2), a camera was added to the passenger side of the vehicle (Figure 5), and the passenger was removed to avoid obstruction of the steering column camera view. Tests with restrained drivers were selected for the photographic analysis to avoid any steering column motion being induced by an unrestrained driver. The onboard steering column camera was run at 1000 frames per second. Within its field of view was a reference point attached to the camera mount to allow documentation of the steering column vertical and rearward displacement relative to the vehicle compartment (Figure 6). Following each test with the steering column camera coverage, the column targets were digitized for graphical presentation of the column displacement. It should be noted that the film analysis was complicated in a couple of the tests due to movement of the reference point. There was also head and sometimes chest contact with the steering column from the restrained drivers which may have had a slight effect on the column movement in some of the tests.

3.0 RESULTS AND DISCUSSION

3.1 Test Results

The steering column motion and intrusion measurements are summarized in Figure 7 and Table 2. The horizontal, vertical, and angular dynamic motion of the steering column is shown in Figure 7 as

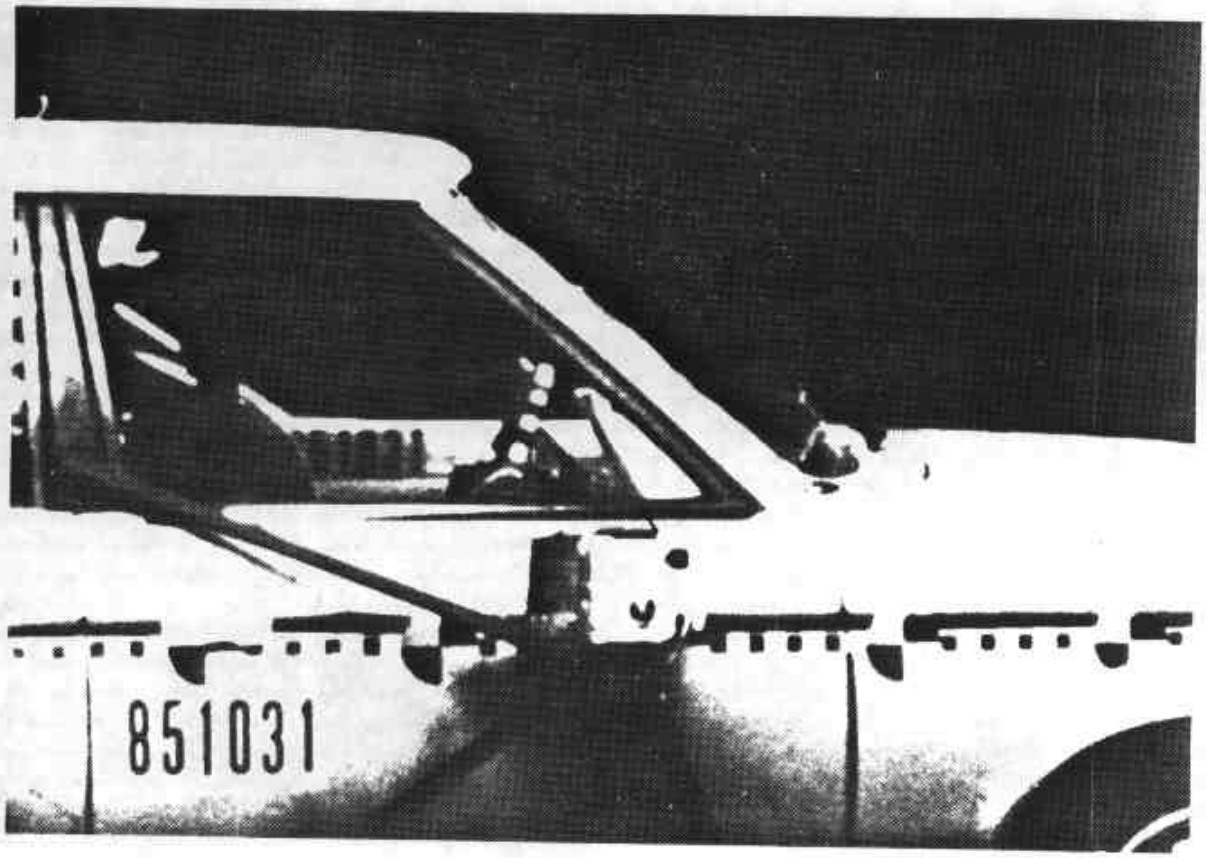


FIGURE 5 -- Steering Column Motion Camera Placement

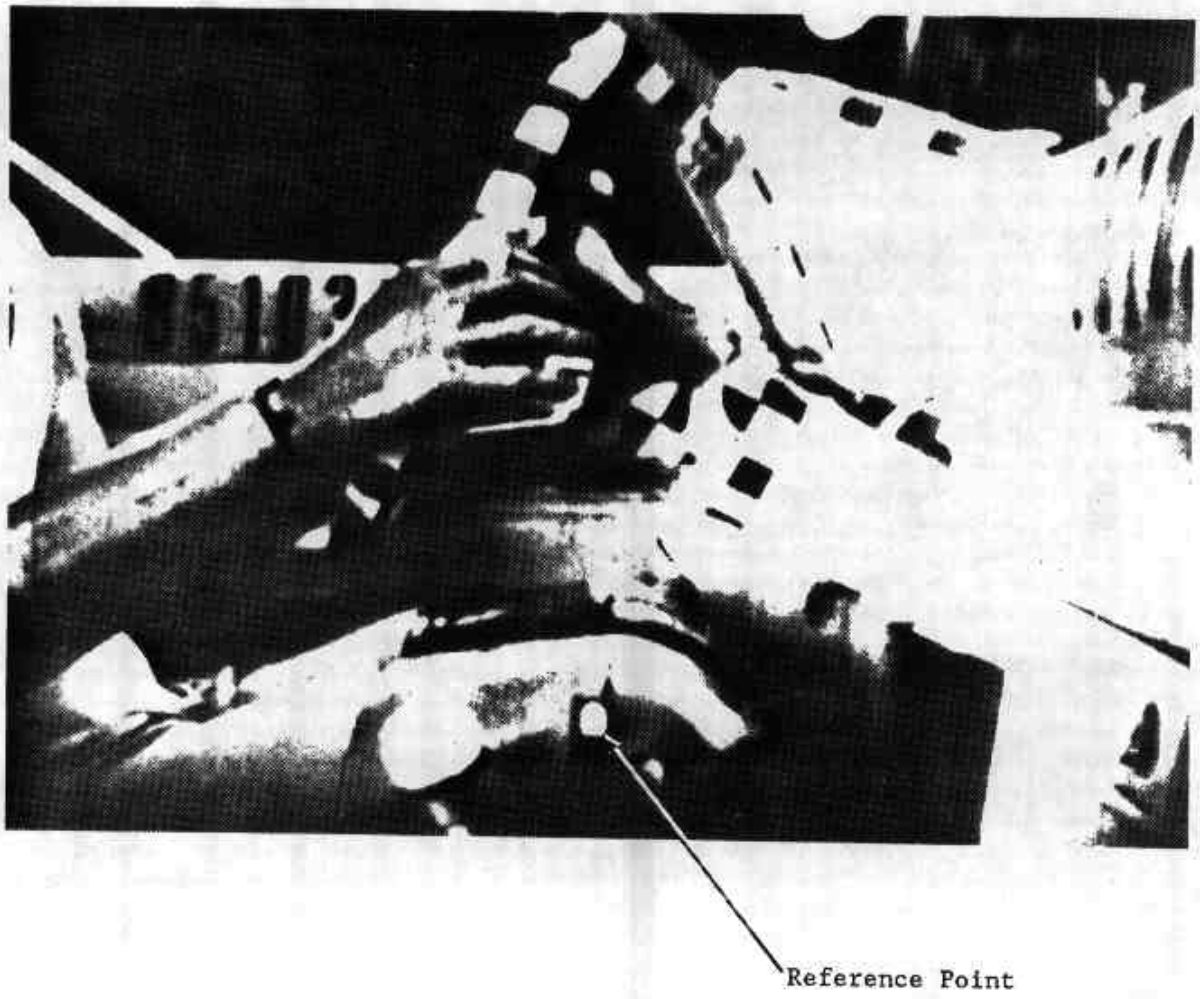
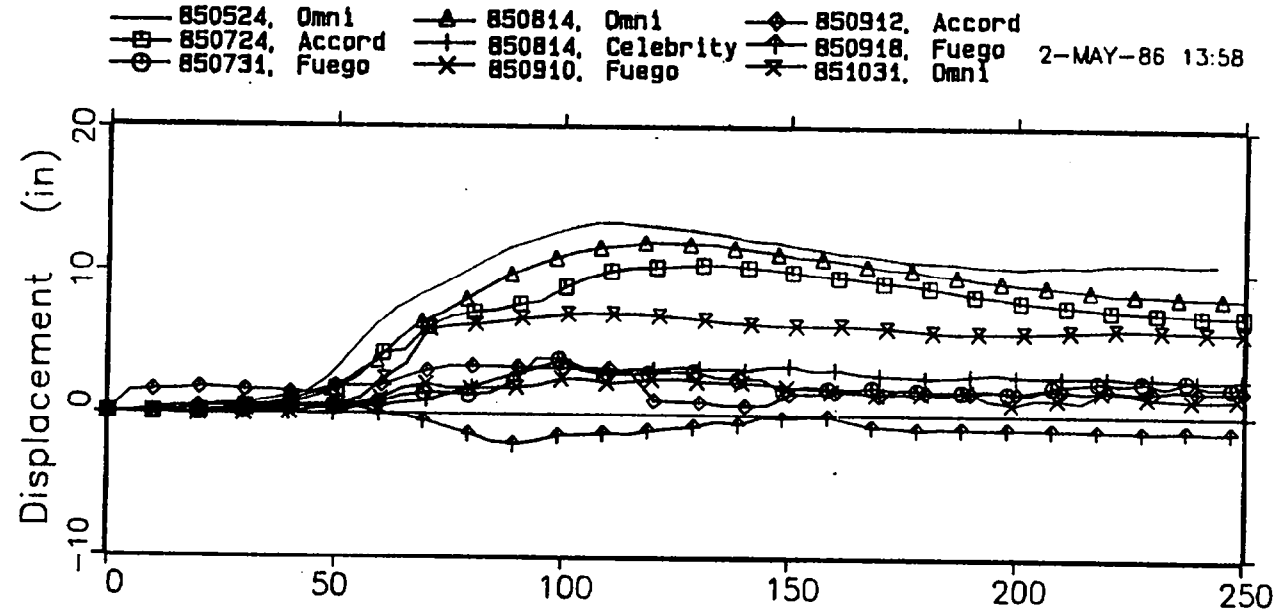
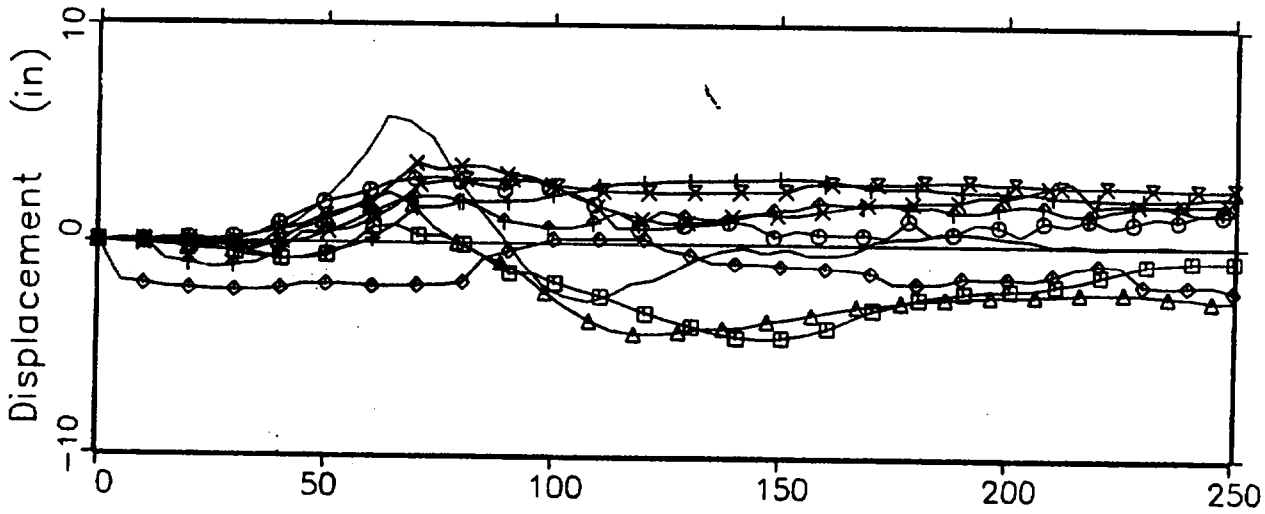


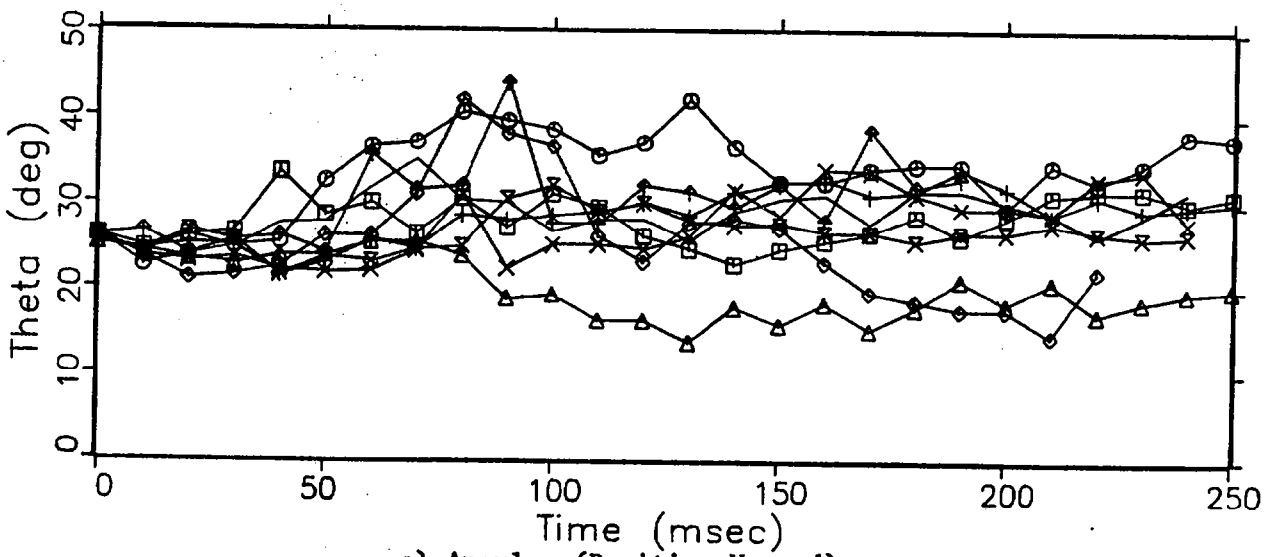
FIGURE 6 -- Steering Column Film Analysis Camera View



a) Horizontal (Positive Rearward)



b) Vertical (Positive Upward)



c) Angular (Positive Upward)

FIGURE 7 -- Steering Column Movement

TABLE 2

Steering Column and Intrusion Analysis Summary

Vehicle	Test No.	Test Configuration	Steering Column Film Analysis				Peak Static Measurement Level					SC Displacement Ratio (Residual/Dynamic)	
			Peak Dynamic X	Z	Residual X	Z	A	B	C	D	E	X	Z
Celebrity	850814	Omni/Celebrity OF	3.6	3.2	2.5	2.3	3.75	2.50	3.75	7.13	6.75	0.69	0.72
Omni	850814	Omni/Celebrity OF	11.9	-4.2	8.2	-2.6	7.00	8.80	13.25	11.62	8.78	0.69	0.62
Omni	850524	Omni/Omni OF	13.4	5.7	10.6	0.0	7.25	9.43	14.98	14.07	12.93	0.79	0.00
Omni	851031	Omni/Pole OF	7.0	2.8	5.8	2.6	4.63	6.55	10.02	12.06	12.86	0.83	0.93
Honda	850807	Honda/Fuego OF	NA	NA	NA	NA	13.63	13.88	18.06	17.25	16.50	----	----
Honda	841114	Honda/Honda FF	NA	NA	NA	NA	1.88	2.94	4.63	6.50	8.25	----	----
Honda	850724	Honda/Honda OF	10.4	-4.5	7.0	-0.7	7.63	7.88	11.00	11.50	12.25	0.67	0.16
Honda	850425	Honda/Pole CTR	NA	NA	NA	NA	2.50	2.75	7.56	8.44	10.00	----	----
Honda	850912	Honda/Pole OF	3.4	-2.3	1.8	-1.9	7.25	7.06	9.13	9.50	10.25	0.53	0.82
Fuego	850918	Fuego/Barrier FF	-2.1	2.1	-1.1	1.6	4.81	3.57	4.19	5.94	4.69	0.52	0.76
Fuego	850731	Fuego/Fuego OF	3.9	2.9	2.5	1.5	3.56	3.70	5.50	5.12	6.25	0.64	0.52
Fuego	850621	Fuego/Pole CTR	NA	NA	NA	NA	2.19	3.26	4.69	8.75	7.81	----	----
Fuego	850910	Fuego/Pole OF	2.5	3.5	1.3	1.9	3.44	3.81	4.69	6.44	6.32	0.52	0.54

determined from the photographic film analysis. Although there are considerable differences in the column motions, they all tend to be characterized by a peak horizontal and vertical displacement which occurs between approximately 70 and 120 msec (roughly the time at which contact with an unrestrained occupant would occur), and levels out to a residual displacement by 200 msec. The peak dynamic and residual (taken at 250 msec) displacements are summarized in Table 2, along with the peak static intrusion measurement (regardless of lateral position) from the five levels. The individual and detailed measurement profiles at all locations are contained the Appendix.

Several observations are apparent from the data summarized in Figure 7 and Table 2:

- The importance of measuring steering column motion dynamically was clearly demonstrated. Note, for example, that the Omni/Omni OF test had the largest amount of dynamic upward motion, but zero residual.

- For the horizontal steering column motion, the residual position appears to be 50 - 80% of the peak dynamic motion. For the vertical motion, there does not appear to be a correlation between the peak dynamic and the residual motion.

- The horizontal movement of the steering column was rearward in all cases except the Fuego/FRB test. The forward movement in the Fixed Rigid Barrier test was the result of column rotation.

- The vertical steering column motion was predominately upward; four columns, however, moved downward significantly (two of those four also experienced upward movement). The maximum upward movement was less than 6 inches.

- The steering column rotation was predominately upward. The upward angular motion was generally less than 10°, although in

three tests the rotation was 15 - 20° during the time interval that occupant contact would be expected to occur.

- The cowl intrusion (levels A and B) correlates well with the horizontal residual steering column movement (illustrated in Figure 8). This is not surprising since the column mounts to the cowl for the vehicles included in this analysis. The Honda/Pole OF test and the Fuego/Barrier test (in which the column rotated as discussed above) were exceptions to the correlation.

- The maximum intrusion levels occurred below the cowl on the firewall and toeboard.

- The occupant compartment Available Internal Distance (AID) which was compromised by the intrusion at the intrument panel level (A and B) ranged from 1 7/8 inch to 13 7/8 inch, dependent upon the vehicle and crash configuration.

The static and dynamic results of Figure 7 and Table 2 indicate that the steering column can have considerably different responses, depending upon the vehicle and the crash configuration. The vehicle influence on the steering column response is illustrated in Figures 9 and 10. In both the small car/car offset tests and the small car/pole offset tests, the Omni steering column horizontal movement was greater than either the Accord or Fuego. For the horizontal motion, the Omni and Fuego represent performance extremes in the offset crash configuration for those vehicles included in the analysis. As was indicated in Figure 2, however, it is possible that even greater performance differences are likely in the accident environment, since the vehicles included in this analysis did not represent the stiffness (nor configuration) extremes from the vehicle fleet.

The crash configuration influence on the steering column response is illustrated for each of the small vehicles in Figures 11 - 13. Note, for example, that the car-to-car offset tests generally had a

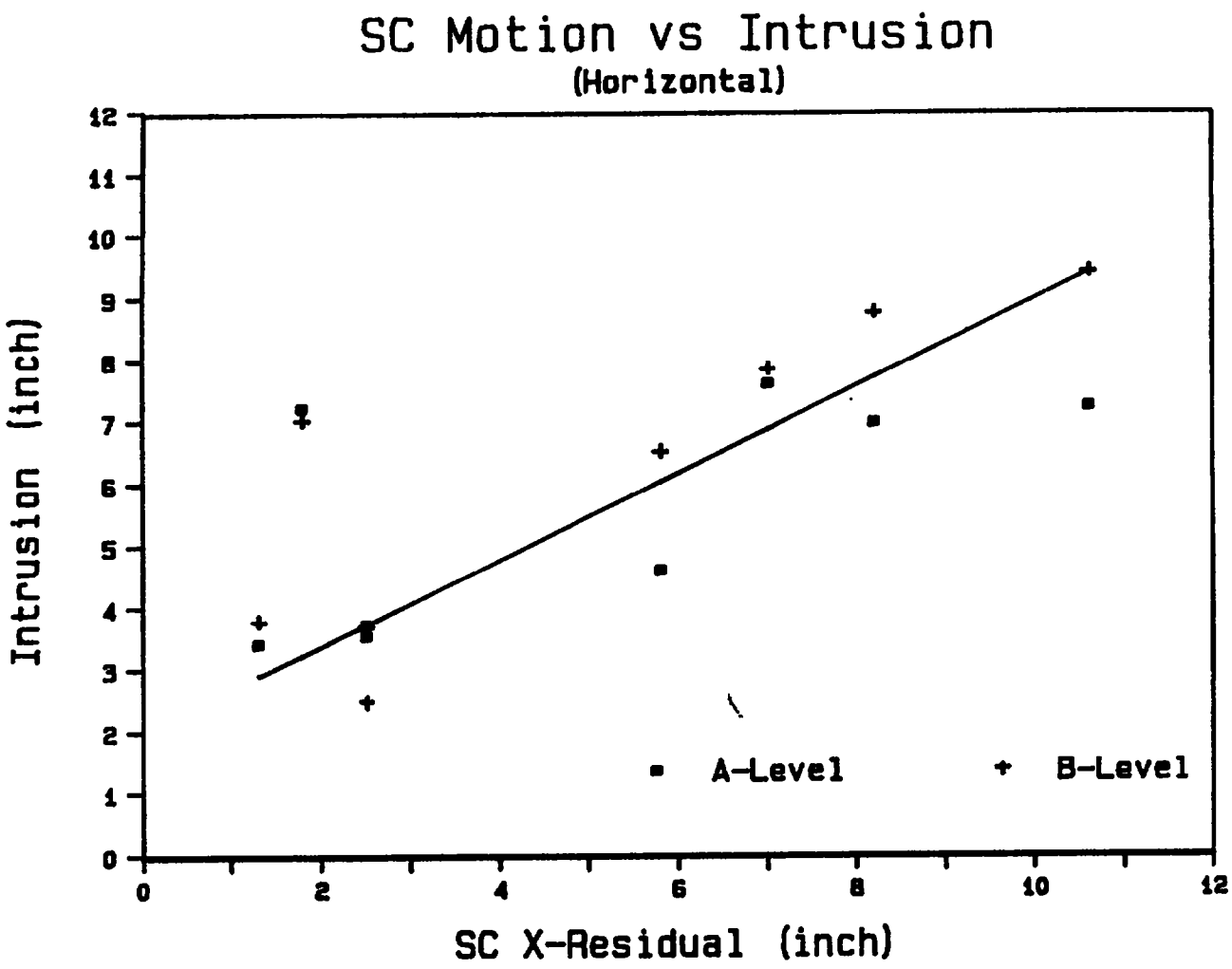


FIGURE 8 -- Residual Steering Column Motion
Correlation to Cowl Intrusion Measurement

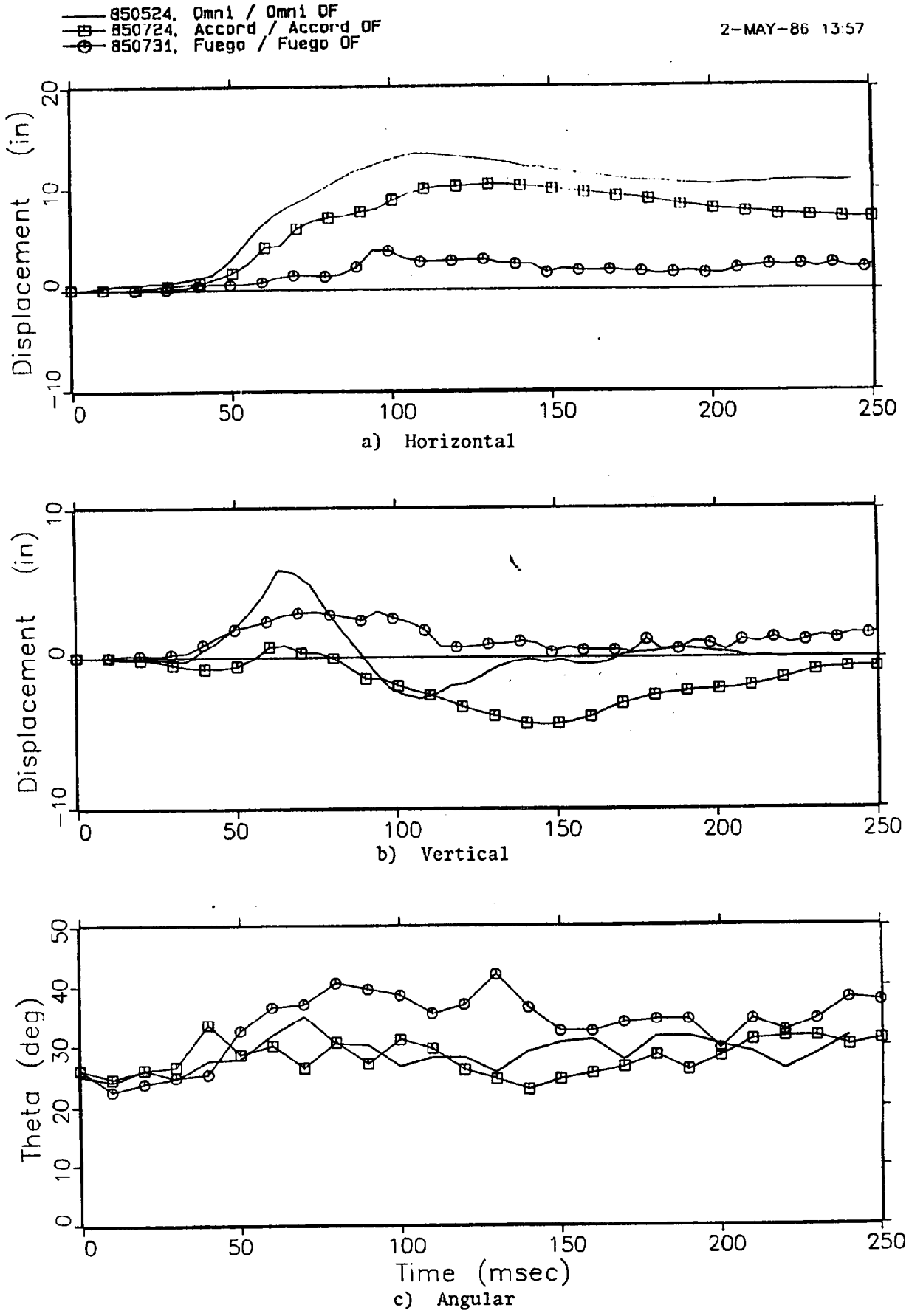
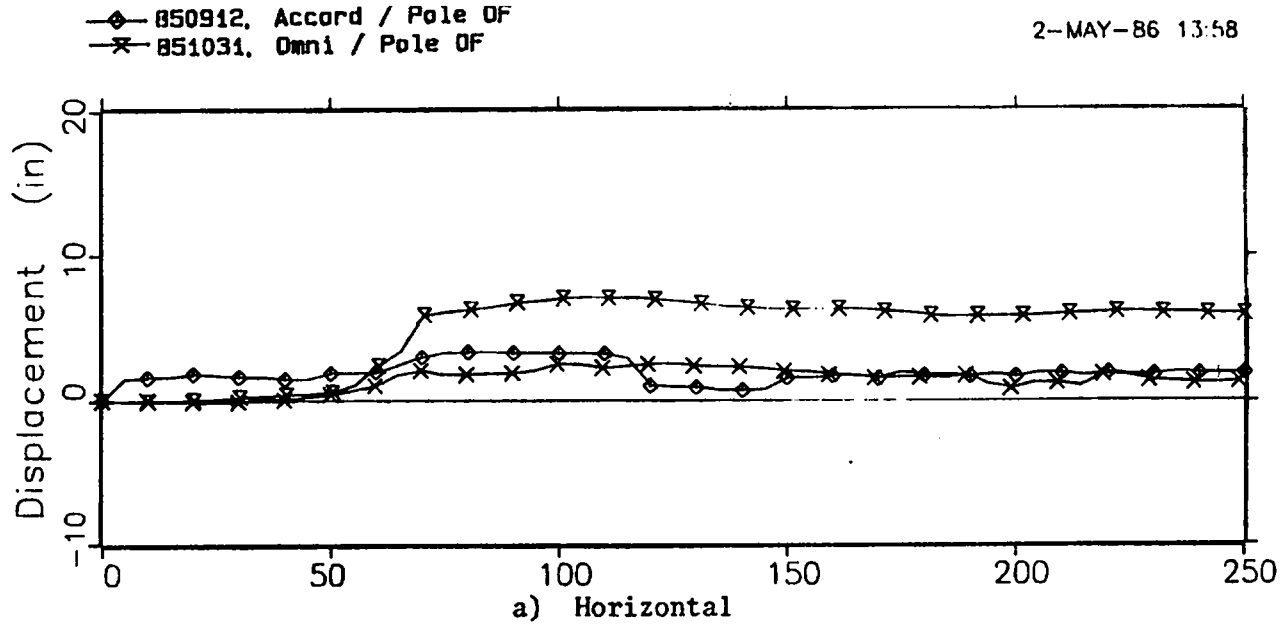
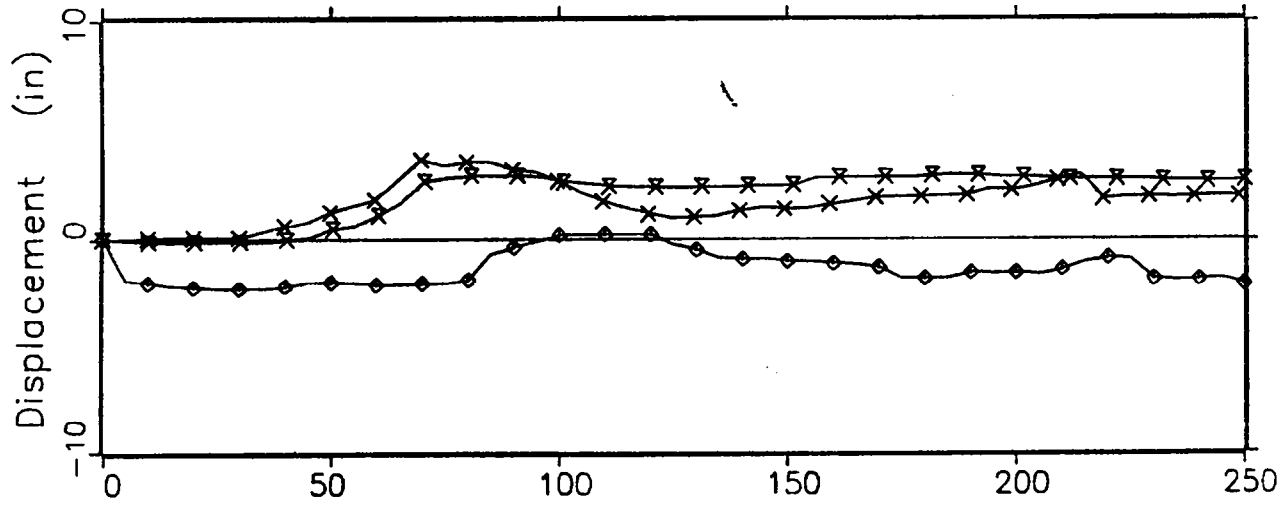


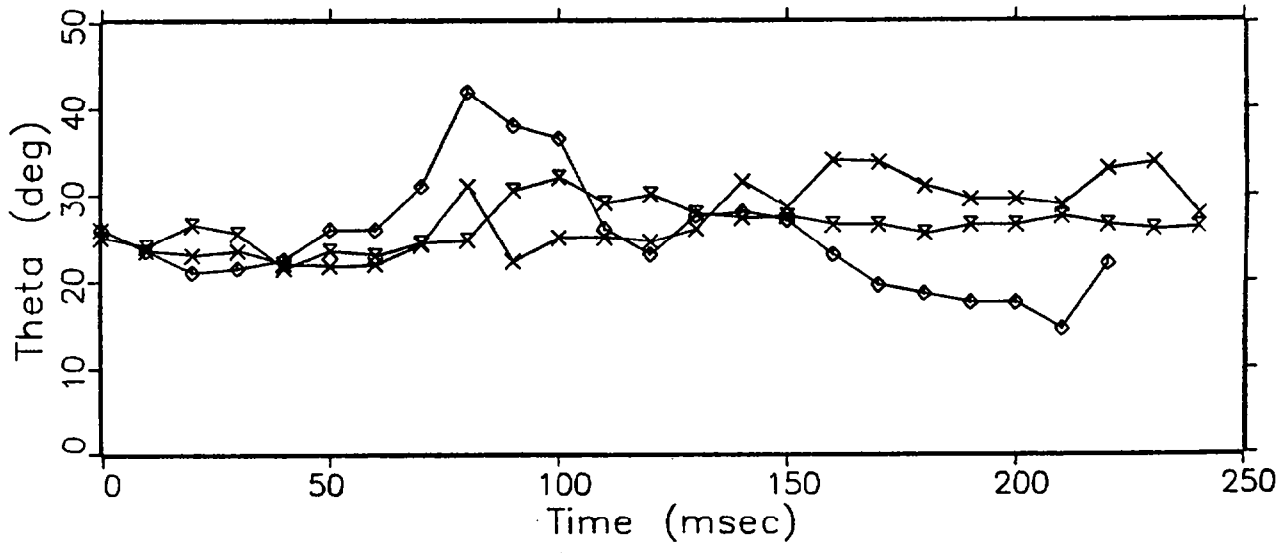
FIGURE 9 -- Car/Car Offset Test Steering Column Motion



a) Horizontal

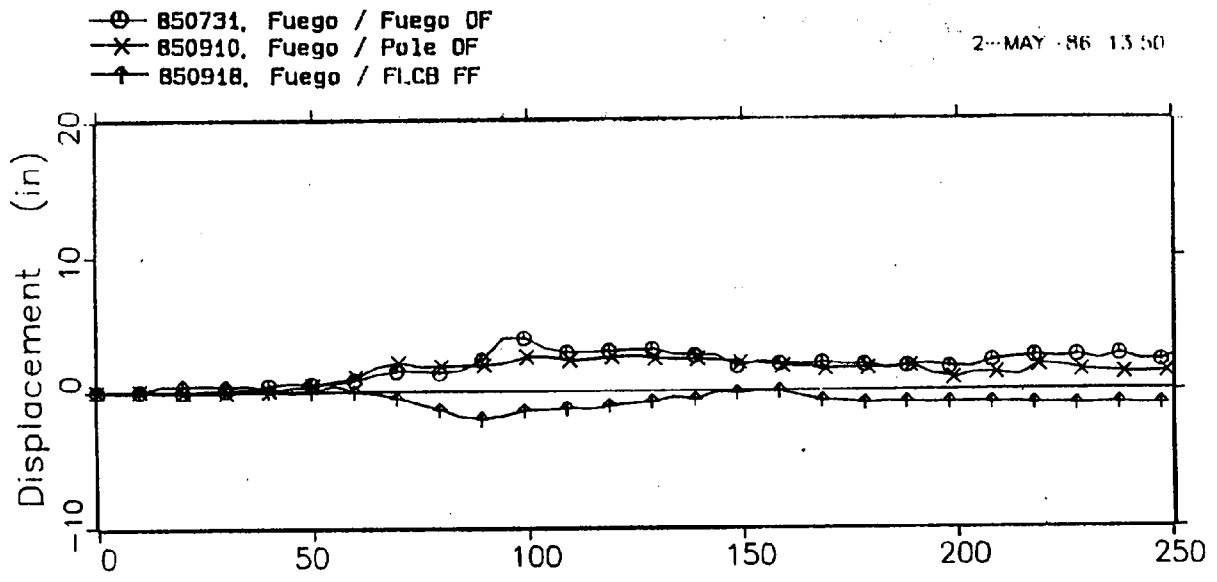


b) Vertical

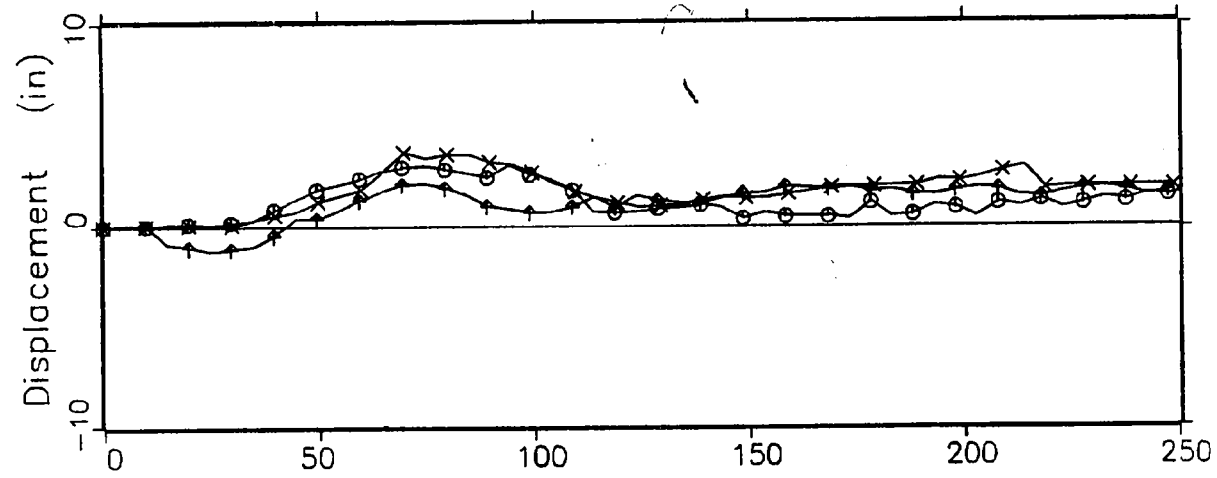


c) Angular

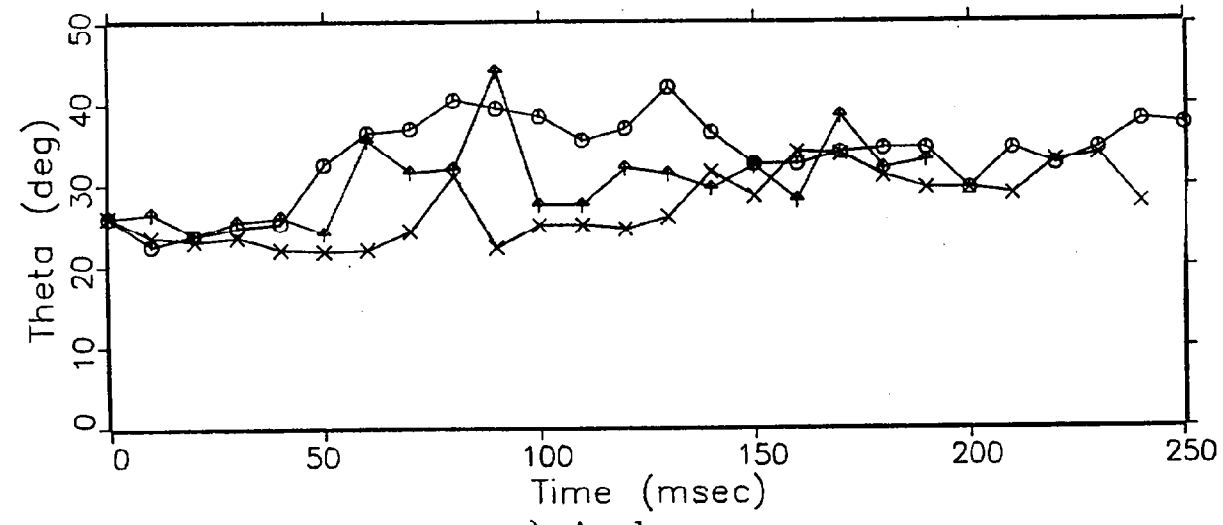
FIGURE 10 -- Car/Pole Offset Test Steering Column Motion



a) Horizontal

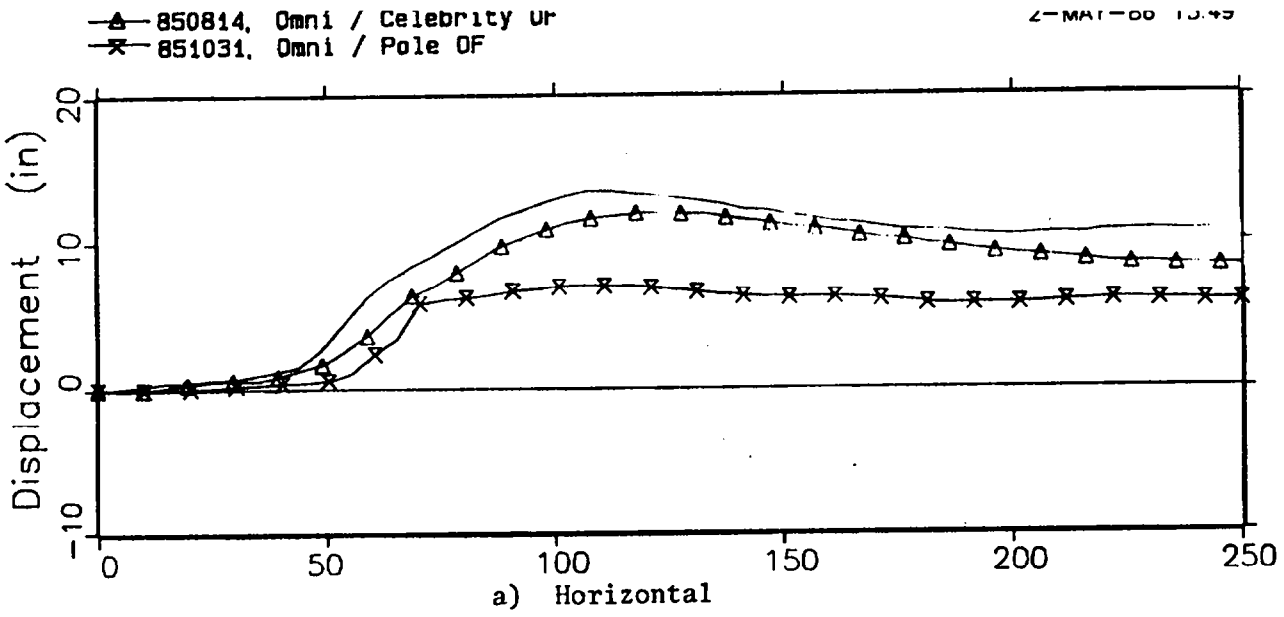


b) Vertical

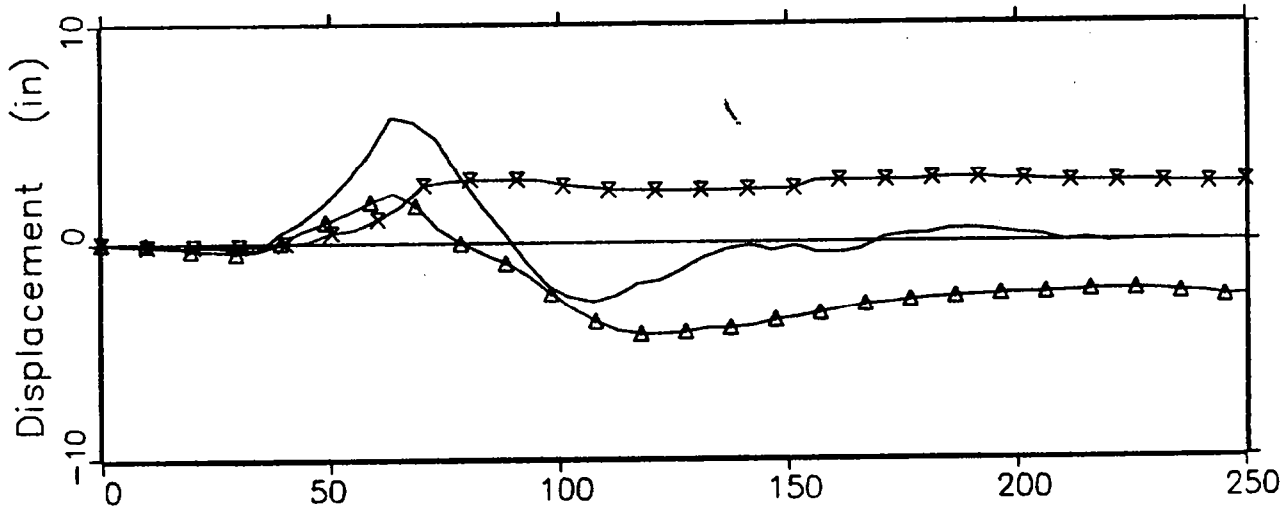


c) Angular

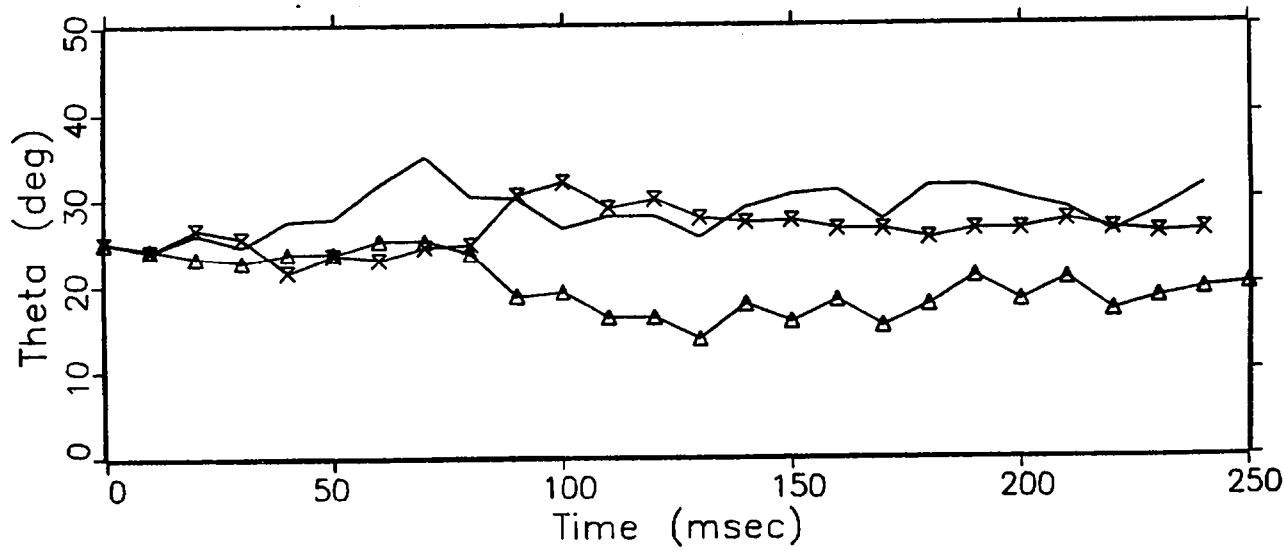
FIGURE 11 -- Fuego Steering Column Motion



a) Horizontal



b) Vertical



c) Angular

FIGURE 12 -- Omni Steering Column Motion

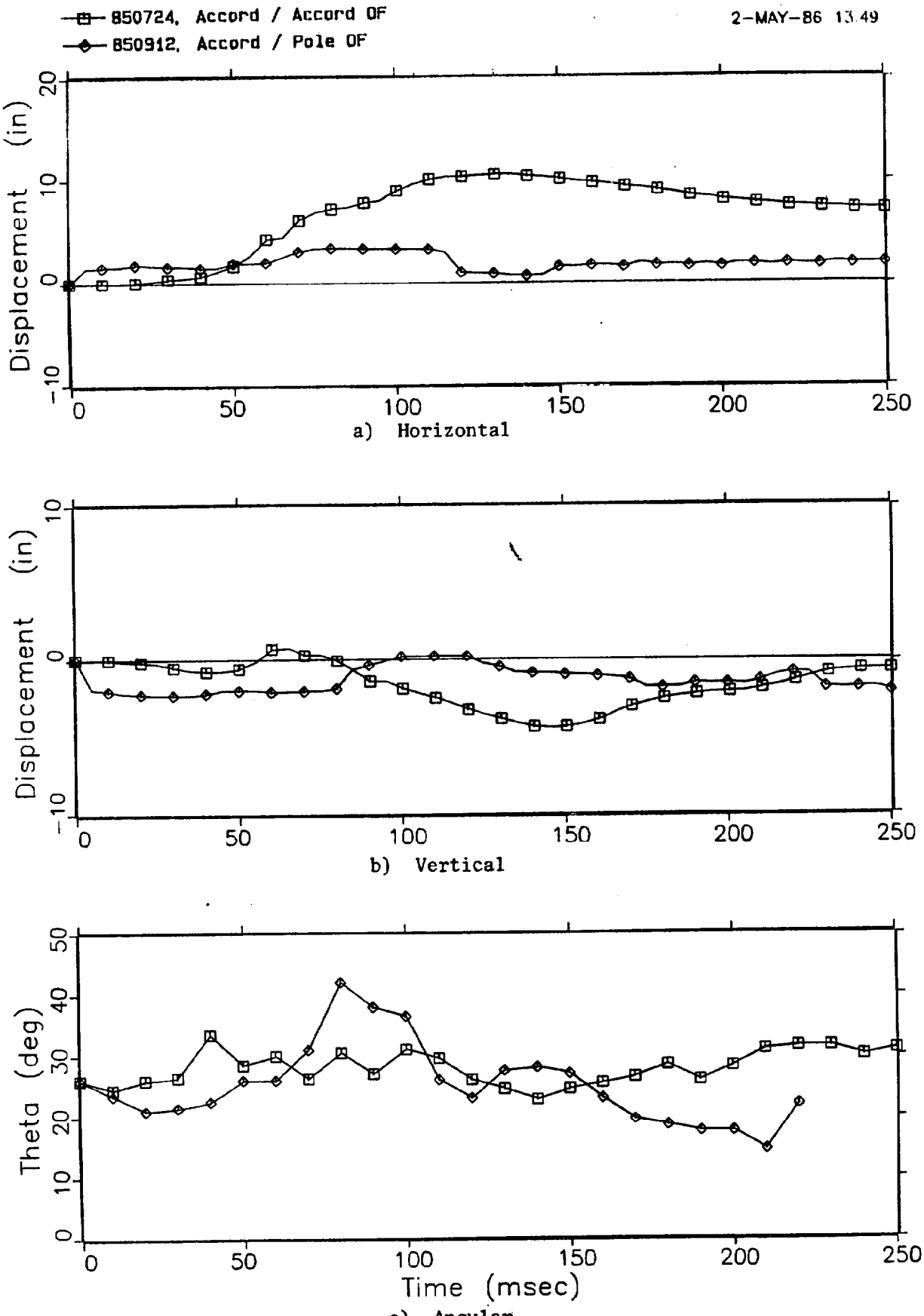


FIGURE 13 -- Accord Steering Column Motion

greater amount of steering column motion than the corresponding car-to-pole offset tests. The Omni vertical column movement was apparently quite dependant upon the struck object. In the Omni/Celebrity OF test, the column movement was the static downward extreme and nearly the dynamic downward extreme (Table 2); whereas, the upward extremes occurred for the Omni/Omni OF dynamically and the Omni/Pole OF statically. The Omni and Fuego column motion extremes are further illustrated in Figures 14 and 15.

The steering column position and intrusion are illustrated in Figures 16 - 28. For those cases in which the film analysis was conducted, the residual steering column position was used. For the others, the static test report locations were used. The cowl and firewall intrusion levels are shown for the lateral position which coincides with the driver position. The instrument panel was not repositioned to represent the cowl intrusion. These figures provide a graphical representation of the steering column motion and intrusion effect upon the compartment distance available to the occupant. The reduced AID dependance upon the vehicle and crash configuration is also illustrated in these figures.

A detailed analysis of the column mountings and design features was not included in this study. In a subsequent 30° oblique fixed rigid barrier crash test program with a VW Golf (8,9), however, the steering column was observed to have very little movement. Although the lack of column movement could have been due to the different crash configuration, it may also have been by design. The Omni and Fuego steering columns mount to the cowl with four bolts (Figure 29 a,b). The Golf and Accord are mounted with only two bolts at the cowl (Figure 29 c,d). The lower end of the Golf column, and possibly the Accord column, appears to have been designed to allow rearward intrusion of the firewall relative to the cowl mounting, without movement of the steering wheel. In the Golf oblique barrier test, the relative movement was absorbed through deformation of the column tube webbing (Figure 29 d). In the Accord, it appears as though a nylon bushing would permit such movement. Further investigation and evaluation of

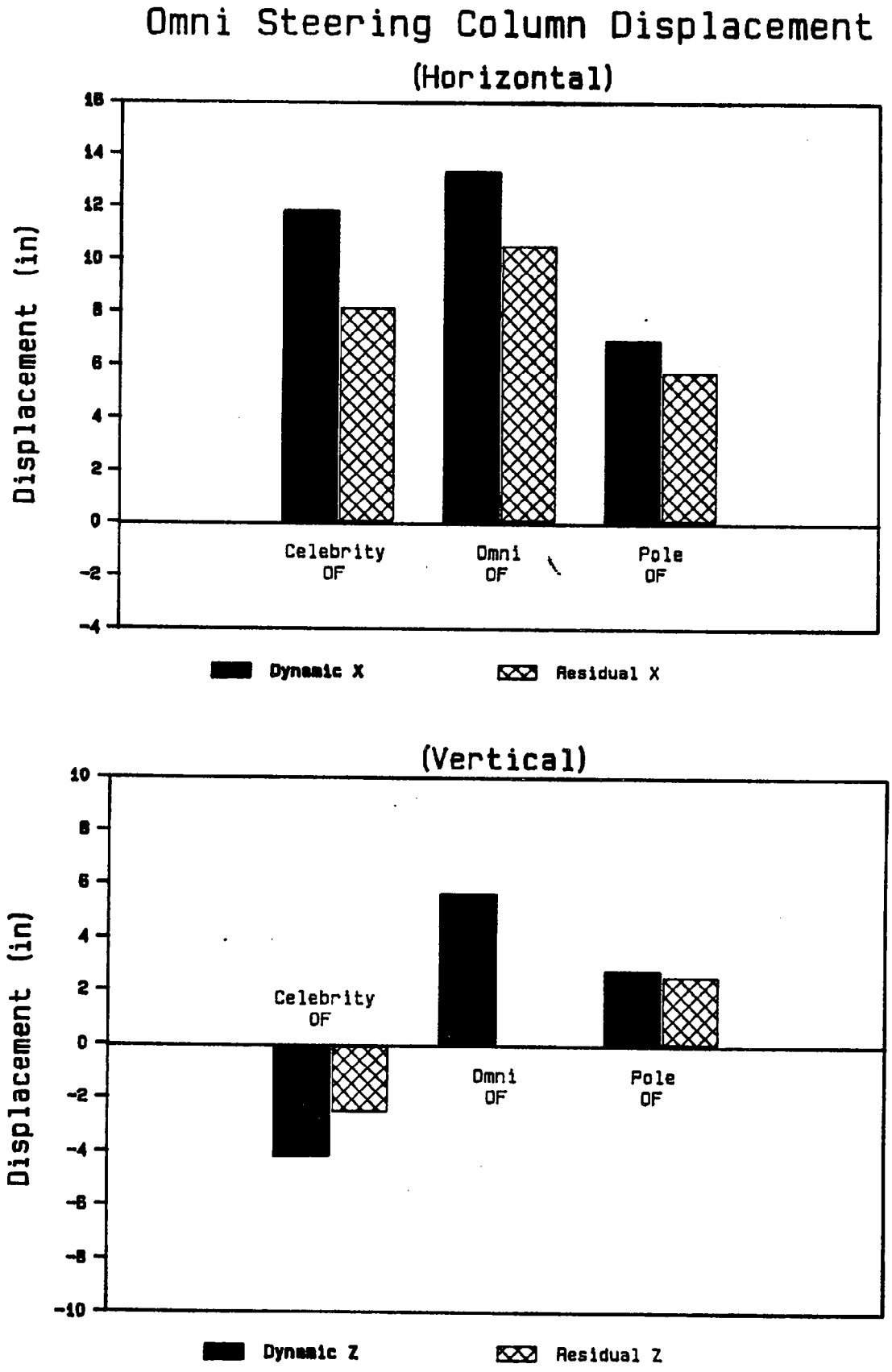


FIGURE 14 -- Omni Steering Column Performance

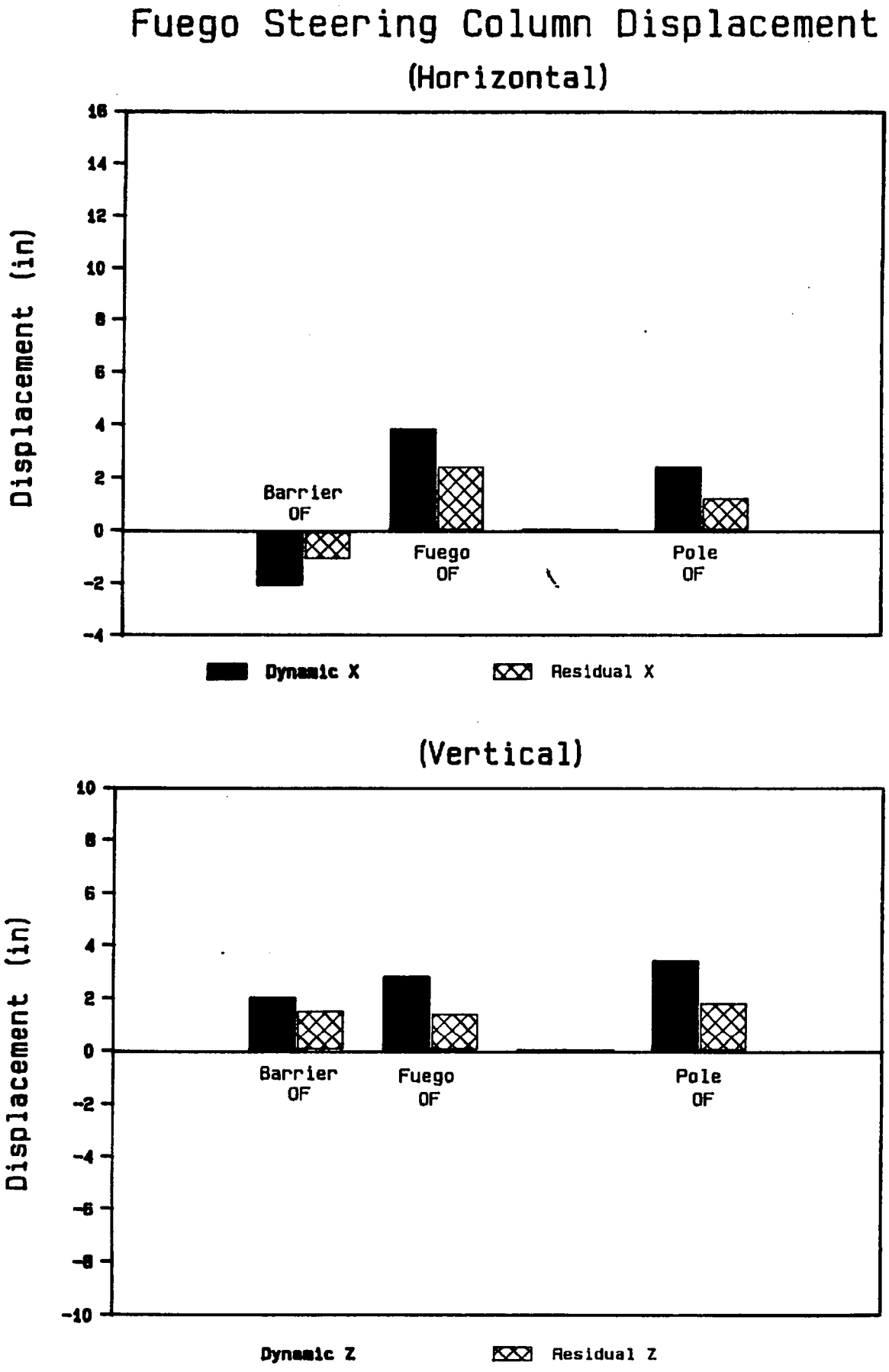


FIGURE 15 -- Fuego Steering Column Performance

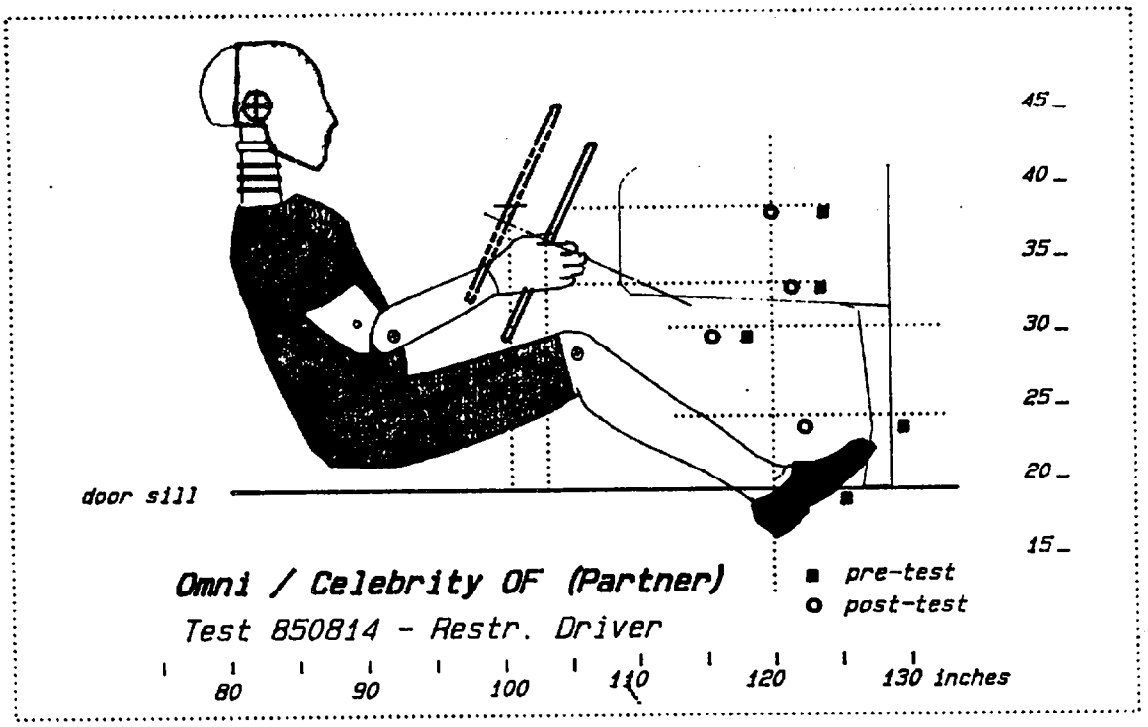


FIGURE 16 -- Celebrity Compartment Space Reduction (850814)

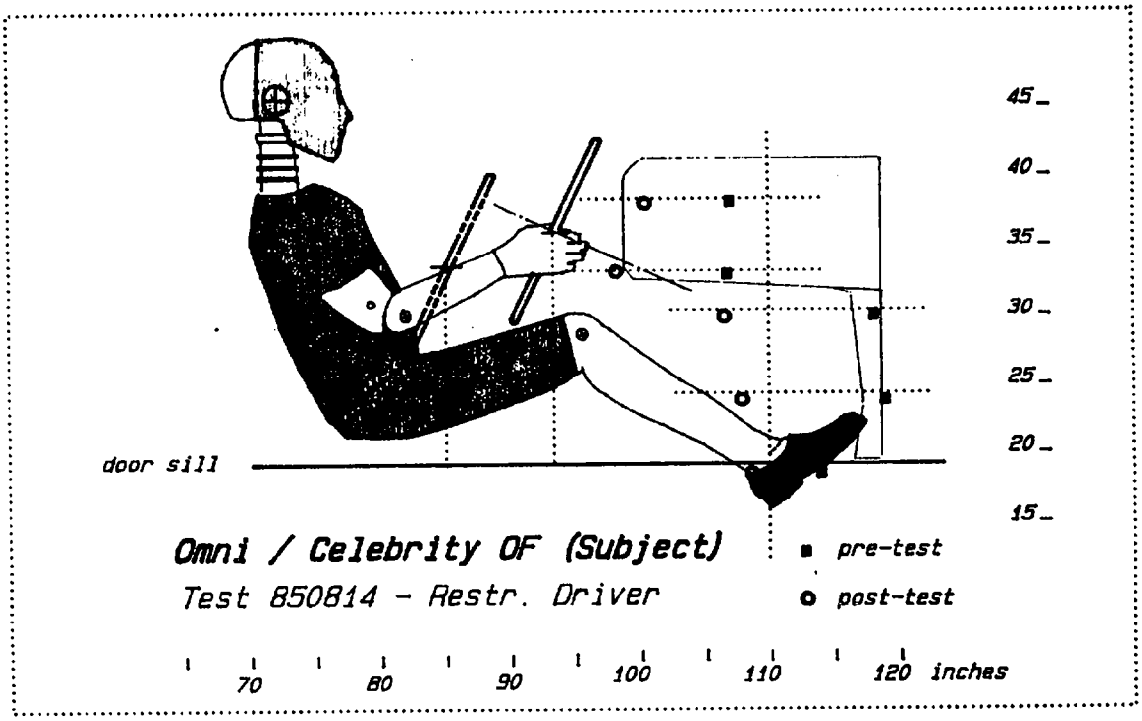


FIGURE 17 -- Omni Compartment Space Reduction (850814)

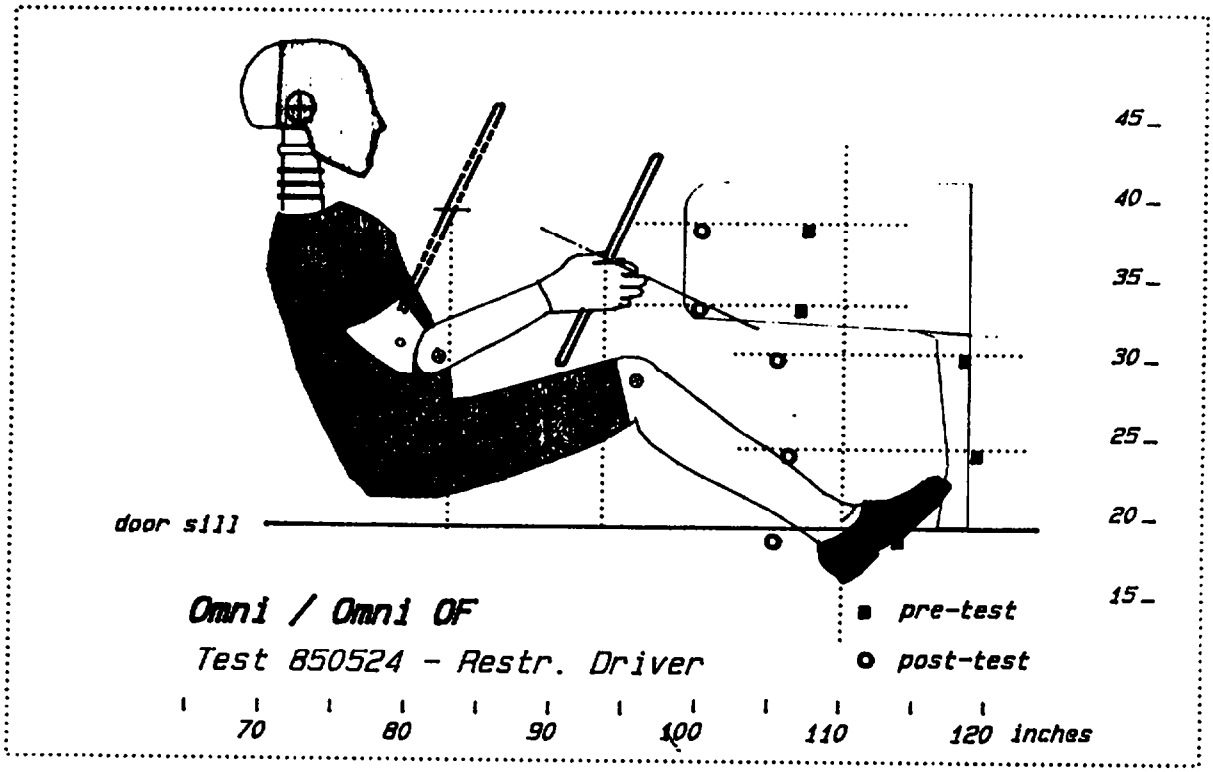


FIGURE 18 -- Omni Compartment Space Reduction (850524)

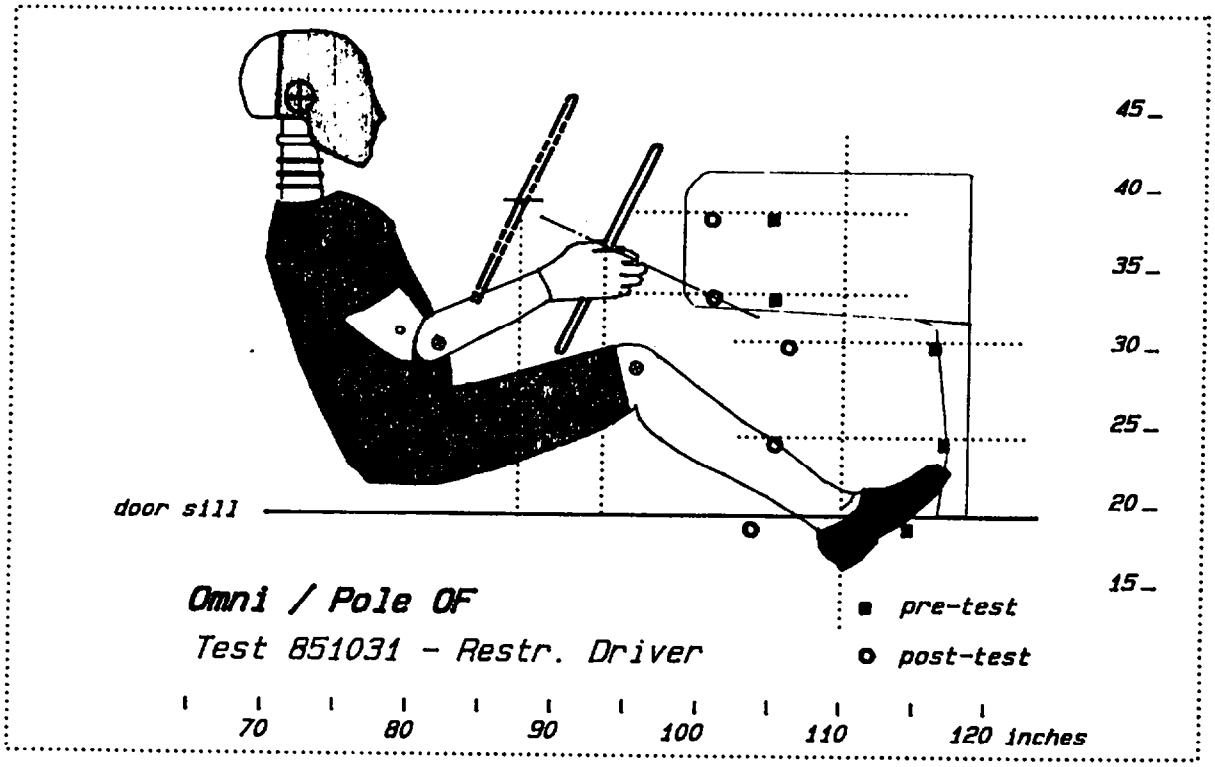


FIGURE 19 -- Omni Compartment Space Reduction (851031)

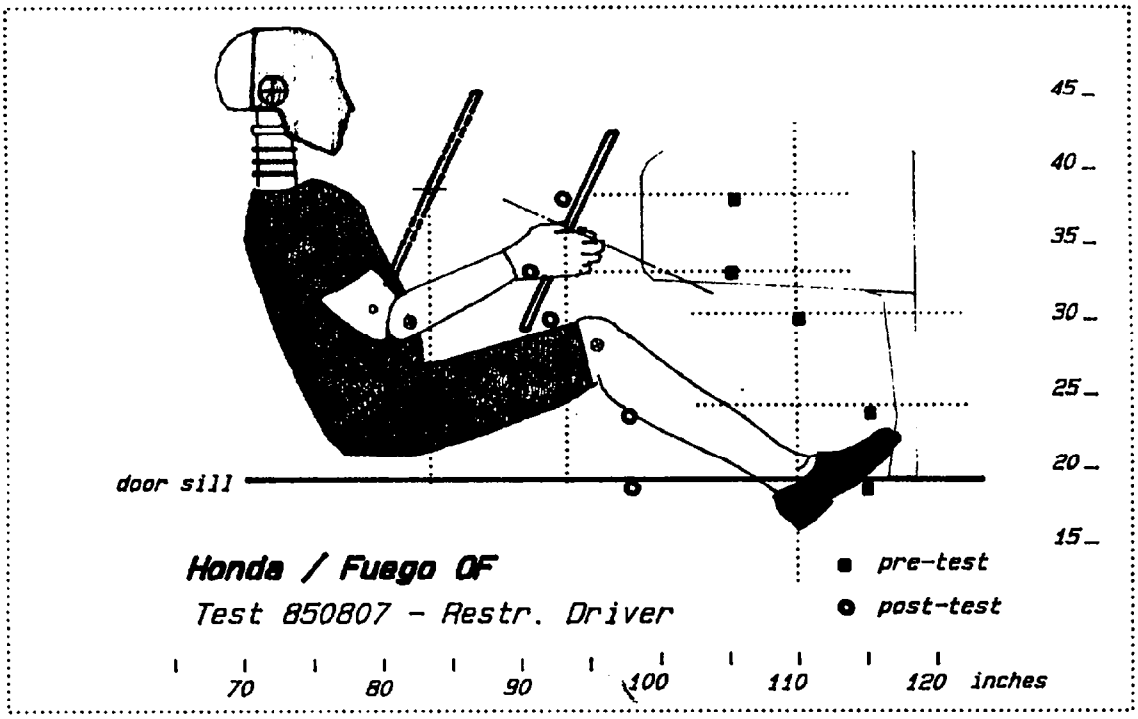


FIGURE 20 -- Honda Compartment Space Reduction (850807)

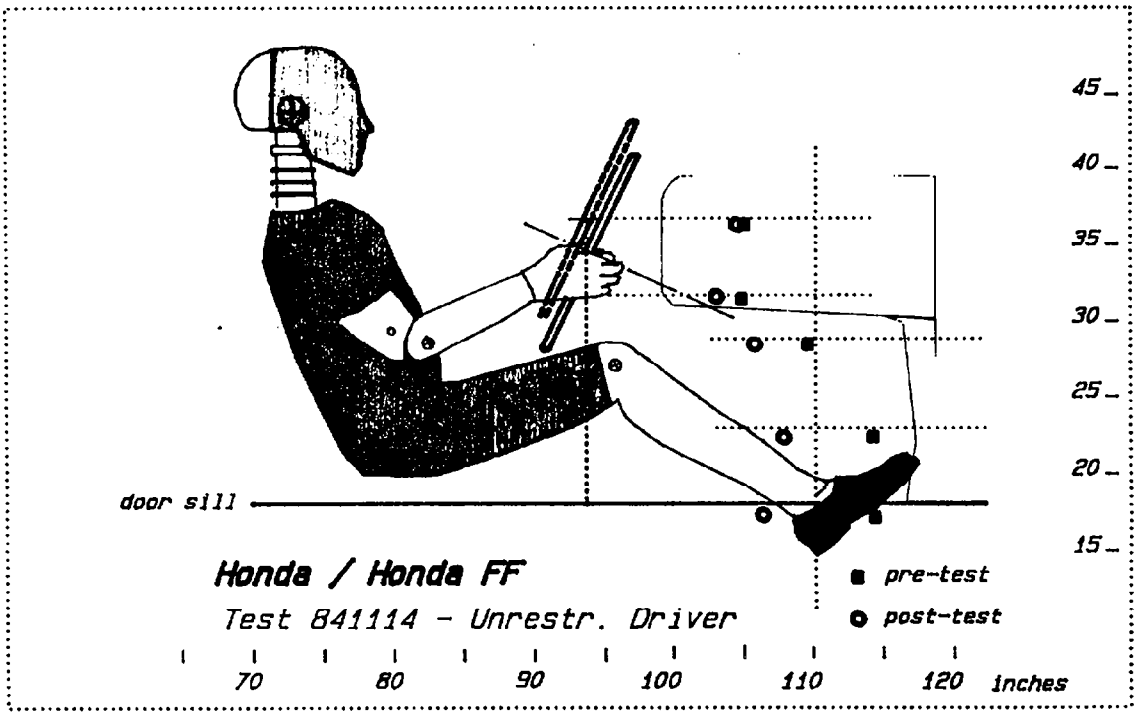


FIGURE 21 -- Honda Compartment Space Reduction (841114)

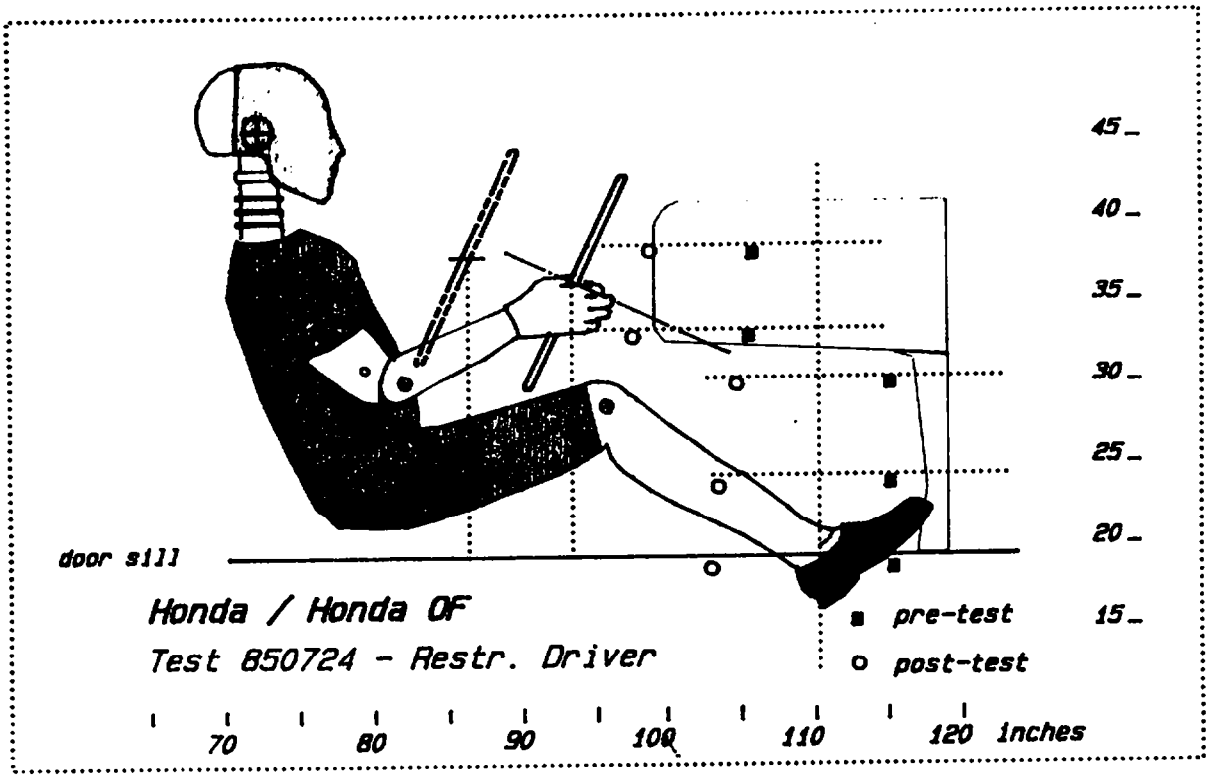


FIGURE 22 -- Honda Compartment Space Reduction (850724)

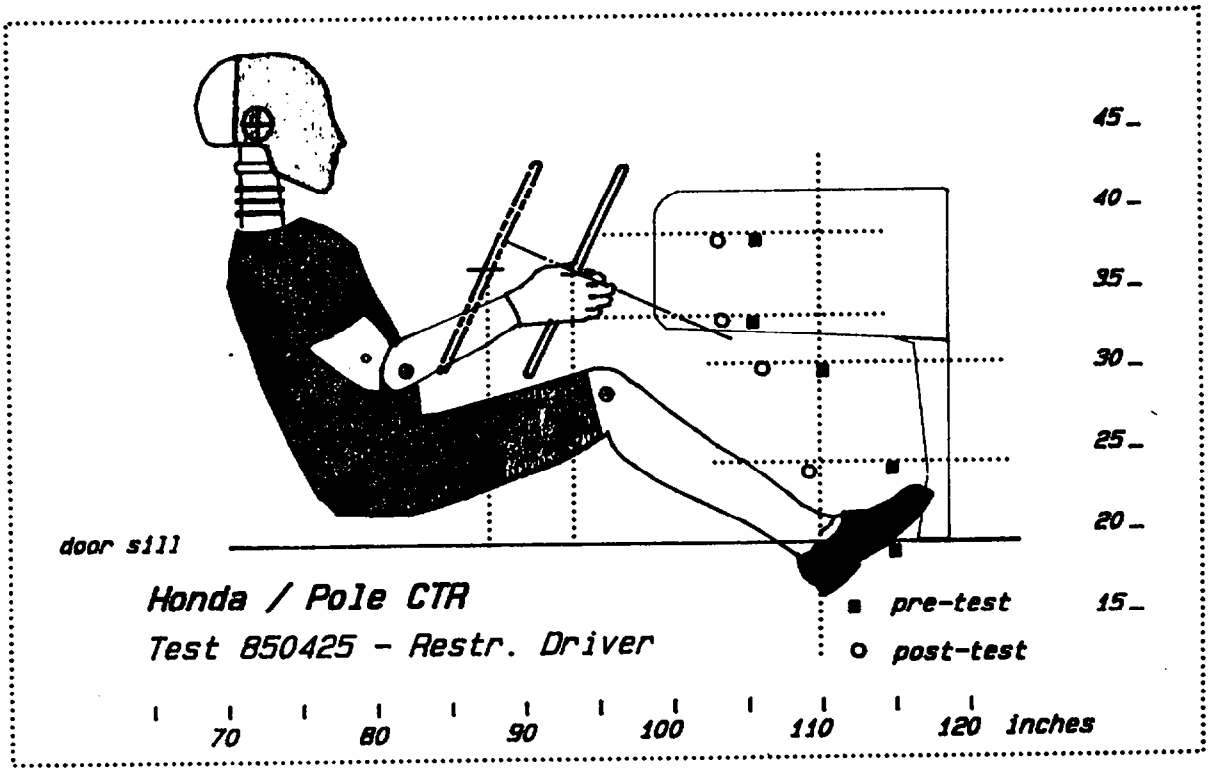


FIGURE 23 -- Honda Compartment Space Reduction (850425)

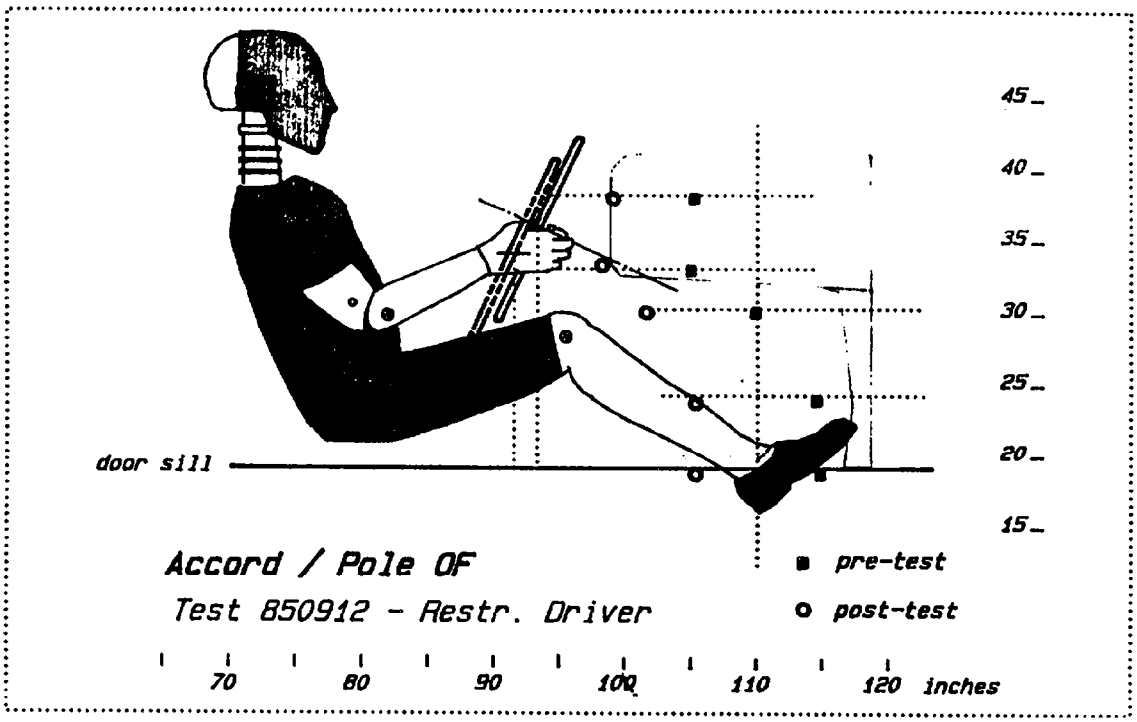


Figure 24 -- Honda Compartment Space Reduction (850912)

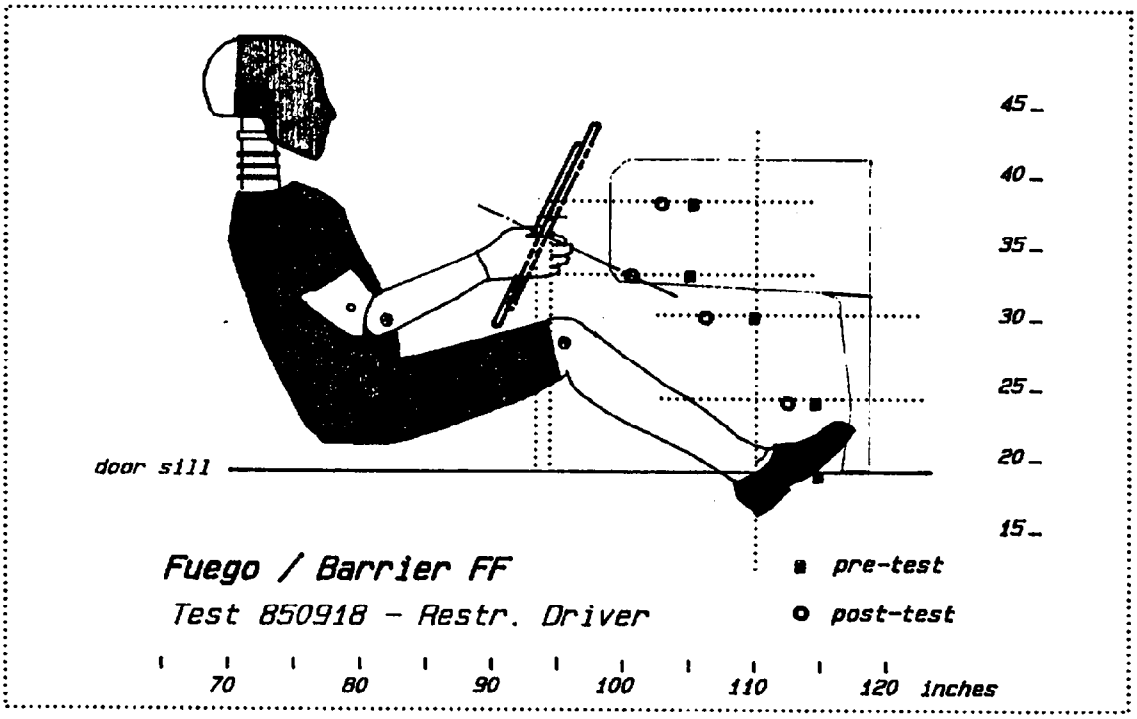


Figure 25 -- Fuego Compartment Space Reduction (850918)

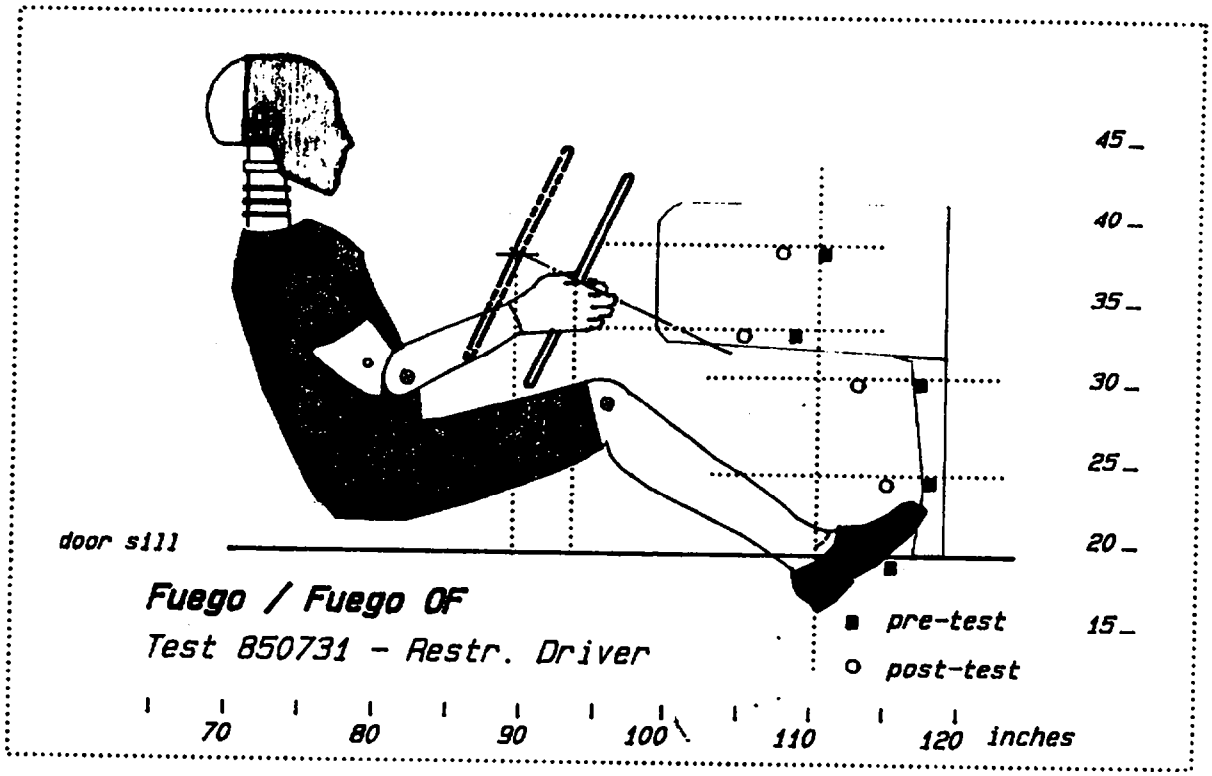


FIGURE 26 -- Fuego Compartment Space Reduction (850731)

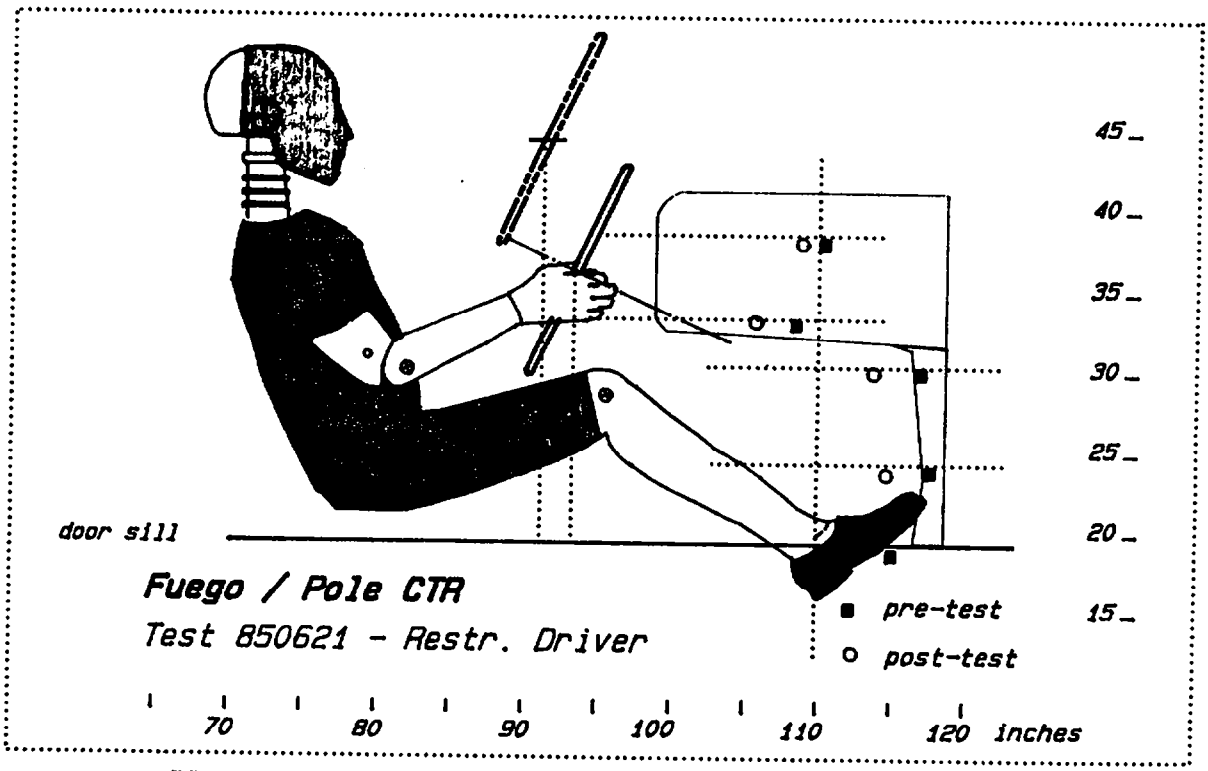


FIGURE 27 -- Fuego Compartment Space Reduction (850621)

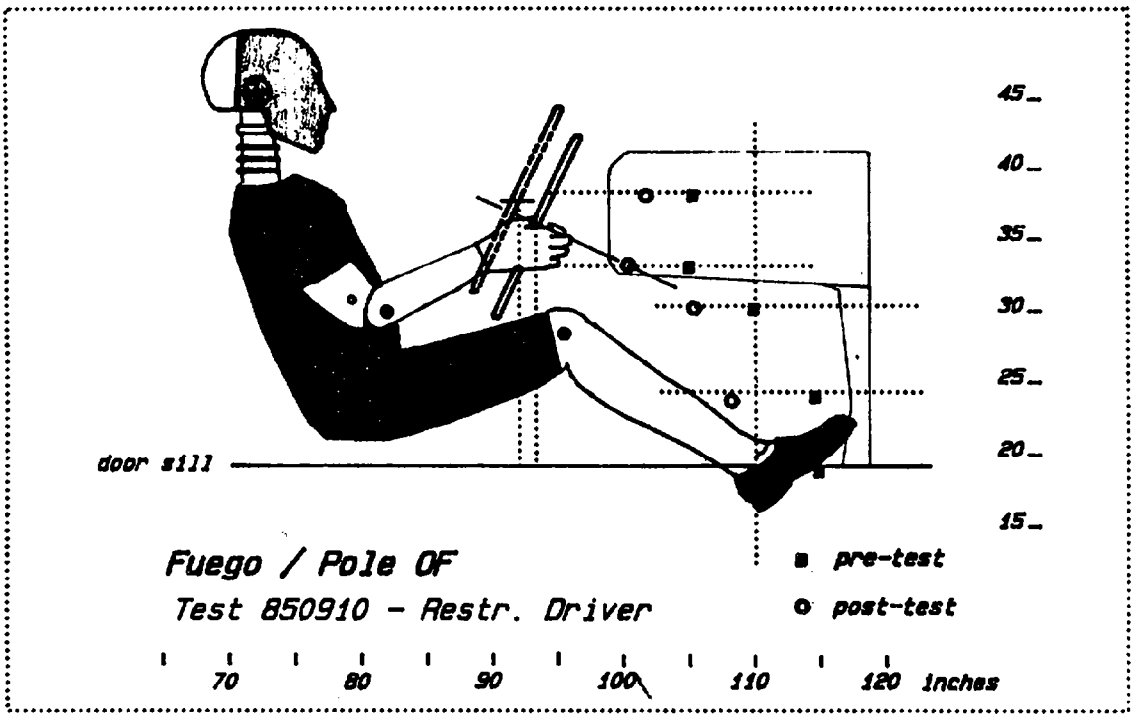
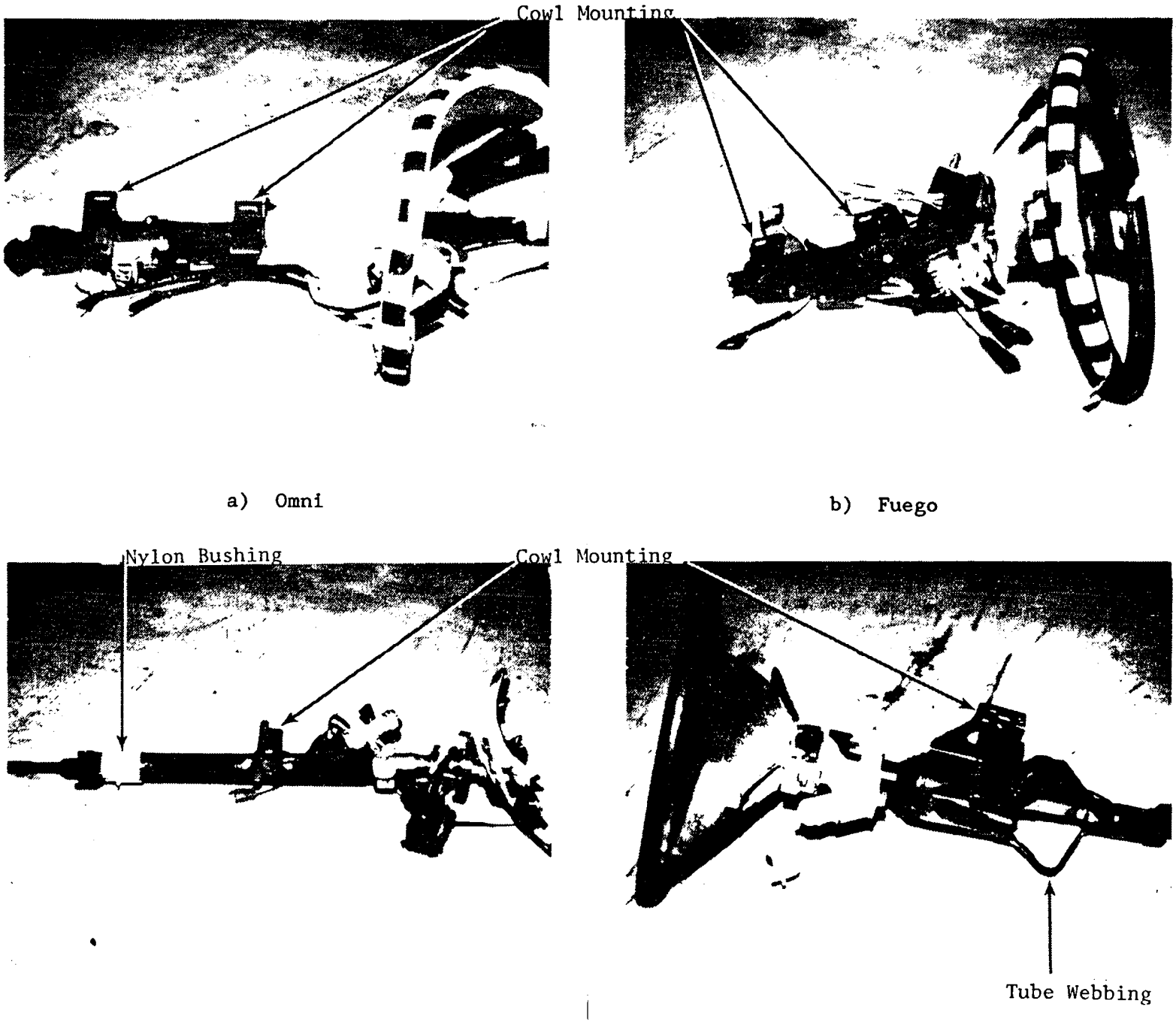


FIGURE 28 -- Fuego Compartment Space Reduction (850910)



a) Omni

b) Fuego

c) Accord

d) Golf

FIGURE 29 -- STEERING COLUMN DESIGNS

these designs is necessary and recommended to better understand their function; this cursory analysis, however, appears to indicate that limitation of the column motion is feasible in production steering column designs.

The ranges of dynamic steering column motion observed in these tests, and the vehicle and crash configuration influence on steering column response may help to explain the apparent lack of correlation between steering column performance in laboratory and compliance test results, and accident data. It also appears feasible to limit the steering column motion.

3.2 Contact Velocity Calculations

Reduced compartment AID due to intrusion, vehicle crash pulse, and steering column dynamic motion all inter-relate to determine survival for both the restrained and unrestrained occupants.

For the restrained occupant, the vertical intrusion would most likely affect the head contact location and velocity; the horizontal intrusion would affect head contact location and, to a lesser extent, contact velocity. No attempt was made to quantify these effects. This is the subject of current research on steering column induced facial injuries. Preliminary results from that work indicate that the steering column vertical velocities may be as much as 15 mph.

For the unrestrained occupant, the horizontal intrusion would primarily affect the chest contact velocity, and the vertical intrusion would influence the vertical impact location, which would be of secondary importance. Steering column velocities relative to the compartment were obtained from the horizontal displacement-time histories of Figure 7 for the Omni (850524) and Fuego (850731) since they represent extreme cases for a given crash configuration, and are shown in Figure 30. Using these velocities, and neglecting head and knee

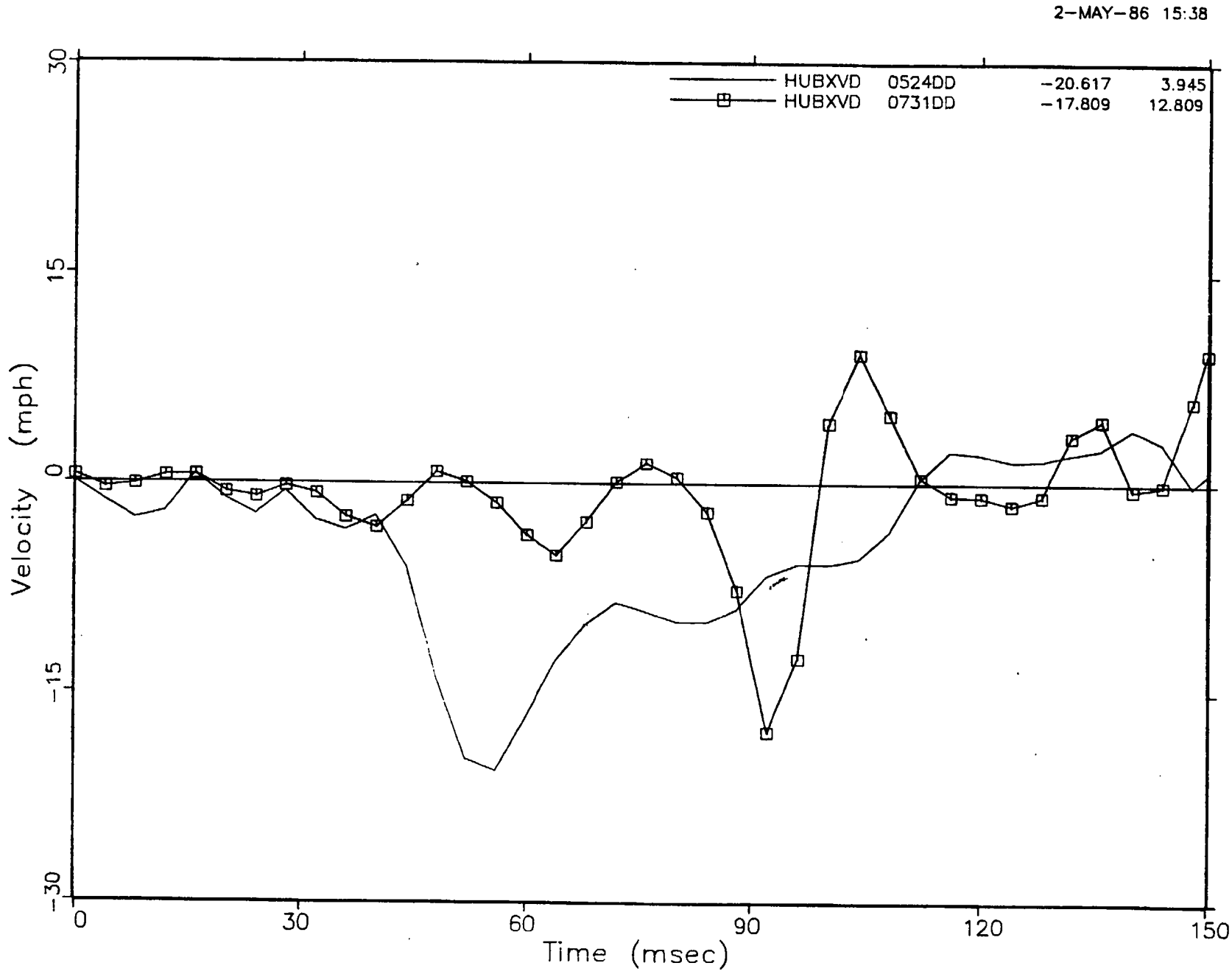


FIGURE 30 -- Steering Column Intrusion Velocities for Omni (850524) and Fuego (850731)

impact and compartment geometry effects, one-dimensional velocity-time diagrams were developed for both the Omni and Fuego (Figures 31 - 32).

The left compartment acceleration and the steering column velocities of Figure 30 were combined to produce these horizontal velocity-time diagrams. The initial dimensions from the dummy chest to the steering wheel hub was 14 - 15 inches for the Omni and Fuego. Using a 15 inch dimension, the contact velocity due to the horizontal column intrusion was estimated assuming that the occupant trajectory would have been directly forward. From Figures 31 and 32, the Omni and Fuego crash pulse differences alone would have had little effect on the unrestrained occupant contact velocity. The contact velocity (ΔV_1) for the unrestrained occupant without intrusion would have been approximately 20 1/2 mph for both tests. With the steering column intrusion taken into consideration, the unrestrained occupant contact velocity (ΔV_2) would have been 24 mph occurring at 70 msec for the Omni, and 30 mph occurring at 90 msec for the Fuego.

These extremes in steering column motion indicate that greater intrusion of the steering column into the occupant compartment (13.4 inches for the Omni versus 3.9 inches for the Fuego) does not necessarily lead to higher unrestrained occupant contact velocities. Figures 30 - 32 illustrate that the lower contact velocity for the Omni steering column intrusion is a result of the intrusion occurring earlier in the crash event than in the Fuego test. The Fuego intrusion began at approximately 80 msec, whereas the Omni intrusion began at 50 msec leading to the reduced contact velocity and greater structural ride-down for the unrestrained occupant. This analysis would indicate that the time of occurrence of steering column intrusion is a greater determinant of unrestrained occupant contact velocity than the amount of intrusion. It also illustrates the sensitivity of the intrusion timing. For example, if the unrestrained Fuego and Omni occupants had been a few inches out-of-position (closer to the steering column) at the time of the crash, the results could have been strongly reversed. That is, the occupant contact velocity could

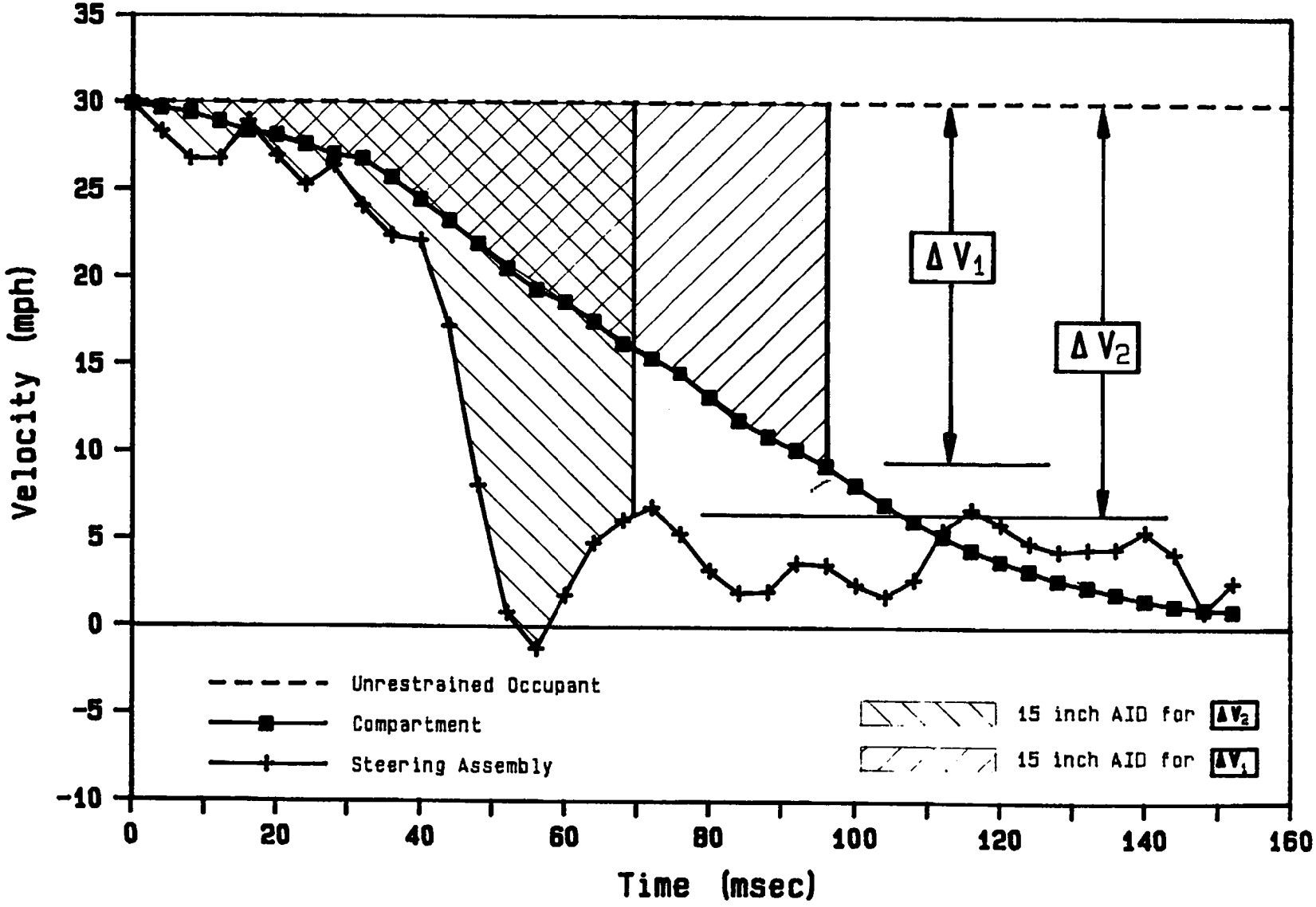


FIGURE 31 -- Omni (850524) Velocity-Time Diagram for Unrestrained Occupant

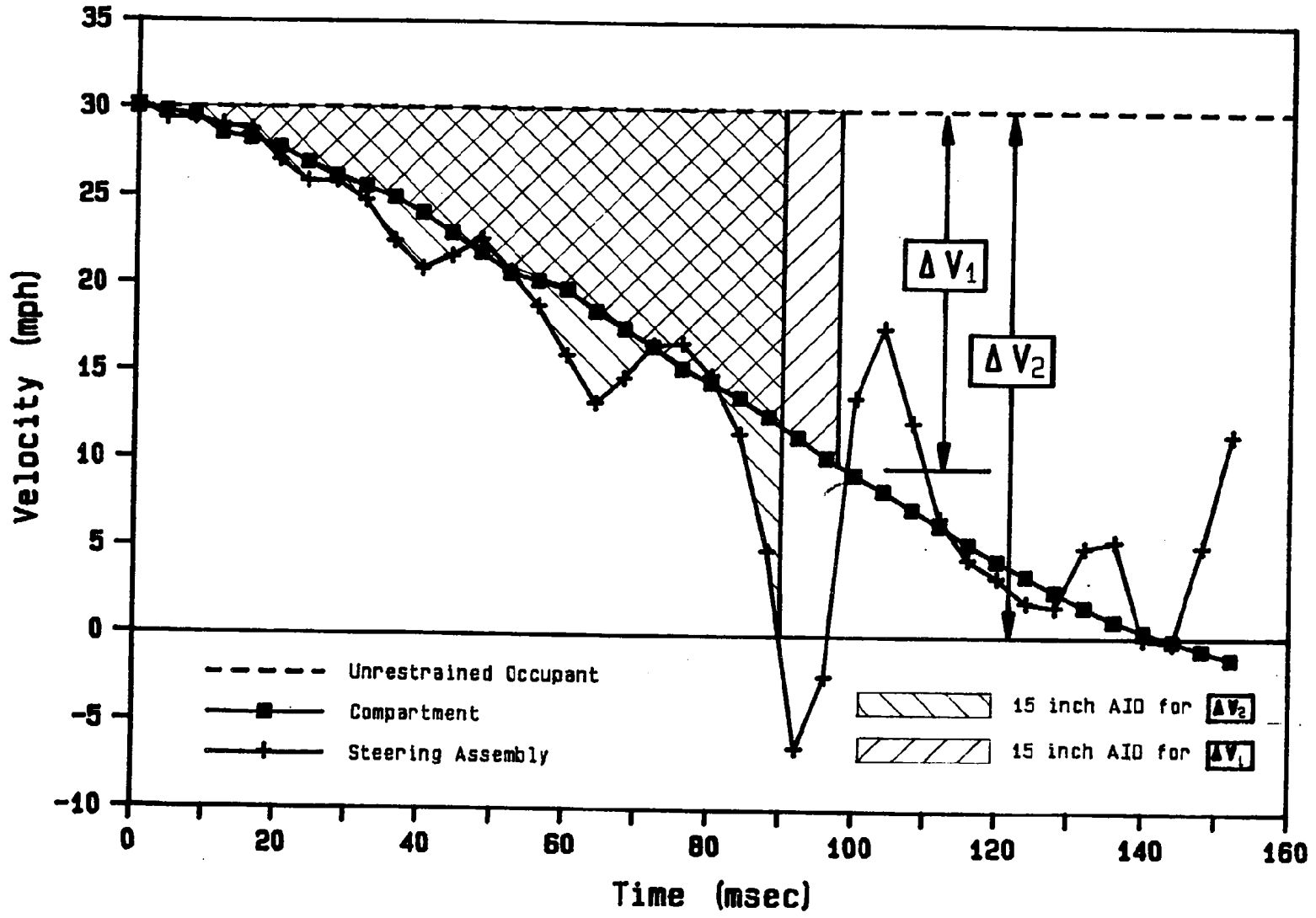


FIGURE 32 -- Fuego (850731) Velocity-Time Diagram for Unrestrained Occupant

easily have been 30 mph (instead of 24) in the Omni, and 15 mph (instead of 30) in the Fuego.

3.3 Dummy Measurement Correlation

The differences in contact velocities for the Omni and Fuego drivers shown in Figures 31 and 32 would be expected to affect dummy responses. Four of the tests in the analysis (including the Omni 850524 and Fuego 850731 tests) were mirror imaged tests with unrestrained Hybrid III drivers in the opposite vehicle. If the intrusion and column motion in both the subject and partner vehicles of each test are assumed to be the same, then the Hybrid III driver response differences between tests can be attributed to steering column motion and intrusion effects given that the column EA capabilities are similar.

The unrestrained Hybrid III driver chest measurements are shown in Table 3 for these four tests. The Omni and Fuego represented column motion and intrusion extremes, but the Hybrid III chest measurements were not significantly different. The Hybrid III chest acceleration of 54g for the Fuego was only 5g (10%) higher than in the Omni test, even though Figures 31 and 32 indicated that a 6 mph (25%) higher contact velocity occurred in the Fuego.

The chest deflections do not appear reasonable. The chest calibration at 22 fps with a six inch rigid impact should simulate a steering wheel hub impact. The Hybrid III 22 fps chest calibration deflection requirement is 2.5 inches. The contact velocities for both the Omni and Fuego would appear to have been greater than 22 fps (15 mph), indicating that the low deflections of Table 3 are likely due to the deflection measurement sensitivity of the Hybrid III to off-axis loading conditions. The sensitivity of the Hybrid III chest deflection measurement is also shown in the two Honda tests. Although the chest acceleration levels are the same, the deflection for the offset test was considerably lower due to the off axis (approximately 10 degrees) loading.

Table 3

SC Movement vs. Dummy Measurement

Vehicle	STEERING COLUMN MEASUREMENT						UNRESTRAINED DRIVER DUMMY MEASUREMENT	
			Steering Column Film Analysis					
	Test No.	Test Configuration	Peak X	Dynamic Z	Residual X	Residual Z	Hybrid III Chest Acceleration (G)	Hybrid III Chest Deflection (in)
Celebrity	850814	Omni OF	3.6	3.2	2.5	2.3		
Omni	850814	Celebrity OF	11.9	-4.2	8.2	-2.6		
Omni	850524	Omni OF	13.4	5.7	10.6	0.0	49	0.37
Omni	851031	Pole OF	7.0	2.8	5.8	2.6		
Honda	850807	Fuego OF	NA	NA	NA	NA		
Honda	841114	Honda FF	NA	NA	NA	NA	59	1.82
Honda	850724	Honda OF	10.4	-4.5	7.0	-0.7	57	0.29
Honda	850425	Pole CTR	NA	NA	NA	NA		
Honda	850912	Pole OF	3.4	-2.3	1.8	-1.9		
Fuego	850918	Barrier FF	-2.1	2.1	-1.1	1.6		
Fuego	850731	Fuego OF	3.9	2.9	2.5	1.5	54	0.26
Fuego	850621	Pole CTR	NA	NA	NA	NA		
Fuego	850910	Pole OF	2.5	3.5	1.3	1.9		

As a final check on the unrestrained occupant contact velocity analysis for the Omni and Fuego, the unrestrained Hybrid III driver measurements were examined from these tests. The dummy measurements support the results of the analysis from Figures 31 and 32, in indicating that the Omni unrestrained occupant impact with the steering column occurred 20 msec earlier than in the Fuego test. The dummy measurements, however, indicated contact times which were approximately 10 msec earlier than those of Figures 31 and 32. As discussed in section 3.2, the intrusion timing is critical to determining the contact velocity, and the 10 msec earlier contact could explain the dummy chest acceleration and deflection measurement similarity for the Omni and Fuego. The earlier contact time indication from the dummy measurements could have been caused by a number of factors including vehicle crash pulse differences, steering column dynamic performance differences, and film analysis inaccuracies. It further illustrates the intrusion timing sensitivity to occupant contact velocity, and the need to dynamically measure the steering column motion.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The steering column performance from thirteen 30 mph ΔV crash tests of Celebrity, Omni, Accord, and Fuego vehicles was analyzed using static measurements, photographic film analysis, a simple, one-dimensional model, and dummy measurement responses. The procedures described in the analysis provide a methodology for documenting intrusion and steering column dynamic performance in crash testing. In addition, a limited post-test comparison of the Omni, Accord, and Fuego columns was made with that of a VW Golf which had experienced a 30 mph ΔV oblique barrier collision. The following conclusions were made from the analysis:

- The importance of measuring steering column motion was clearly demonstrated. Significant differences between dynamic motions and residual displacements measured post-test were observed.

- Although the magnitude of intrusion of the steering column into the occupant compartment did not correlate with unrestrained driver contact velocity, the time occurrence of steering column intrusion was found to be a critial factor in determining unrestrained driver contact velocity.

- Unrestrained driver contact velocities estimated both with and without steering column intrusion indicated that considerably higher contact velocities can occur with intrusion.

- Post-test examination of the steering assemblies appeared to indicate that limitation of column motion due to firewall intrusion is feasible in production steering column designs.

- The column performance was dependant upon not only the vehicle, but also the crash configuration.

- The residual rearward position of the steering column was 50 - 80% of the peak dynamic displacement. There was no correlation for the vertical displacement.

- Intrusion of the cowl structure was well correlated with the horizontal residual steering column movement.

- The maximum upward movement of the column was less than six inches.

- The horizontal movement of the steering column was rearward in all cases except the Fuego/FRB test. The forward movement in the Fixed Rigid Barrier test was the result of column rotation.

- Hybrid III chest deflection measurements in offset frontal tests were unreasonably low, likely due to the deflection measurement sensitivity to off-axis loading conditions.

The dependence of the steering column dynamic performance on the crash configuration, and the importance the column intrusion time occurrence has in determining the unrestrained driver contact velocity may well be significant factors in explaining the discrepancy between test results and accident data. The following recommendations are made for future steering assembly efforts:

- Apply the static measurement and photographic film analysis methodology developed in this study to other production vehicles and crash configurations to better characterize steering column intrusion and its effect on occupant contact velocities.

- Identify existing and/or develop new ways of mounting steering assemblies in vehicles which reduce column motion during typical crashes.

- Establish steering column performance requirements to be effective over ranges of intrusion, contact velocity, and column angular motion, as determined from crash test results on vehicles with improved column mounting designs.

- Utilize Hybrid III chest acceleration rather than chest deflection to assess injury severity from off-axis steering assembly chest impacts until the Hybrid III deflection criterion has been extended to the off-axis loading condition.

5.0 REFERENCES

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8. Wade, B. and Sankey, J.; "FMVSS 208 RM CRASH SIMULATION SUPPORT: A Crash Test of A 1986 Volkswagen Golf Into A Fixed 30 Degree Oblique Barrier With A Closing Velocity of 48.4 kph," Test Report No. 860220, Vehicle Research and Test Center, Project No. VRTC-86-0027, March 1986.

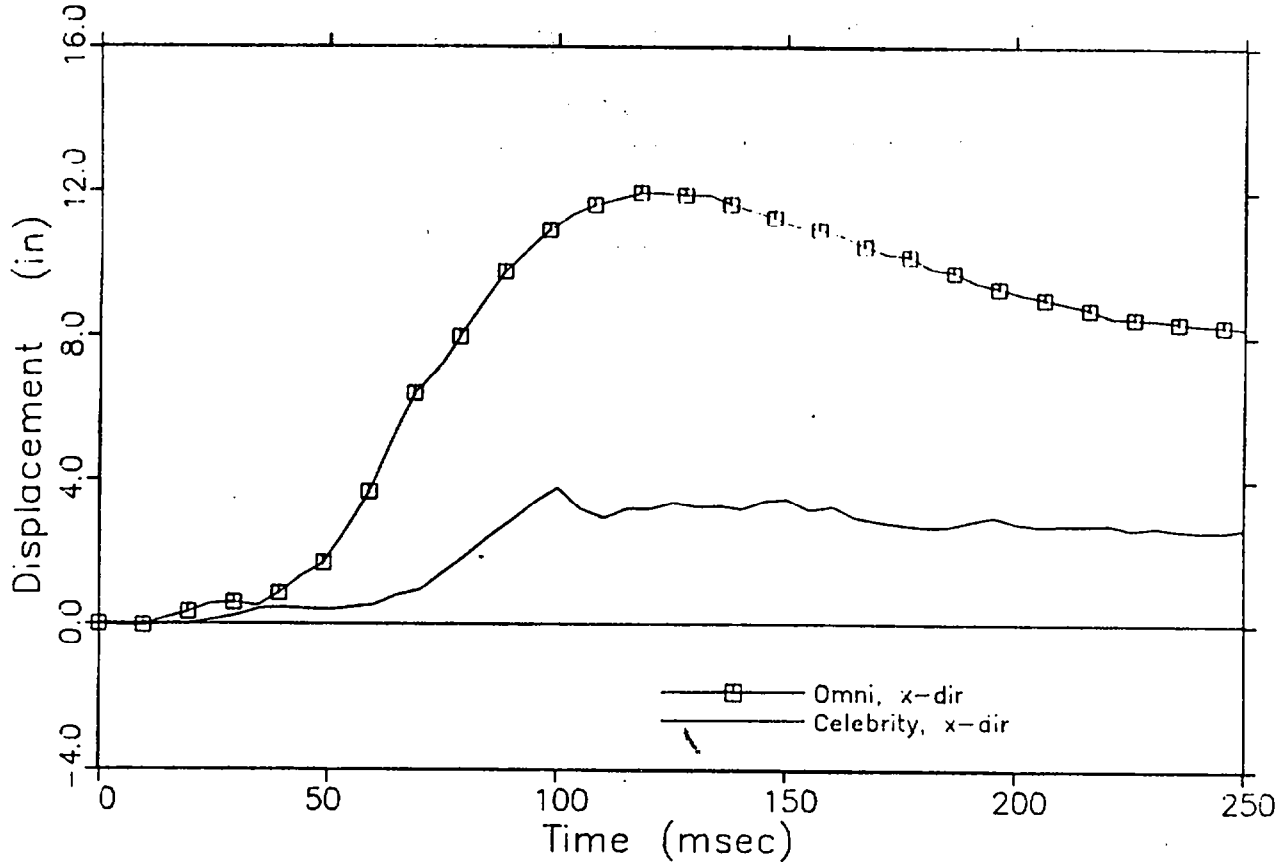
9. Wade, B. and Sankey, J.; "FMVSS 208 RM CRASH SIMULATION SUPPORT: A Crash Test of A 1986 Volkswagen Golf Into A Fixed 30 Degree Oblique Barrier With A Closing Velocity of 48.3 kph," Test Report No. 860225, Vehicle Research and Test Center, Project No. VRTC-86-0027, March 1986.

APPENDIX

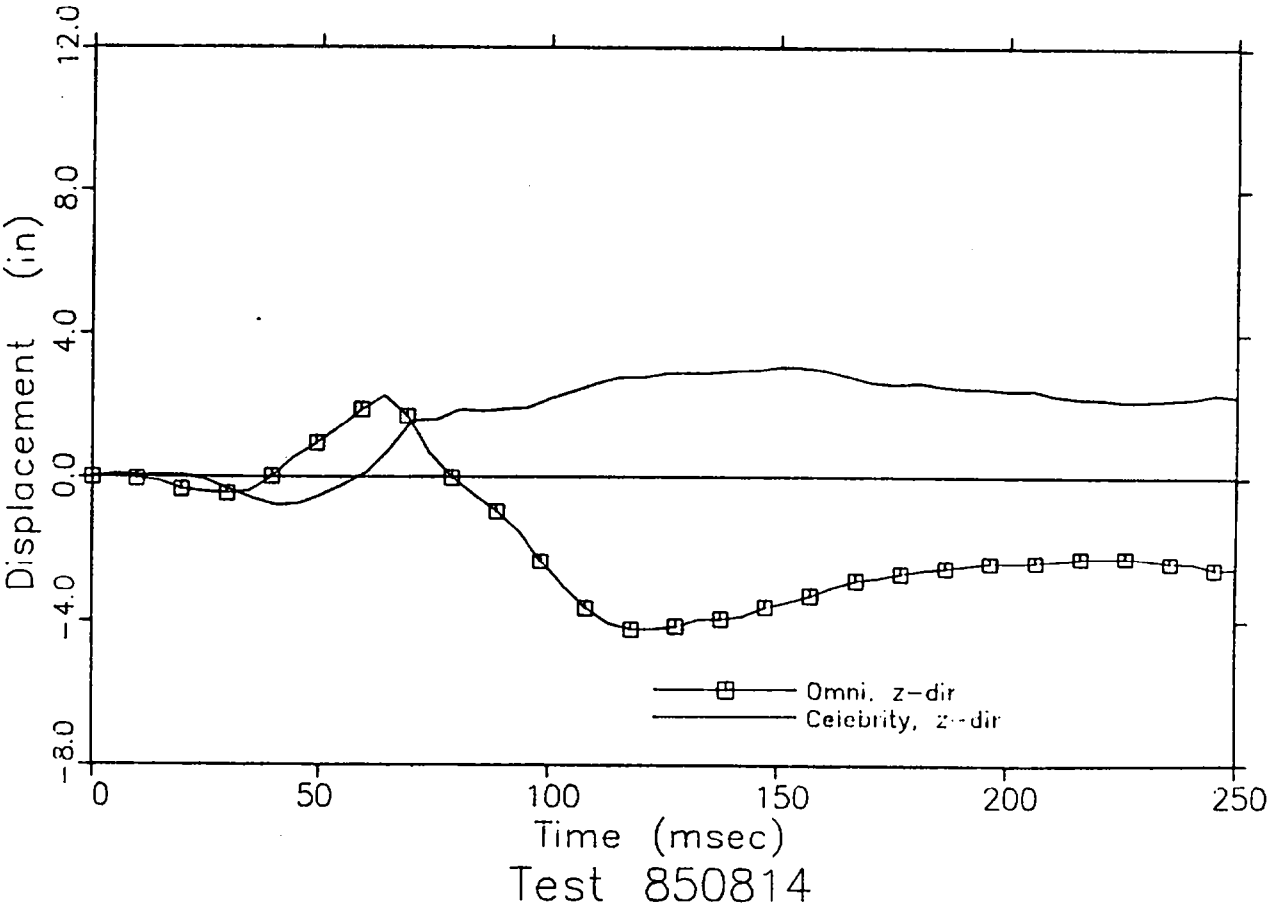
Steering Column and Intrusion Analysis Data

Omni/Celebrity OF

Test Number 850814



a) Horizontal (Positive Rearward)

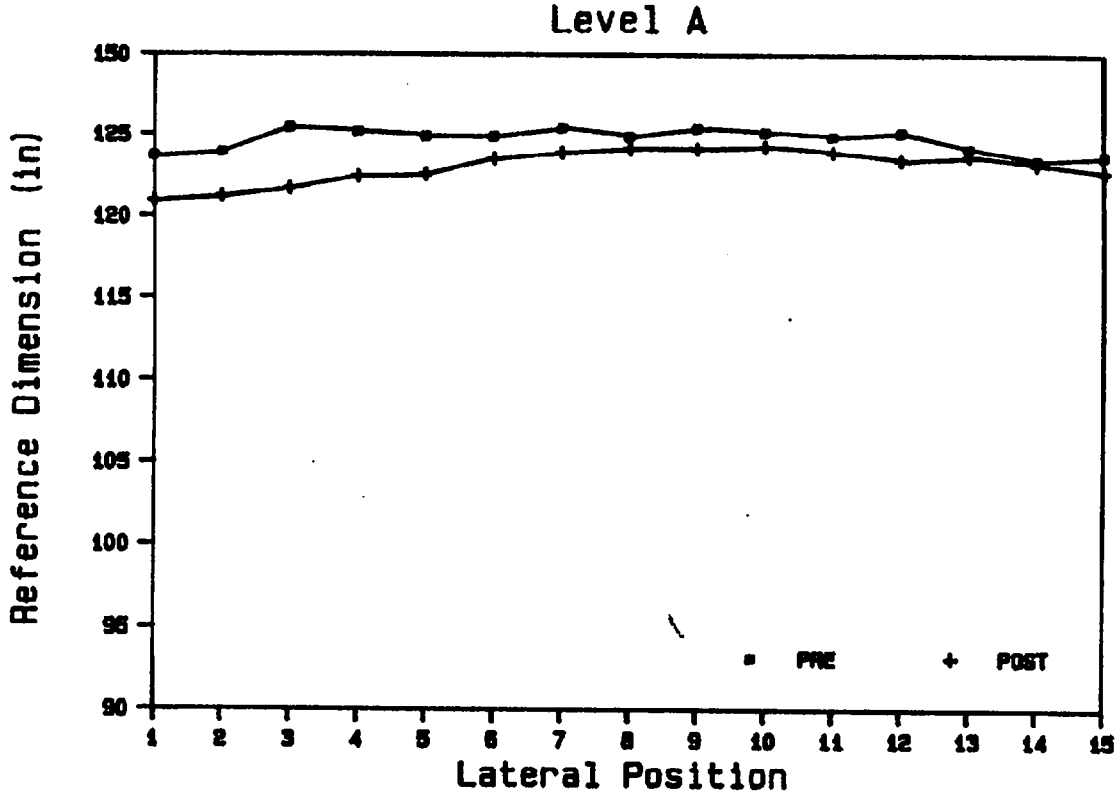


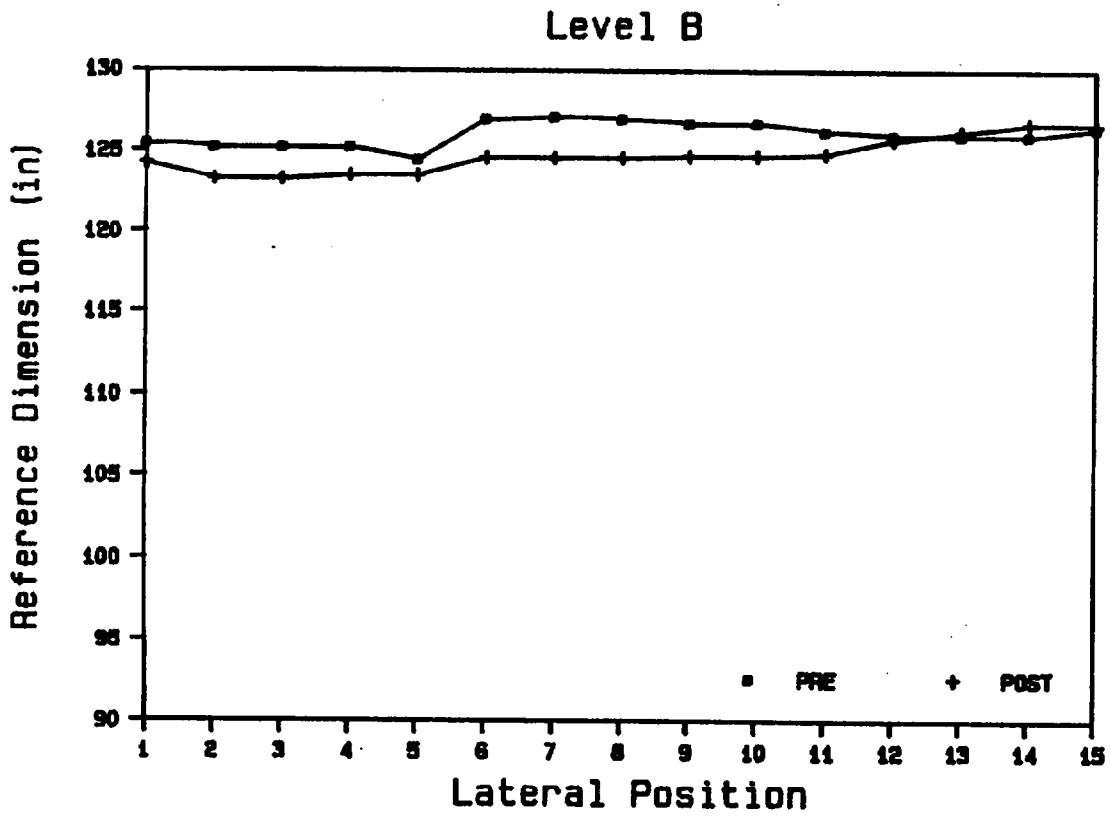
Test 850814

b) Vertical (Positive Upward)

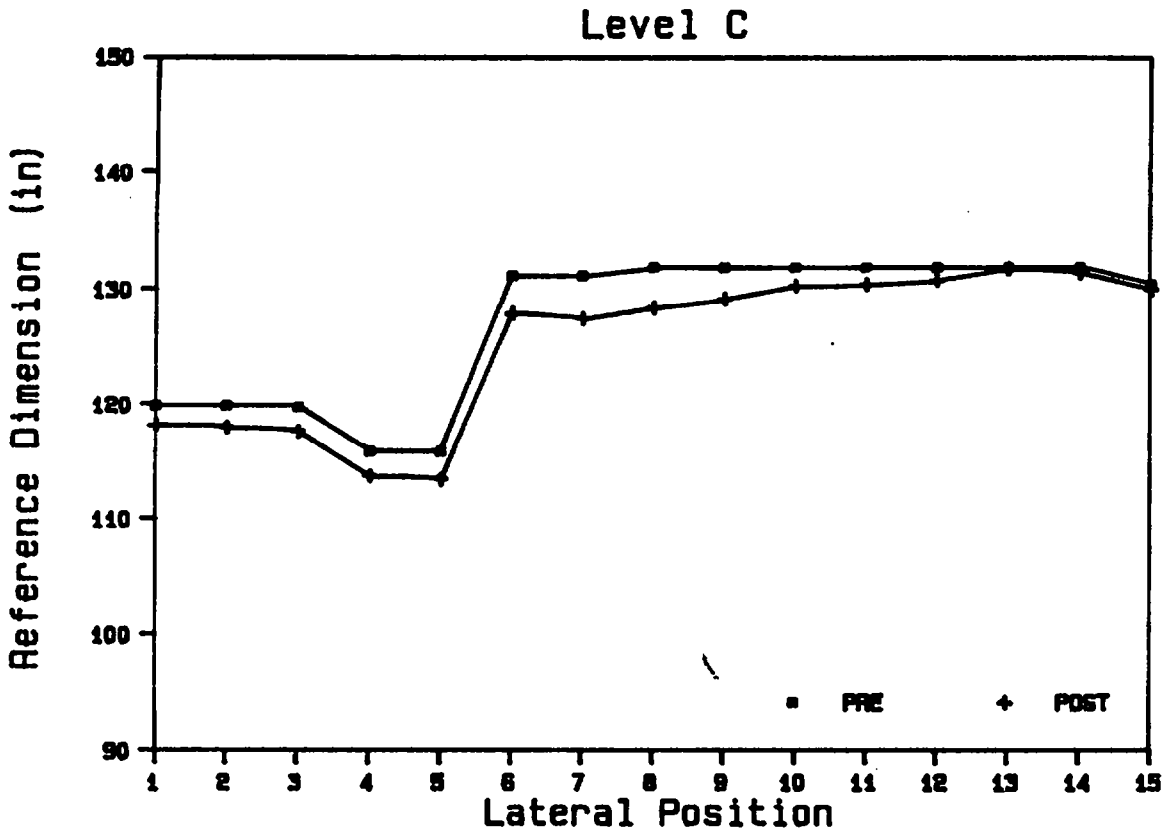
Steering Column Movement

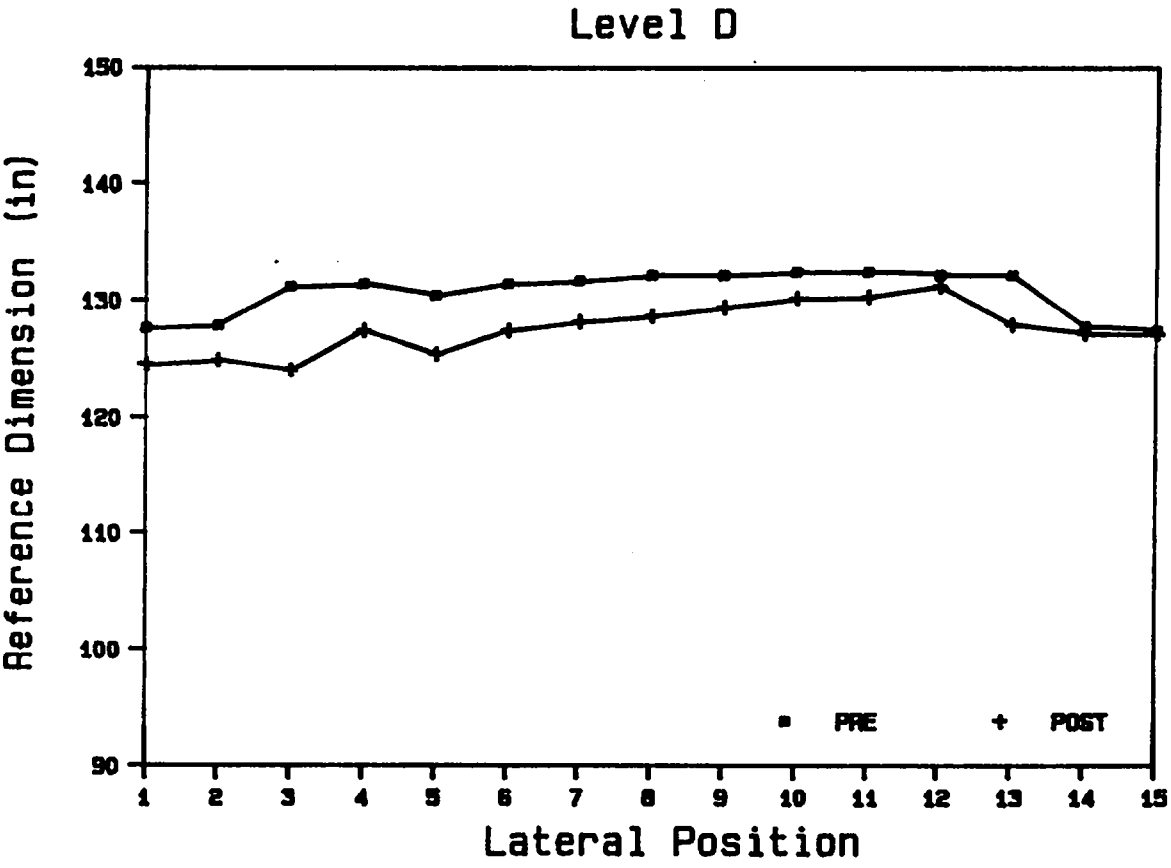
Celebrity Intrusion - Test 850814





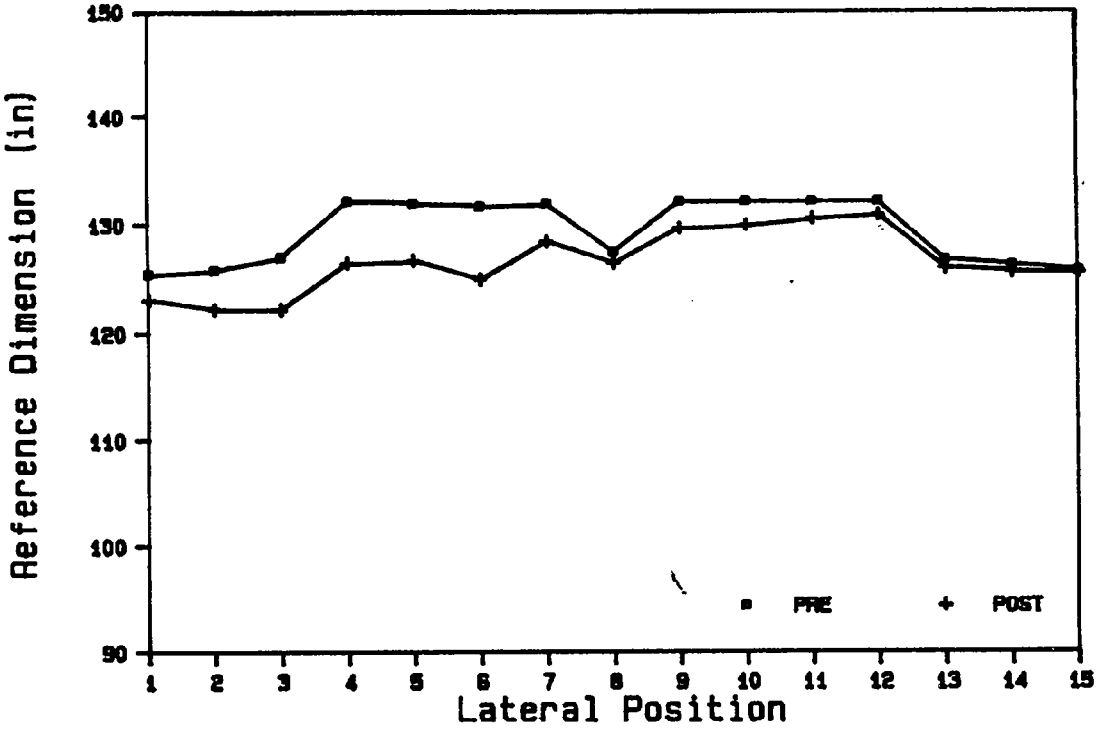
Celebrity Intrusion - Test 850814





Celebrity Intrusion - Test 850814

Level E

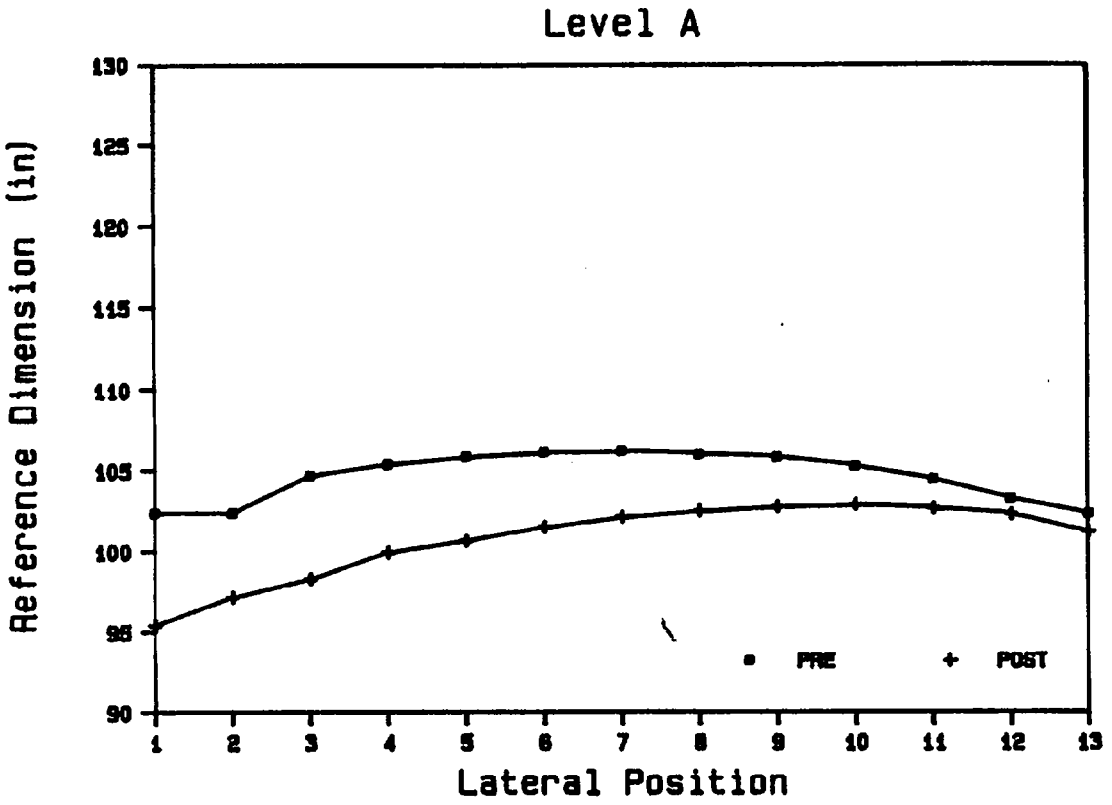


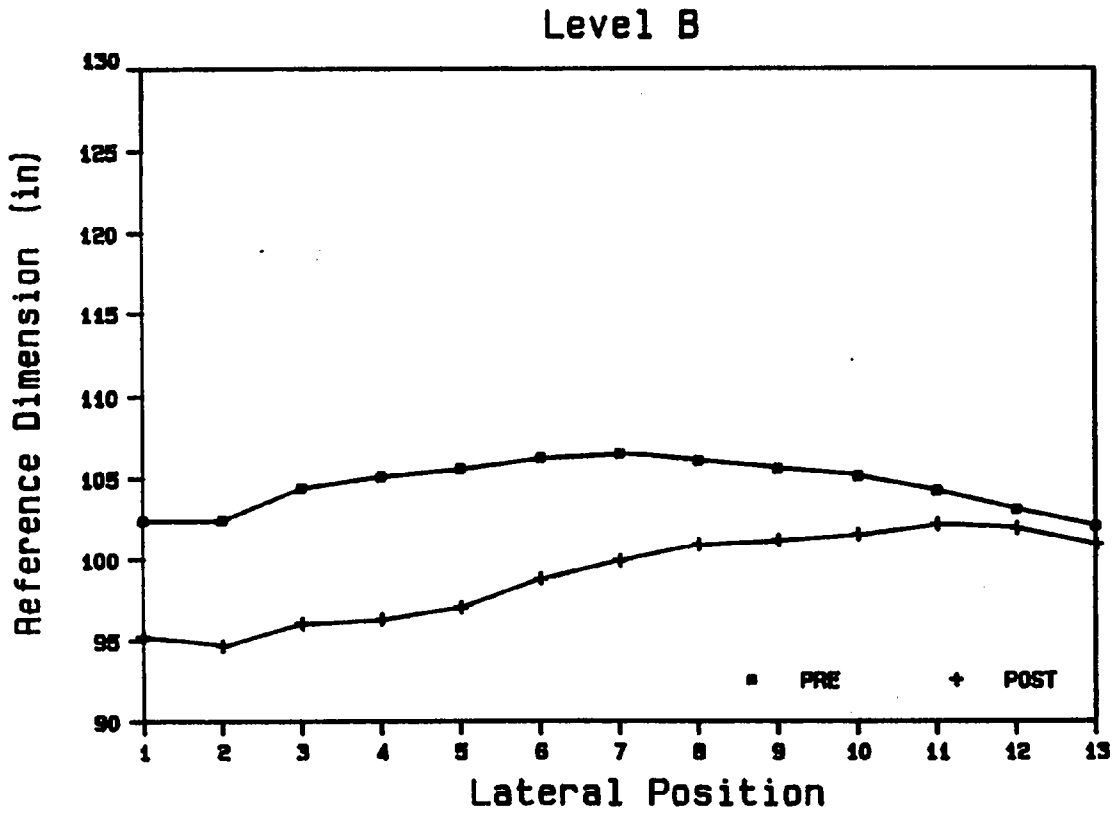
REFERENCE MEASUREMENTS

Celebrity OF *Test 850814*

Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	PRE	123.75	124.00	125.50	125.25	125.00	125.00	125.50	125.00	125.50	125.25	125.00	125.25	124.25	123.50	123.75
	POST	121.00	121.25	121.75	122.50	122.63	123.63	124.00	124.25	124.25	124.38	124.00	123.50	123.75	123.25	122.75
	DIFF.	2.75	2.75	(3.75)	2.75	2.38	1.38	1.50	0.75	1.25	0.88	1.00	1.75	0.50	0.25	1.00
B	PRE	125.50	125.25	125.25	125.25	124.50	127.00	127.13	127.00	126.75	126.75	126.25	126.00	126.00	126.00	126.50
	POST	124.25	123.25	123.25	123.50	123.50	124.63	124.63	124.63	124.75	124.75	124.88	125.75	126.25	126.75	126.63
	DIFF.	1.25	2.00	2.00	1.75	1.00	2.38	(2.50)	2.38	2.00	2.00	1.38	0.25	-0.25	-0.75	-0.13
C	PRE	120.00	120.00	119.88	116.00	116.00	131.25	131.25	132.00	132.00	132.00	132.00	132.00	132.00	132.00	130.50
	POST	118.25	118.00	117.63	113.75	113.50	128.00	127.50	128.50	129.25	130.38	130.50	130.88	131.88	131.50	130.00
	DIFF.	1.75	2.00	2.25	2.25	2.50	3.25	(3.75)	3.50	2.75	1.63	1.50	1.13	0.13	0.50	0.50
D	PRE	127.75	128.00	131.25	131.50	130.50	131.50	131.75	132.25	132.25	132.50	132.50	132.25	132.25	127.88	127.50
	POST	124.63	125.00	124.13	127.50	125.50	127.50	128.25	128.75	129.50	130.25	130.38	131.25	128.00	127.25	127.25
	DIFF.	3.13	3.00	(7.13)	4.00	5.00	4.00	3.50	3.50	2.75	2.25	2.13	1.00	4.25	0.63	0.25
E	PRE	125.50	125.88	127.00	132.25	132.00	131.75	132.00	127.50	132.25	132.25	132.25	132.25	126.75	126.25	125.75
	POST	123.13	122.25	122.25	126.50	126.75	125.00	128.50	126.50	129.75	130.00	130.63	131.00	126.00	125.63	125.63
	DIFF.	2.38	3.63	4.75	5.75	5.25	(6.75)	3.50	1.00	2.50	2.25	1.63	1.25	0.75	0.63	0.13

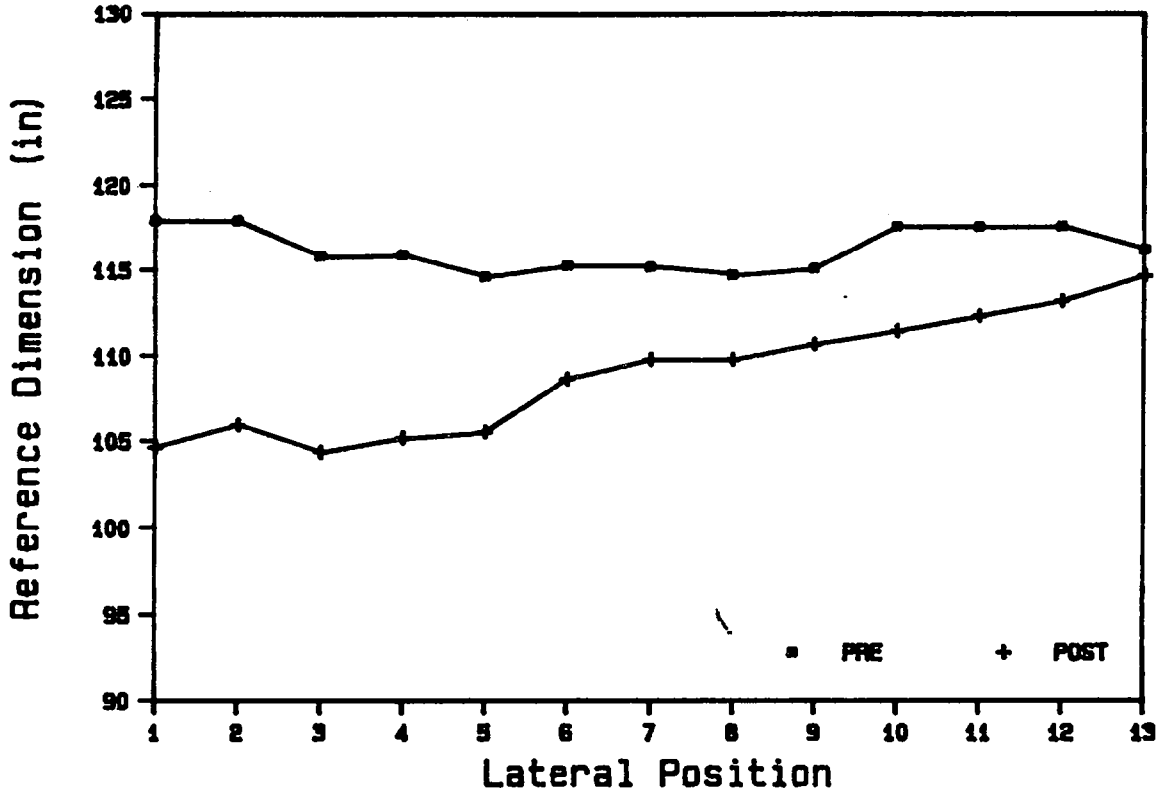
Omni Intrusion - Test 850814



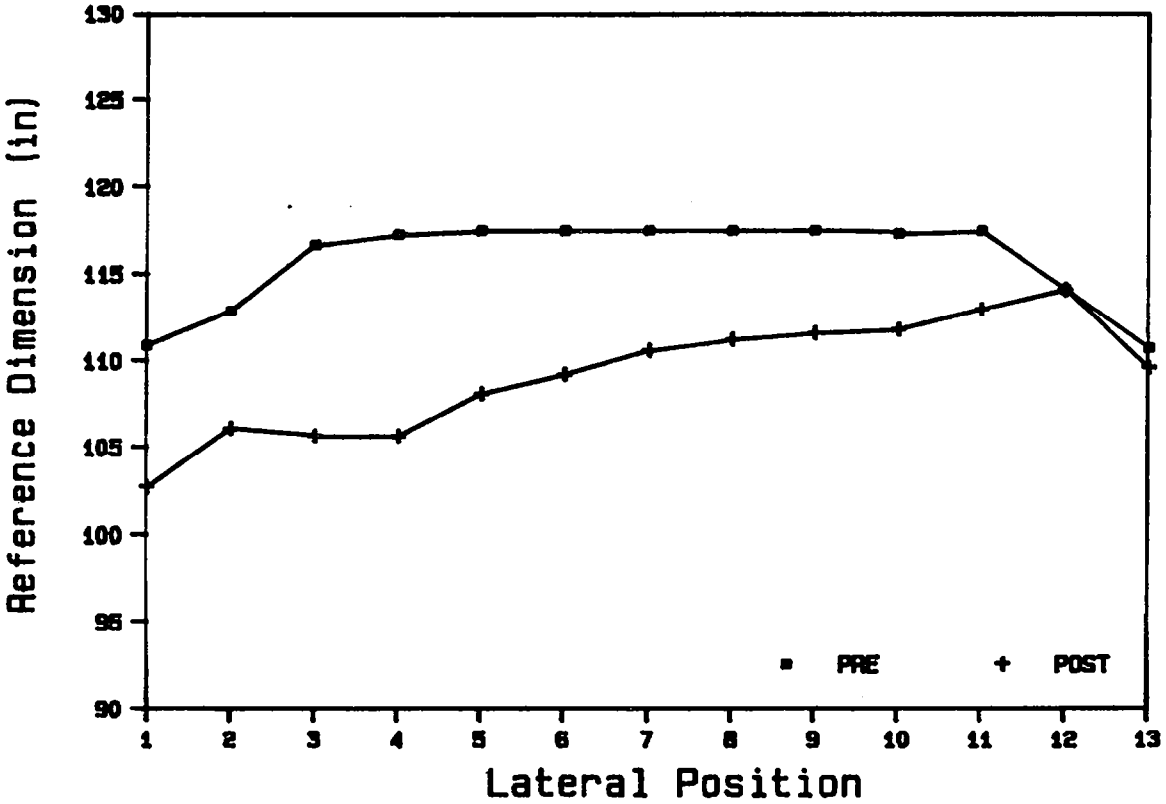


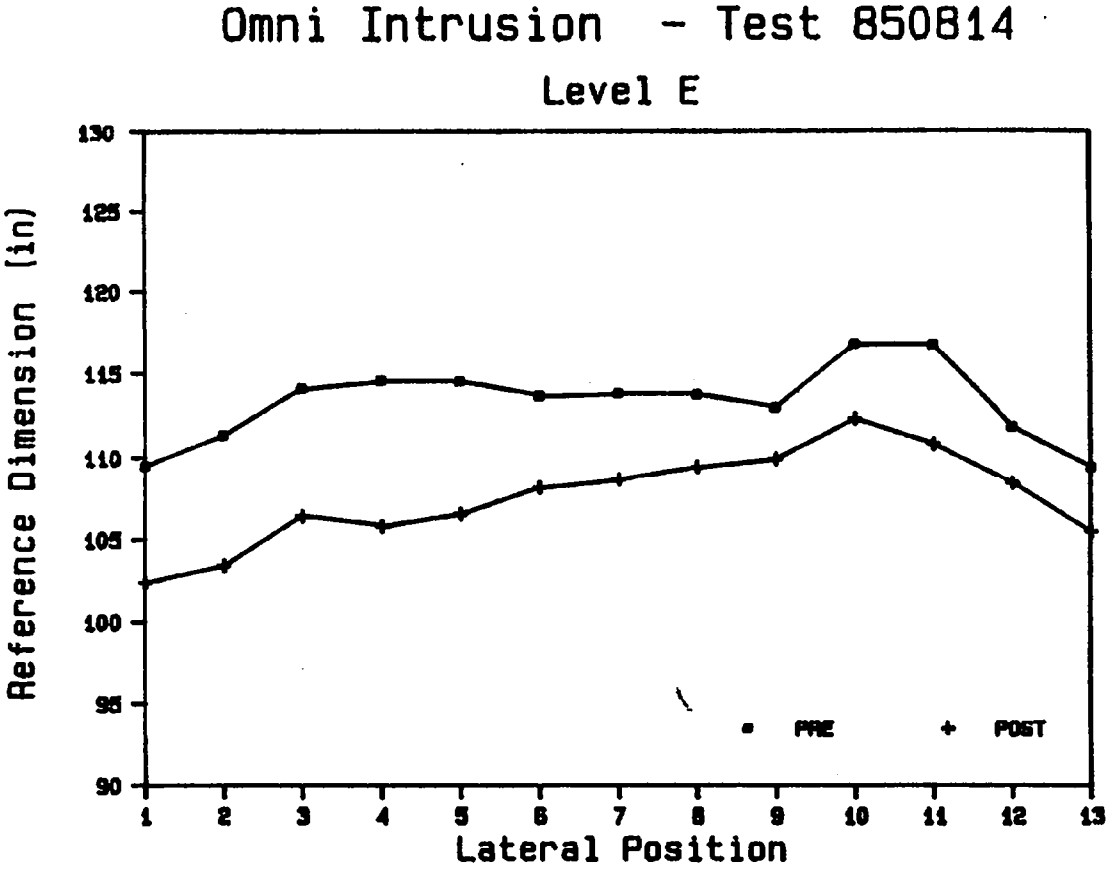
Omni Intrusion - Test 850814

Level C



Level D




Omni Intrusion - Test 850814
Level E
Reference Dimension (in)
130
125
120
115
110
105
100
95
90
1
2
3
4
5
6
7
8
9
10
11
12
13
Lateral Position
PRE
POST

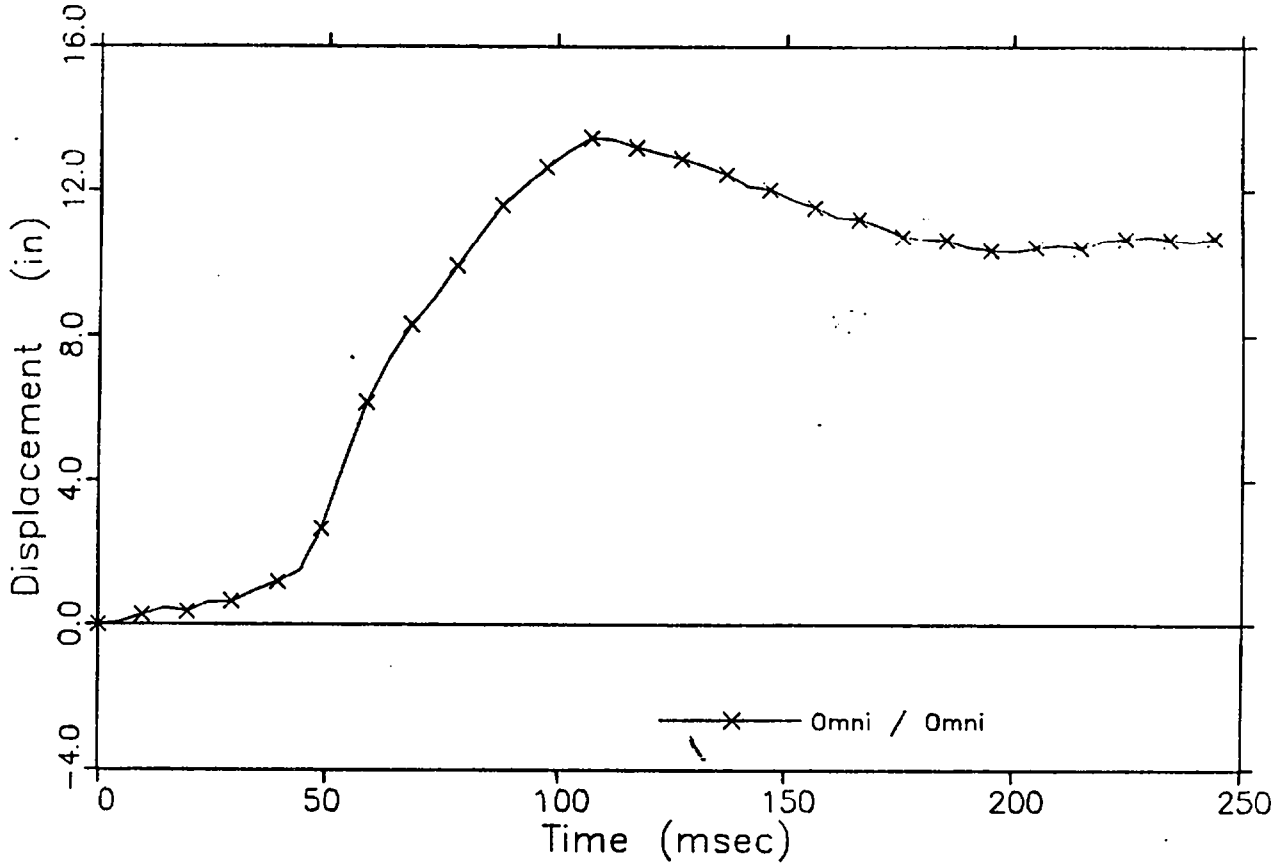
REFERENCE MEASUREMENTS

Omni OF *Test 850814*

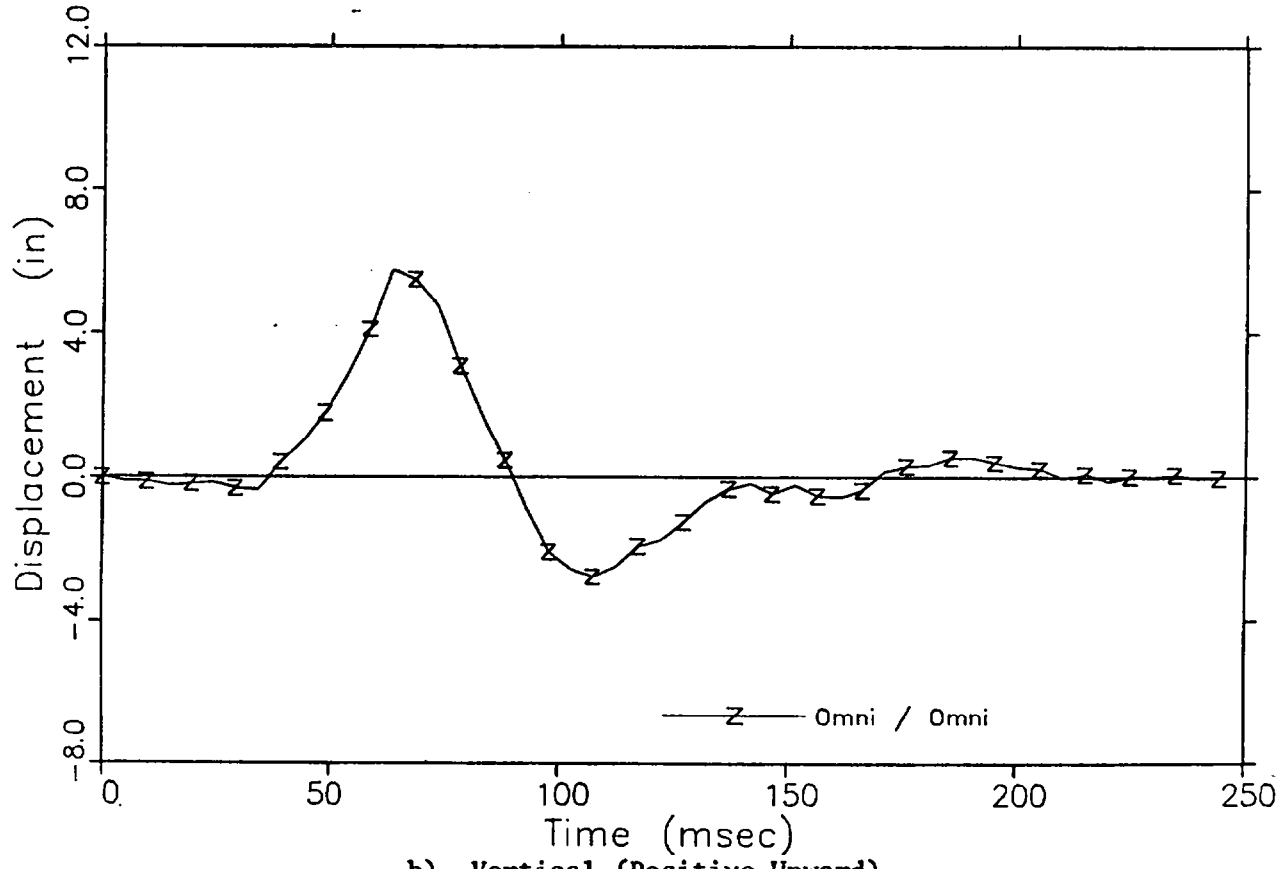
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	102.50	102.50	104.75	105.45	105.90	106.18	106.24	106.05	105.86	105.33	104.52	103.32	102.40
	POST	95.50	97.25	98.38	100.00	100.75	101.63	102.25	102.63	102.88	103.00	102.75	102.38	101.25
	DIFF.	(7.00)	5.25	6.37	5.45	5.15	4.56	3.99	3.42	2.99	2.33	1.77	0.94	1.15
B	PRE	102.50	102.53	104.50	105.18	105.67	106.32	106.56	106.13	105.64	105.18	104.29	103.16	102.14
	POST	95.25	94.75	96.13	96.38	97.13	98.88	100.00	101.00	101.25	101.63	102.25	102.00	101.00
	DIFF.	7.25	7.78	8.38	(8.80)	8.55	7.45	6.56	5.13	4.39	3.56	2.04	1.16	1.14
C	PRE	118.00	118.00	115.89	116.00	114.67	115.35	115.25	114.78	115.17	117.66	117.63	117.66	116.29
	POST	104.75	106.00	104.44	105.25	105.63	108.75	109.88	109.88	110.75	111.50	112.38	113.25	114.75
	DIFF.	(13.25)	12.00	11.45	10.75	9.05	6.60	5.38	4.91	4.42	6.16	5.25	4.41	1.54
D	PRE	110.95	112.92	116.72	117.31	117.50	117.50	117.50	117.50	117.50	117.32	117.48	114.14	110.75
	POST	102.75	106.13	105.69	105.69	108.13	109.25	110.63	111.25	111.63	111.81	113.00	114.13	109.63
	DIFF.	8.20	6.80	11.03	(11.62)	9.38	8.25	6.88	6.25	5.88	5.51	4.48	0.02	1.13
E	PRE	109.57	111.42	114.17	114.66	114.62	113.74	113.90	113.83	113.04	116.91	116.86	111.91	109.46
	POST	102.50	103.50	106.50	105.88	106.63	108.25	108.75	109.50	110.00	112.38	110.88	108.50	105.50
	DIFF.	7.06	7.92	7.67	(8.78)	7.99	5.49	5.14	4.33	3.03	4.53	5.98	3.41	3.95

Omni/Omni OF

Test Number 850524



a) Horizontal (Positive Rearward)

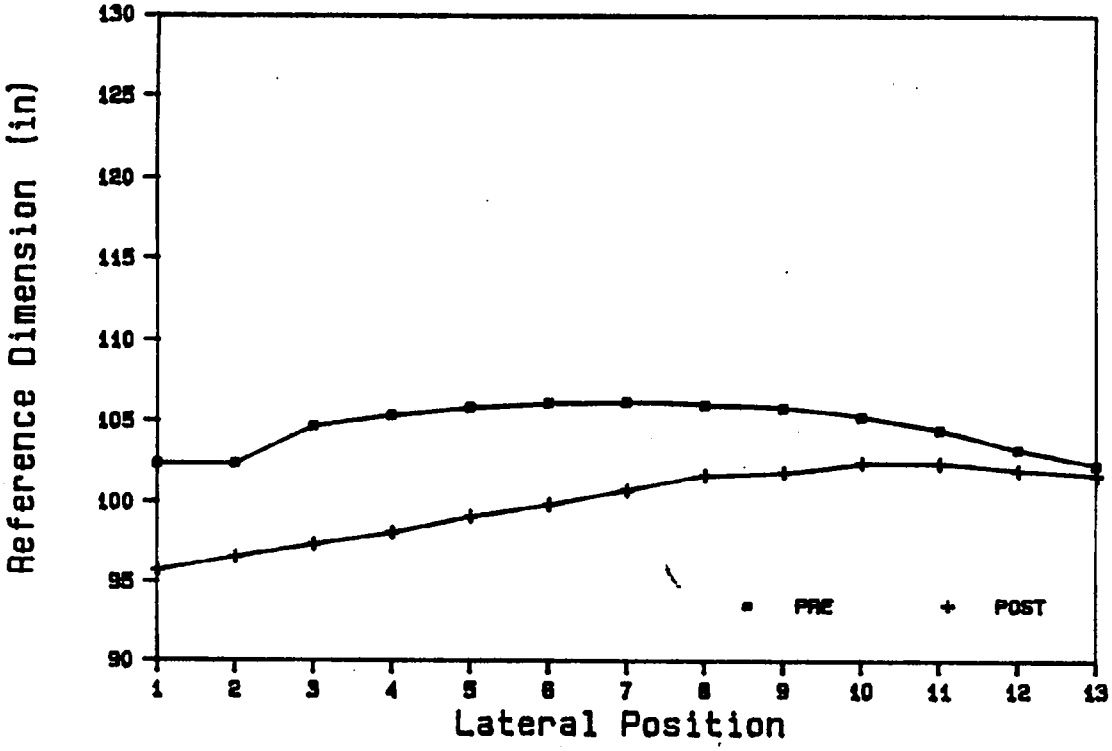


b) Vertical (Positive Upward)

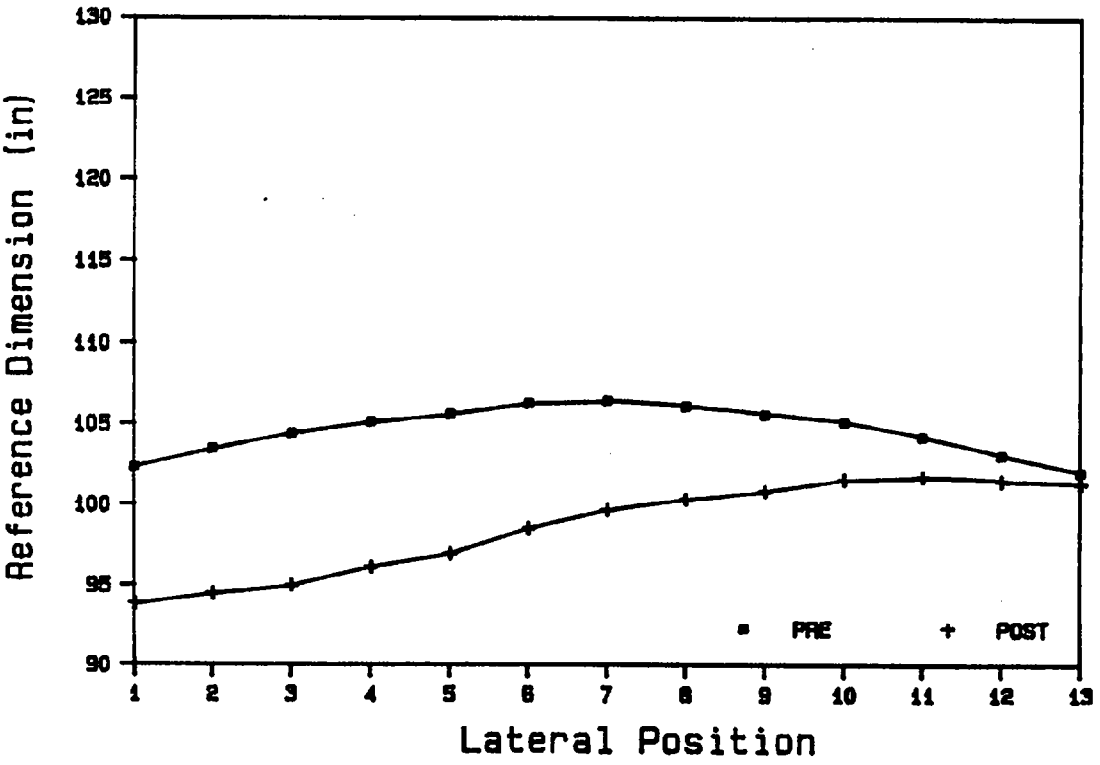
Steering Column Movement

Omni Intrusion - Test 850524

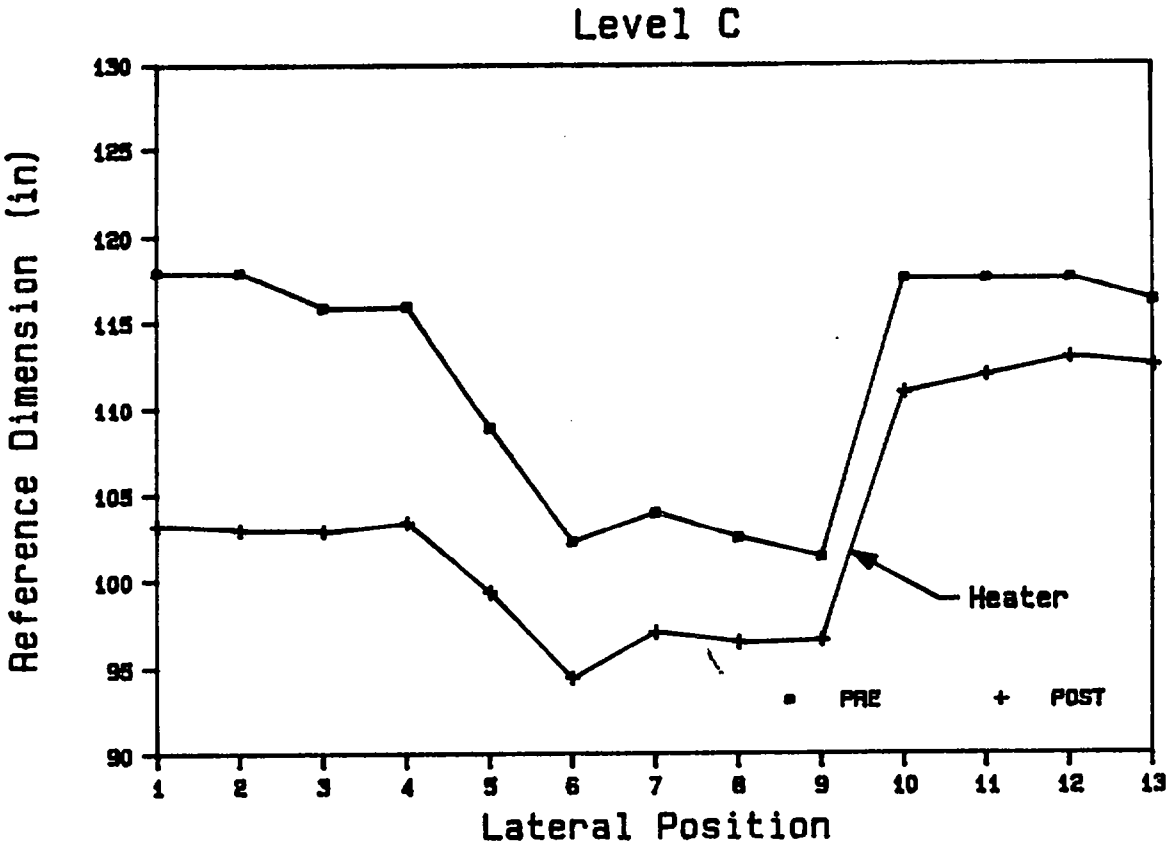
Level A

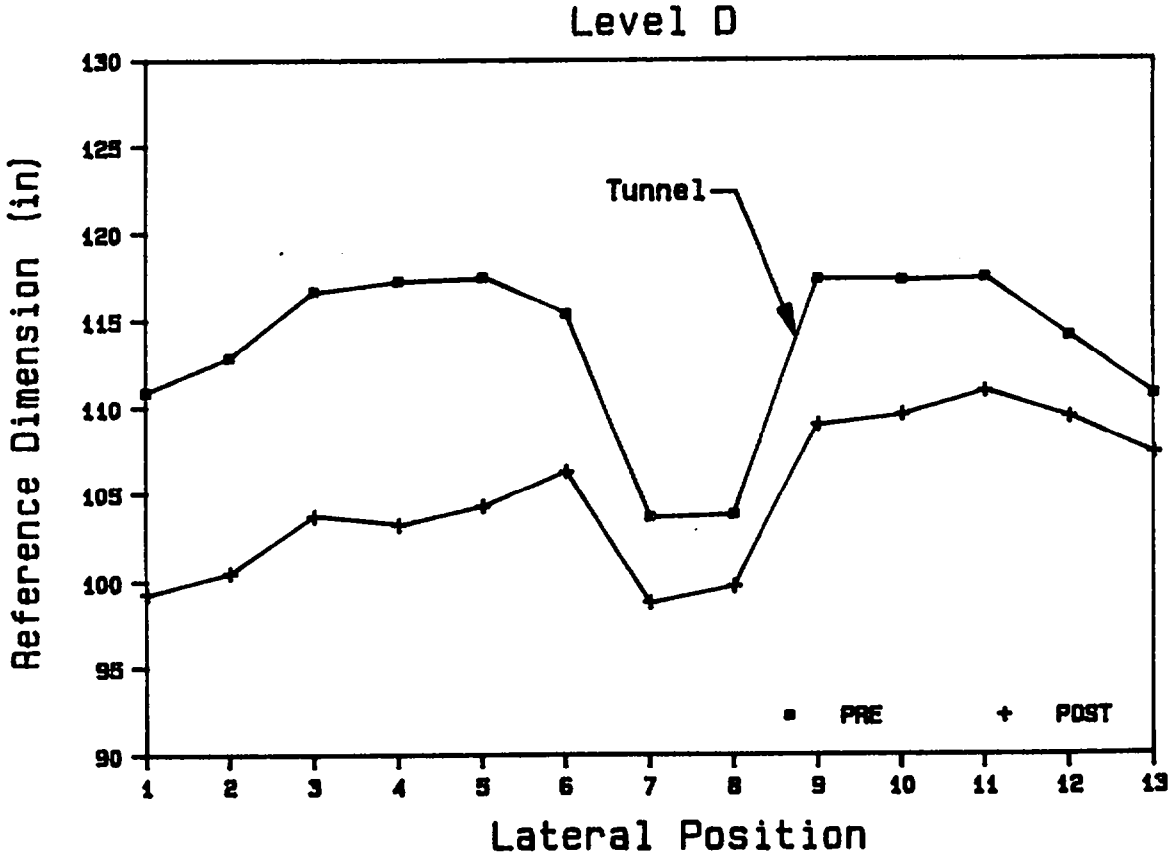


Level B

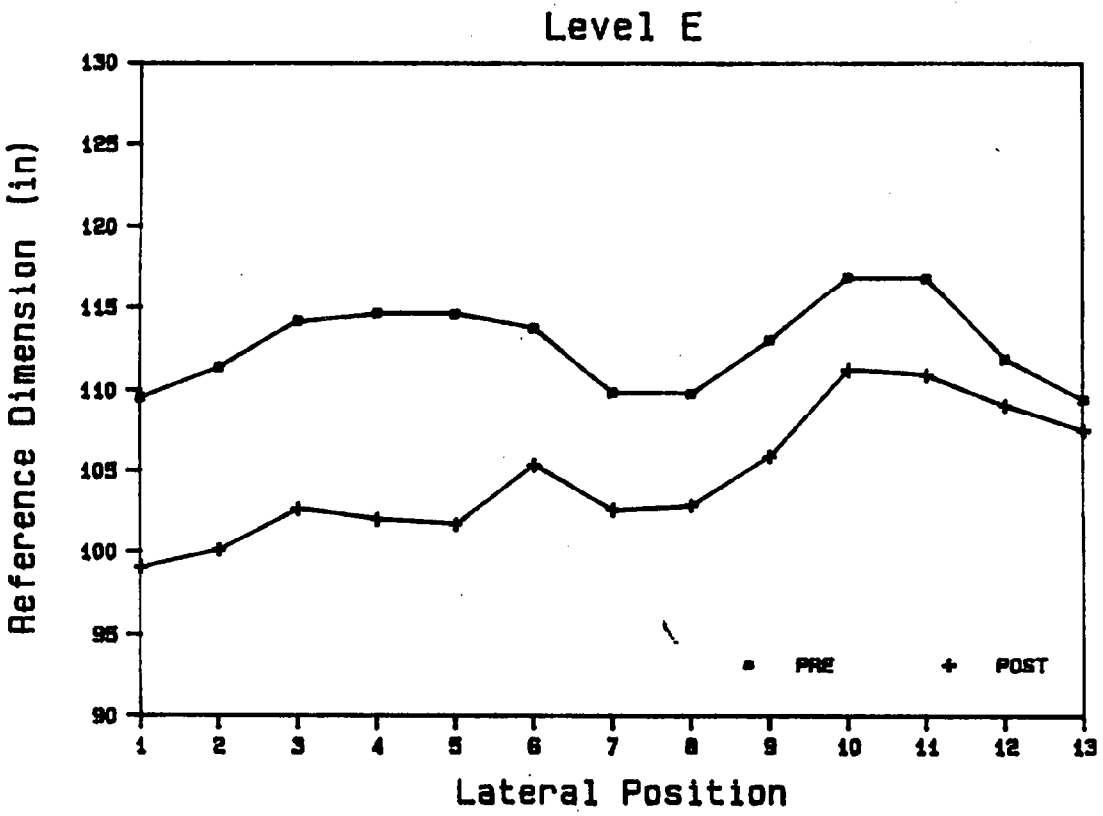


Omni Intrusion - Test 850524





Omni Intrusion - Test 850524



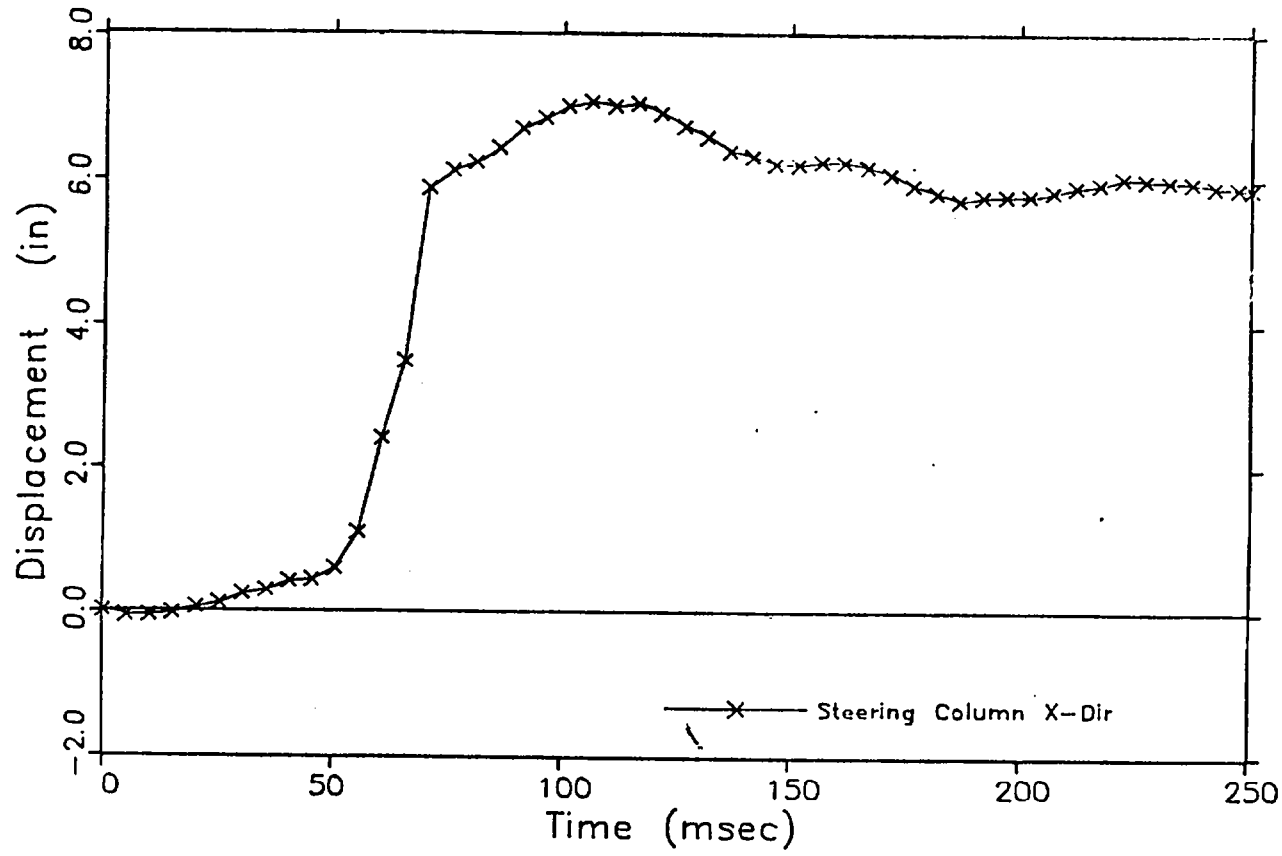
REFERENCE MEASUREMENTS

Omni OF *Test 850524*

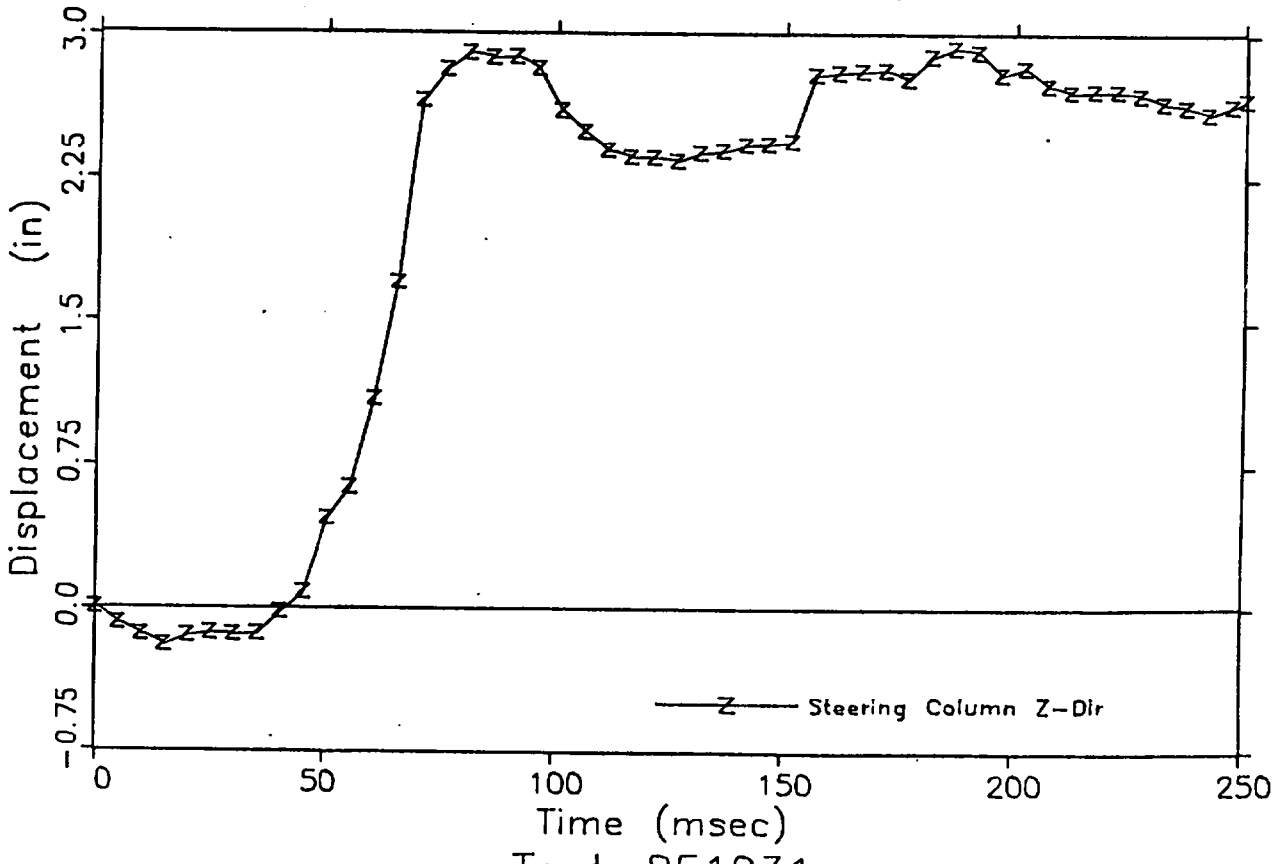
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	102.48	102.48	104.77	105.44	105.90	106.18	106.24	106.05	105.86	105.33	104.52	103.32	102.39
	POST	95.81	96.66	97.47	98.19	99.19	99.91	100.80	101.77	101.96	102.55	102.49	102.04	101.72
	DIFF.	6.68	5.82	7.30	7.25	6.71	6.27	5.44	4.28	3.90	2.78	2.03	1.28	0.67
B	PRE	102.43	103.54	104.49	105.18	105.67	106.32	106.50	106.13	105.65	105.18	104.29	103.16	102.14
	POST	93.88	94.55	95.06	96.19	97.02	98.57	99.74	100.41	100.93	101.67	101.85	101.60	101.40
	DIFF.	8.55	8.99	9.43	8.99	8.65	7.75	6.82	5.72	4.72	3.51	2.44	1.56	0.74
C	PRE	118.00	117.98	115.89	116.00	108.92	102.32	104.00	102.53	101.42	117.66	117.63	117.66	116.29
	POST	103.25	103.00	102.94	103.44	99.36	94.50	97.09	96.51	96.68	111.01	112.01	113.01	112.51
	DIFF.	14.75	14.98	12.95	12.56	9.56	7.87	6.91	6.02	4.43	6.65	5.62	4.65	3.78
D	PRE	110.95	112.92	116.72	117.31	117.50	115.43	103.69	103.84	117.40	117.33	117.48	114.14	110.75
	POST	99.33	100.53	103.76	103.24	104.32	106.30	98.82	99.75	109.04	109.59	110.94	109.44	107.32
	DIFF.	11.62	12.39	12.96	14.07	13.18	9.13	4.87	4.09	8.36	7.76	6.54	4.70	3.43
E	PRE	109.61	111.46	114.24	114.72	114.68	113.80	109.93	109.87	113.10	116.98	116.93	111.96	109.49
	POST	99.11	100.19	102.73	102.07	101.75	105.44	102.67	102.96	105.97	111.32	110.98	109.13	107.54
	DIFF.	10.51	11.27	11.51	12.65	12.93	8.36	7.26	6.91	7.13	5.66	5.95	2.83	1.95

Omni/Pole OF

Test Number 851031



a) Horizontal (Positive Rearward)

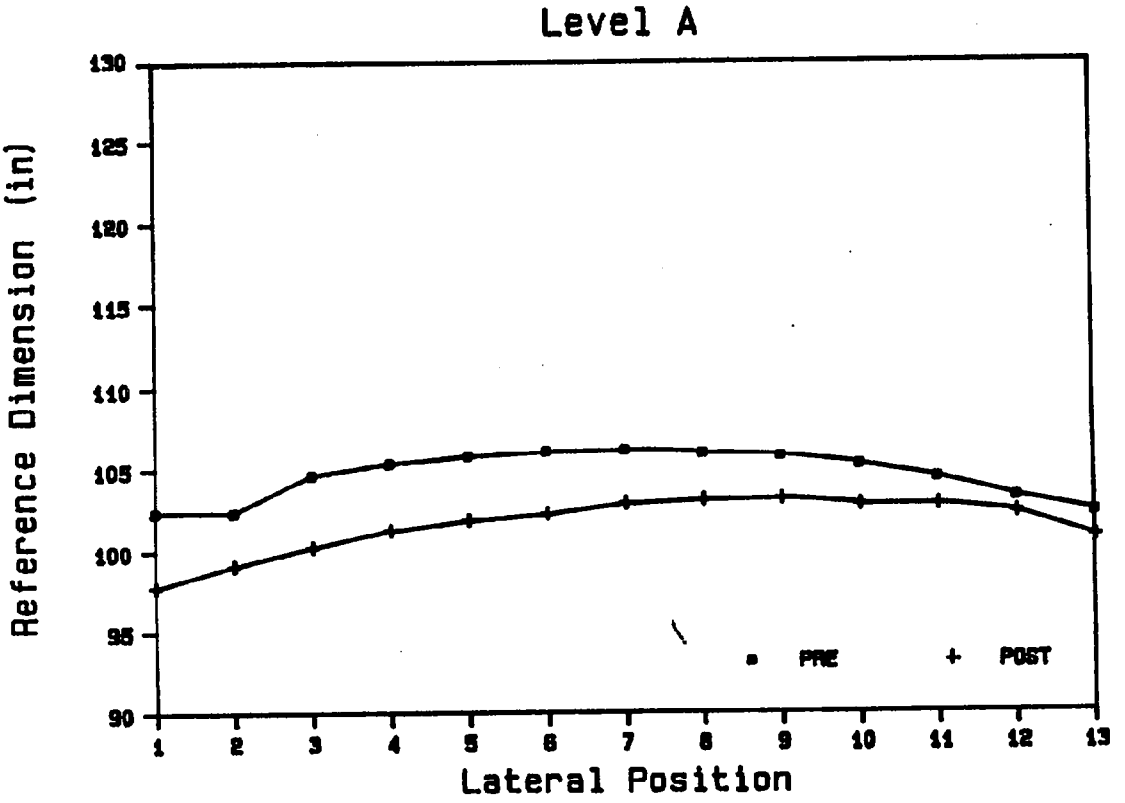


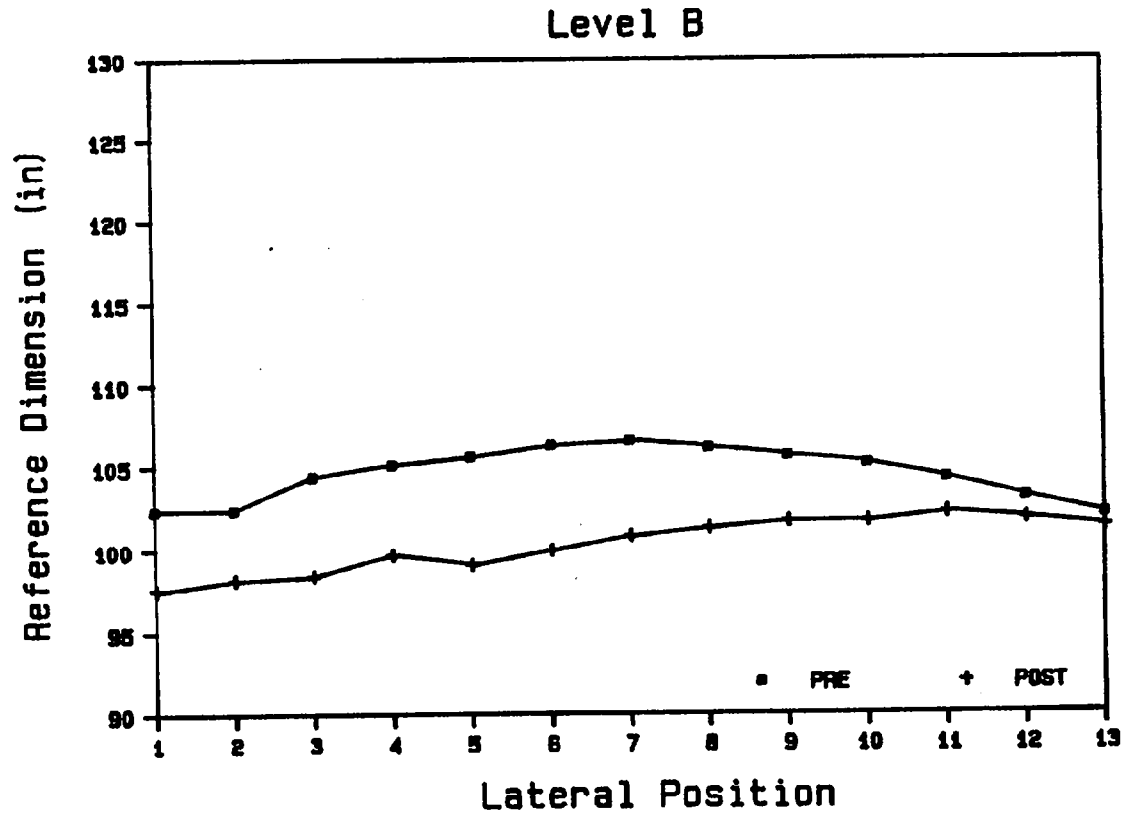
Test 851031

b) Vertical (Positive Upward)

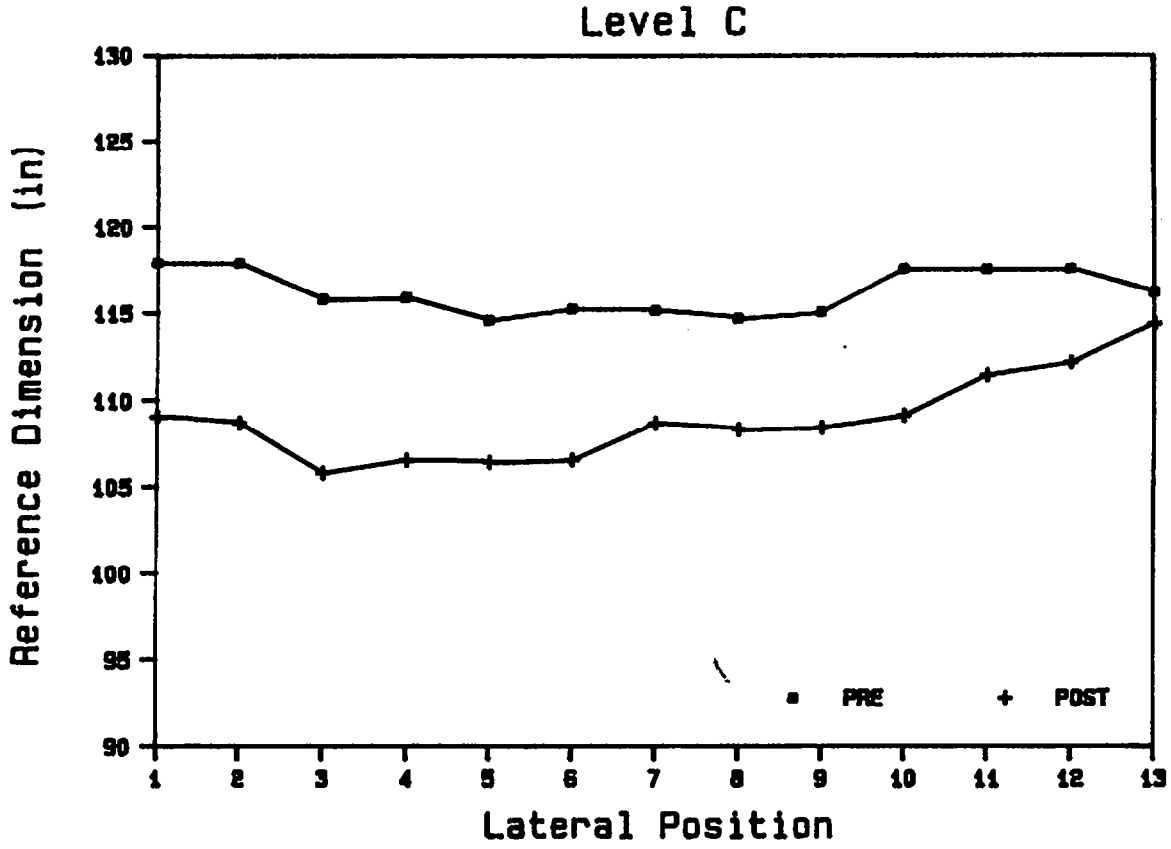
Steering Column Movement

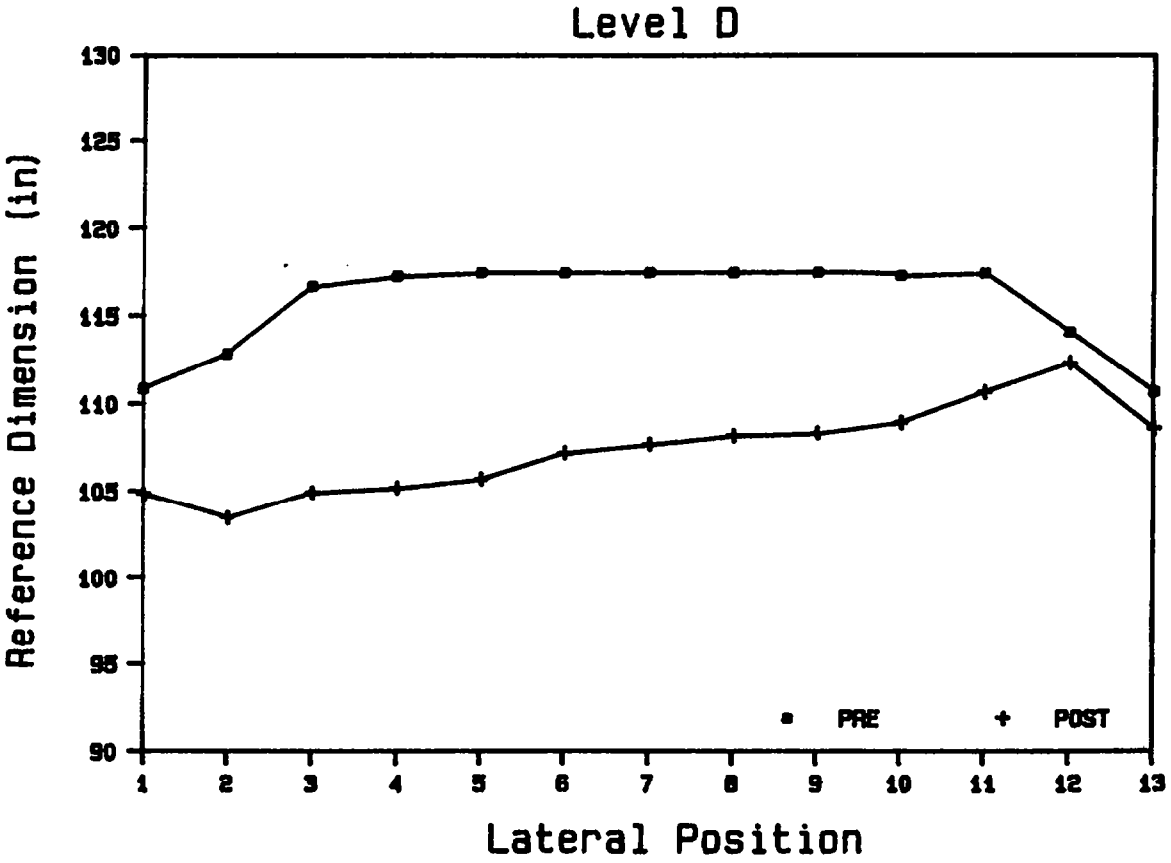
Omni Intrusion - Test 851031

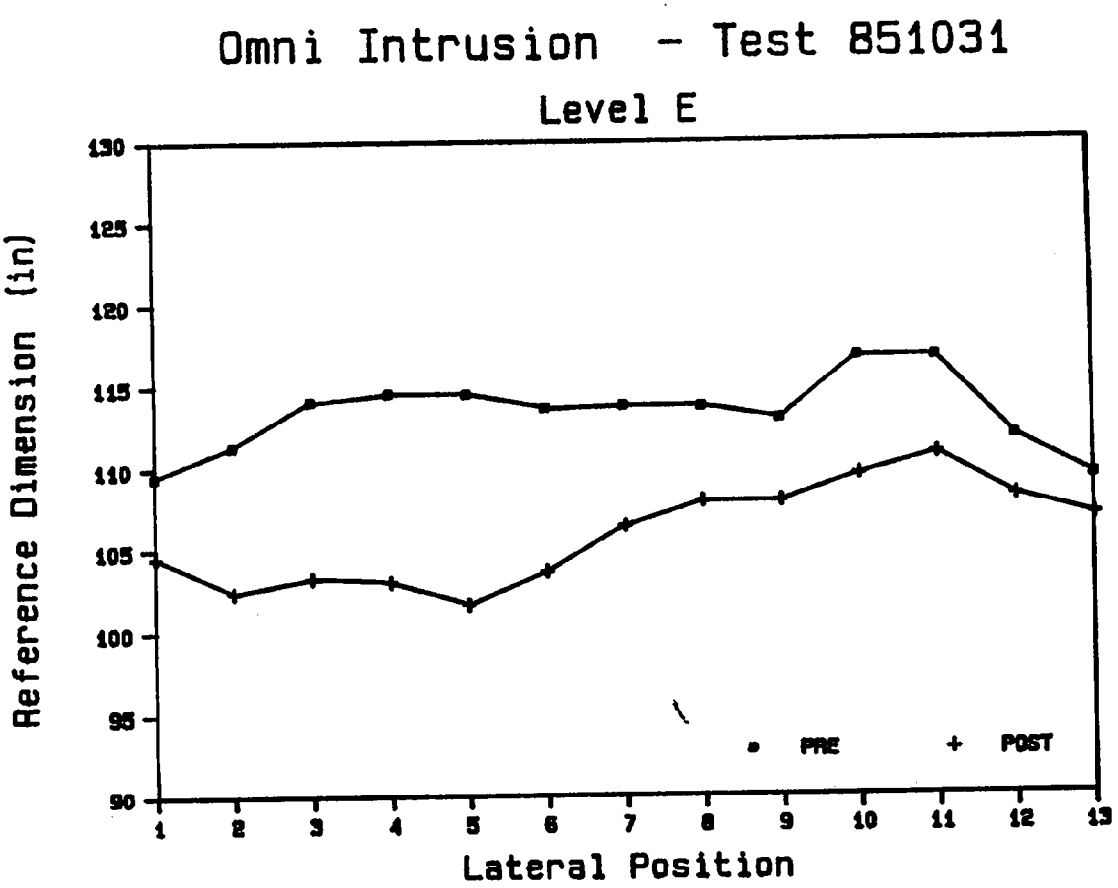




Omni Intrusion - Test 851031






Omni Intrusion - Test 851031
Level E
Reference Dimension (in)
130
125
120
115
110
105
100
95
90
1
2
3
4
5
6
7
8
9
10
11
12
13
PRE
POST
Lateral Position

REFERENCE MEASUREMENTS

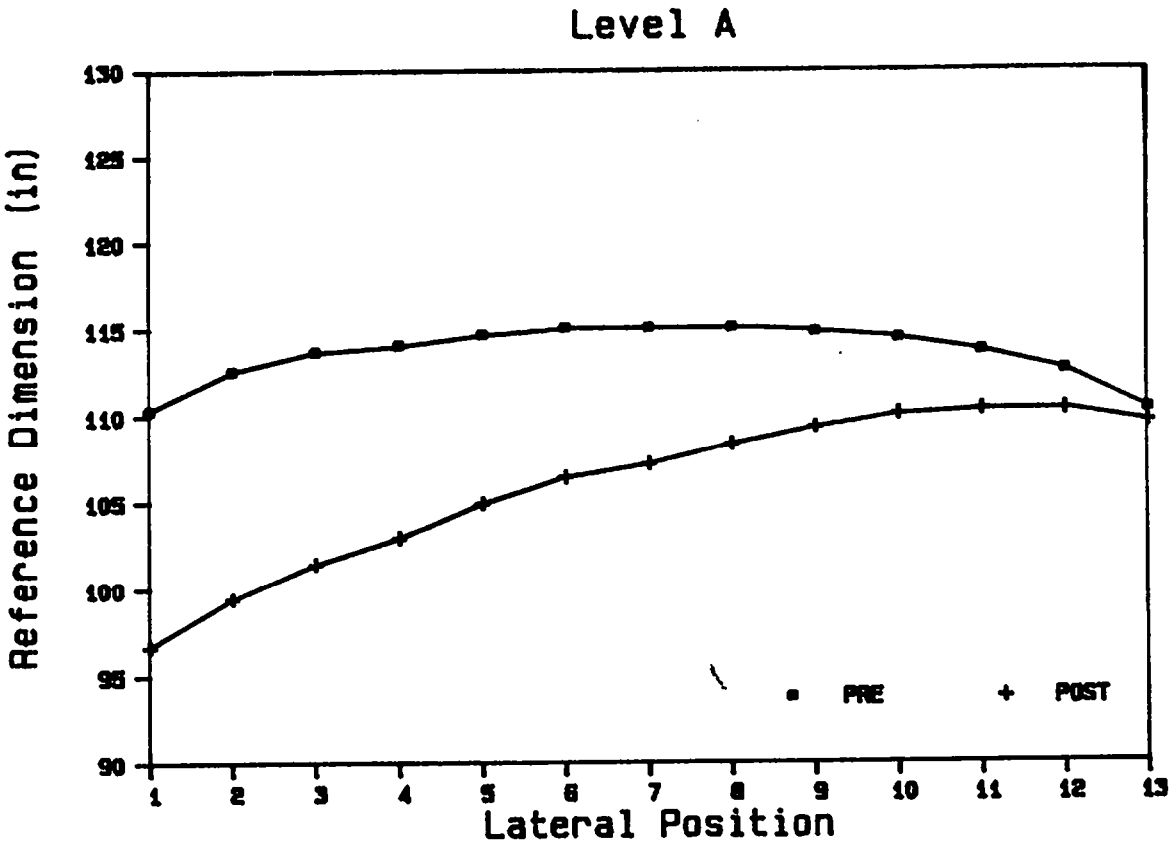
Omni / Pole OF *Test 851031*

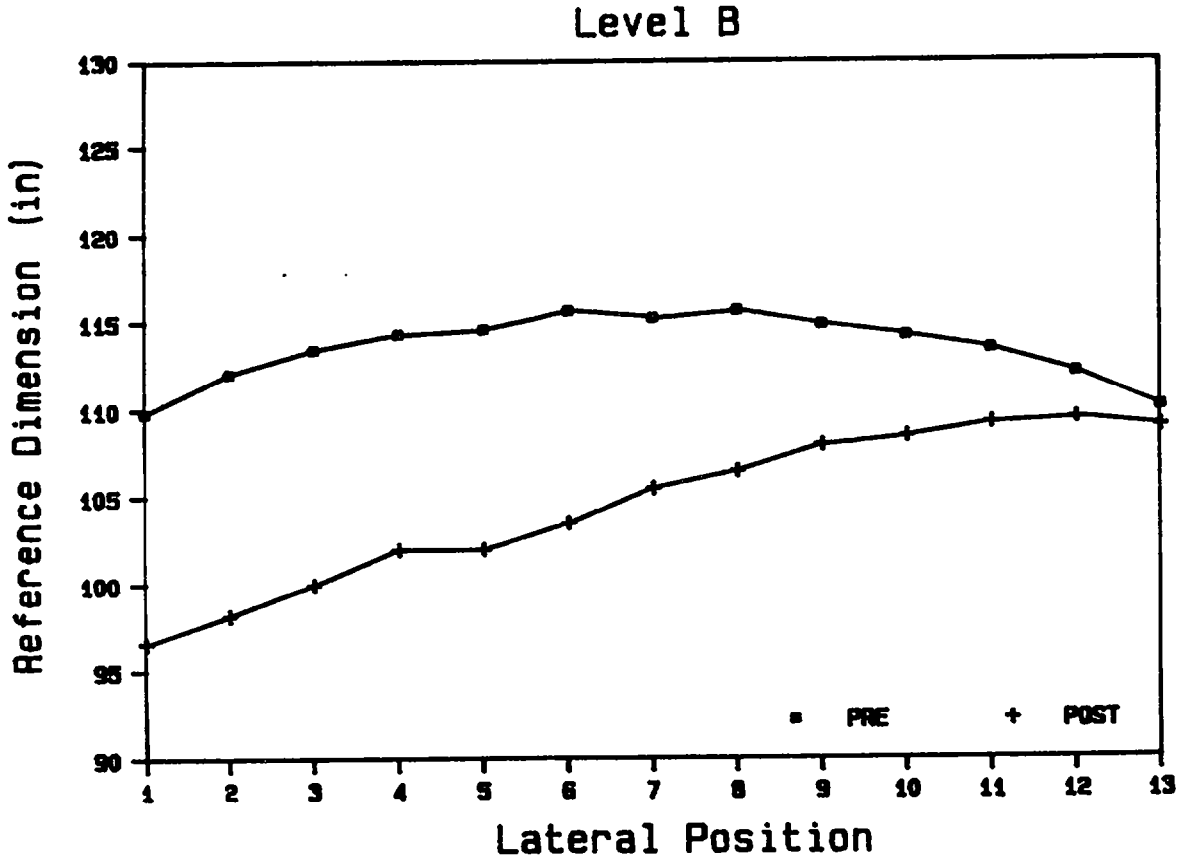
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	102.50	102.50	104.75	105.45	105.90	106.18	106.24	106.05	105.86	105.33	104.52	103.32	102.40
	POST	97.88	99.19	100.31	101.38	102.00	102.38	103.00	103.19	103.25	102.88	102.88	102.88	100.88
	DIFF.	4.63	3.31	4.44	4.08	3.90	3.81	3.24	2.86	2.61	2.45	1.64	0.94	1.53
B	PRE	102.50	102.53	104.50	105.18	105.67	106.32	106.56	106.13	105.64	105.18	104.29	103.16	102.14
	POST	97.63	98.25	98.50	99.75	99.13	100.00	100.88	101.38	101.75	101.75	102.25	101.88	101.38
	DIFF.	4.88	4.28	6.00	5.43	6.55	6.32	5.69	4.75	3.89	3.43	2.04	1.28	0.77
C	PRE	118.00	118.00	115.89	116.00	114.67	115.35	115.25	114.78	115.17	117.66	117.63	117.66	116.29
	POST	109.13	108.75	105.88	106.63	106.50	106.63	108.75	108.38	108.50	109.19	111.50	112.25	114.50
	DIFF.	8.88	9.25	10.02	9.38	8.17	8.72	6.50	6.41	6.67	8.47	6.13	5.41	1.79
D	PRE	110.95	112.92	116.72	117.31	117.50	117.50	117.50	117.50	117.50	117.32	117.48	114.14	110.75
	POST	104.88	103.50	105.00	105.25	105.75	107.25	107.75	108.25	108.38	109.00	110.75	112.38	108.63
	DIFF.	6.08	9.42	11.72	12.06	11.75	10.25	9.75	9.25	9.13	8.32	6.73	1.77	2.13
E	PRE	109.57	111.42	114.17	114.66	114.62	113.74	113.90	113.83	113.04	116.91	116.86	111.91	109.46
	POST	104.63	102.50	103.38	103.13	101.75	103.75	106.50	108.00	108.00	109.63	110.88	108.25	107.00
	DIFF.	4.94	8.92	10.79	11.53	12.86	9.99	7.39	5.83	5.03	7.28	5.98	3.66	2.45

Honda/Fuego OF

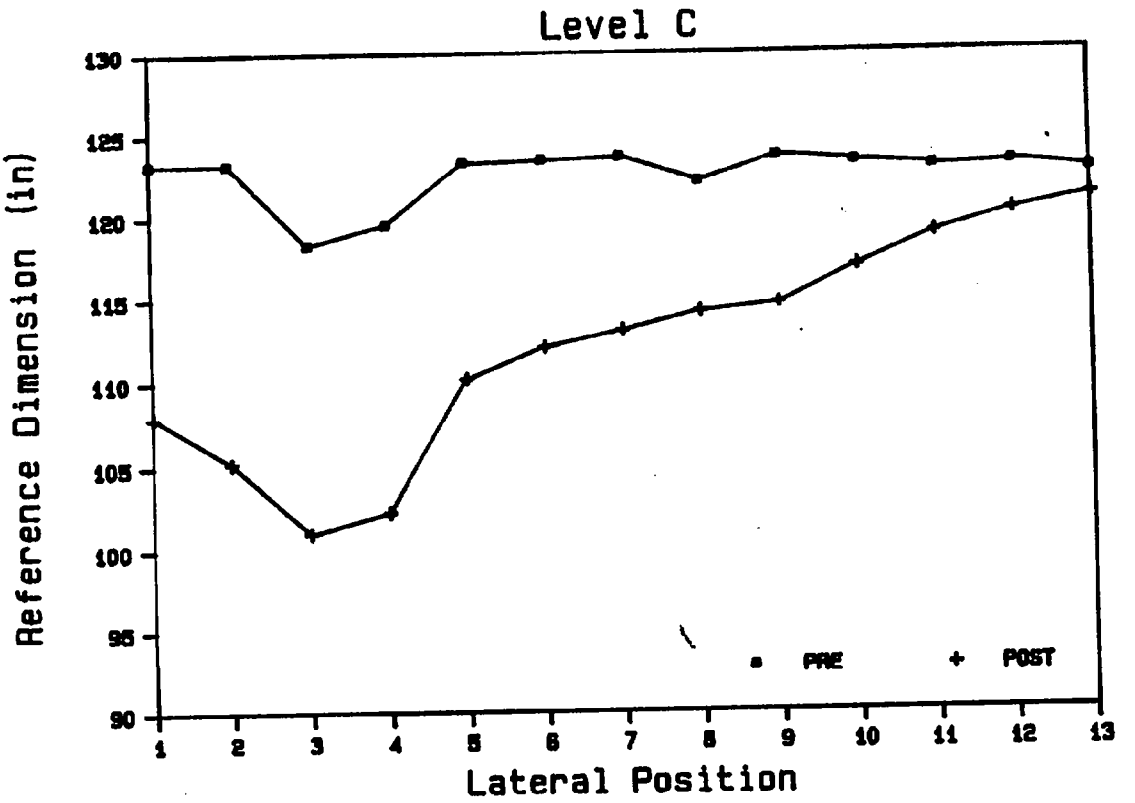
Test Number 850807

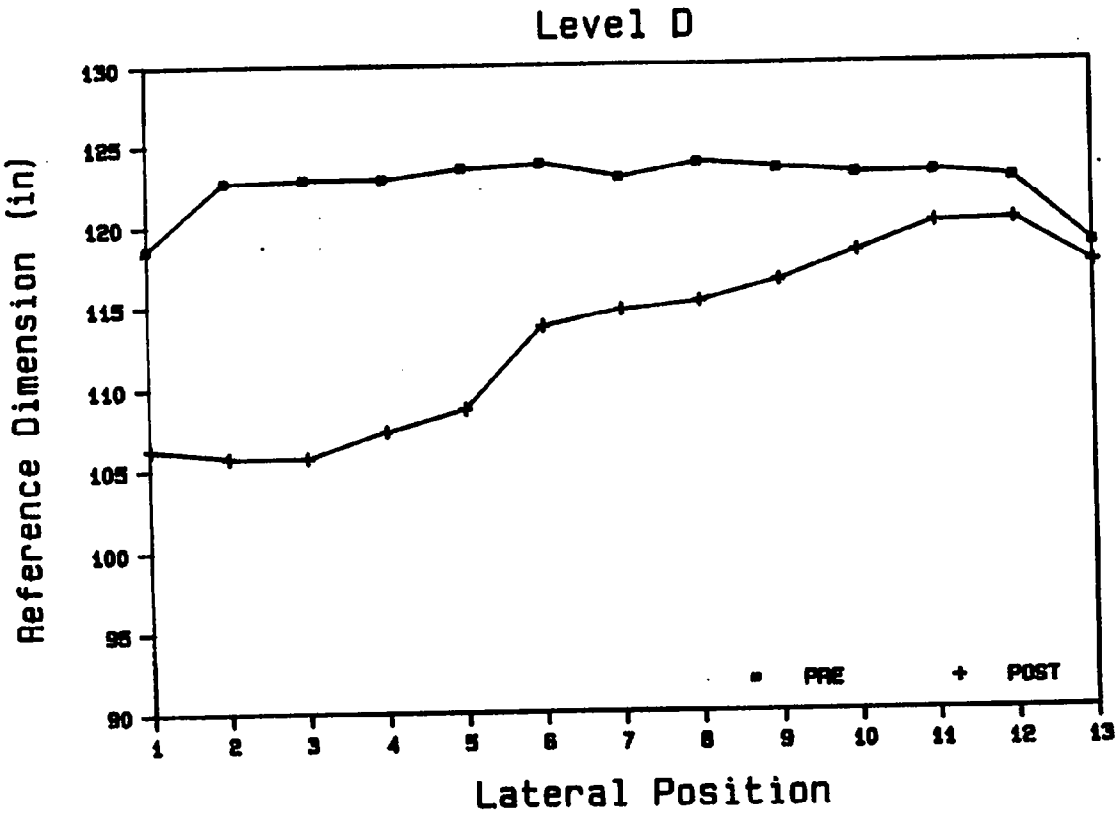
Honda Intrusion - Test 850807





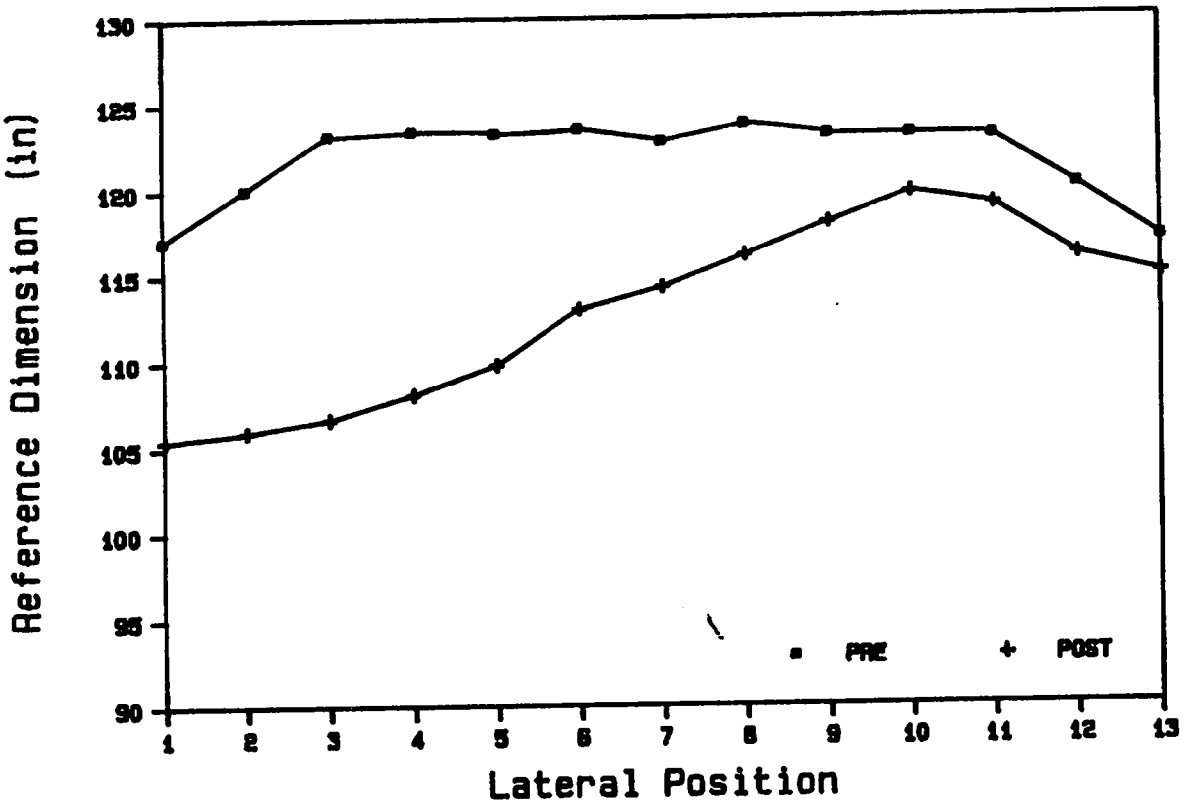
Honda Intrusion - Test 850807





Honda Intrusion - Test 850807

Level E



REFERENCE MEASUREMENTS

Honda / Fuego OF

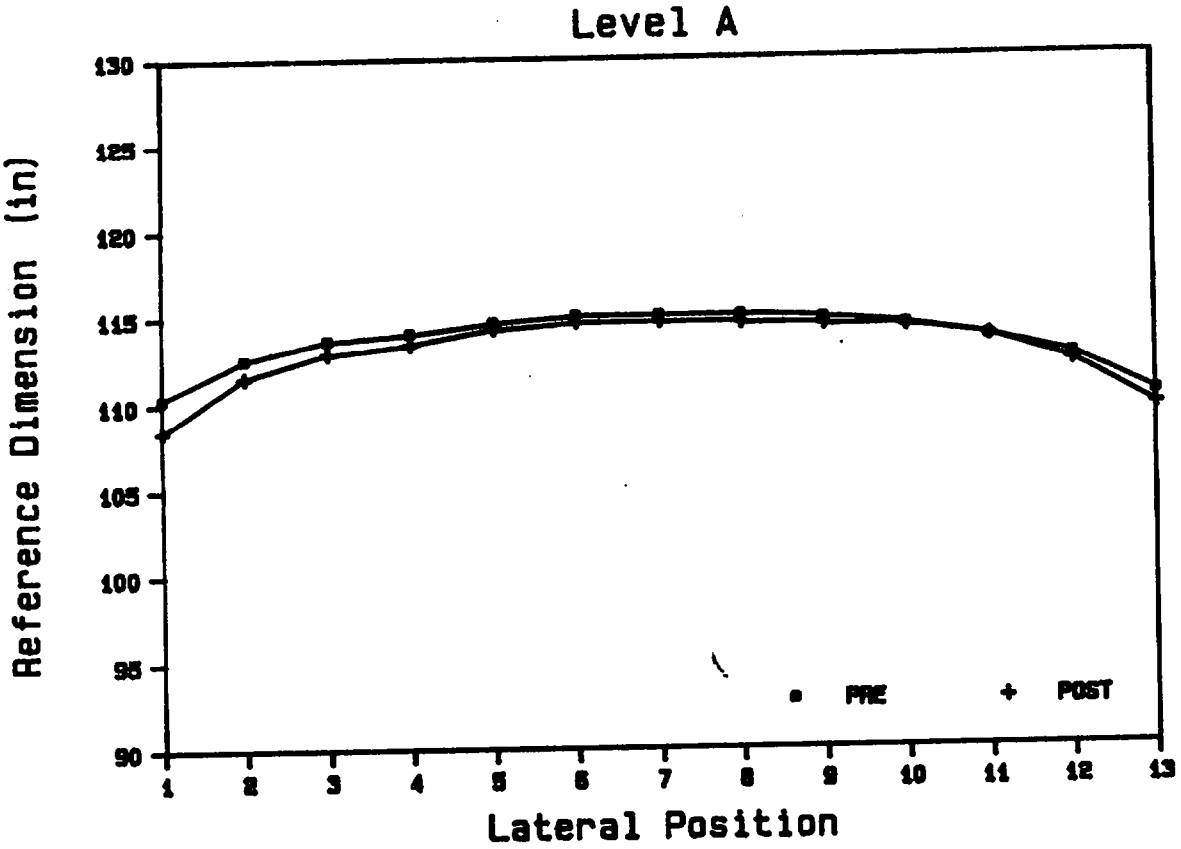
Test 850807

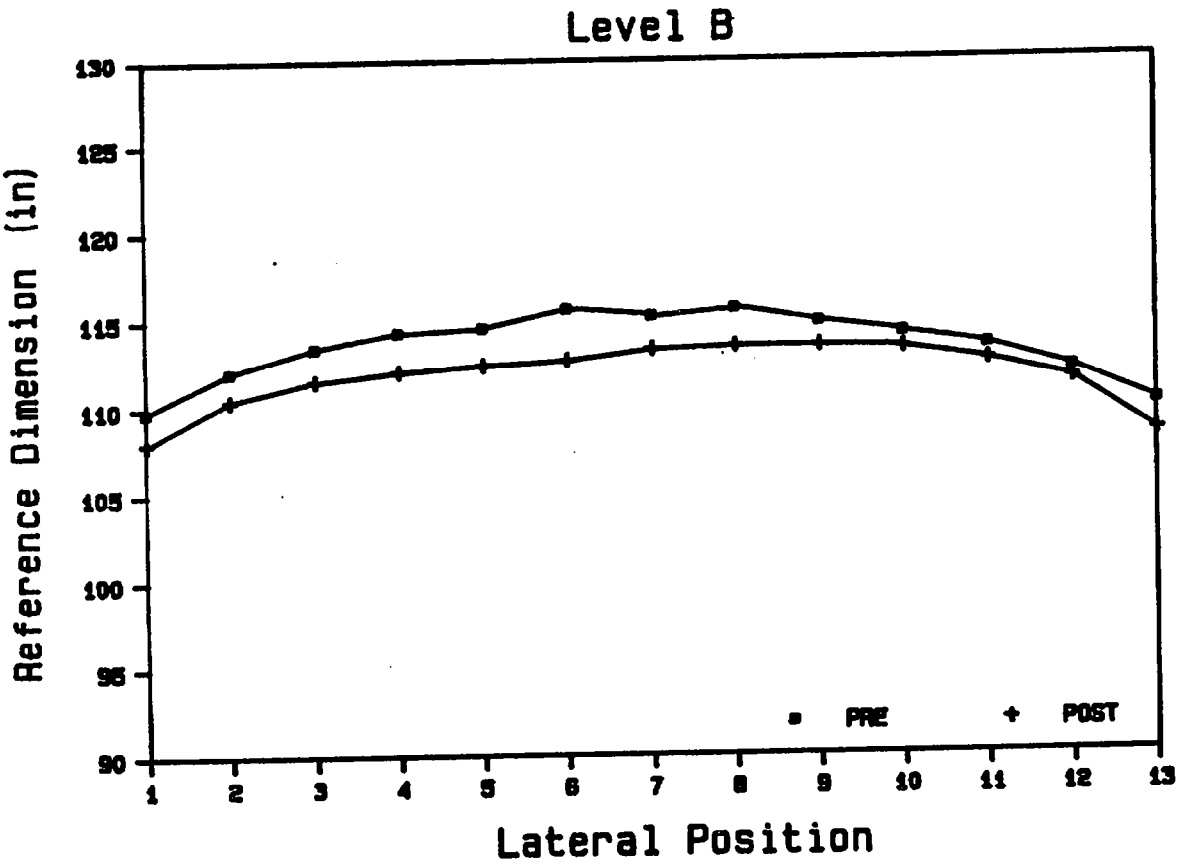
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	110.38	112.63	113.75	114.13	114.75	115.13	115.13	115.13	114.88	114.50	113.75	112.63	110.38
	POST	96.75	99.50	101.50	103.00	105.00	106.50	107.25	108.38	109.38	110.13	110.38	110.38	109.63
	DIFF.	13.63	13.13	12.25	11.13	9.75	8.63	7.88	6.75	5.50	4.38	3.38	2.25	0.75
B	PRE	109.88	112.13	113.50	114.38	114.63	115.69	115.25	115.69	114.88	114.25	113.50	112.13	110.13
	POST	96.63	98.25	100.00	102.00	102.00	103.50	105.50	106.50	108.00	108.50	109.25	109.50	109.00
	DIFF.	13.25	13.88	13.50	12.38	12.63	12.19	9.75	9.19	6.88	5.75	4.25	2.63	1.13
C	PRE	123.31	123.31	118.38	119.63	123.38	123.50	123.69	122.13	123.69	123.31	123.00	123.19	122.69
	POST	108.00	105.25	101.13	102.38	110.25	112.13	113.13	114.25	114.75	117.00	118.94	120.25	121.13
	DIFF.	15.31	18.06	17.25	17.25	13.13	11.38	10.56	7.88	8.94	6.31	4.06	2.95	1.56
D	PRE	118.63	122.81	123.00	123.00	123.63	123.88	123.00	123.88	123.44	123.13	123.19	122.75	118.63
	POST	106.25	105.75	105.75	107.38	108.75	113.75	114.75	115.25	116.50	118.25	120.00	120.13	117.38
	DIFF.	12.38	17.06	17.25	15.63	14.88	10.13	8.25	8.63	6.94	4.88	3.19	2.63	1.25
E	PRE	117.13	120.13	123.25	123.50	123.38	123.63	122.88	123.88	123.25	123.25	123.13	120.25	117.13
	POST	105.50	106.00	106.75	108.19	109.88	113.13	114.38	116.25	118.13	119.88	119.13	116.13	115.00
	DIFF.	11.63	14.13	16.50	15.31	13.50	10.50	8.50	7.63	5.13	3.38	4.00	4.13	2.13

Honda/Honda FF

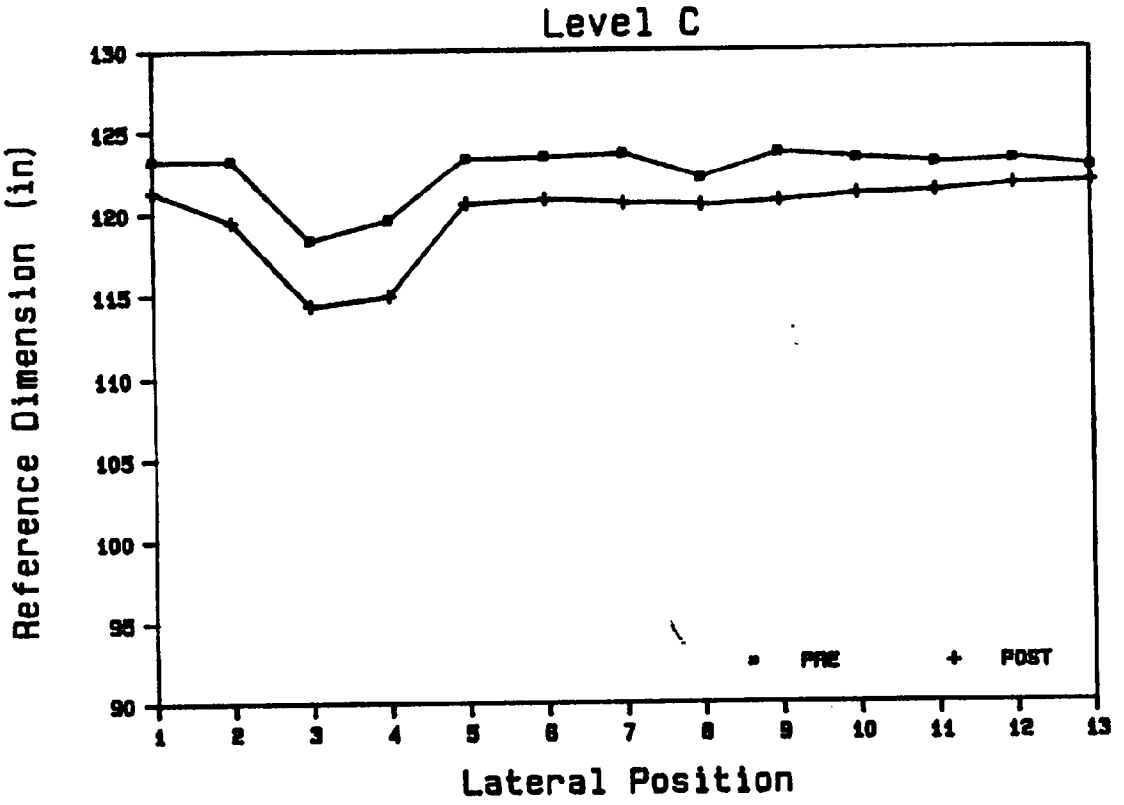
Test Number 841114

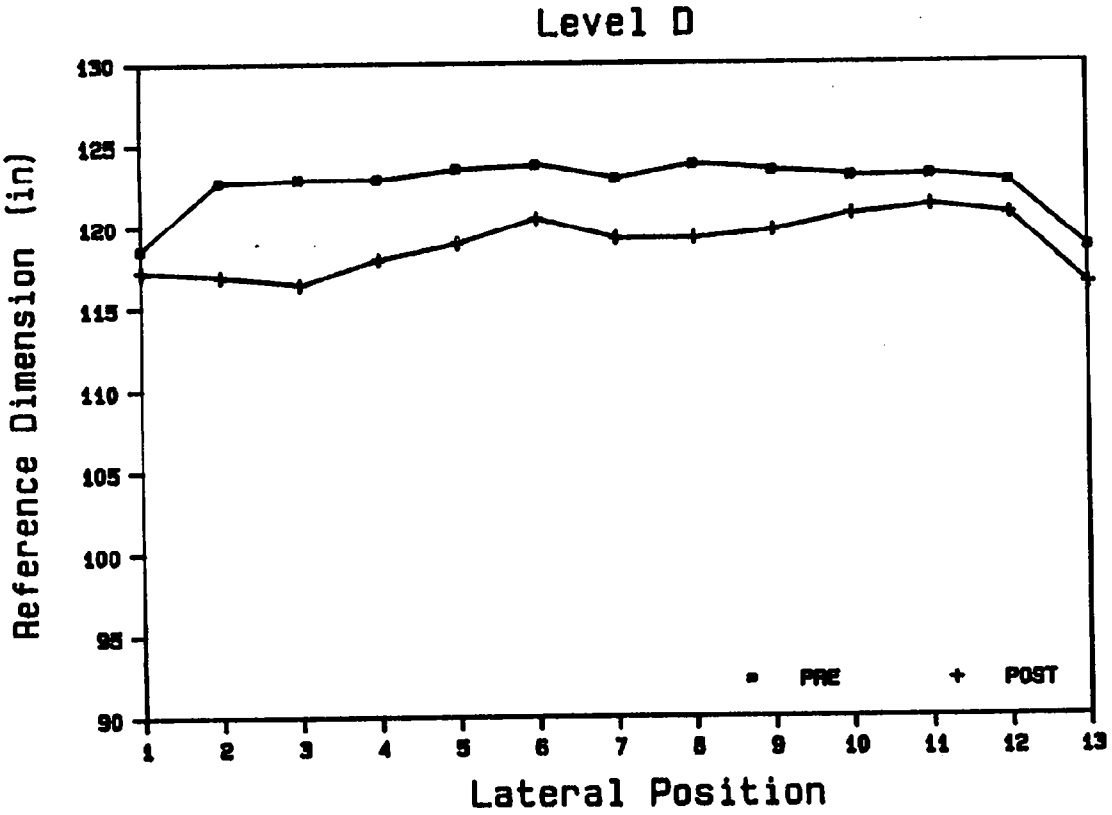
Honda Intrusion - Test 841114



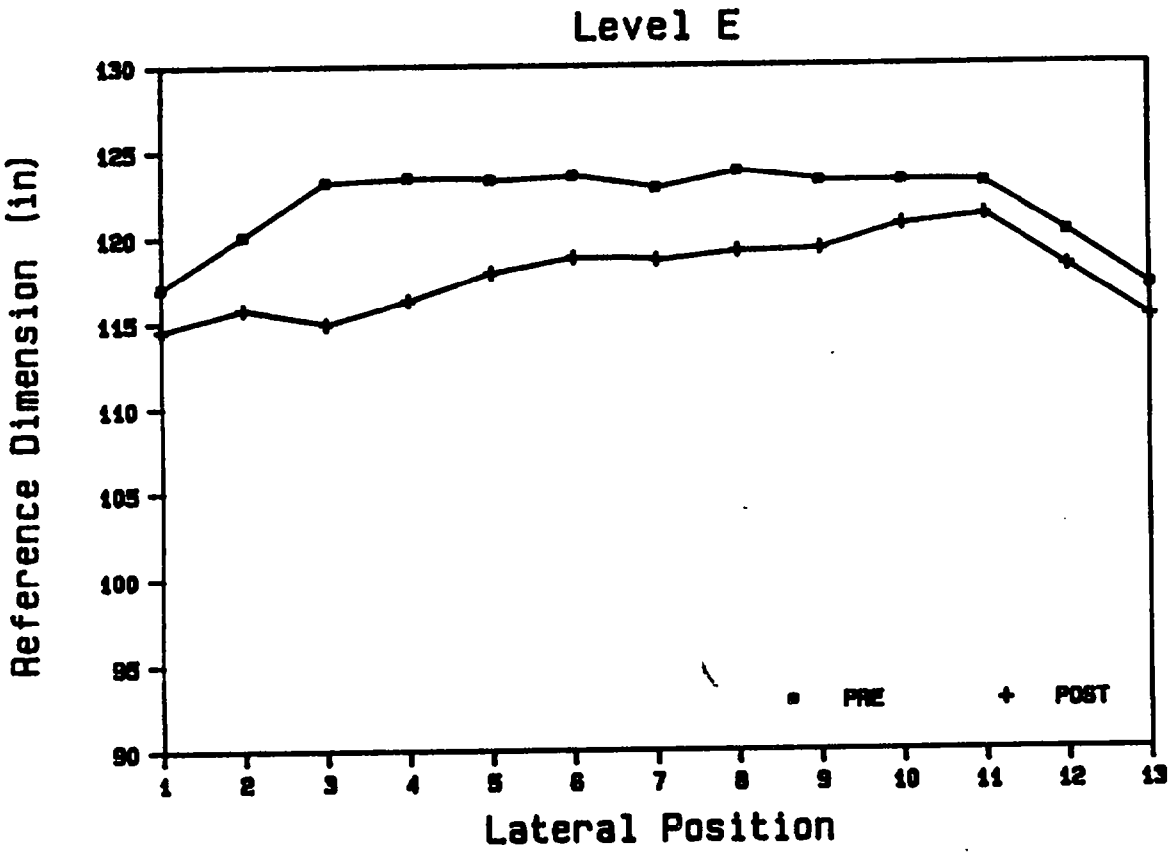


Honda Intrusion - Test 841114





Honda Intrusion - Test 841114



REFERENCE MEASUREMENTS

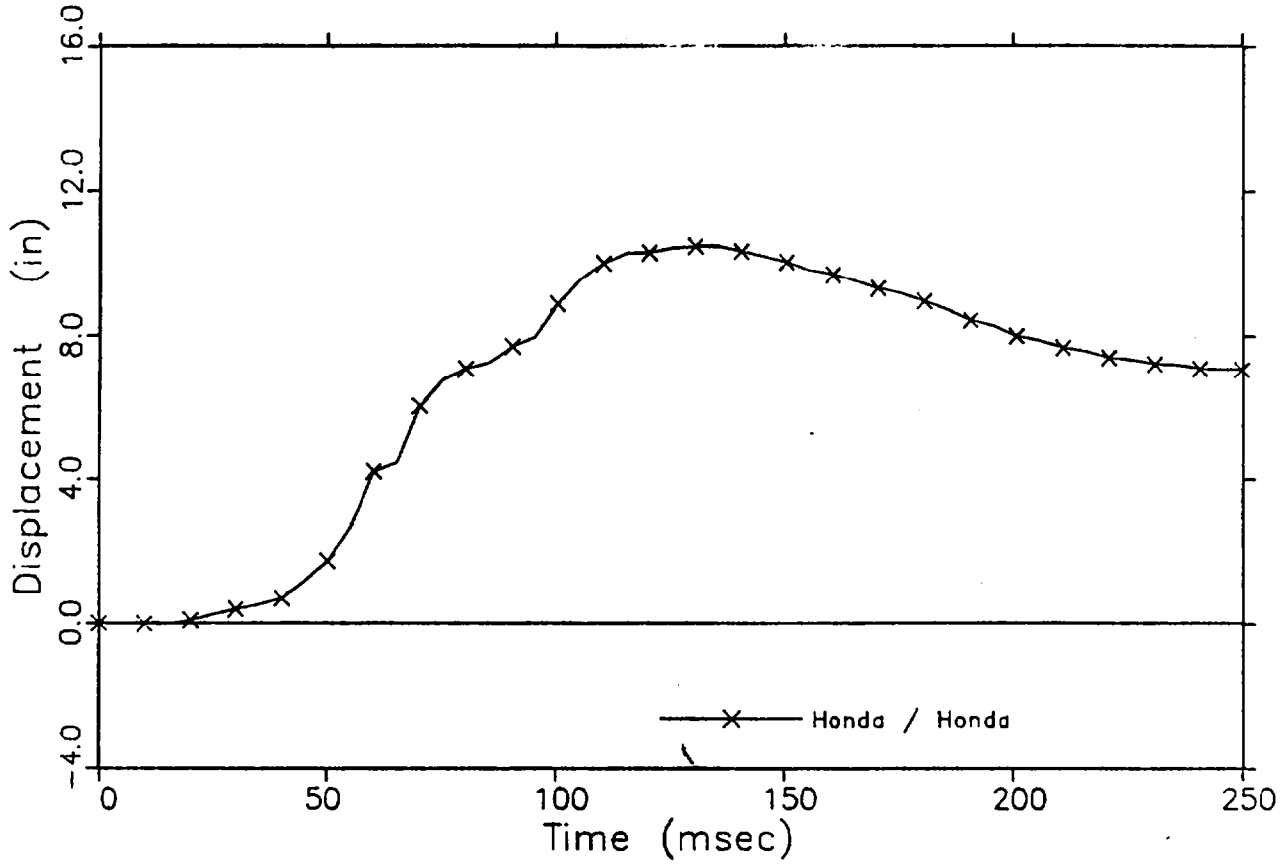
Honda / Honda FF

Test 841114

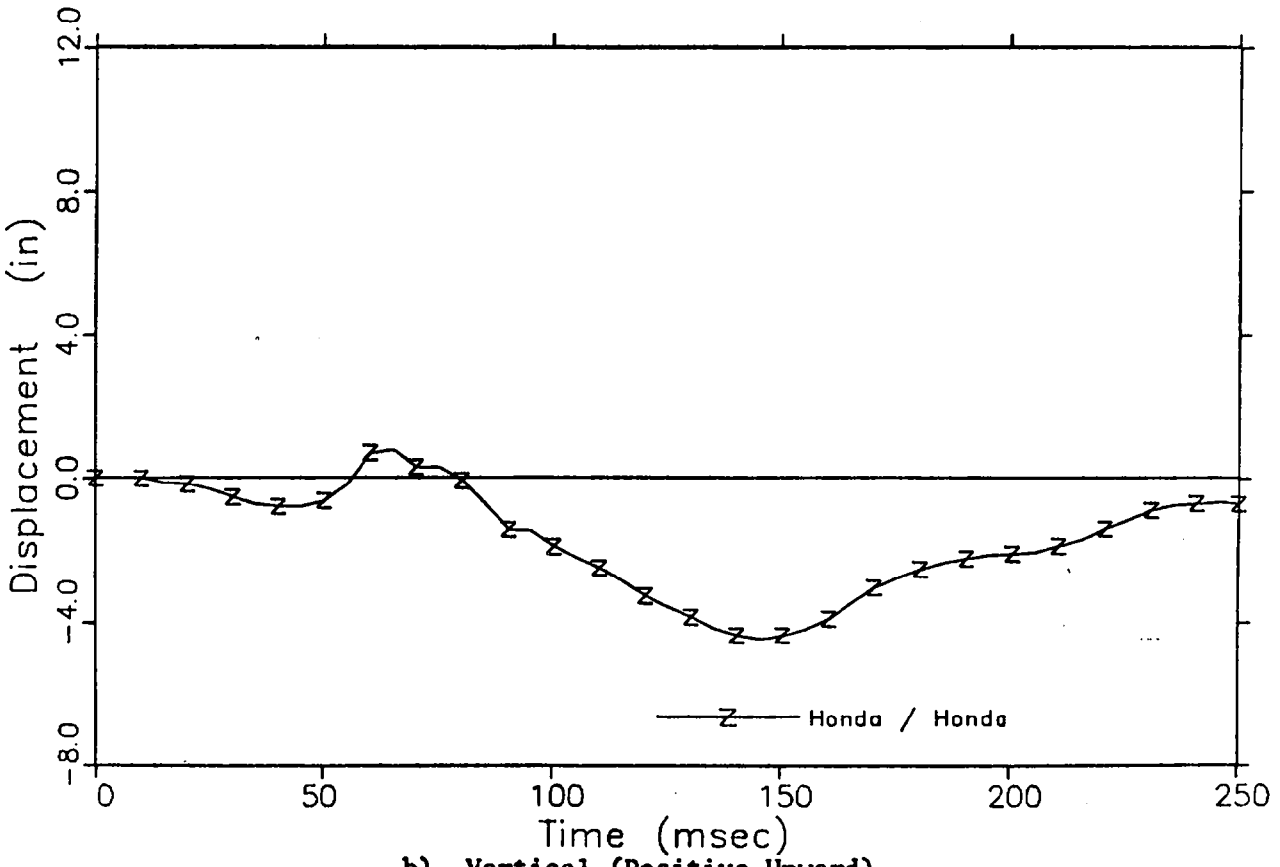
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	110.38	112.63	113.75	114.13	114.75	115.13	115.13	115.13	114.88	114.50	113.75	112.63	110.38
	POST	108.50	111.63	113.00	113.50	114.38	114.75	114.75	114.63	114.50	114.38	113.75	112.25	109.63
	DIFF.	1.88	1.00	0.75	0.63	0.38	0.38	0.38	0.50	0.38	0.13	0.00	0.38	0.75
B	PRE	109.88	112.13	113.50	114.38	114.63	115.69	115.25	115.69	114.88	114.25	113.50	112.13	110.13
	POST	108.00	110.50	111.63	112.13	112.50	112.75	113.38	113.50	113.50	113.38	112.63	111.50	108.38
	DIFF.	1.88	1.63	1.88	2.25	2.13	2.94	1.88	2.19	1.38	0.88	0.88	0.63	1.75
C	PRE	123.31	123.31	118.38	119.63	123.38	123.50	123.69	122.13	123.69	123.31	123.00	123.19	122.69
	POST	121.38	119.50	114.38	115.00	120.63	120.88	120.63	120.50	120.75	121.13	121.25	121.63	121.75
	DIFF.	1.94	3.81	4.00	4.63	2.75	2.63	3.06	1.63	2.94	2.19	1.75	1.56	0.94
D	PRE	118.63	122.81	123.00	123.00	123.63	123.88	123.00	123.88	123.44	123.13	123.19	122.75	118.63
	POST	117.25	117.00	116.50	118.00	119.00	120.50	119.25	119.25	119.75	120.75	121.25	120.69	116.38
	DIFF.	1.38	5.81	6.50	5.00	4.63	3.38	3.75	4.63	3.69	2.38	1.95	2.06	2.25
E	PRE	117.13	120.13	123.25	123.50	123.38	123.63	122.88	123.88	123.25	123.25	123.13	120.25	117.13
	POST	114.63	115.88	115.00	116.38	118.00	118.88	118.75	119.25	119.38	120.75	121.25	118.25	115.25
	DIFF.	2.50	4.25	8.25	7.13	5.38	4.75	4.13	4.63	3.88	2.50	1.88	2.00	1.88

Honda/Honda OF

Test Number 850724



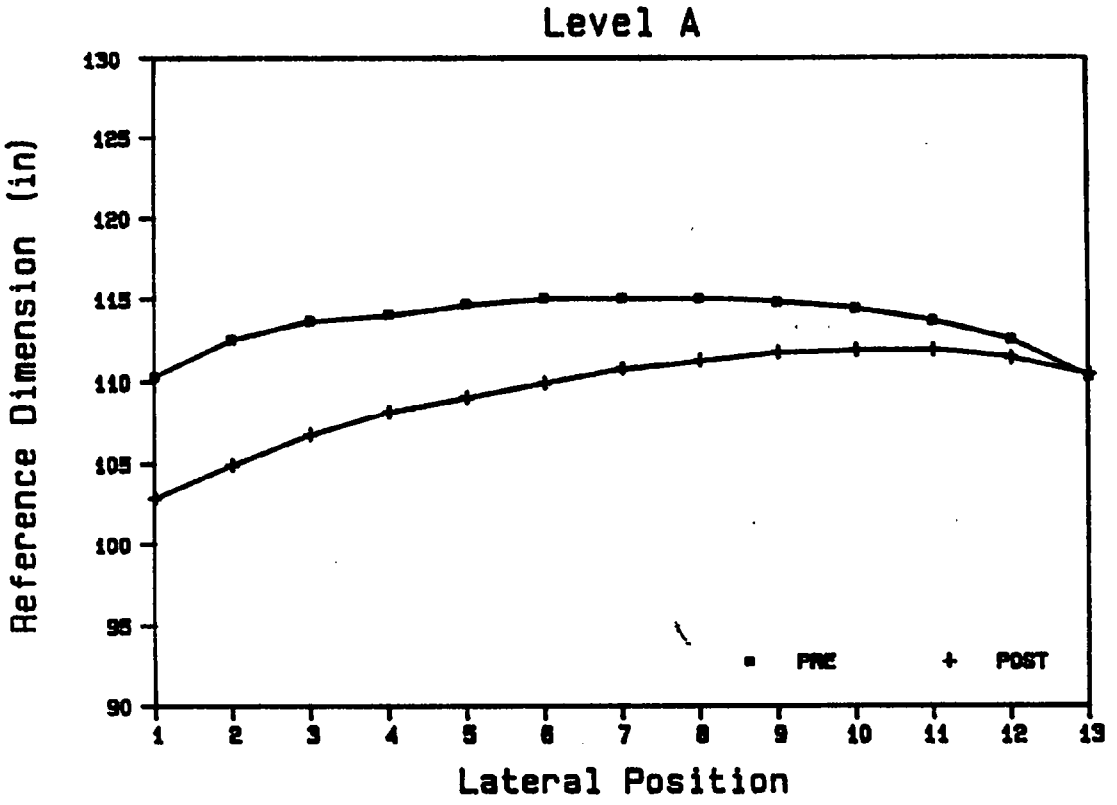
a) Horizontal (Positive Rearward)

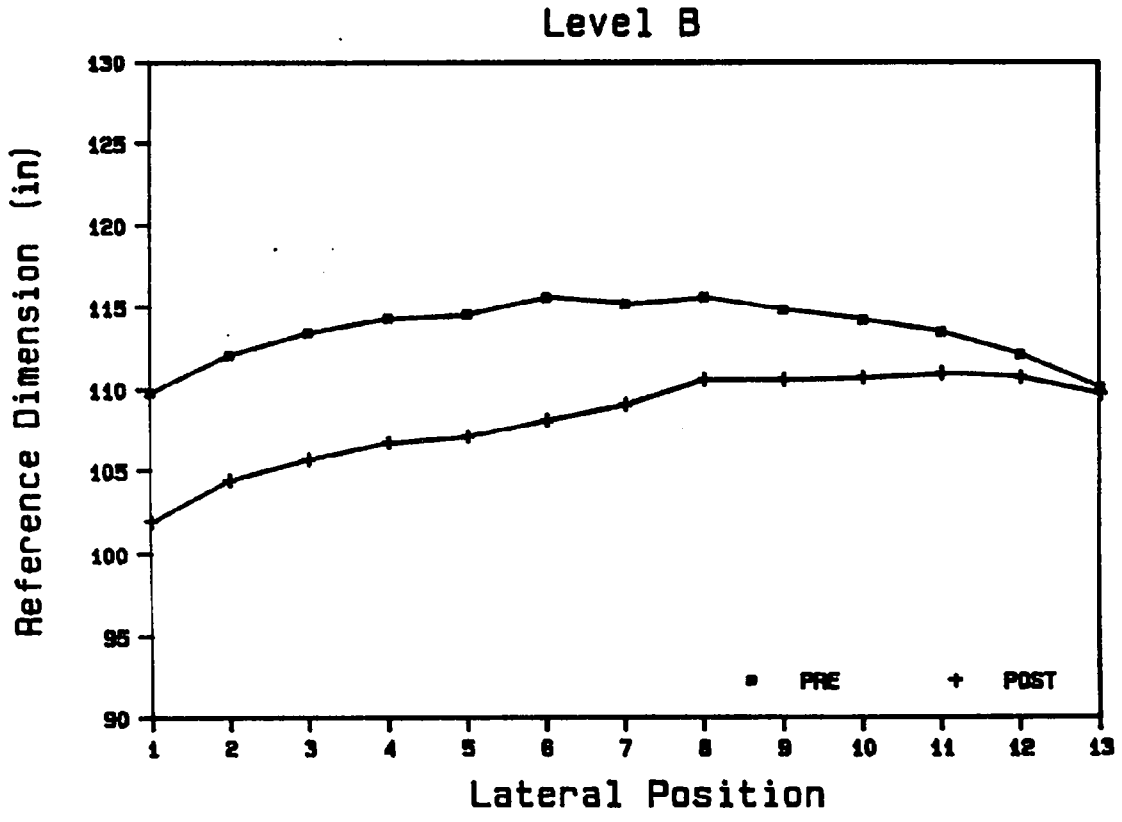


b) Vertical (Positive Upward)

Steering Column Movement

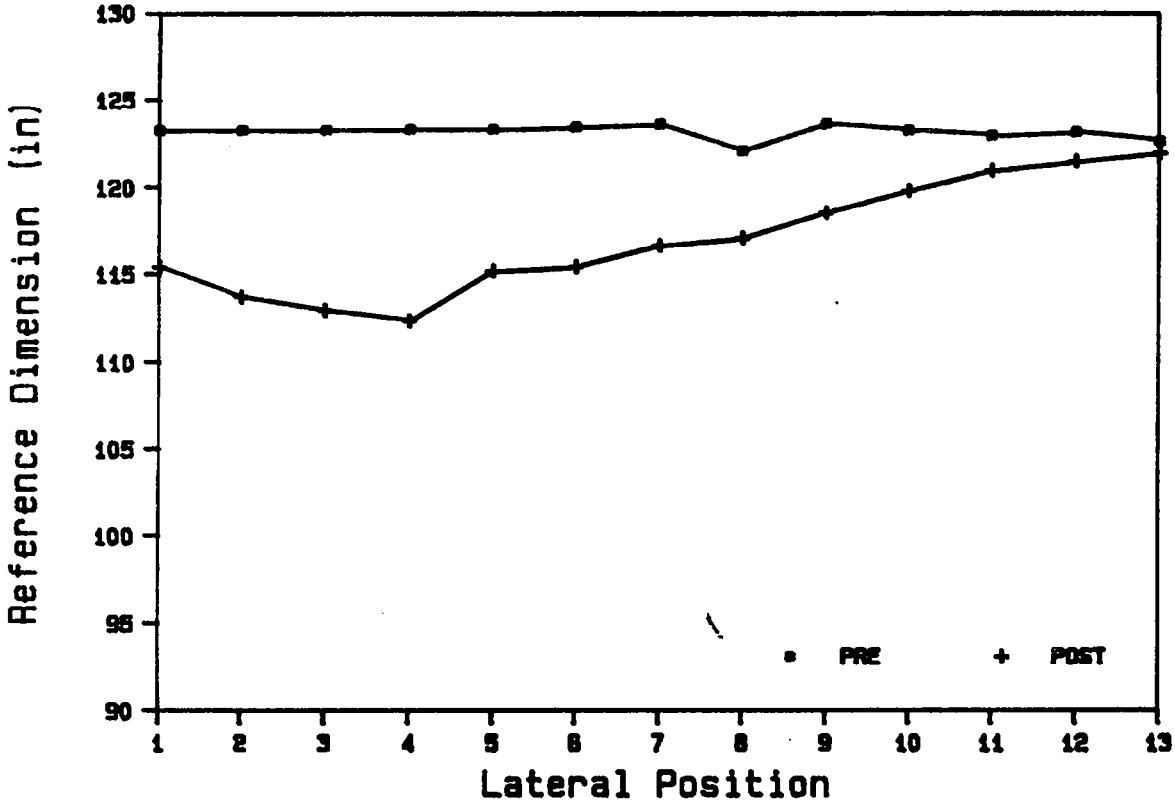
Honda Intrusion - Test 850724



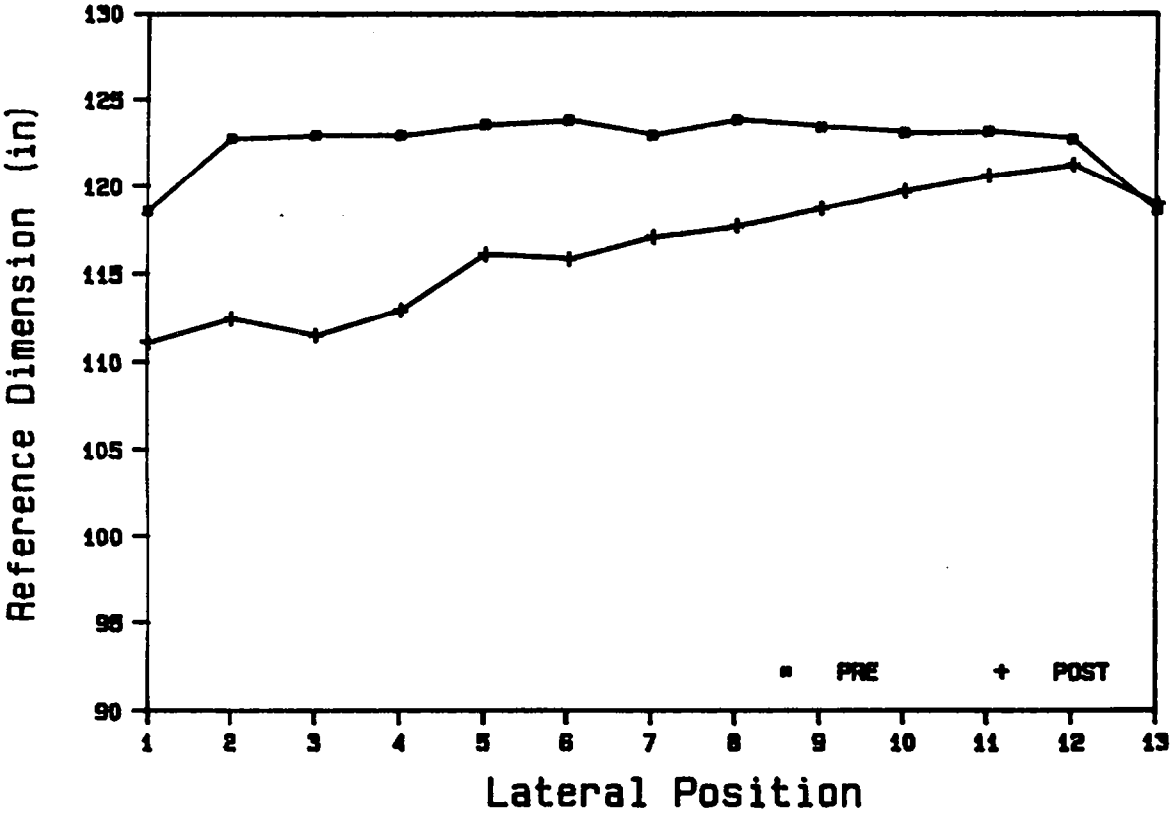


Honda Intrusion - Test 850724

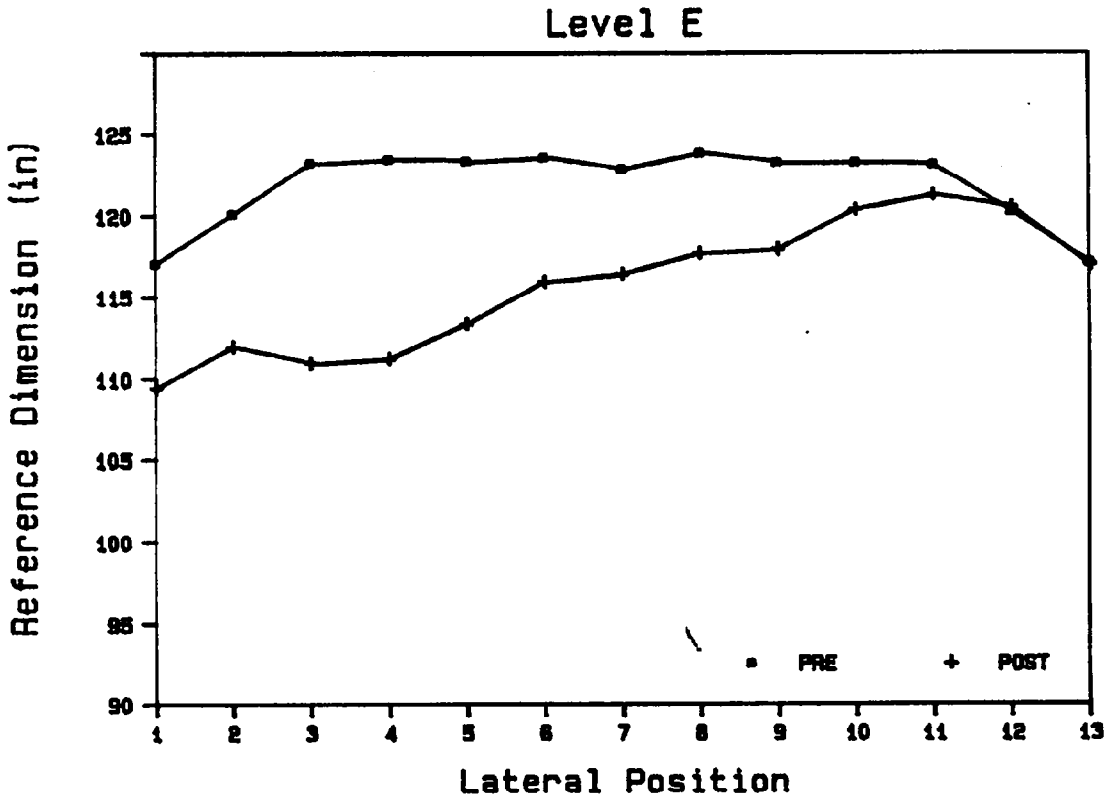
Level C



Level D



Honda Intrusion - Test 850724



REFERENCE MEASUREMENTS

Honda / Honda OF *Test 850724*

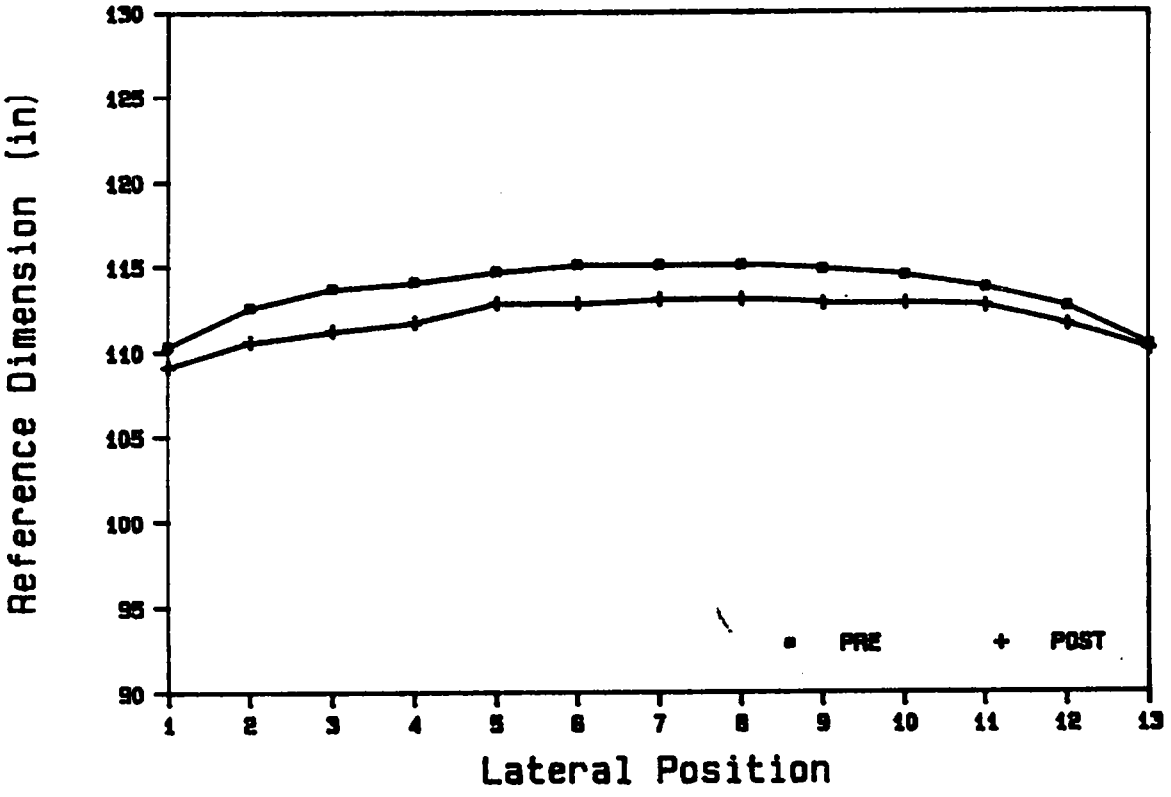
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	110.38	112.63	113.75	114.13	114.75	115.13	115.13	115.13	114.88	114.51	113.76	112.63	110.38
	POST	103.00	105.00	106.88	108.25	109.13	110.00	110.88	111.38	111.88	112.00	112.00	111.50	110.50
	DIFF.	7.38	7.63	6.87	5.88	5.62	5.13	4.25	3.75	3.00	2.50	1.75	1.13	-0.13
B	PRE	109.88	112.13	113.50	114.38	114.63	115.69	115.25	115.69	114.88	114.25	113.50	112.13	110.13
	POST	102.00	104.50	105.75	106.75	107.13	108.19	109.13	110.63	110.63	110.75	111.00	110.75	109.75
	DIFF.	7.88	7.63	7.75	7.63	7.50	7.50	6.13	5.06	4.25	3.50	2.50	1.38	0.38
C	PRE	123.31	123.31	123.32	123.38	123.38	123.50	123.69	122.13	123.69	123.31	123.00	123.19	122.69
	POST	115.50	113.75	113.00	112.38	115.25	115.50	116.75	117.19	118.63	119.88	121.00	121.50	122.00
	DIFF.	7.81	9.56	10.32	11.00	8.13	8.00	6.94	4.94	5.06	3.44	2.00	1.69	0.69
D	PRE	118.63	122.81	123.00	123.00	123.63	123.88	123.00	123.88	123.44	123.13	123.19	122.75	118.63
	POST	111.13	112.50	111.50	113.00	116.13	115.88	117.13	117.75	118.75	119.75	120.63	121.25	119.00
	DIFF.	7.50	10.31	11.50	10.00	7.50	8.00	5.88	6.13	4.69	3.38	2.56	1.50	-0.38
E	PRE	117.13	120.13	123.25	123.50	123.38	123.63	122.88	123.88	123.25	123.25	123.13	120.25	117.13
	POST	109.50	112.00	111.00	111.25	113.38	116.00	116.50	117.75	118.00	120.38	121.25	120.50	117.00
	DIFF.	7.63	8.13	12.25	12.25	10.00	7.63	6.38	6.13	5.25	2.88	1.88	-0.25	0.13

Honda/Pole CTR

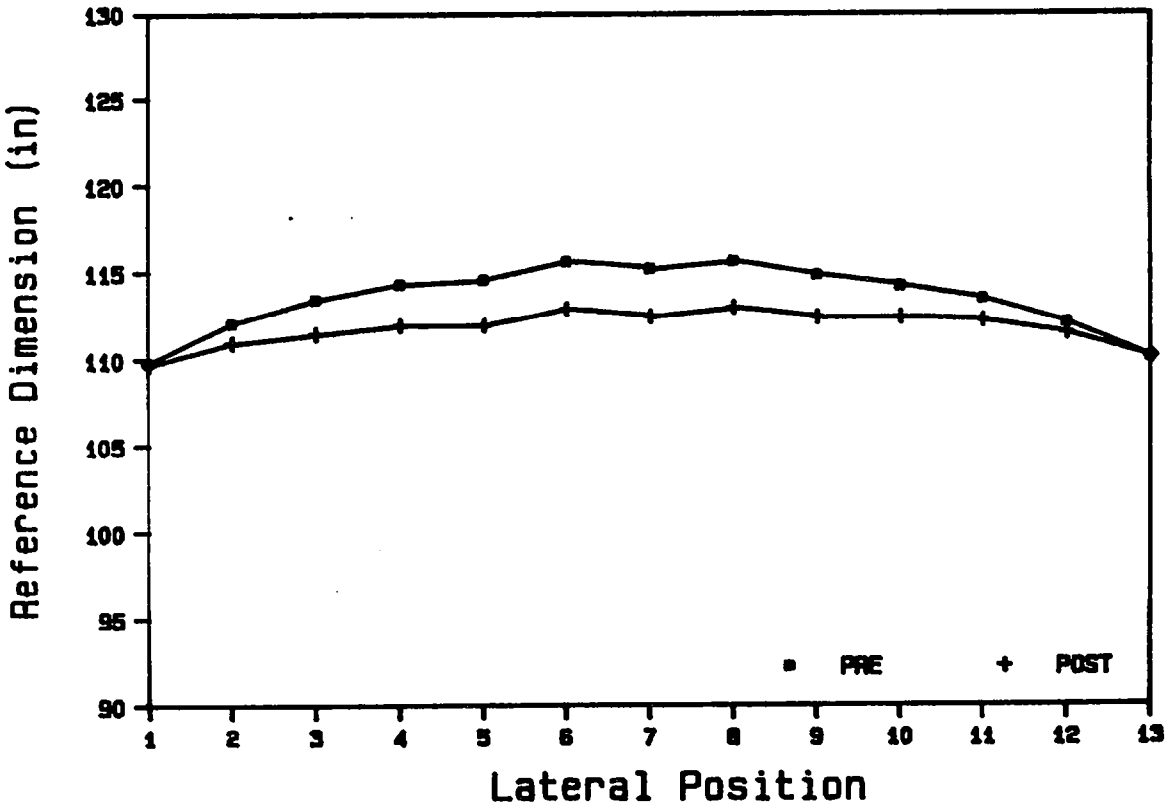
Test Number 850425

Honda Intrusion - Test 850425

Level A

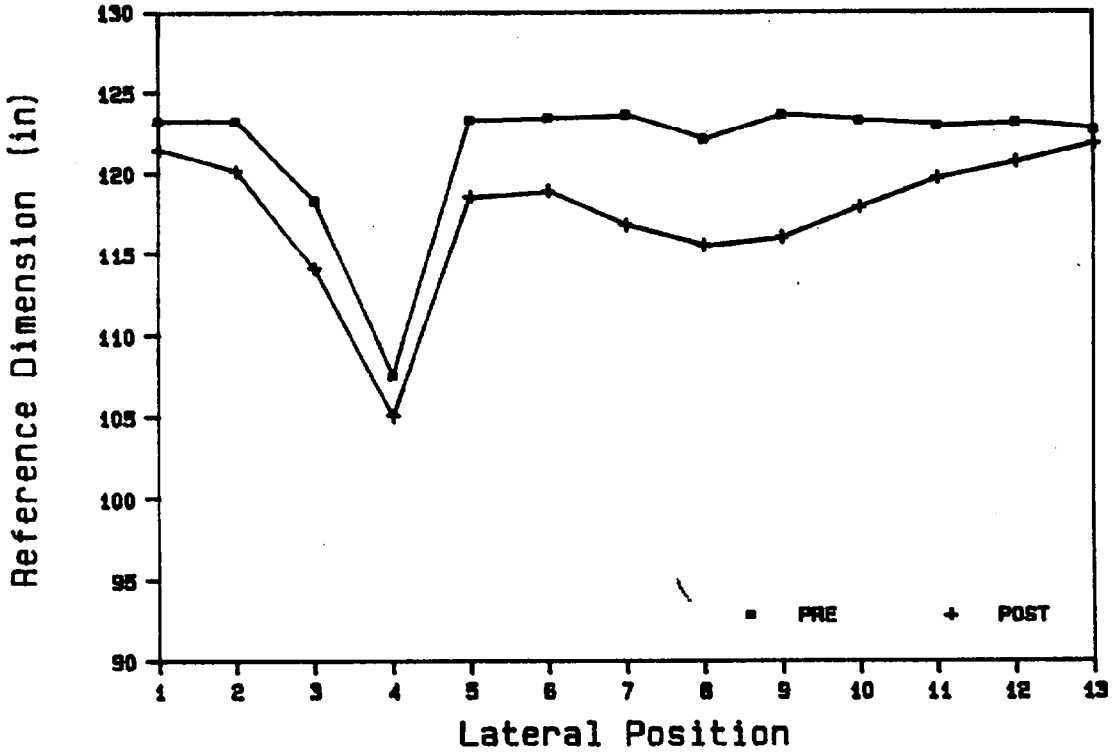


Level B

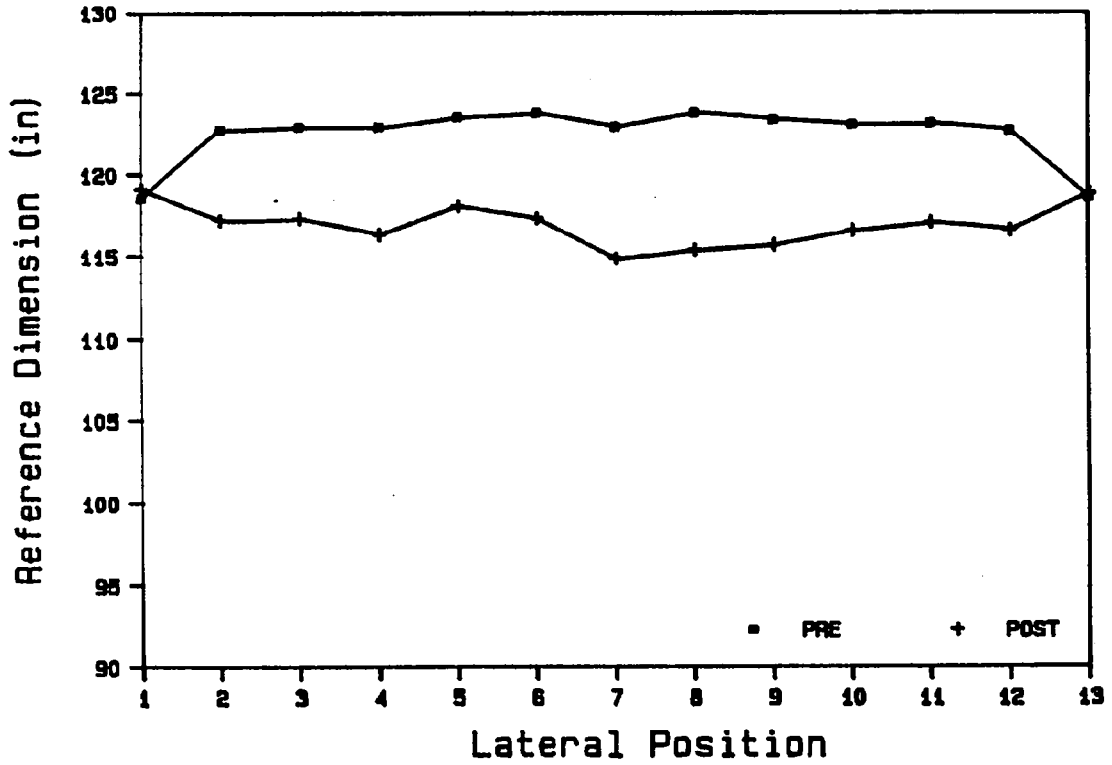


Honda Intrusion - Test 850425

Level C

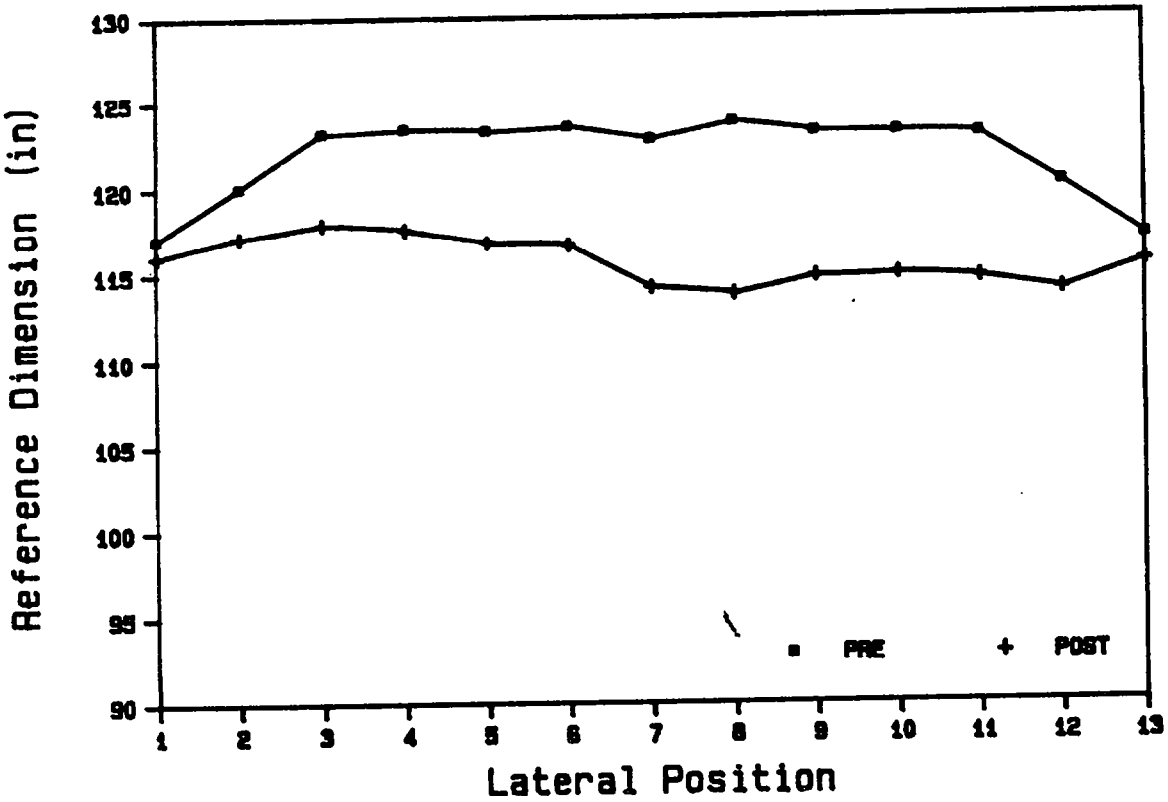


Level D



Honda Intrusion - Test 850425

Level E



REFERENCE MEASUREMENTS

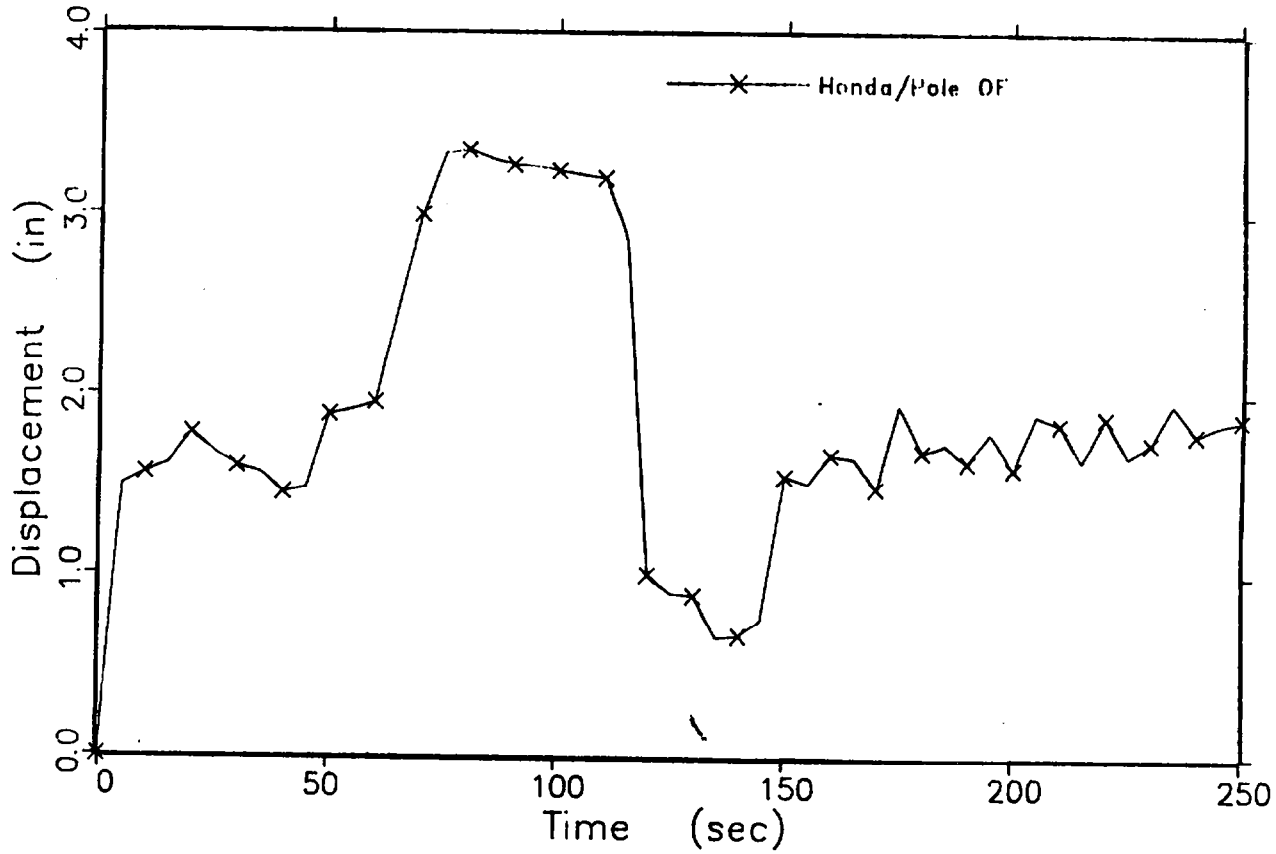
Honda / Pole CTR

Test 850425

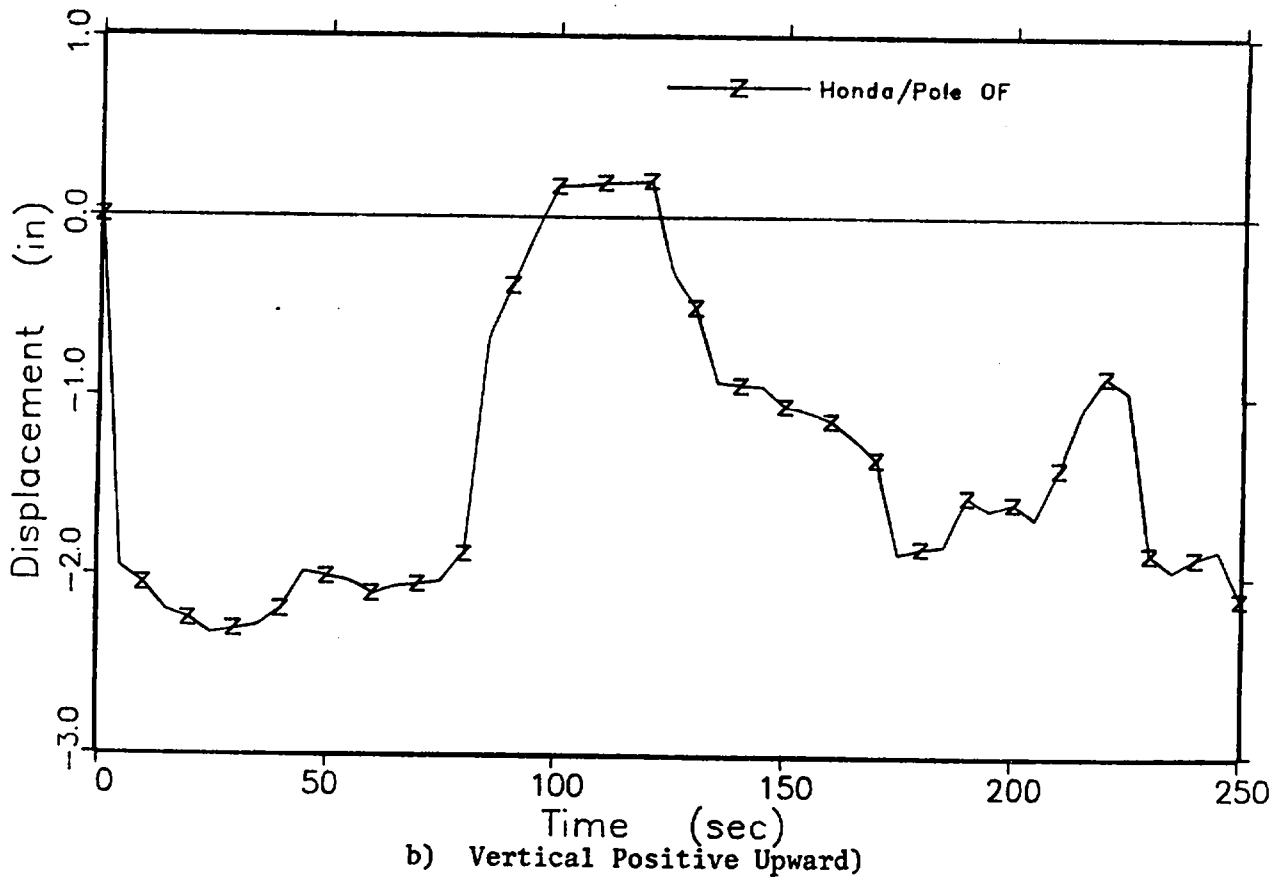
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	110.38	112.63	113.75	114.13	114.75	115.13	115.13	115.13	114.88	114.50	113.75	112.63	110.38
	POST	109.19	110.63	111.25	111.75	112.88	112.88	113.13	113.13	112.88	112.88	112.69	111.56	110.13
	DIFF.	1.19	2.00	2.50	2.38	1.88	2.25	2.00	2.00	2.00	1.63	1.06	1.06	0.25
B	PRE	109.88	112.13	113.50	114.38	114.63	115.69	115.25	115.69	114.88	114.25	113.50	112.13	110.13
	POST	109.75	111.00	111.50	112.00	112.00	112.94	112.50	113.00	112.44	112.44	112.25	111.50	110.13
	DIFF.	0.13	1.13	2.00	2.38	2.63	2.75	2.75	2.69	2.44	1.81	1.25	0.63	0.00
C	PRE	123.31	123.31	118.38	107.63	123.38	123.50	123.69	122.13	123.69	123.31	123.00	123.19	122.69
	POST	121.50	120.19	114.13	105.13	118.63	119.00	116.88	115.63	116.13	118.00	119.75	120.75	121.88
	DIFF.	1.81	3.13	4.25	2.50	4.75	4.50	6.81	6.50	7.56	5.31	3.25	2.44	0.81
D	PRE	118.63	122.81	123.00	123.00	123.63	123.88	123.00	123.88	123.44	123.13	123.19	122.75	118.63
	POST	119.13	117.25	117.38	116.38	118.13	117.38	114.88	115.44	115.75	116.63	117.13	116.63	118.88
	DIFF.	-0.50	5.56	5.63	6.63	5.50	6.50	8.13	8.44	7.69	6.50	6.06	6.13	-0.25
E	PRE	117.13	120.13	123.25	123.50	123.38	123.63	122.88	123.88	123.25	123.25	123.13	120.25	117.13
	POST	116.13	117.25	118.00	117.67	116.88	116.75	114.25	113.88	114.88	115.00	114.75	114.00	115.63
	DIFF.	1.00	2.88	5.25	5.83	6.50	6.88	8.63	10.00	8.38	8.25	8.38	6.25	1.50

Honda/Pole OF

Test Number 850912



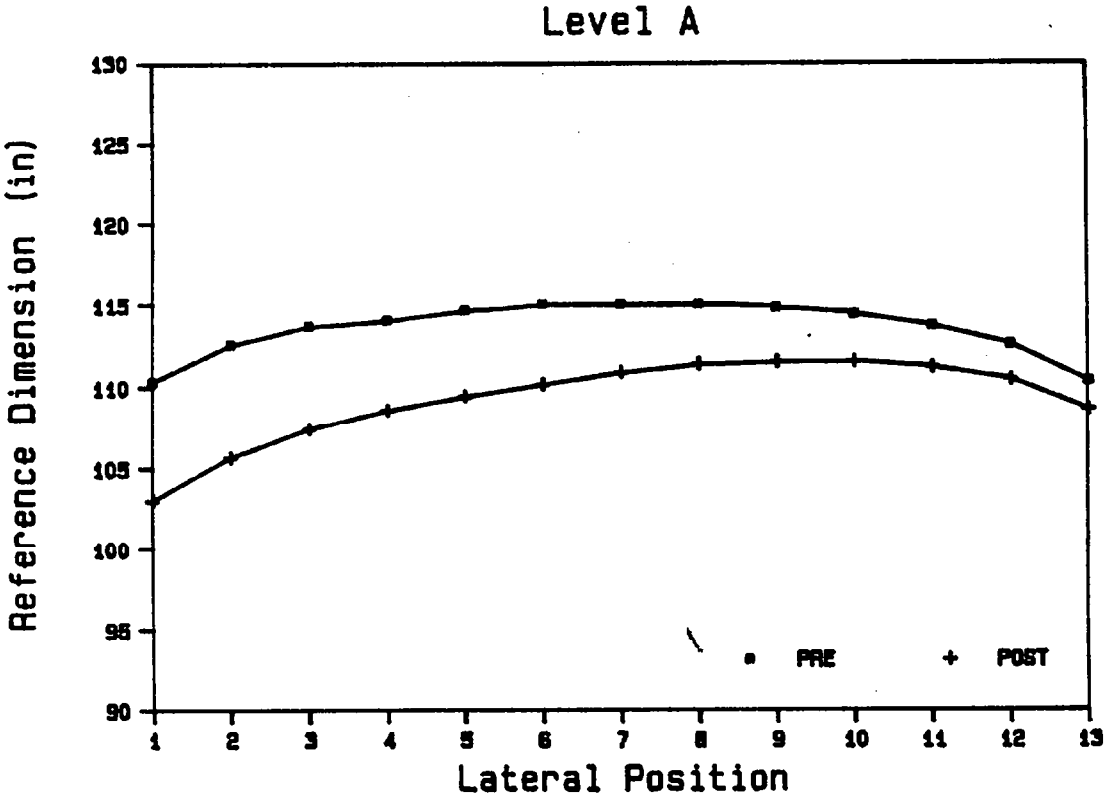
a) Horizontal (Positive Rearward)

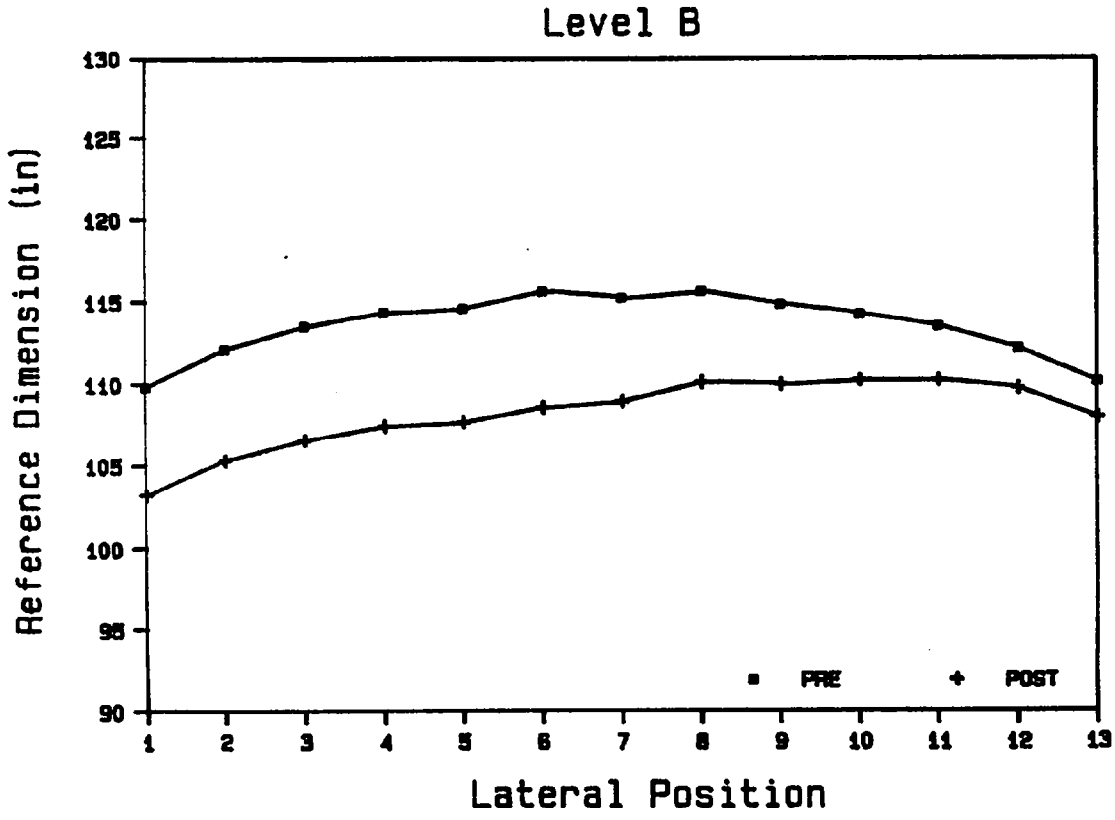


b) Vertical Positive Upward)

Steering Column Movement

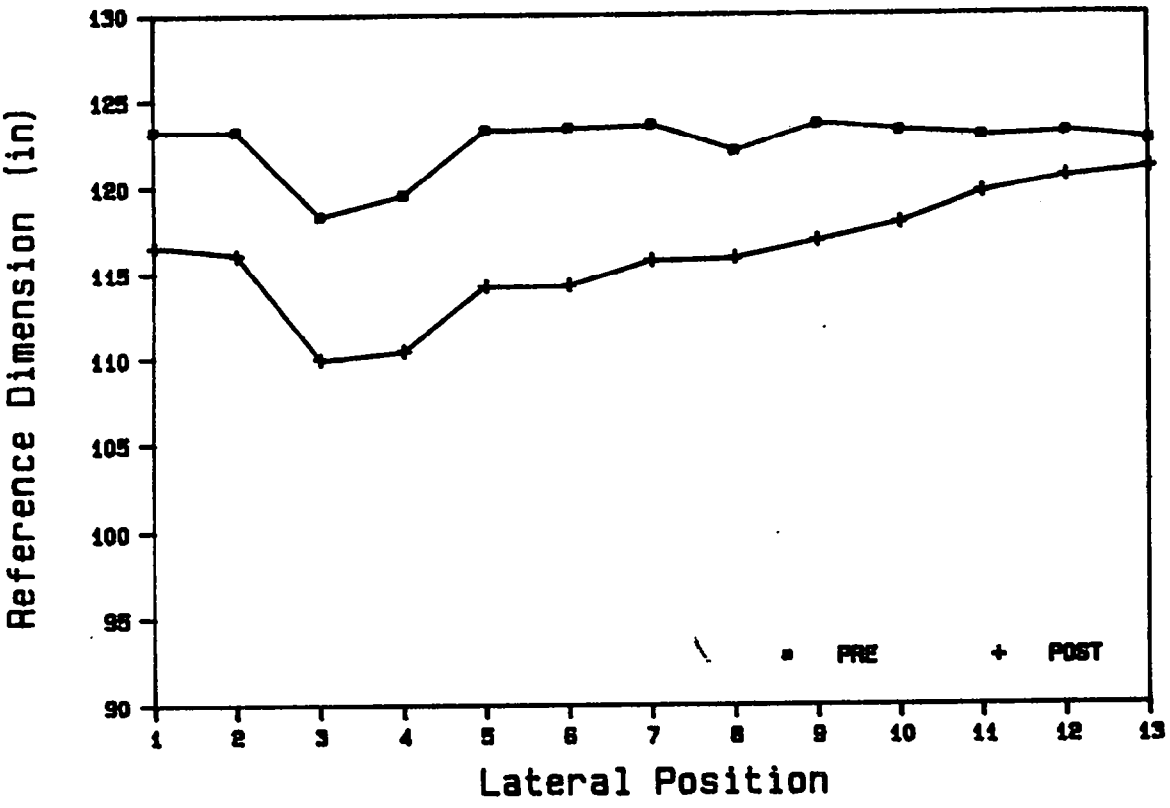
Honda Intrusion - Test 850912



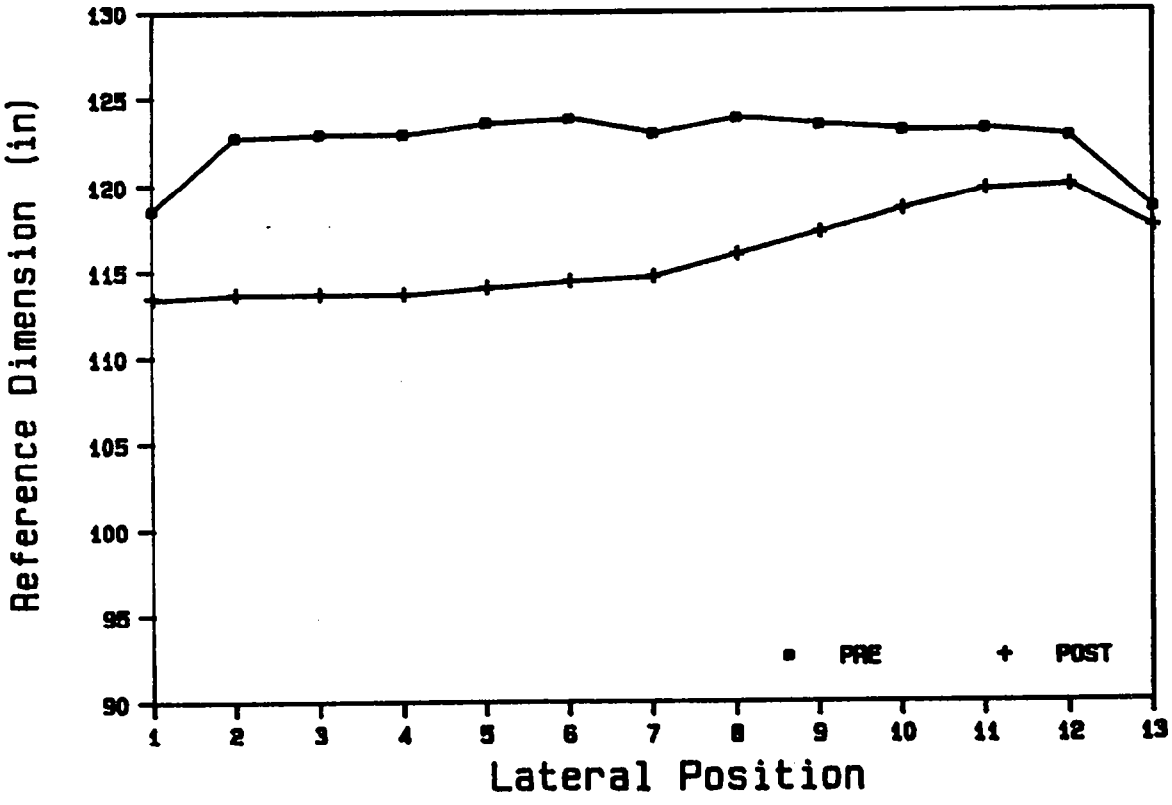


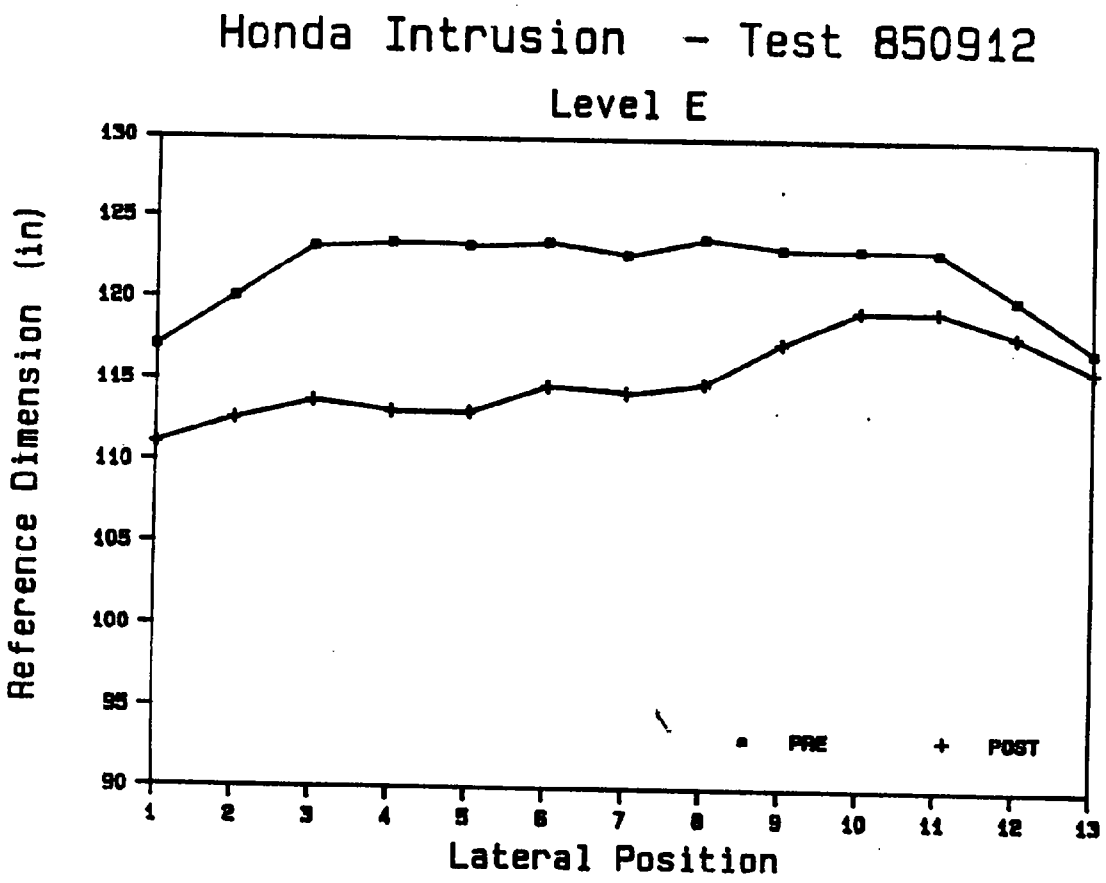
Honda Intrusion - Test 850912

Level C



Level D




Honda Intrusion - Test 850912
Level E
Reference Dimension (in)
130
125
120
115
110
105
100
95
90
1
2
3
4
5
6
7
8
9
10
11
12
13
PRE
POST
Lateral Position

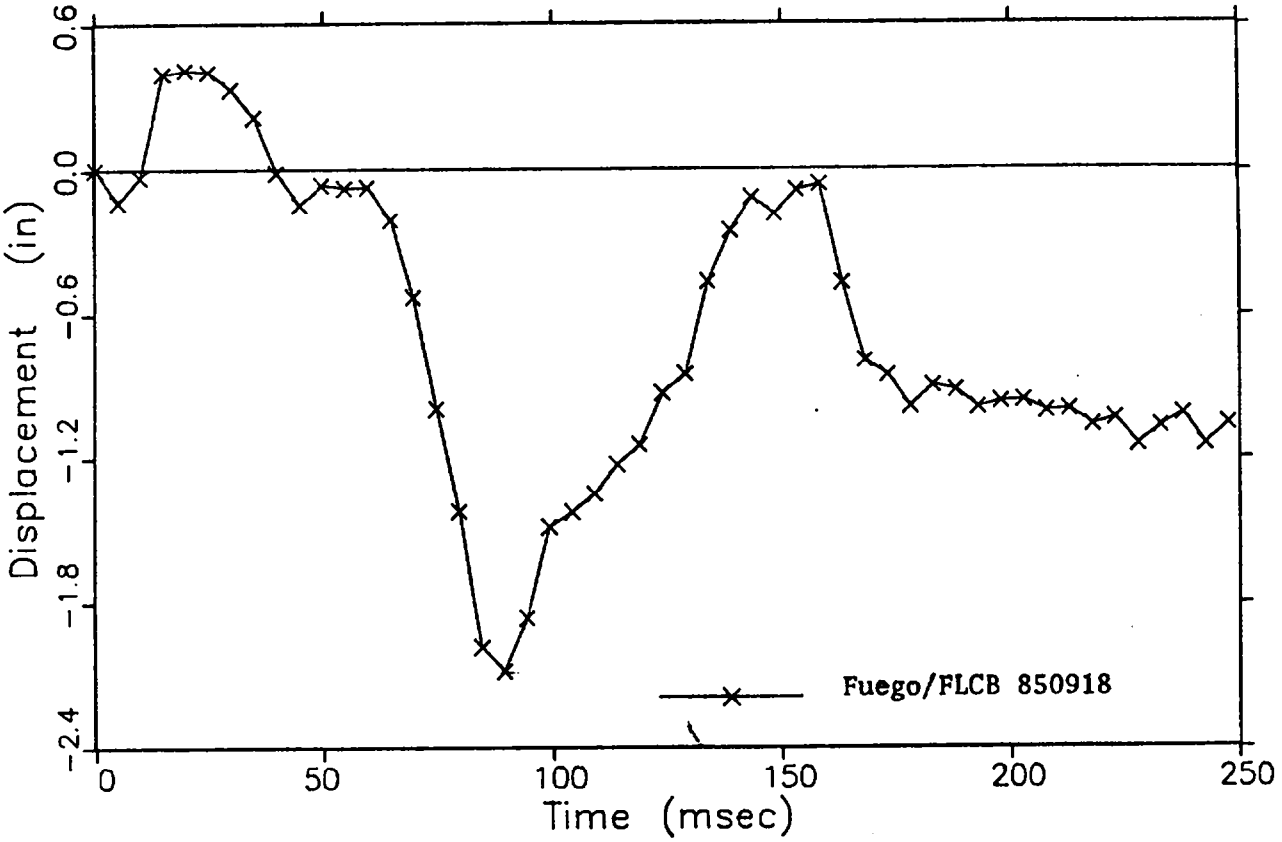
REFERENCE MEASUREMENTS

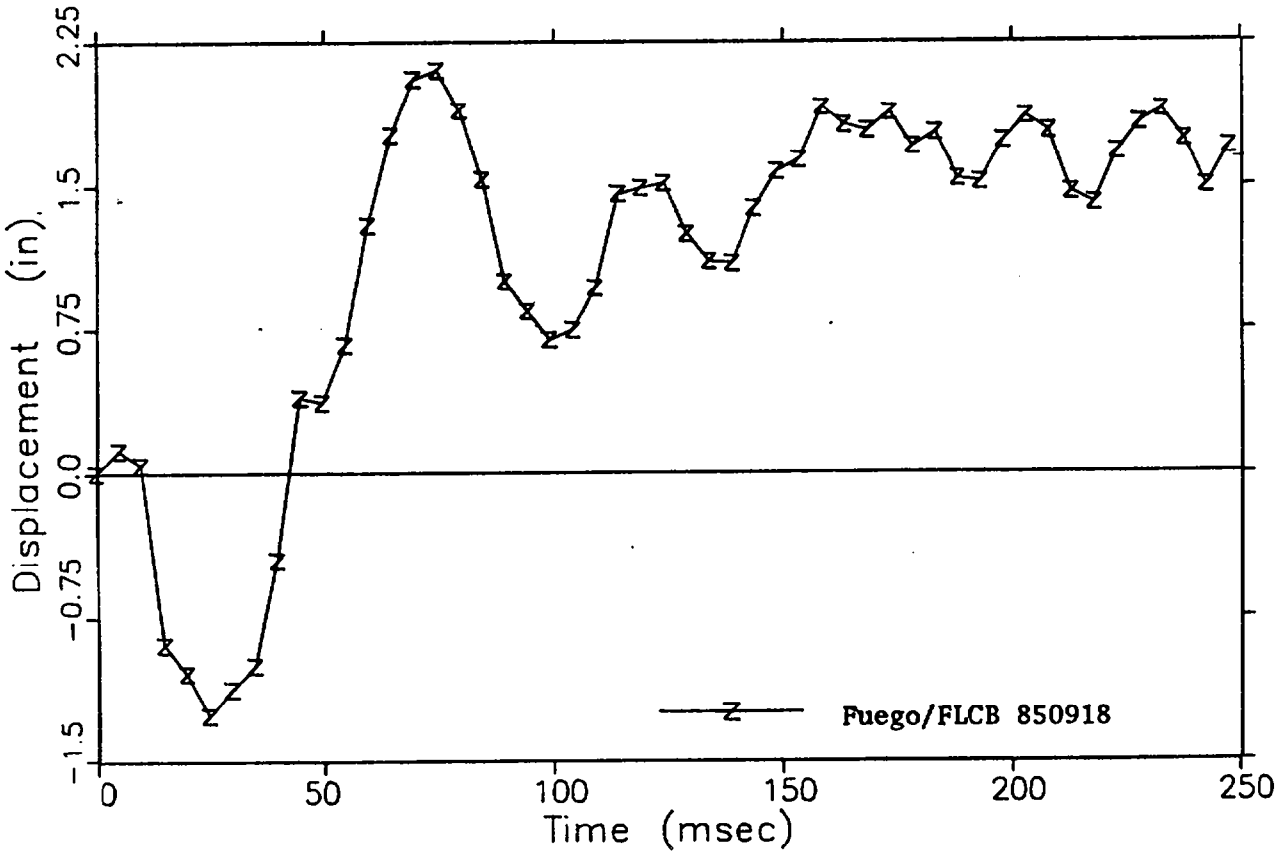
Honda / Pole OF *Test 850912*

Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13
A	PRE	110.38	112.63	113.75	114.13	114.75	115.13	115.13	115.13	114.88	114.50	113.75	112.63	110.38
	POST	103.13	105.75	107.50	108.63	109.50	110.25	111.00	111.50	111.63	111.63	111.25	110.50	108.63
	DIFF.	7.25	6.88	6.25	5.50	5.25	4.88	4.13	3.63	3.25	2.88	2.50	2.13	1.75
B	PRE	109.88	112.13	113.50	114.38	114.63	115.69	115.25	115.69	114.88	114.25	113.50	112.13	110.13
	POST	103.25	105.38	106.63	107.50	107.75	108.63	109.00	110.13	110.00	110.25	110.25	109.75	108.00
	DIFF.	6.63	6.75	6.88	6.88	6.88	7.06	6.25	5.56	4.88	4.00	3.25	2.38	2.13
C	PRE	123.31	123.31	118.38	119.63	123.38	123.50	123.69	122.13	123.69	123.31	123.00	123.19	122.69
	POST	116.63	116.13	110.00	110.50	114.31	114.38	115.88	116.00	117.00	118.00	119.75	120.63	121.13
	DIFF.	6.69	7.19	8.38	9.13	9.06	9.13	7.81	6.13	6.69	5.31	3.25	2.56	1.56
D	PRE	118.63	122.81	123.00	123.00	123.63	123.88	123.00	123.88	123.44	123.13	123.19	122.75	118.63
	POST	113.50	113.75	113.75	113.75	114.13	114.50	114.75	116.00	117.25	118.63	119.79	120.00	117.50
	DIFF.	5.13	9.06	9.25	9.25	9.50	9.38	8.25	7.88	6.19	4.50	3.40	2.75	1.13
E	PRE	117.13	120.13	123.25	123.50	123.38	123.63	122.88	123.88	123.25	123.25	123.13	120.25	117.13
	POST	111.13	112.63	113.75	113.13	113.13	114.75	114.38	115.00	117.50	119.50	119.50	118.00	115.88
	DIFF.	6.00	7.50	9.50	10.38	10.25	8.88	8.50	8.88	5.75	3.75	3.63	2.25	1.25

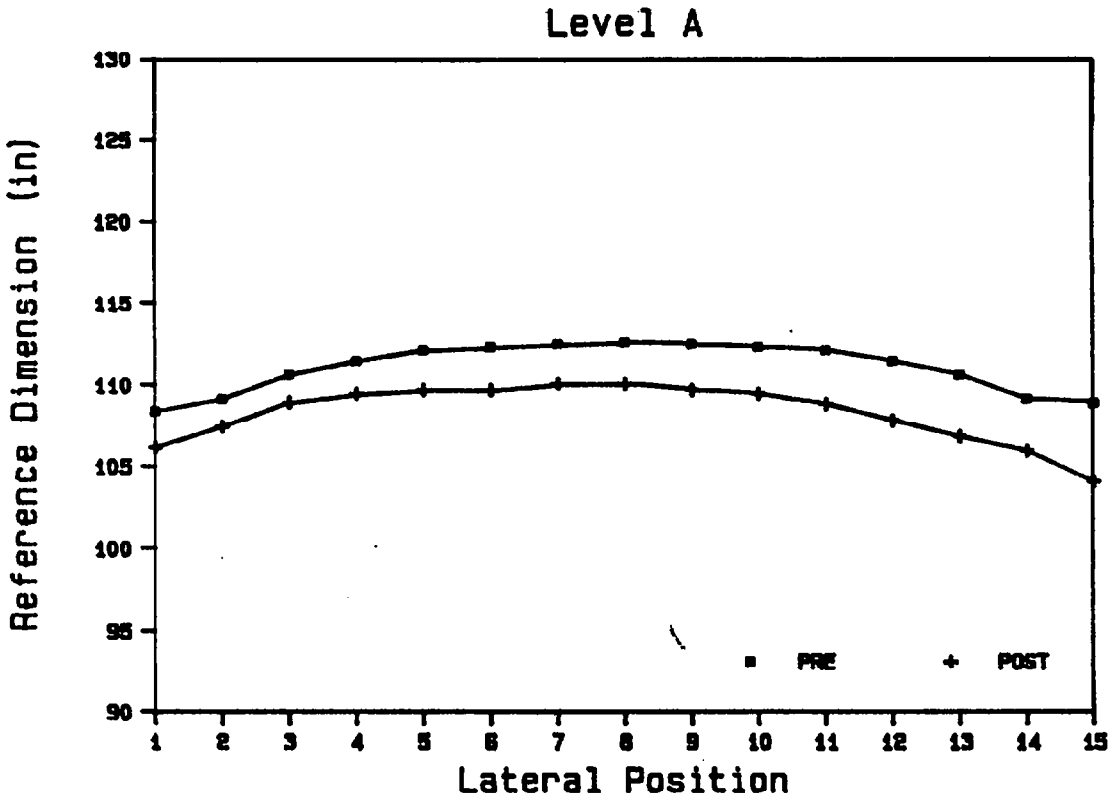
Fuego/Barrier FF

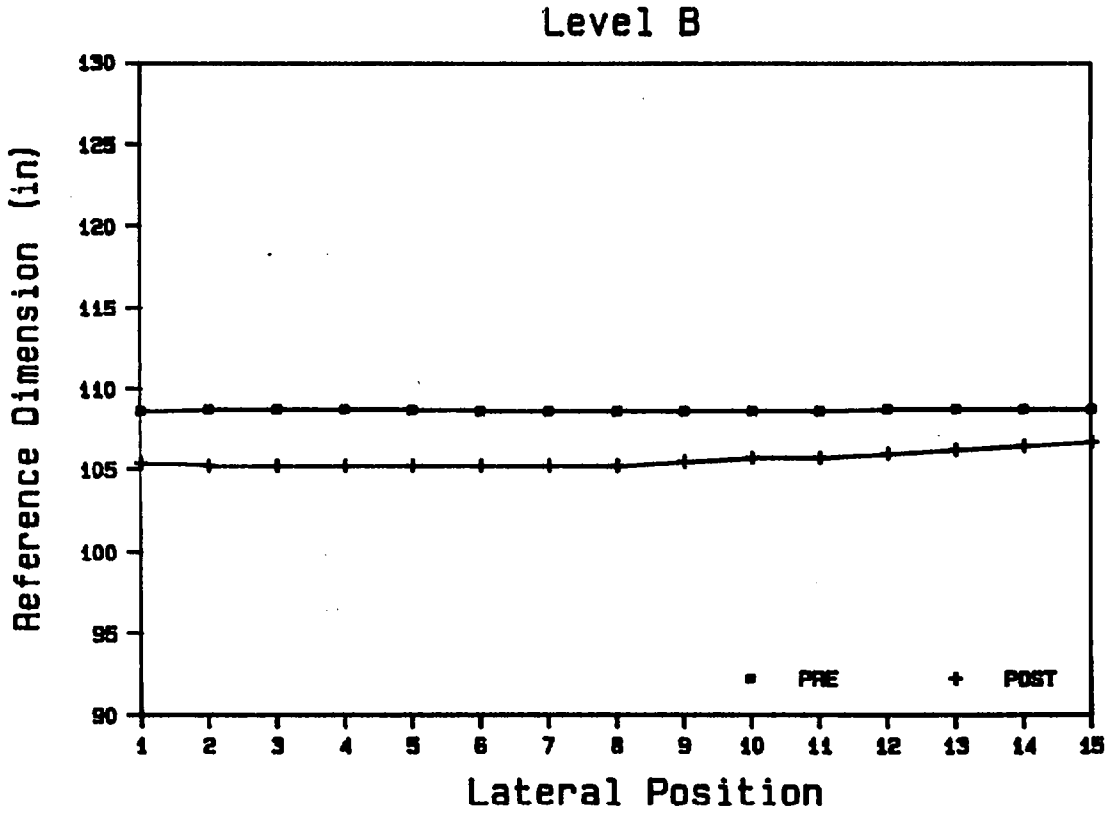
Test Number 850918


Displacement (in)
0.6
0.0
-0.6
-1.2
-1.8
-2.4
0
50
100
150
200
250
Time (msec)
Fuego/FLCB 850918


Displacement (in)
2.25
1.5
0.75
0.0
-0.75
-1.5
0
50
100
150
200
250
Time (msec)
Fuego/FLCB 850918

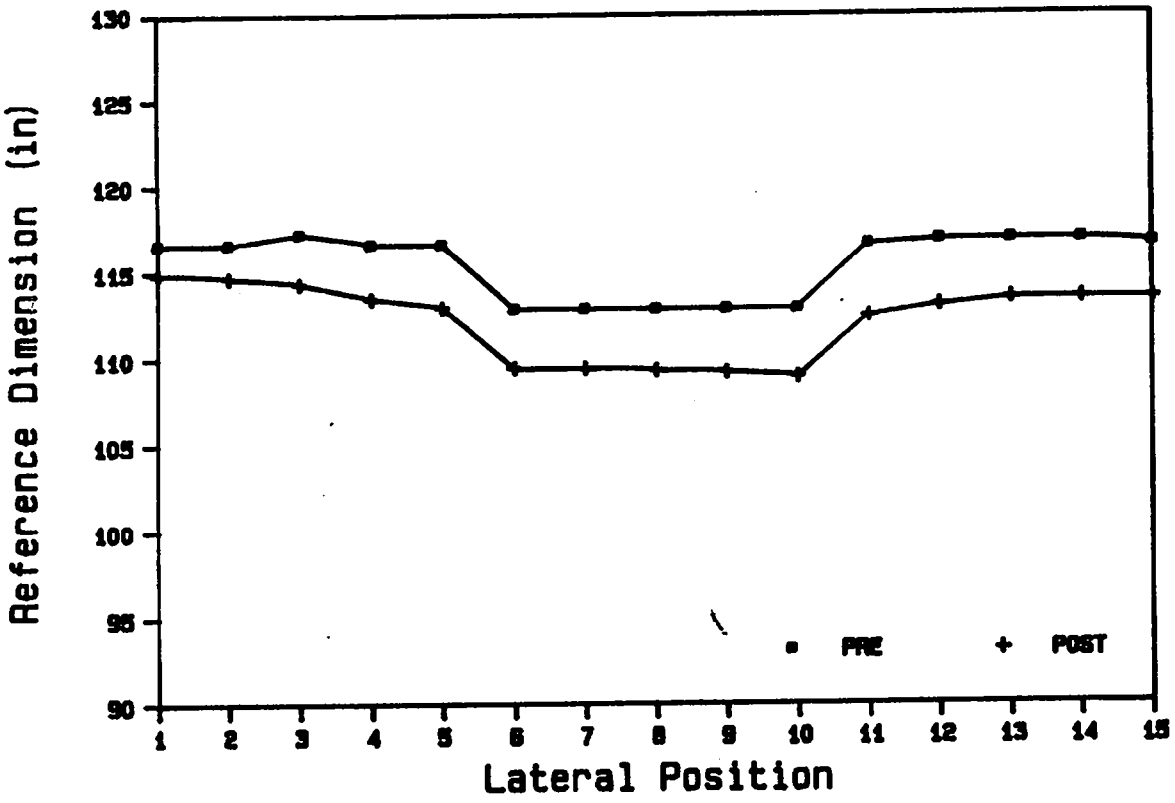
Fuego Intrusion - Test 850918



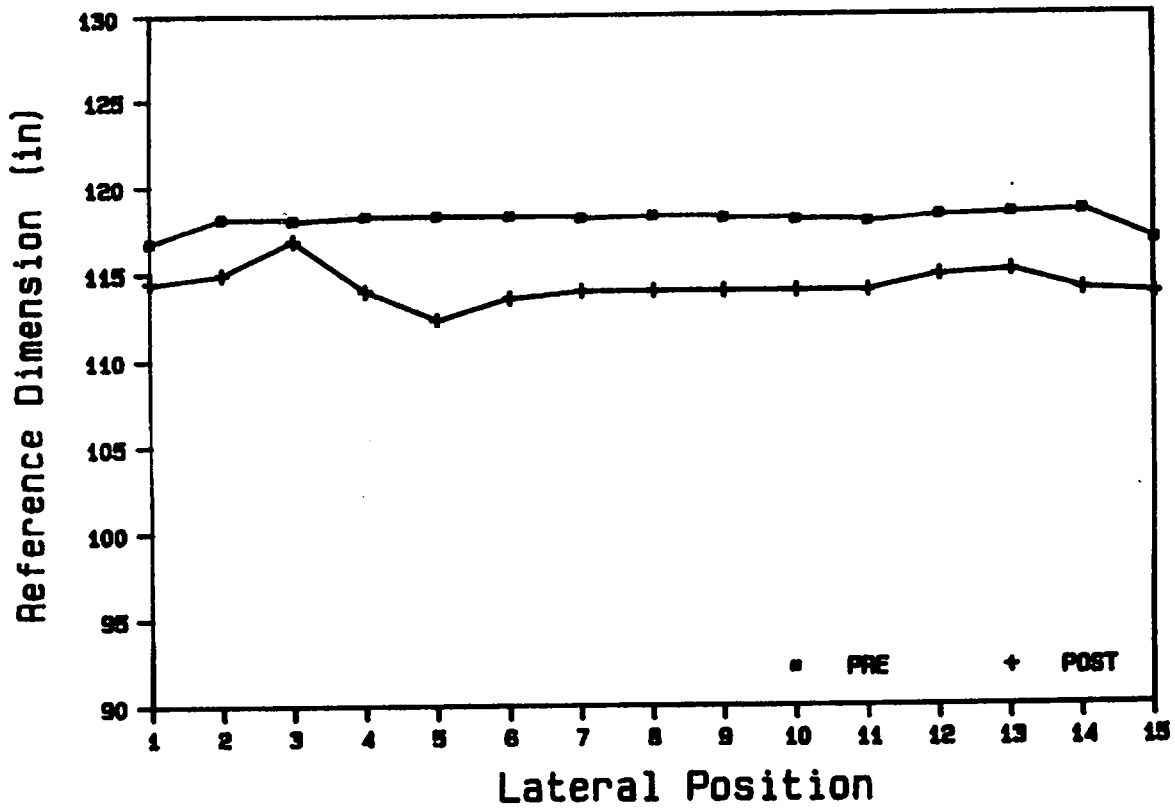


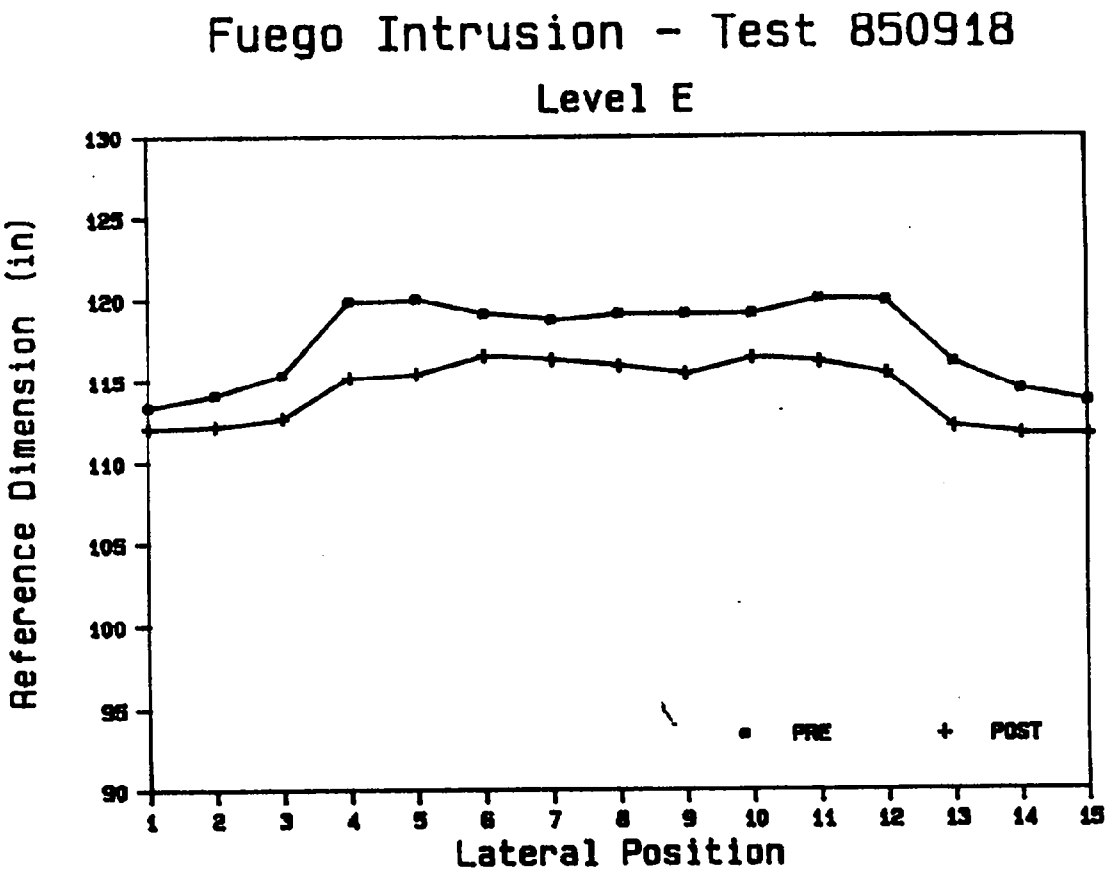
Fuego Intrusion - Test 850918

Level C



Level D




Fuego Intrusion - Test 850918
Level E
Reference Dimension (in)
130
125
120
115
110
105
100
95
90
PRE
POST
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Lateral Position

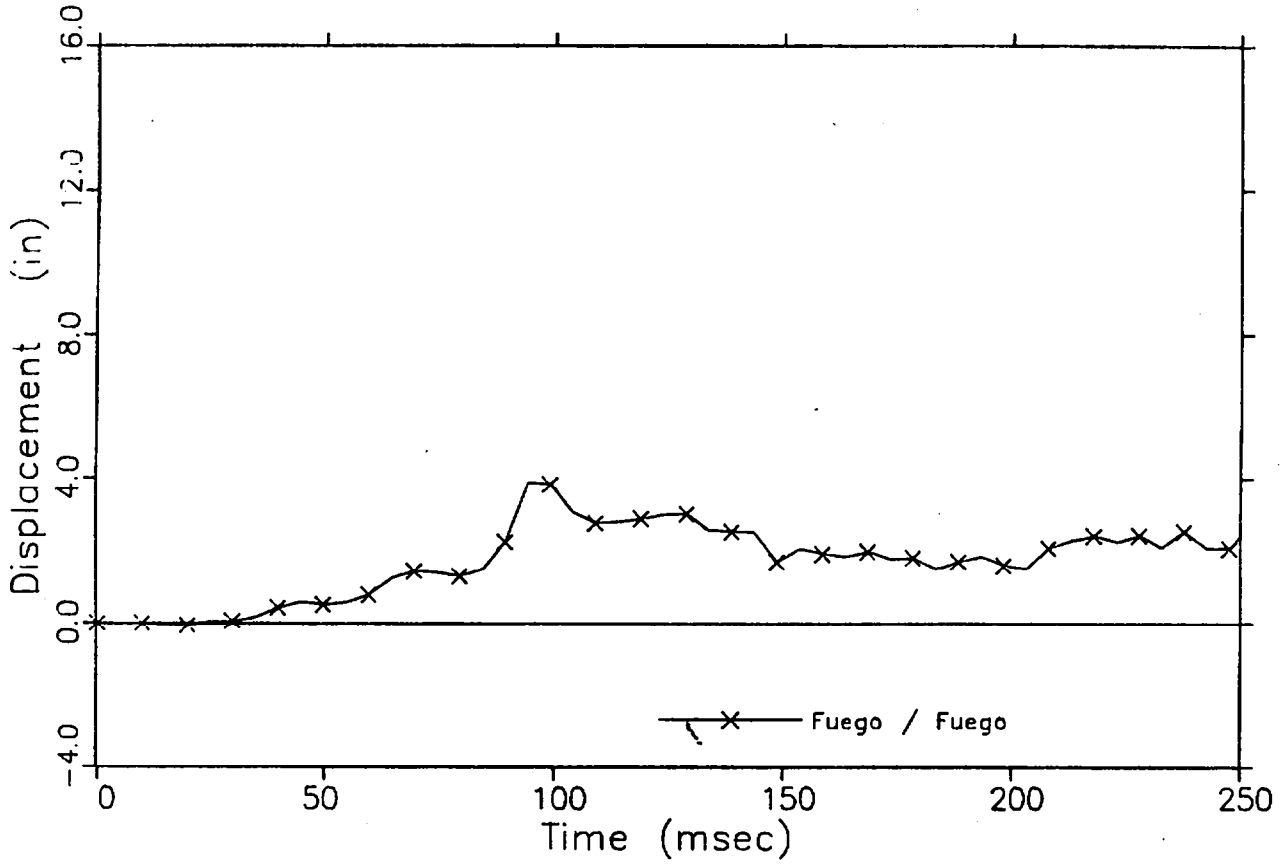
REFERENCE MEASUREMENTS

Fuego / FLC Barrier FF *Test 850918*

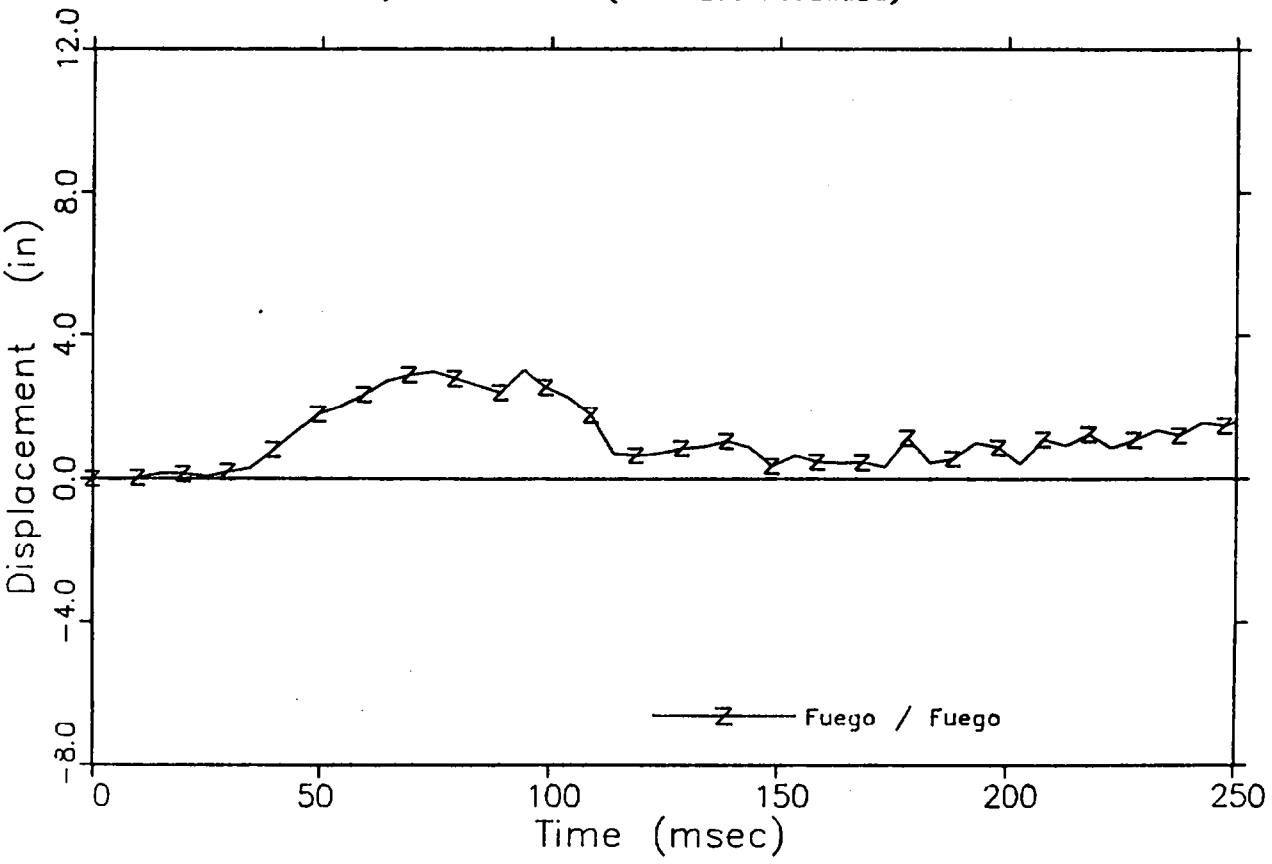
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	PRE	108.44	109.19	110.69	111.50	112.19	112.38	112.56	112.69	112.56	112.38	112.19	111.50	110.69	109.19	108.94
	POST	106.25	107.50	109.00	109.50	109.75	109.75	110.13	110.13	109.75	109.50	108.88	107.88	106.88	106.00	104.13
	DIFF.	2.19	1.69	1.69	2.00	2.44	2.63	2.44	2.56	2.81	2.88	3.31	3.63	3.81	3.19	4.81
B	PRE	108.69	108.81	108.82	108.82	108.76	108.69	108.69	108.69	108.69	108.69	108.69	108.82	108.82	108.81	108.82
	POST	105.38	105.25	105.25	105.25	105.25	105.25	105.25	105.25	105.50	105.75	105.75	106.00	106.25	106.50	106.75
	DIFF.	3.31	3.56	3.57	3.57	3.51	3.44	3.44	3.44	3.19	2.94	2.94	2.82	2.57	2.31	2.07
C	PRE	116.69	116.69	117.31	116.69	116.69	112.94	112.94	112.94	112.94	112.94	116.69	116.94	116.94	116.94	116.69
	POST	115.00	114.75	114.38	113.50	113.00	109.50	109.50	109.38	109.25	109.00	112.50	113.13	113.50	113.50	113.50
	DIFF.	1.69	1.94	2.94	3.19	3.69	3.44	3.44	3.56	3.69	3.94	4.19	3.81	3.44	3.44	3.19
D	PRE	116.82	118.19	118.06	118.31	118.32	118.31	118.19	118.31	118.19	118.07	117.94	118.31	118.44	118.56	116.82
	POST	114.50	115.00	116.88	114.00	112.38	113.63	114.00	114.00	114.00	114.00	114.00	114.88	115.13	114.00	113.75
	DIFF.	2.32	3.19	1.19	4.31	5.94	4.69	4.19	4.31	4.19	4.07	3.94	3.44	3.31	4.56	3.07
E	PRE	113.44	114.19	115.44	119.94	120.07	119.19	118.82	119.19	119.19	119.19	120.07	119.94	116.19	114.44	113.69
	POST	112.13	112.25	112.75	115.25	115.50	116.63	116.38	116.00	115.50	116.50	117.25	115.50	112.13	111.69	111.63
	DIFF.	1.31	1.94	2.69	4.69	4.57	2.56	2.44	3.19	3.69	2.69	3.82	4.44	4.06	2.75	2.06

Fuego/Fuego OF

Test Number 850731



a) Horizontal (Positive Rearward)

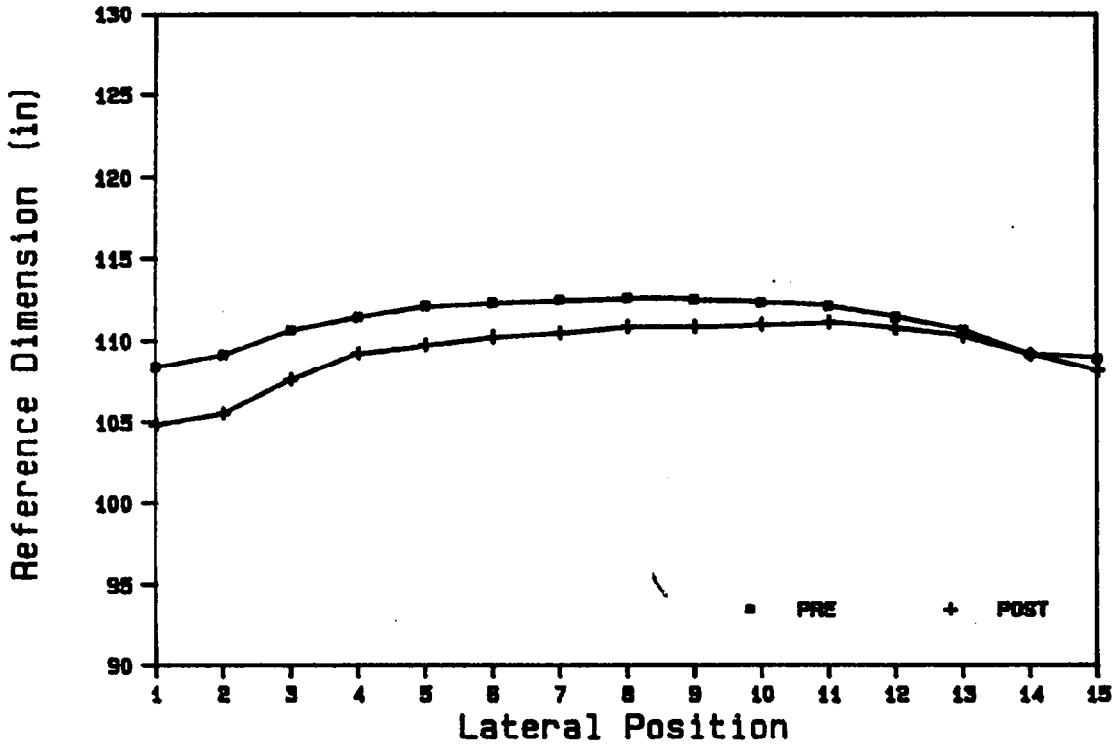


b) Vertical (Positive Upward)

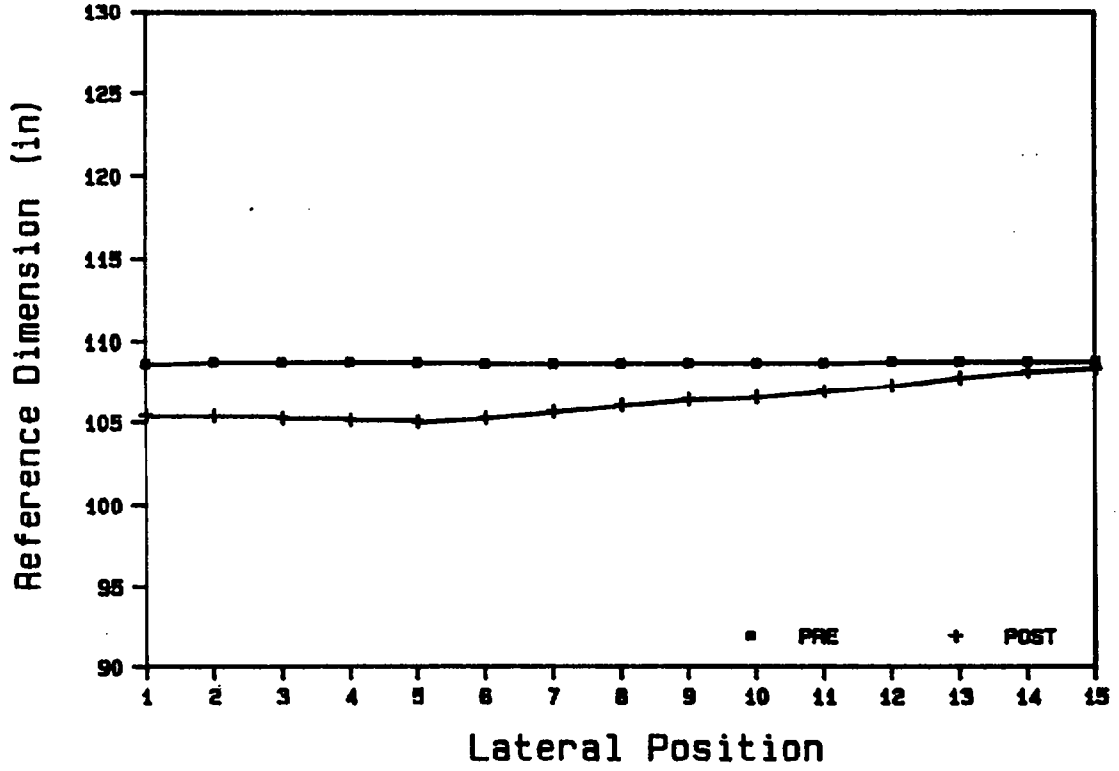
Steering Column Movement

Fuego Intrusion - Test 850731

Level A

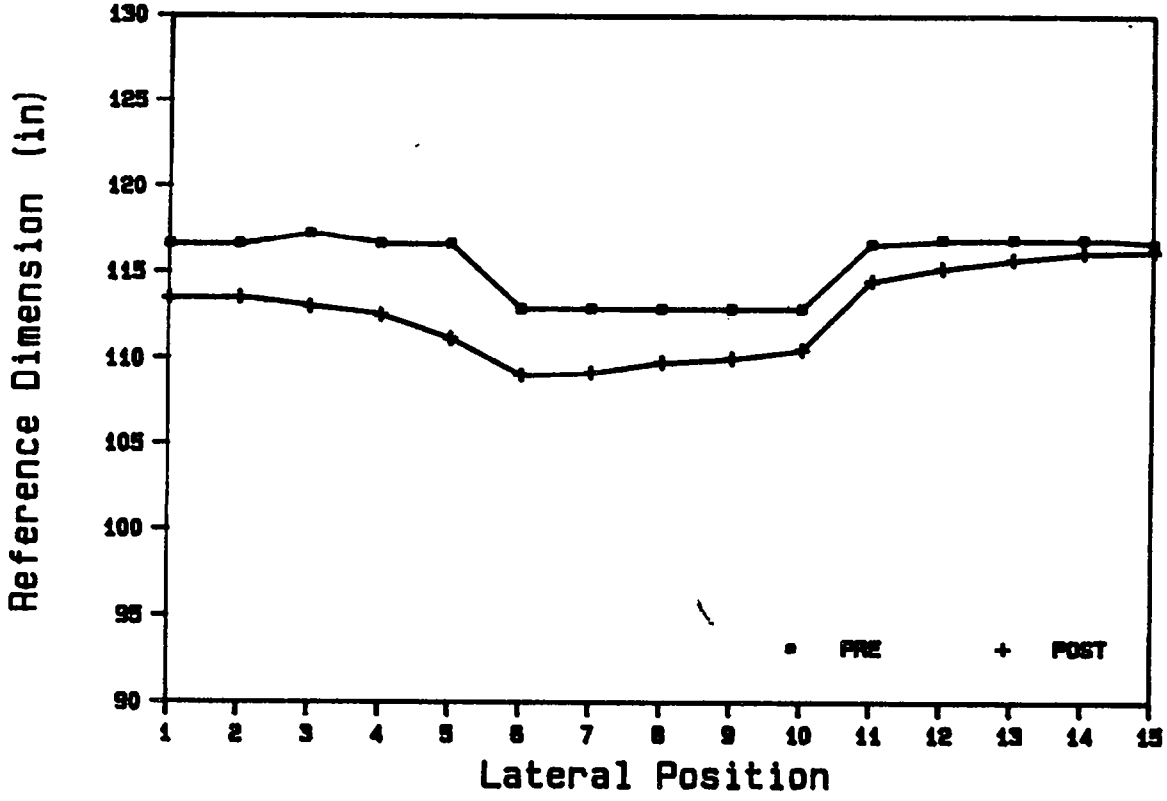


Level B

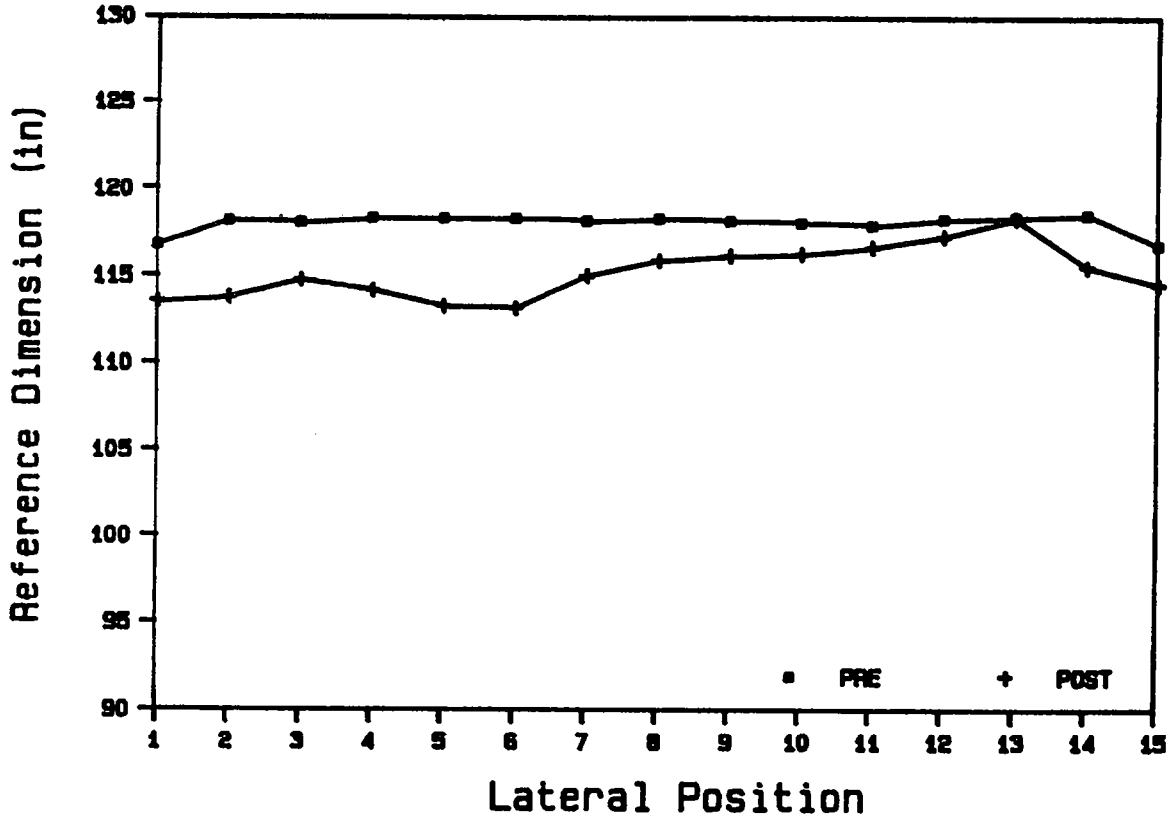


Fuego Intrusion - Test 850731

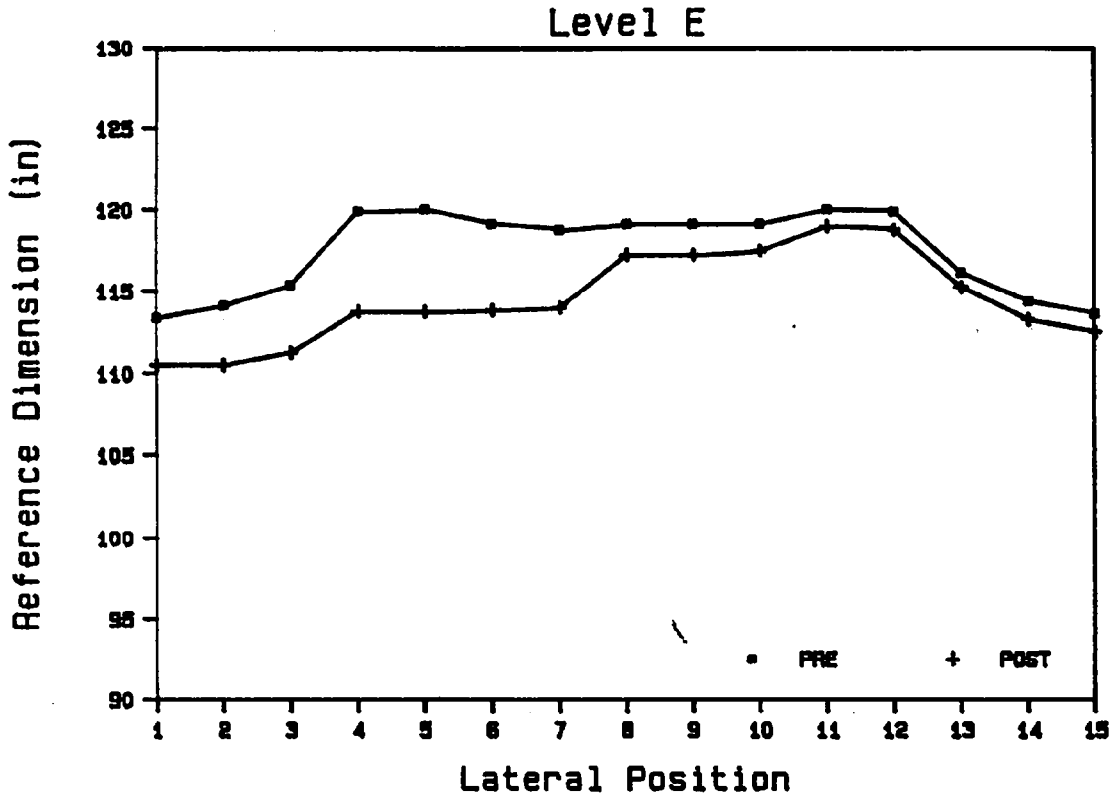
Level C



Level D



Fuego Intrusion - Test 850731



REFERENCE MEASUREMENTS

Fuego OF *Test 850731*

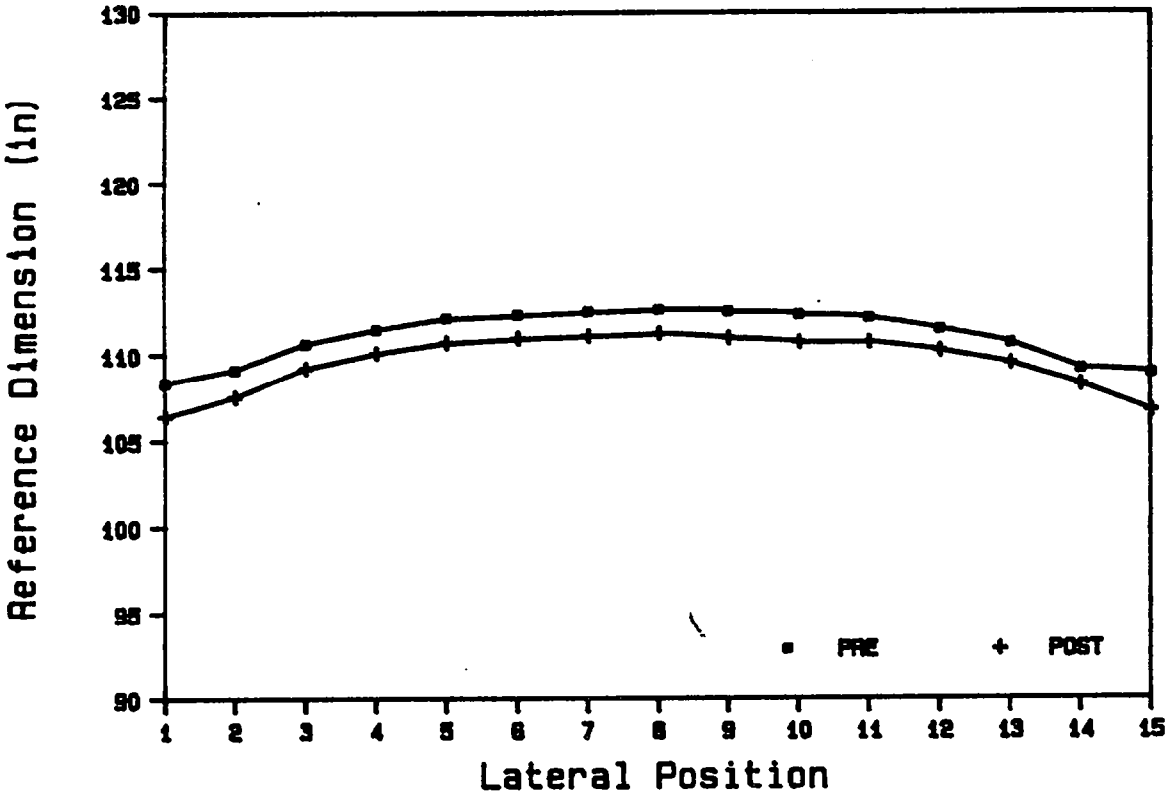
Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	PRE	108.44	109.19	110.69	111.50	112.19	112.38	112.56	112.69	112.56	112.38	112.19	111.50	110.69	109.19	108.94
	POST	104.94	105.63	107.69	109.31	109.81	110.31	110.56	110.94	110.94	111.06	111.19	110.81	110.31	109.19	108.19
	DIFF.	3.50	(3.56)	3.00	2.19	2.38	2.06	2.00	1.75	1.63	1.31	1.00	0.69	0.38	0.00	0.75
B	PRE	108.69	108.81	108.82	108.82	108.76	108.69	108.69	108.69	108.69	108.69	108.69	108.82	108.82	108.81	108.82
	POST	105.44	105.44	105.31	105.19	105.06	105.31	105.69	106.06	106.44	106.56	106.94	107.31	107.81	108.19	108.44
	DIFF.	3.25	3.38	3.50	3.63	(3.70)	3.38	3.00	2.63	2.25	2.13	1.75	1.50	1.00	0.62	0.38
C	PRE	116.69	116.69	117.31	116.69	116.69	112.94	112.94	112.94	112.94	112.94	116.69	116.94	116.94	116.94	116.69
	POST	113.56	113.56	113.06	112.56	111.19	109.06	109.19	109.81	110.06	110.56	114.56	115.31	115.81	116.19	116.31
	DIFF.	3.13	3.13	4.25	4.13	(5.50)	3.88	3.75	3.13	2.88	2.38	2.13	1.63	1.13	0.75	0.38
D	PRE	116.82	118.19	118.06	118.31	118.32	118.31	118.19	118.31	118.19	118.07	117.94	118.31	118.44	118.56	116.82
	POST	113.56	113.81	114.81	114.19	113.31	113.19	115.06	115.94	116.19	116.31	116.69	117.31	118.31	115.56	114.56
	DIFF.	3.25	4.38	3.25	4.12	5.00	(5.12)	3.13	2.37	2.00	1.75	1.25	1.00	0.13	3.00	2.25
E	PRE	113.44	114.19	115.44	119.94	120.07	119.19	118.82	119.19	119.19	119.19	120.07	119.94	116.19	114.44	113.69
	POST	110.56	110.56	111.31	113.81	113.81	113.94	114.06	117.31	117.31	117.56	119.06	118.81	115.31	113.31	112.56
	DIFF.	2.88	3.63	4.13	6.13	(6.25)	5.25	4.75	1.88	1.88	1.63	1.00	1.13	0.88	1.13	1.13

Fuego/Pole CTR

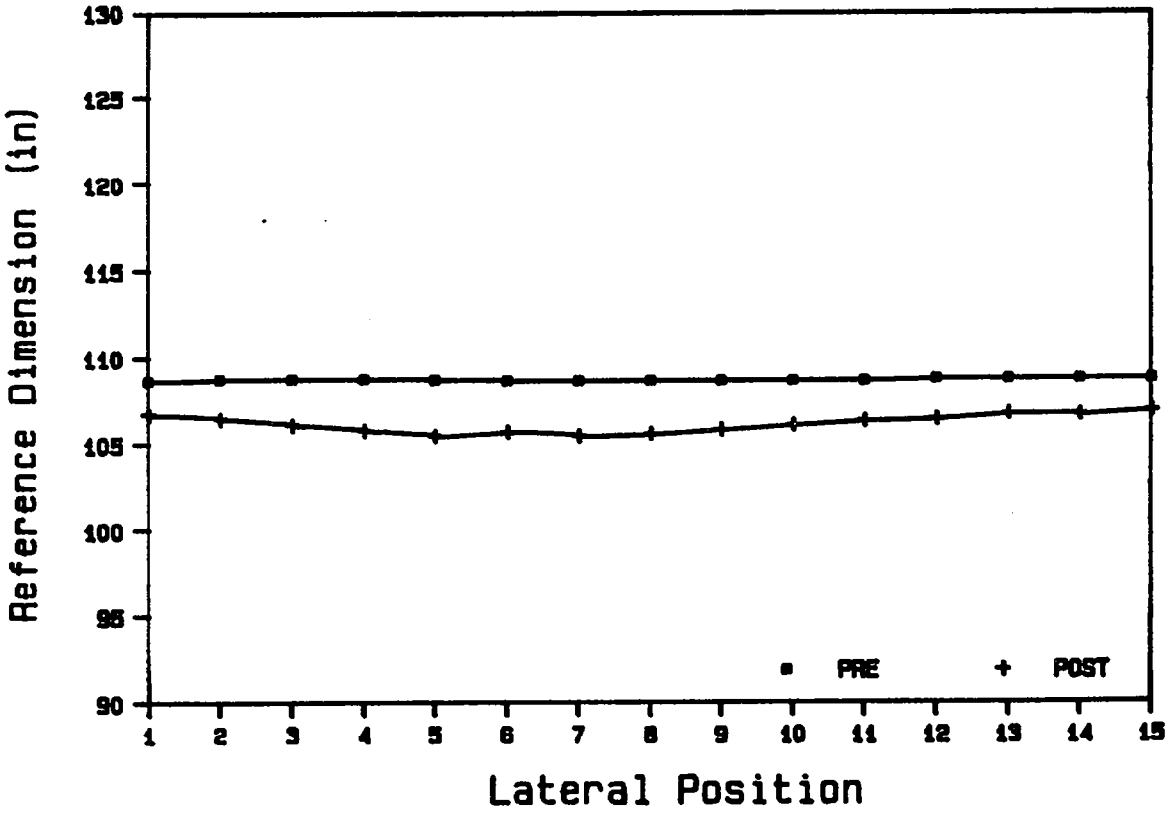
Test Number 850621

Fuego Intrusion - Test 850621

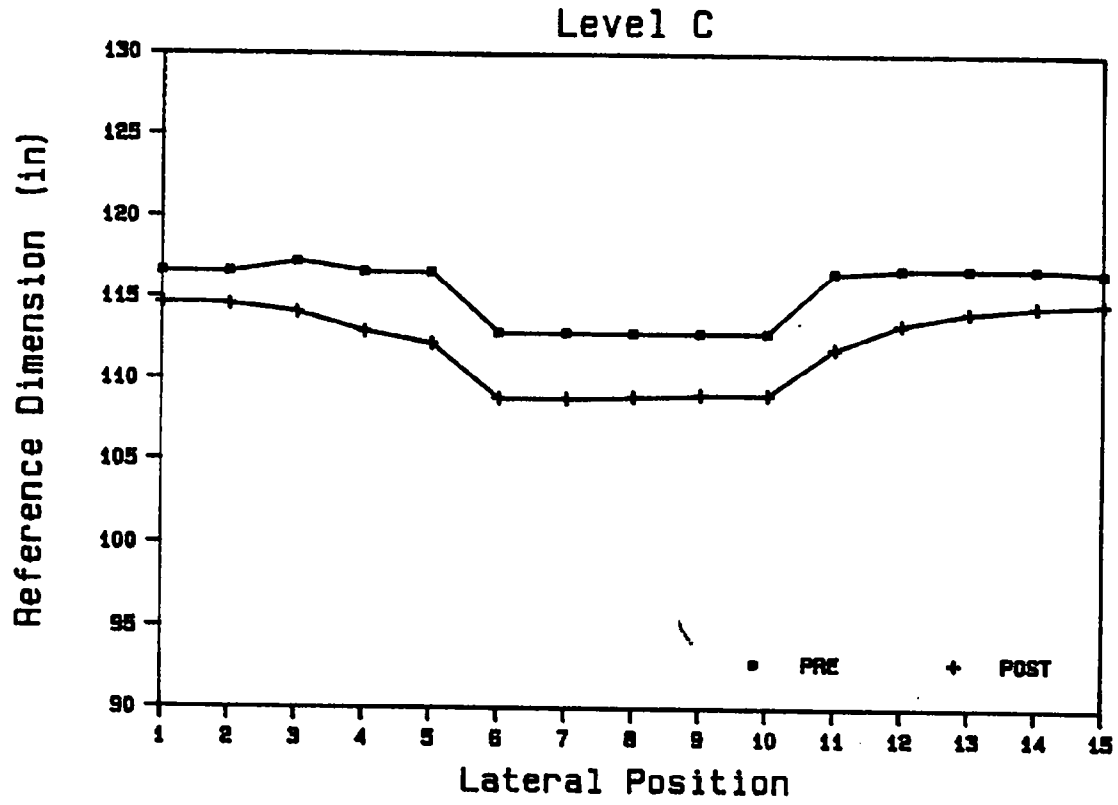
Level A

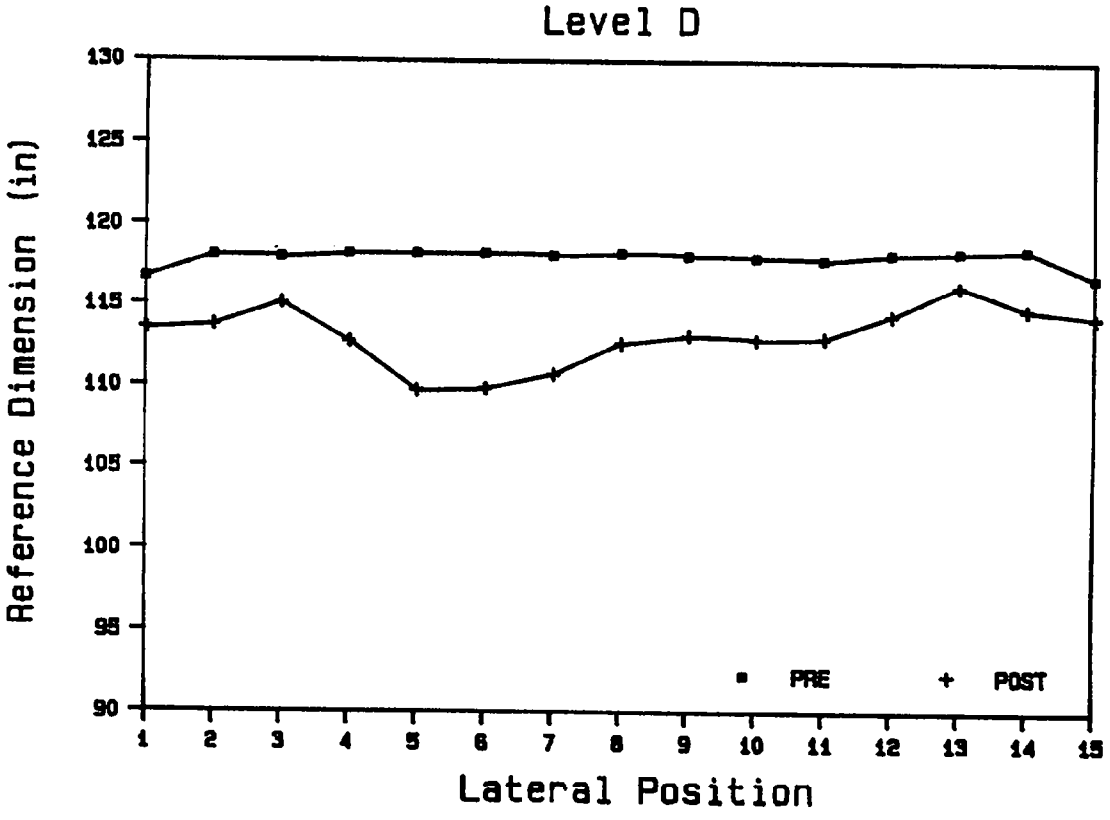


Level B



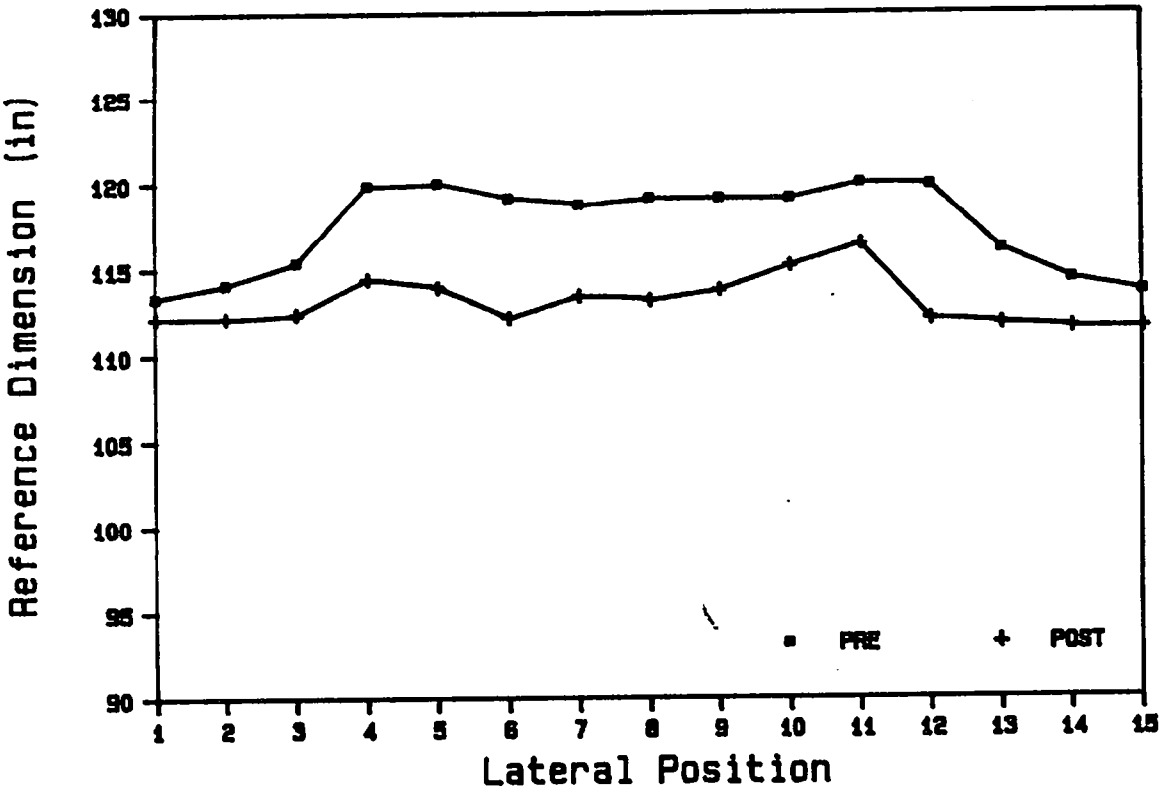
Fuego Intrusion - Test 850621





Fuego Intrusion - Test 850621

Level E



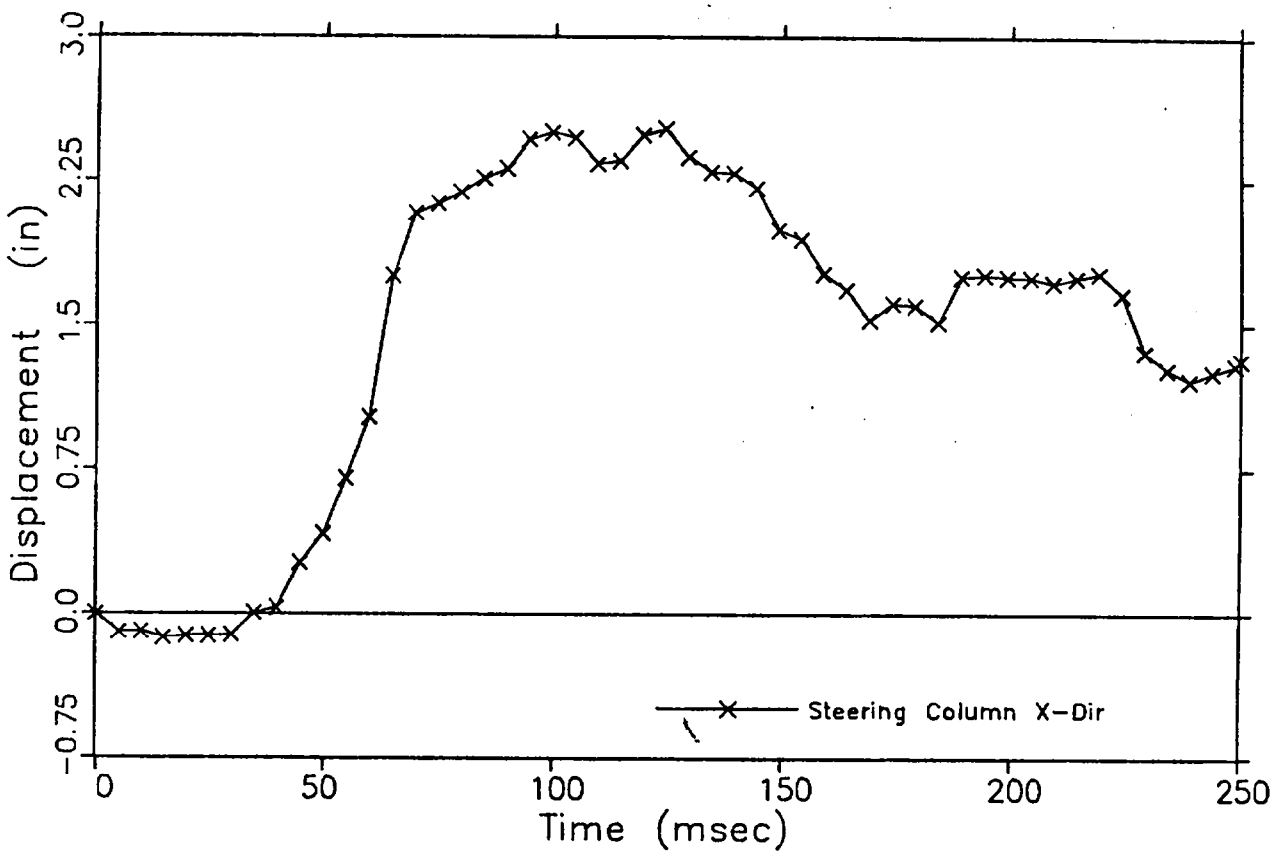
REFERENCE MEASUREMENTS

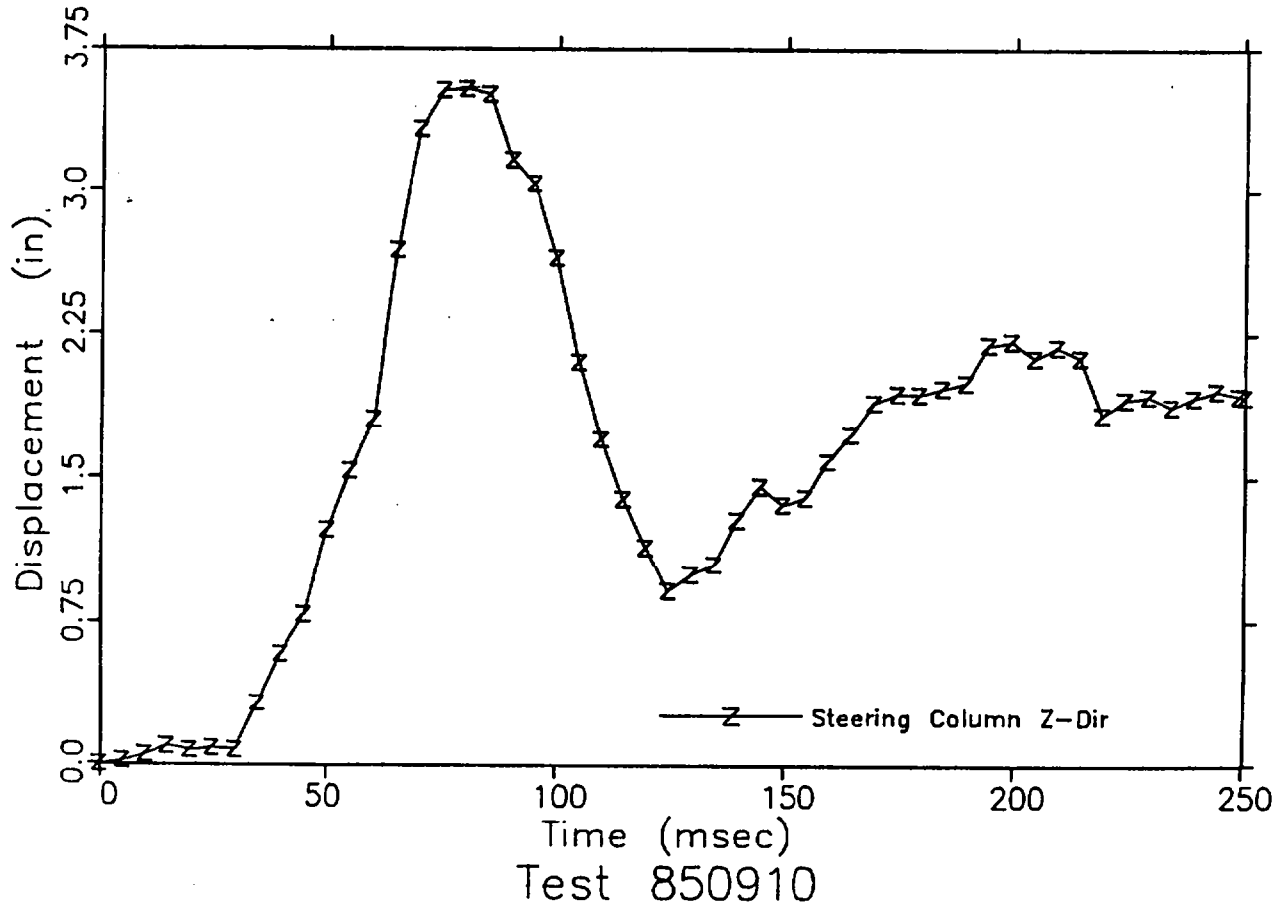
Fuego / Pole CTR *Test 850621*

Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	PRE	108.44	109.19	110.69	111.50	112.19	112.38	112.56	112.69	112.56	112.38	112.19	111.50	110.69	109.19	108.94
	POST	106.50	107.63	109.25	110.13	110.75	111.00	111.13	111.25	111.00	110.75	110.75	110.25	109.50	108.25	106.75
	DIFF.	1.94	1.56	1.44	1.38	1.44	1.38	1.44	1.44	1.56	1.63	1.44	1.25	1.19	0.94	(2.19)
B	PRE	108.69	108.81	108.82	108.82	108.76	108.69	108.69	108.69	108.69	108.69	108.69	108.82	108.82	108.81	108.82
	POST	106.75	106.50	106.13	105.81	105.50	105.75	105.50	105.63	105.88	106.13	106.38	106.50	106.81	106.75	107.00
	DIFF.	1.94	2.31	2.69	3.00	(3.26)	2.94	3.19	3.06	2.81	2.56	2.31	2.32	2.00	2.06	1.82
C	PRE	116.69	116.69	117.31	116.69	116.69	112.94	112.94	112.94	112.94	112.94	116.69	116.94	116.94	116.94	116.69
	POST	114.75	114.63	114.13	113.00	112.25	108.88	108.88	109.00	109.13	109.13	112.00	113.50	114.25	114.63	114.81
	DIFF.	1.94	2.06	3.19	3.69	4.44	4.06	4.06	3.94	3.81	3.81	(4.69)	3.44	2.69	2.31	1.88
D	PRE	116.82	118.19	118.06	118.31	118.32	118.31	118.19	118.31	118.19	118.07	117.94	118.31	118.44	118.56	116.82
	POST	113.50	113.75	115.13	112.75	109.75	109.88	110.75	112.63	113.13	112.88	113.00	114.38	116.25	114.75	114.25
	DIFF.	3.32	4.44	2.94	5.56	(8.57)	8.44	7.44	5.69	5.06	5.19	4.94	3.94	2.19	3.81	2.57
E	PRE	113.44	114.19	115.44	119.94	120.07	119.19	118.82	119.19	119.19	119.19	120.07	119.94	116.19	114.44	113.69
	POST	112.25	112.25	112.50	114.50	114.00	112.25	113.50	113.25	113.88	115.25	116.50	112.13	111.88	111.63	111.63
	DIFF.	1.19	1.94	2.94	5.44	6.07	6.94	5.32	5.94	5.31	3.94	3.57	(7.81)	4.31	2.81	2.06

Fuego/Pole OF

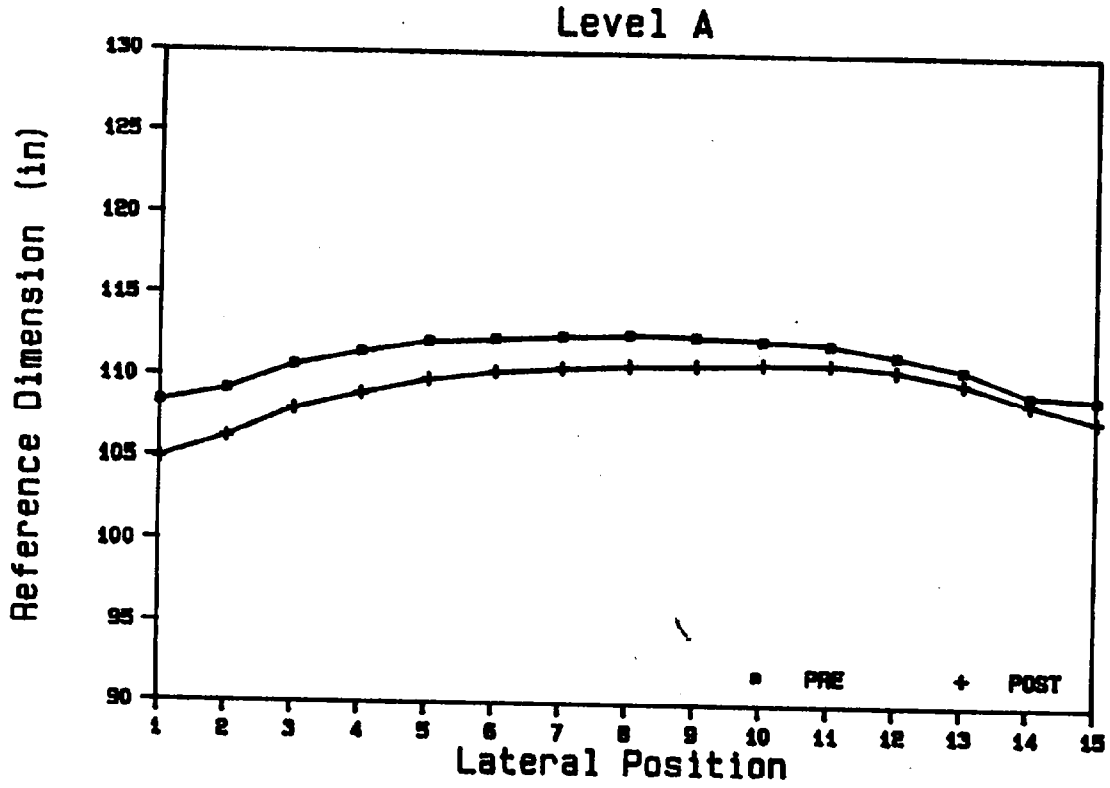
Test Number 850910

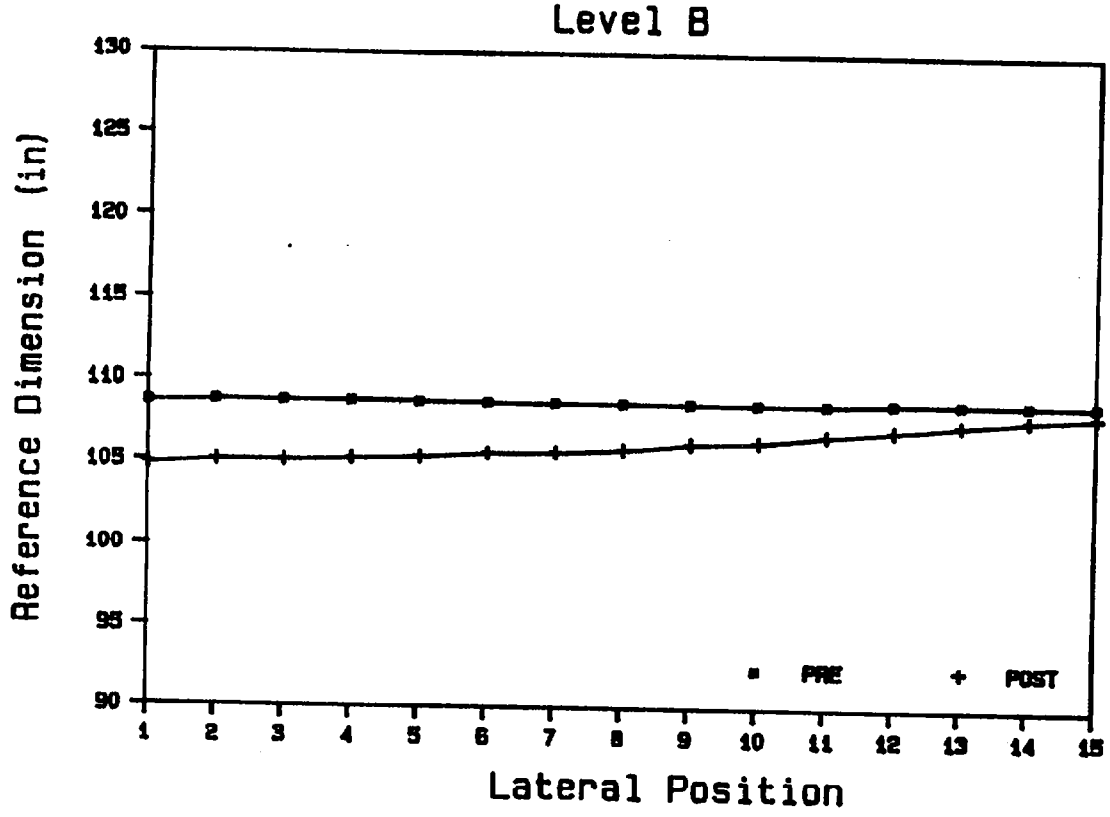

Displacement (in)
3.0
2.25
1.5
0.75
0.0
-0.75
0
50
100
150
200
250
Time (msec)
Steering Column X-Dir


Displacement (in)
3.75
3.0
2.25
1.5
0.75
0.0
0
50
100
150
200
250
Time (msec)
Steering Column Z-Dir

Test 850910

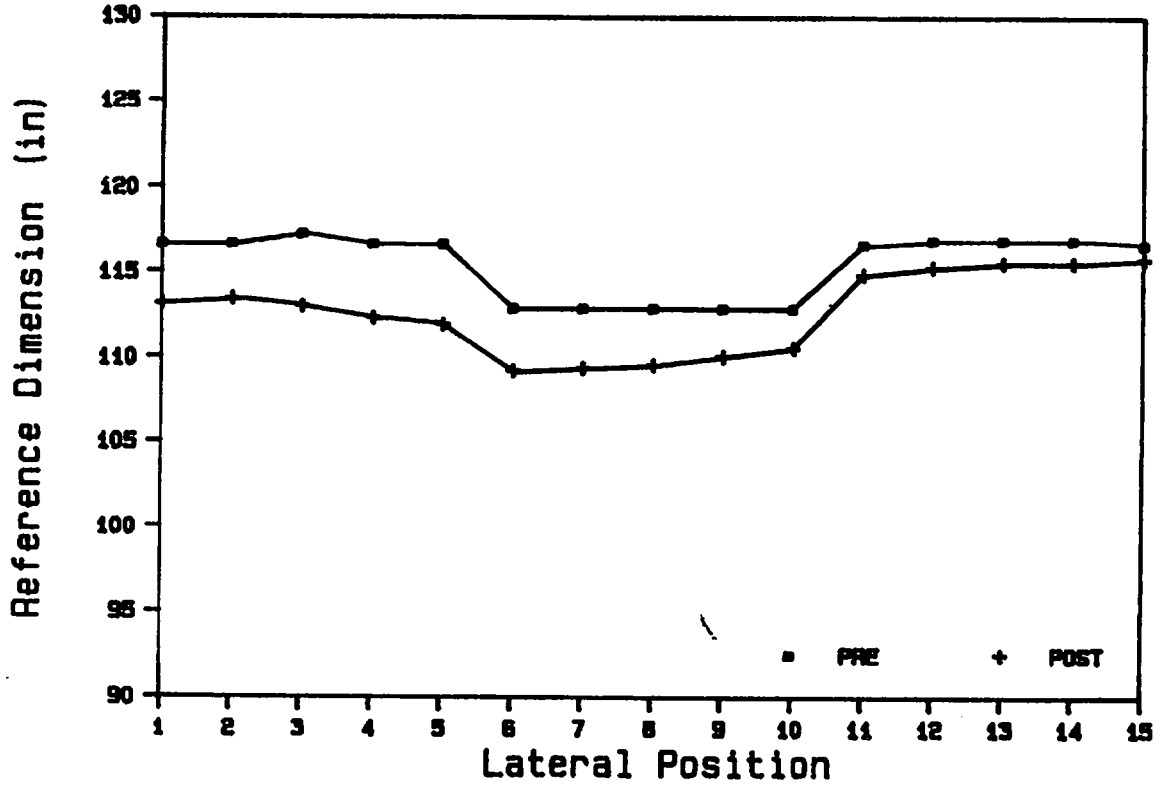
Fuego Intrusion - Test 850910



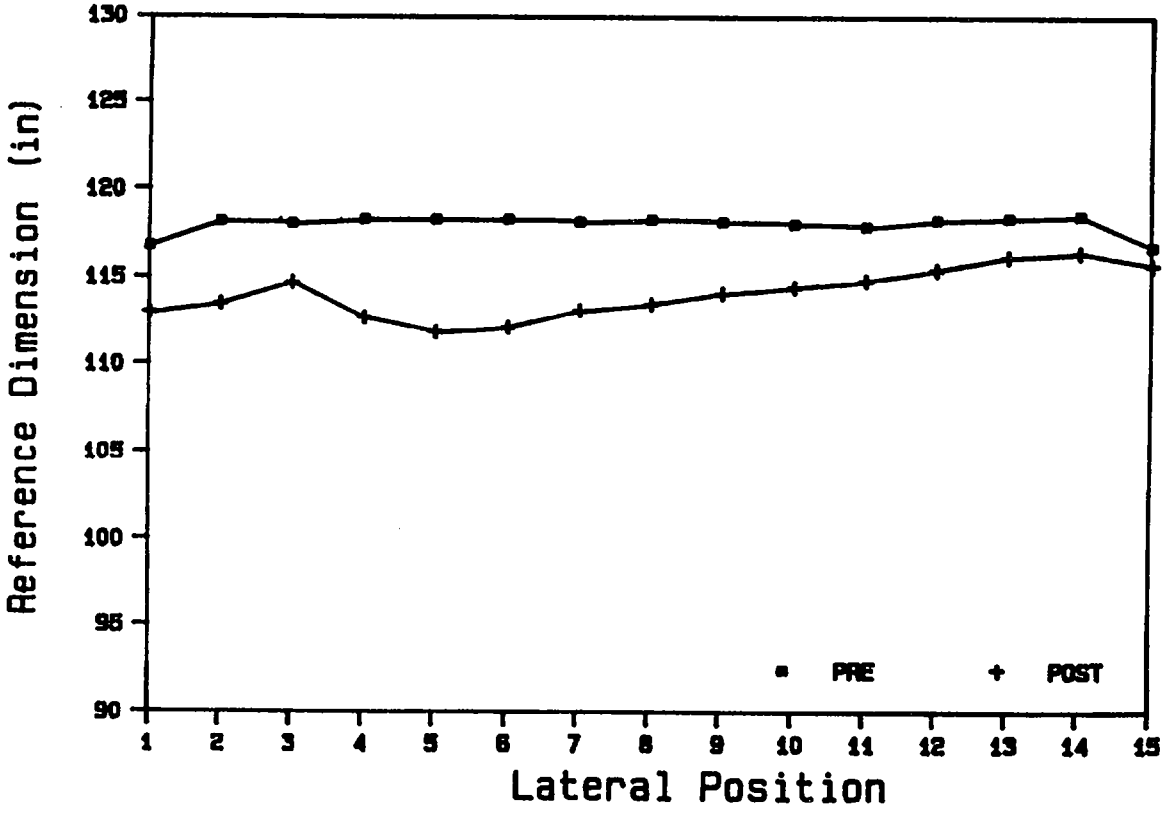


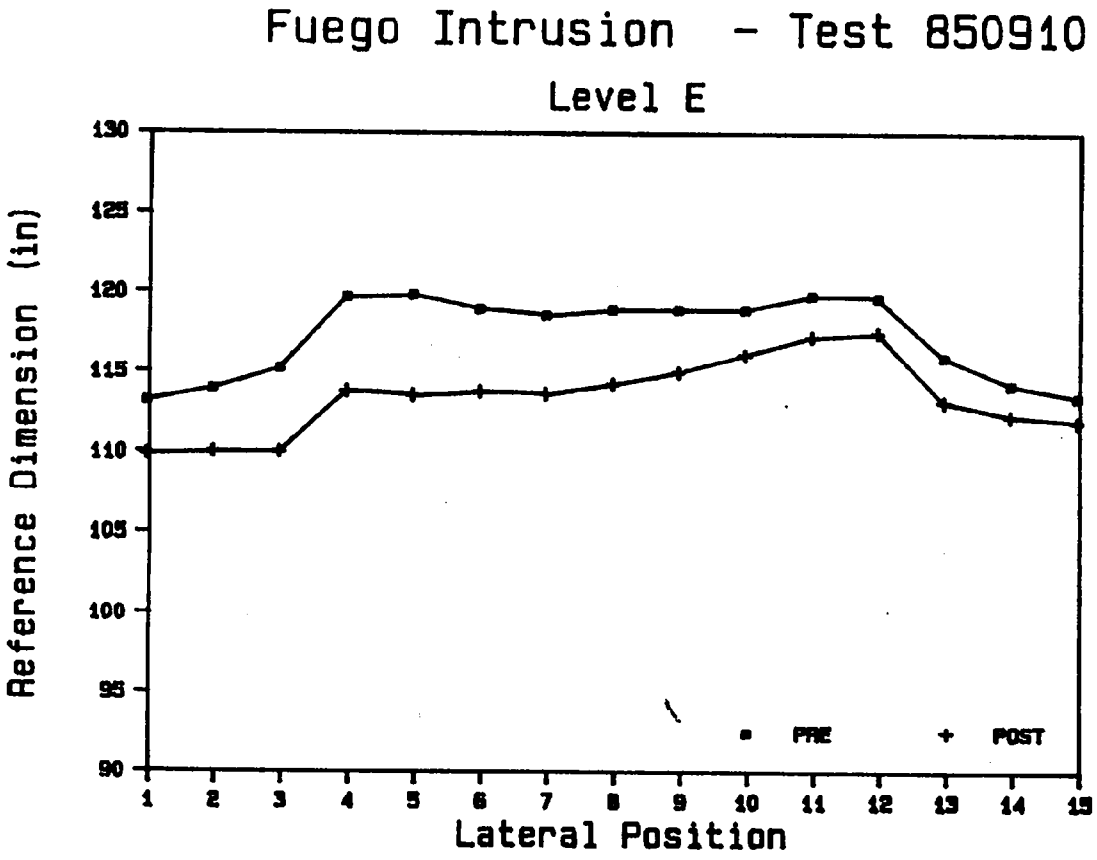
Fuego Intrusion - Test 850910

Level C



Level D




Fuego Intrusion - Test 850910
Level E
Reference Dimension (in)
130
125
120
115
110
105
100
95
90
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Lateral Position
PRE
POST

REFERENCE MEASUREMENTS

Fuego OF *Test 850910*

Row	Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	PRE	108.44	109.19	110.69	111.50	112.19	112.38	112.56	112.69	112.56	112.38	112.19	111.50	110.69	109.19	108.94
	POST	105.00	106.25	108.00	109.00	109.88	110.38	110.63	110.81	110.88	111.00	111.00	110.63	109.88	108.63	107.63
	DIFF.	(3.44)	2.94	2.69	2.50	2.31	2.00	1.94	1.88	1.69	1.38	1.19	0.88	0.81	0.56	1.31
B	PRE	108.69	108.81	108.82	108.82	108.76	108.69	108.69	108.69	108.69	108.69	108.69	108.82	108.82	108.81	108.82
	POST	104.88	105.31	105.13	105.25	105.38	105.63	105.69	105.88	106.25	106.38	106.81	107.13	107.50	107.88	108.13
	DIFF.	(3.81)	3.69	3.69	3.57	3.38	3.06	3.00	2.81	2.44	2.31	1.88	1.69	1.32	0.94	0.69
C	PRE	116.69	116.69	117.31	116.69	116.69	112.94	112.94	112.94	112.94	112.94	116.69	116.94	116.94	116.94	116.69
	POST	113.25	113.50	113.06	112.38	112.00	109.25	109.44	109.63	110.13	110.63	114.94	115.38	115.63	115.63	115.88
	DIFF.	3.44	3.19	4.25	4.31	(4.69)	3.69	3.50	3.31	2.81	2.31	1.75	1.56	1.31	1.31	0.81
D	PRE	116.82	118.19	118.06	118.31	118.32	118.31	118.19	118.31	118.19	118.07	117.94	118.31	118.44	118.56	116.82
	POST	113.00	113.50	114.75	112.69	111.88	112.13	113.13	113.50	114.13	114.50	114.88	115.50	116.25	116.50	115.75
	DIFF.	3.82	4.69	3.31	5.63	(6.44)	6.19	5.06	4.81	4.06	3.57	3.06	2.81	2.19	2.06	1.07
E	PRE	113.44	114.19	115.44	119.94	120.07	119.19	118.82	119.19	119.19	119.19	120.07	119.94	116.19	114.44	113.69
	POST	110.13	110.25	110.25	114.00	113.75	114.00	113.88	114.50	115.25	116.38	117.50	117.75	113.88	112.50	112.13
	DIFF.	3.31	3.94	5.19	5.94	(6.32)	5.19	4.94	4.69	3.94	2.81	2.57	2.19	2.81	1.94	1.56