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Validation Command Language: Supplement to 1979 Version

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16. Abstract

This report supplements a report to the UMTRI report entitled "Validation Command Language (1979 Version)." The Validation Command Language computer program has been developed to aid the automotive safety researcher in quantifying comparisons between input test results and predictions of mathematical crash victim simulations. Applications are manipulation, analysis, comparison, and graphical display of dynamic impact data. Examples and user information is contained in the report.

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1.0 INTRODUCTION

This report supplements the UMTRI report entitled "Validation Command Language (1979 Version)" (See Reference 1), Section 2. Part 2 of the report amplifies Section 2.2.1 and 2.2.7 of Reference 1 to provide step-by-step instructions for filtering data. Part 3 deals with the changes to the original VCL (now known as the MVMA version). Parts 4 and 5 deal respectively with the CAL/HSRI 3-D Version of the VCL and the new graphics postprocessor for the VCL.

2.0 USER INSTRUCTIONS FOR FILTERING DATA

The sections of the VCL report which are pertinent to this discussion are found in Section 2.2.1 (pp. 15 and 16), Section 2.2.7 (pp. 29 to 34), and example three contained in Section 2.4 (pp 43 to 45 and 65 to 95).

The following steps can be used to achieve filtering of data by means of the VCL.

Step 1. The data to be filtered is formatted as follows: if 600 points are to be provided, 602 cards must be prepared. The first card contains the start time, the time increment (Δt), the number of points (600), the dimension code, and a unit switch. See pp. 15 and 16 of report for details on the selection of these quantities.

The second card contains the format in parenthesis starting in the first column, e.g., (E15.0). Then follow the six hundred (or whatever) data cards, one point per card which may be left-adjusted if a decimal point is always punched. Otherwise the decimal point will be placed according to the specified format from the right of the field specified in the format.

Step 2. The Sampling rate $s=1/t$ is computed and the frequency (f) at which filtering is desired is chosen. The ratio or normalized upper passband frequency is computed as f/s. Then using Table 6 of the report (page 34), the value in the second column closest to this ratio is selected and the corresponding filter name in the first column is jotted down, e.g., LP224492.

If none of these filters is acceptable, it is possible to generate a new filter made to order (with the FG command) or it is possible to halve or quarter the sampling rate and perhaps find a ready made filter closer to the desired normalized upper passband frequency. These two techniques are not normally used and will not be described here.

Step 3. The VCL is then run using the commands outlined in Table 1 with the data deck provided in Step 1 attached to the logical device number named.

TABLE 1. VCL COMMANDS FOR FILTERING USER DATA

CP.
1, final time (msec), output unit switch (see page 7)*

TR filename*
TQ TESTV.
1, Δt (msec), final time (msec)*
FD TESTV, TESTQ, filtername.
TP TESTQ
0, Δt, final time*

*The values referred to symbolically are supplied to be consistant with those specified in the data deck generated in Step One which is tored in file "filename". The filtername used is the one determined in Step Two.

3.0 UPDATES TO THE MVMA VERSION OF THE VCL

The principal changes in the MVMA Version have to do with a restructuring of the data references to MVMA quantities stored from the MVMA runs. Command changes also have occurred in the McAuto implementation. The next subsection deals with these command changes. The final subsection deals with the corrections for data references.

3.1 Changes in Commands

The McAuto version changes one command and implements the "OFF-LINE" option of the "Start Plot" command.

The Test Quantity Command no longer accepts a filename. A TQ is meaningful only after a TR and before the next TR or MR or FG. Likewise a MQ is meaningful only after a MR and before the next TR or MR or FG. Table 2 presents the revised commands.

3.2 Changes in Data Reference Parameters

Many changes have been made in quantities printed as part of the MVMA 2-D tabular printout. Table 3 of this report replaces Table 3 of the VCL Report.

TABLE 2. REVISED MVMA VCL COMMANDS

Sentence Contents	Sentence Abbreviation	Notes
TEST RUN Filename	TR	Filename of file which contains user data
TEST QUANTITY Dataname (a) File record number ( ) (b) Time increment (msec) (c) Final time (msec)	TQ	Dataname is name by which this data is to be referenced. File record number is starting record of file which contains first header card for this data. More than one such data set can exist in one file
MODEL RUN Filename 1 Filename 2	MR	Filename 1 is basic hold file for MVMA run and Filename 2 is contact information hold file

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (1 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Airbag CG force components - head moment	20	3
Airbag CG force components - head x	20	1
Airbag CG force components - head z	20	2
Airbag CG force components - lower torso moment	20	12
Airbag CG force components - lower torso x	20	10
Airbag CG force components - lower torso z	20	11
Airbag CG force components - middle torso moment	20	9
Airbag CG force components - middle torso x	20	7
Airbag CG force components - middle torso z	20	8
Airbag CG force components - upper leg moment	20	15
Airbag CG force components - upper leg x	20	13
Airbag CG force components - upper leg z	20	14
Airbag CG force components - upper torso moment	20	6
Airbag CG force components - upper torso x	20	4
Airbag CG force components - upper torso z	20	5
Airbag contact forces - head pressure	19	1
Airbag contact forces - head tension	19	2
Airbag contact forces - lower torso pressure	19	7
Airbag contact forces - lower torso tension	19	8
Airbag contact forces - middle torso pressure	19	5
Airbag contact forces - middle torso tension	19	6
Airbag contact forces - upper leg pressure	19	9
Airbag contact forces - upper leg tension	19	10
Airbag contact forces - upper torso pressure	19	3
Airbag contact forces - upper torso tension	19	4
Airbag variables - bag gas mass	18	4
Airbag variables - bag pressure	18	1
Airbag variables - bag temperature	18	2
Airbag variables - bag volume	18	3
Airbag variables - mass flow in	18	5
Airbag variables - mass flow out	18	6
Airbag variables - supply temperature	18	7
Body joint coordinate - elbow x	13	9
Body joint coordinate - elbow z	13	10
Body joint coordinate - hip x	13	5
Body joint coordinate - hip z	13	6
Body joint coordinate - knee x	13	7
Body joint coordinate - knee z	13	8
Body joint coordinate - lower spine x	13	3
Body joint coordinate - lower spine z	13	4
Body joint coordinate - upper spine x	13	1
Body joint coordinate - upper spine z	13	2
Body joint velocity - elbow x	14	9
Body joint velocity - elbow z	14	10
Body joint velocity - hip x	14	5
Body joint velocity - hip z	14	6

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (2 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Body joint velocity - knee x	14	7
Body joint velocity - knee z	14	8
Body joint velocity - lower spine x	14	3
Body joint velocity - lower spine z	14	4
Body joint velocity - upper spine x	14	1
Body joint velocity - upper spine z	14	2
Body link angles - head	10	1
Body link angles - lower arm	10	10
Body link angles - lower leg	10	7
Body link angles - lower torso	10	5
Body link angles - middle torso	10	4
Body link angles - neck	10	2
Body link angles - shoulder	10	8
Body link angles - upper arm	10	9
Body link angles - upper leg	10	6
Body link angles - upper torso	10	3
Body link angular acceleration - head	12	1
Body link angular acceleration - lower arm	12	10
Body link angular acceleration - lower leg	12	7
Body link angular acceleration - lower torso	12	5
Body link angular acceleration - middle torso	12	4
Body link angular acceleration - neck	12	2
Body link angular acceleration - shoulder	12	8
Body link angular acceleration - upper arm	12	9
Body link angular acceleration - upper leg	12	6
Body link angular acceleration - upper torso	12	3
Body link angular velocity - head	11	1
Body link angular velocity - lower arm	11	10
Body link angular velocity - lower leg	11	7
Body link angular velocity - lower torso	11	5
Body link angular velocity - middle torso	11	4
Body link angular velocity - neck	11	2
Body link angular velocity - shoulder	11	8
Body link angular velocity - upper arm	11	9
Body link angular velocity - upper leg	11	6
Body link angular velocity - upper torso	11	3
Center of mass resultant moment - head	32	1
Center of mass resultant moment - head applied force component	32	9
Center of mass resultant moment - lower arm	32	8
Center of mass resultant moment - lower leg	32	6
Center of mass resultant moment - lower torso	32	4
Center of mass resultant moment - middle torso	32	3
Center of mass resultant moment - upper arm	32	7
Center of mass resultant moment - upper leg	32	5
Center of mass resultant moment - upper torso	32	2
Center of mass x force component - head	30	1
Center of mass x force component - head applied force component	30	9
Center of mass x force component - lower arm	30	8
Center of mass x force component - lower leg	30	6

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (page 3 of 10).

QUANTITY DESCRIPTION	CATG. NO	COL. NO.
Center of mass x force component - lower torso	30	4
Center of mass x force component - middle torso	30	3
Center of mass x force component - upper arm	30	7
Center of mass x force component - upper leg	30	5
Center of mass x force component - upper torso	30	2
Center of mass z force component - head	31	1
Center of mass z force component - head applied force component	31	9
Center of mass z force component - lower arm	31	8
Center of mass z force component - lower leg	31	6
Center of mass z force component - lower torso	31	4
Center of mass z force component - middle torso	31	3
Center of mass z force component - upper arm	31	7
Center of mass z force component - upper leg	31	5
Center of mass z force component - upper torso	31	2
Contact belt vs attachment - absorbed energy	4	31
Contact belt vs attachment - deflection rate	4	25
Contact belt vs attachment - deflection	4	24
Contact belt vs attachment - unadjusted tension	4	26
Contact belt vs attachment - resultant force	4	28
Contact belt vs attachment - resultant heading angle	4	30
Contact belt vs attachment - ring equil. tension	4	26
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Contact ellipse vs ellipse - body segment x for ellipse A	4	20
Contact ellipse vs ellipse - body segment z for ellipse A	4	21
Contact ellipse vs ellipse - body segment x for ellipse B	4	22
Contact ellipse vs ellipse - body segment z for ellipse B	4	23
Contact ellipse vs ellipse - center point x for ellipse A	4	16
Contact ellipse vs ellipse - center point z for ellipse A	4	17
Contact ellipse vs ellipse - center point x for ellipse B	4	18
Contact ellipse vs ellipse - center point z for ellipse B	4	19
Contact ellipse vs ellipse - deflection rate	4	14
Contact ellipse vs ellipse - deflection	4	13
Contact ellipse vs ellipse - normal force	4	15
Contact ellipse vs line - contact point x on body segment	4	11
Contact ellipse vs line - contact point z on body segment	4	12
Contact ellipse vs line - contact point position on line	4	7
Contact ellipse vs line - contact point velocity on line	4	8

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TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (page 4 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Contact ellipse vs line - contact point x in inertial space	4	9
Contact ellipse vs line - contact point z in inertial space	4	10
Contact ellipse vs line - line deflection (ellipse)	4	1(2)
Contact ellipse vs line - line defl. rate (ellipse)	4	3(4)
Contact ellipse vs line - normal force	4	5
Contact ellipse vs line - tangential force	4	6
Femur and tibia loads - femur axial at knee	40	2
Femur and tibia loads - femur axial at sensor	40	1
Femur and tibia loads - femur shear at knee	40	3
Femur and tibia loads - tibia axial at foot	40	5
Femur and tibia loads - tibia axial at knee	40	4
Filtered accelerations - chest A-P	7	4
Filtered accelerations - chest resultant	7	6
Filtered accelerations - chest S-I	7	5
Filtered accelerations - head A-P	7	1
Filtered accelerations - head resultant	7	3
Filtered accelerations - head S-I	7	2
Filtered accelerations - hip resultant	7	9
Filtered accelerations - hip x	7	7
Filtered accelerations - hip z	7	8
Filtered severity index - chest SI A-P	9	7
Filtered severity index - chest SI resultant	9	9
Filtered severity index - chest SI S-I	9	8
Filtered severity index - chest mod SI A-P	9	10
Filtered severity index - chest mod SI resultant	9	12
Filtered severity index - chest mod SI S-I	9	11
Filtered severity index - head SI A-P	9	1
Filtered severity index - head SI resultant	9	3
Filtered severity index - head SI S-I	9	2
Filtered severity index - head mod SI A-P	9	4
Filtered severity index - head mod SI resultant	9	6
Filtered severity index - head mod SI S-I	9	5
Friction component joint torque - elbow	25	8
Friction component joint torque - hip	25	5
Friction component joint torque - knee	25	6
Friction component joint torque - lower neck	25	2
Friction component joint torque - lower spine	25	4
Friction component joint torque - shoulder at arm	25	7
Friction component joint torque - upper neck	25	1
Friction component joint torque - upper spine	25	3
Joint absorbed energy - elbow	16	11
Joint absorbed energy - hip	16	6
Joint absorbed energy - knee	16	7
Joint absorbed energy - lower neck	16	2
Joint absorbed energy - lower spine	16	5
Joint absorbed energy - neck length	16	3
Joint absorbed energy - shoulder at arm	16	9

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TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (page 5 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Joint absorbed energy - shoulder at torso	16	8
Joint absorbed energy - shoulder length	16	10
Joint absorbed energy - upper neck	16	1
Joint absorbed energy - upper spine	16	4
Joint friction absorbed energy - elbow	28	8
Joint friction absorbed energy - hip	28	5
Joint friction absorbed energy - knee	28	6
Joint friction absorbed energy - lower neck	28	2
Joint friction absorbed energy - lower spine	28	4
Joint friction absorbed energy - shoulder at arm	28	7
Joint friction absorbed energy - upper neck	28	1
Joint friction absorbed energy - upper spine	28	3
Joint muscle tension absorbed energy - elbow	39	8
Joint muscle tension absorbed energy - hip	39	6
Joint muscle tension absorbed energy - knee	39	7
Joint muscle tension absorbed energy - lower neck	39	2
Joint muscle tension absorbed energy - lower spine	39	5
Joint muscle tension absorbed energy - neck length	39	3
Joint muscle tension absorbed energy - shoulder at arm	39	11
Joint muscle tension absorbed energy - shoulder at torso	39	9
Joint muscle tension absorbed energy - shoulder length	39	10
Joint muscle tension absorbed energy - upper neck	39	1
Joint muscle tension absorbed energy - upper spine	39	4
Joint stop absorbed energy - elbow	27	9
Joint stop absorbed energy - hip	27	5
Joint stop absorbed energy - knee	27	6
Joint stop absorbed energy - lower neck	27	2
Joint stop absorbed energy - lower spine	27	4
Joint stop absorbed energy - shoulder at arm	27	7
Joint stop absorbed energy - shoulder length	27	8
Joint stop absorbed energy - upper neck	27	1
Joint stop absorbed energy - upper spine	27	3
Joint torques - elbow	15	9
Joint torques - hip	15	5
Joint torques - knee	15	6
Joint torques - lower neck	15	2
Joint torques - lower spine	15	4
Joint torques - shoulder at arm	15	8
Joint torques - shoulder at torso	15	7
Joint torques - upper neck	15	1
Joint torques - upper spine	15	3
Joint viscous absorbed energy - elbow	29	10
Joint viscous absorbed energy - hip	29	6
Joint viscous absorbed energy - knee	29	7
Joint viscous absorbed energy - lower neck	29	2
Joint viscous absorbed energy - lower spine	29	5
Joint viscous absorbed energy - neck length	29	3
Joint viscous absorbed energy - shoulder at arm	29	8
Joint viscous absorbed energy - shoulder length	29	9
Joint viscous absorbed energy - upper neck	29	1

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (page 6 of 10).

QUANTITY DESCRIPTION	CATG NO.	COL. NO.
Joint viscous absorbed energy - upper spine	29	4
Kinetic energy - arms	17	5
Kinetic energy - head	17	2
Kinetic energy - head superior-inferior	17	4
Kinetic energy - torso	17	3
Kinetic energy - total body	17	1
Line movement of Point A x	3	1
Line movement of Point A z	3	2
Line movement of Point 1 x	3	3
Line movement of Point 1 z	3	4
Line movement of Point 2 x	3	5
Line movement of Point 2 z	3	6
Line movement of Point 3 x	3	7
Line movement of Point 3 z	3	8
Line movement of Point 4 x	3	9
Line movement of Point 4 z	3	10
Line movement of Point 5 x	3	11
Line movement of Point 5 z	3	12
Linear component of joint torque - elbow	23	8
Linear component of joint torque - hip	23	5
Linear component of joint torque - knee	23	6
Linear component of joint torque - lower neck	23	2
Linear component of joint torque - lower spine	23	4
Linear component of joint torque - shoulder at arm	23	7
Linear component of joint torque - upper neck	23	1
Linear component of joint torque - upper spine	23	3
Muscle tension forces - neck	38	10
Muscle tension forces - shoulder length	38	11
Muscle tension torque - elbow	38	9
Muscle tension torque - hip	38	5
Muscle tension torque - knee	38	6
Muscle tension torque - lower neck	38	2
Muscle tension torque - lower spine	38	4
Muscle tension torque - shoulder at arm	38	8
Muscle tension torque - shoulder at torso	38	7
Muscle tension torque - upper neck	38	1
Muscle tension torque - upper spine	38	3
Neck and shoulder forces - neck linear	37	1
Neck and shoulder forces - neck muscle	37	4
Neck and shoulder forces - neck non-linear	37	2
Neck and shoulder forces - neck total	37	5
Neck and shoulder forces - neck viscous	37	3
Neck and shoulder forces - shoulder linear	37	6
Neck and shoulder forces - shoulder muscle	37	9
Neck and shoulder forces - shoulder non-linear	37	7
Neck and shoulder forces - shoulder total	37	10
Neck and shoulder forces - shoulder viscous	37	8
Neck joint coordinates - lower neck x	21	5
Neck joint coordinates - lower neck z	21	6

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (page 7 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Neck joint coordinates - lower neck x velocity	21	7
Neck joint coordinates - lower neck z velocity	21	8
Neck joint coordinates - neck length	21	9
Neck joint coordinates - neck length rate	21	10
Neck joint coordinates - upper neck x	21	1
Neck joint coordinates - upper neck z	21	2
Neck joint coordinates - upper neck x velocity	21	3
Neck joint coordinates - upper neck z velocity	21	4
Nonlinear component of joint torque - elbow	24	8
Nonlinear component of joint torque - hip	24	5
Nonlinear component of joint torque - knee	24	6
Nonlinear component of joint torque - lower neck	24	2
Nonlinear component of joint torque - lower spine	24	4
Nonlinear component of joint torque - shoulder at arm	24	7
Nonlinear component of joint torque - upper neck	24	1
Nonlinear component of joint torque - upper spine	24	3
Quantity for region - average migration XR	2	3
Quantity for region - average migration ZR	2	4
Quantity for region - end point movement A-X	2	5
Quantity for region - end point movement A-Z	2	6
Quantity for region - end point movement B-X	2	7
Quantity for region - end point movement B-Z	2	8
Quantity for region - force component XR	2	1
Quantity for region - force component ZR	2	2
Quantity for region - number ellipse contacting	2	9
Shoulder joint coordinates - shoulder at arm x	22	5
Shoulder joint coordinates - shoulder at arm z	22	6
Shoulder joint coordinates - shoulder at arm x velocity	22	7
Shoulder joint coordinates - shoulder at arm z velocity	22	8
Shoulder joint coordinates - shoulder at torso x	22	1
Shoulder joint coordinates - shoulder at torso z	22	2
Shoulder joint coordinates - shoulder at torso x velocity	22	3
Shoulder joint coordinates - shoulder at torso z velocity	22	4
Shoulder joint coordinates - shoulder length	22	9
Shoulder joint coordinates - shoulder length rate	22	10
Steering column coordinates - gear box x	33	11
Steering column coordinates - gear box z	33	12
Steering column coordinates - wheel attachment point x	33	9
Steering column coordinates - wheel attachment point x	33	10
Steering column coordinates - wheel hub x	33	7
Steering column coordinates - wheel hub z	33	8
Steering column coordinates - wheel lower edge x	33	1
Steering column coordinates - wheel lower edge z	33	2

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (8 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Steering column coordinates - wheel middle edge x	33	3
Steering column coordinates - wheel middle edge z	33	4
Steering column coordinates - wheel upper edge x	33	5
Steering column coordinates - wheel upper edge z	33	6
Steering column force components - head moment	36	3
Steering column force components - head x	36	1
Steering column force components - head z	36	2
Steering column force components - lower torso moment	36	12
Steering column force components - lower torso x	36	10
Steering column force components - lower torso z	36	11
Steering column force components - middle torso moment	36	9
Steering column force components - middle torso x	36	7
Steering column force components - middle torso z	36	8
Steering column force components - upper torso moment	36	6
Steering column force components - upper torso x	36	4
Steering column force components - upper torso z	36	5
Steering column forces - lower column extensional normal force	35	10
Steering column forces - lower hinge moment	35	12
Steering column forces - upper column extensional normal force	35	9
Steering column forces - upper hinge moment	35	11
Steering column forces - wheel hub normal force	35	7
Steering column forces - wheel hub tangential force	35	8
Steering column forces - wheel lower edge normal force	35	1
Steering column forces - wheel lower edge tangential force	35	2
Steering column forces - wheel middle edge normal force	35	3
Steering column forces - wheel middle edge tangential force	35	4
Steering column forces - wheel upper edge normal force	35	5
Steering column forces - wheel upper edge tangential force	35	6
Steering column kinematics - lower column extensional displacement	34	3
Steering column kinematics - lower column extensional velocity	34	4
Steering column kinematics - lower hinge angular displacement	34	7
Steering column kinematics - lower hinge angular velocity	34	8
Steering column kinematics - upper column extensional displacement	34	1
Steering column kinematics - upper column extensional velocity	34	2

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (9 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Steering column kinematics - upper hinge angular displacement	34	5
Steering column kinematics - upper hinge angular velocity	34	6
Unfiltered accelerations - chest A-P	6	4
Unfiltered accelerations - chest resultant	6	6
Unfiltered accelerations - chest S-I	6	5
Unfiltered accelerations - head A-P	6	1
Unfiltered accelerations - head resultant	6	3
Unfiltered accelerations - head S-I	6	2
Unfiltered accelerations - hip resultant	6	9
Unfiltered accelerations - hip x	6	7
Unfiltered accelerations - hip z	6	8
Unfiltered severity index - chest SI A-P	8	7
Unfiltered severity index - chest SI resultant	8	9
Unfiltered severity index - chest SI S-I	8	8
Unfiltered severity index - chest modified SI A-P	8	10
Unfiltered severity index - chest modified SI resultant	8	12
Unfiltered severity index - chest modified SI S-I	8	11
Unfiltered severity index - head SI A-P	8	1
Unfiltered severity index - head SI resultant	8	3
Unfiltered severity index - head SI S-I	8	2
Unfiltered severity index - head modified SI A-P	8	4
Unfiltered severity index - head modified SI resultant	8	6
Unfiltered severity index - head modified SI S-I	8	5
Vehicle response - horizontal acceleration	1	4
Vehicle response - horizontal displacement	1	2
Vehicle response - horizontal time	1	1
Vehicle response - horizontal velocity	1	3
Vehicle response - pitch acceleration	1	10
Vehicle response - pitch angle	1	8
Vehicle response - pitch velocity	1	9
Vehicle response - vertical acceleration	1	7
Vehicle response - vertical displacement	1	5
Vehicle response - vertical velocity	1	6
Viscosity component joint torque - elbow	26	8
Viscosity component joint torque - hip	26	5
Viscosity component joint torque - knee	26	6
Viscosity component joint torque - lower neck	26	2
Viscosity component joint torque - lower spine	26	4
Viscosity component joint torque - shoulder at arm	26	7
Viscosity component joint torque - upper neck	26	1
Viscosity component joint torque - upper spine	26	3

TABLE 3. OUTPUT TEST VARIABLES AND THEIR SPECIFICATIONS (10 of 10).

QUANTITY DESCRIPTION	CATG. NO.	COL. NO.
Chest C.G. motion - x-position	47	1
Chest C.G. motion - x-velocity	47	2
Chest C.G. motion - x-acceleration	47	3
Chest C.G. motion - z-position	47	4
Chest C.G. motion - z-velocity	47	5
Chest C.G. motion - z-acceleration	47	6
Head C.G. motion - x-position	46	1
Head C.G. motion - x-velocity	46	2
Head C.G. motion - x-acceleration	46	3
Head C.G. motion - z-position	46	4
Head C.G. motion - z-velocity	46	5
Head C.G. motion - z-acceleration	46	6
Head C.G. motion - head angle	46	7
Head C.G. motion - angular velocity	46	8
Head C.G. motion - angular acceleration	46	9
Hip motion - x-position	48	1
Hip motion - x-velocity	48	2
Hip motion - x-acceleration	48	3
Hip motion - z-position	48	4
Hip motion - z-velocity	48	5
Hip motion - z-acceleration	48	6
Joint relative angles - upper neck	49	1
Joint relative angles - lower neck	49	2
Joint relative angles - upper spine	49	3
Joint relative angles - lower spine	49	4
Joint relative angles - hip	49	5
Joint relative angles - knee	49	6
Joint relative angles - shoulder at arm	49	7
Joint relative angles - elbow	49	8
Joint relative angle velocities - upper neck	50	1
Joint relative angle velocities - lower neck	50	2
Joint relative angle velocities - upper spine	50	3
Joint relative angle velocities - lower spine	50	4
Joint relative angle velocities - hip	50	5
Joint relative angle velocities - knee	50	6
Joint relative angle velocities - shoulder at arm	50	7
Joint relative angle velocities - elbow	50	8
Neck reaction forces - upper neck shear on neck	5	1
Neck reaction forces - upper neck compressive on neck	5	2
Neck reaction forces - upper neck shear on head	5	3
Neck reaction forces - upper neck compressive on head	5	4
Neck reaction forces - lower neck shear on neck	5	5
Neck reaction forces - lower neck compressive on neck	5	6
Neck reaction forces - lower neck shear on torso	5	7
Neck reaction forces - lower neck compressive on torso	5	8
Neck reaction forces - moment at upper neck	5	9
Neck reaction forces - moment at lower neck	5	10

4.0 THE CAL/HSRI VERSION OF THE VCL

This original VCL was developed for use with the MVMA 2-D Model. It proved useful enough that a version was developed for use with the CAL/HSRI 3-D Model (Reference 2). This necessitated changes in the model data reading, many minor changes in commands, and a new model data reference system. The next subsection discusses the changes in commands while the last subsection discusses the available model data.

4.1 Changes in Commands

The data structure employed in CAL/HSRI 3-D Model storage is much simpler and less comprehensive than the MVMA 2-D. On the other hand, the CAL/HSRI 3-D Model has much more general possibilities in the use of units. The result of these differences caused changes in many commands. Table 4 contains the revised command prototypes. This table supplements both Table 2 of this report and Table 1 of the VCL Reoport. Table 5 of this report replaces Table 2 of the VCL report. The ordering restrictions mentioned in Section 3.1 also apply here.

4.2 Changes in Data Reference Parameters

The CAL/HSRI 3-D Model Data is specified by using the 3-D output page number, an index specifying which group of data on that page (there often may be more than one) and an index specifying which variable in the set. From these three indices, the model quantity desired is located in the binary hold file. Section 2.2.2 of the VCL Report does not apply to the CAL/HSRI 3-D Version of the VCL. Table 6 of the present report replaces both Tables 3 and 4 of the VCL report. The examples in the VCL report pages 43-95 do not apply to the CAL/HSRI 3-D VCL. Table 7 supplements Table 10 of the VCL Report while Table 8 supplements Table 17.

TABLE 4. CAL/HSRI VCL COMMANDS

Sentence Contents	Sentence Abbreviation	Notes
CONTROL PARAMETERS lindimname forcedimname timename (a) Print Control = no teletype output = 1 regular teletype output = 2 regular plus supplementary teletype output (b) Default final time (timename)	CP	The unit names supplies represent the basic units for VCL output inthis run. If this command is completely left out the two values default to 0 and 300 and the units default to inches, pounds, and seconds
MODEL RUN Filename (a) linear dimension factor (b) force dimension factor (c) time dimension factor	MR	This filename of the CAL/HSRI 3-D Hold file. The three conversion factors are the necessary multiplicative constants to change the units of the CVS model output to the units desired for the VCL output

TABLE 4. CAL/HSRI VCL COMMANDS (continued)

Sentence Contents	Sentence Abbreviation	Notes
MODEL QUANTITY Dataname (a) 3-D output page number (b) 3-D output group on page specified (c) 3-D output variable number is output group specified (d) Starting time (e) Time Increment (f) Final time	MQ	All times are in VCL output units

TABLE 5. TEST DATA QUANTITY DIMENSION CODE INDICES

Quantity Type	Default Dimensions	Code Index
distance	in	1
force	lb	2
time	sec	3
torque or moment	in-lb	4
velocity	in/sec	5
acceleration	G's	6
angle value	deg	7
angle velocity	rev/sec	8
angle acceleration	rev/sec/sec	9
strain	in/in	10
pressure	psig	11
temperature	°R	12

TABLE 6. CAL/HSRI 3-D DATA QUANTITIES AVAILABLE

Quantity Description	Cat. No.	Relative Col. No.	Number of Groups
Airbag center location -x	11-15	4	
Airbag center location -y	11-15	5	
Airbag center location -z	11-15	6	
Airbag contact force -x	11-15	13	3
Airbag contact force -y	11-15	14	3
Airbag contact force -z	11-15	15	3
Airbag orientation angle - pitch	11-15	11	
Airbag orientation angle - roll	11-15	12	
Airbag orientation angle - yaw	11-15	10	
Airbag semiaxis length -A	11-15	7	
Airbag semiaxis length -B	11-15	8	
Airbag semiaxis length -C	11-15	9	
Airbag static pressure	11-15	3	
Airbag supply pressure	11-15	1	
Airbag temperature	11-15	2	
Belt force - point A	9	2	4
Belt force - point B	9	4	4
Belt strain - point A	9	1	4
Belt strain - point B	9	3	4
Joint flex. angle	7	1	6
Joint flex. spring torque	7	3	6
Joint resultant torque	7	6	6
Joint tors. angle	7	2	6
Joint tors. spring torque	7	4	6
Joint viscous and coulomb torque	7	5	6
Panel versus segment contact deflection	8	1	7
Panel versus segment contact friction force	8	3	7
Panel versus segment contact location -x	8	5	7
Panel versus segment contact location -y	8	6	7
Panel versus segment contact location -z	8	7	7
Panel versus segment contact normal force	8	2	7
Panel versus segment contact resultant force	8	4	7
Segment angular acceleration - resultant	4	4	4
Segment angular acceleration -x	4	1	4
Segment angular acceleration -y	4	2	4
Segment angular acceleration -z	4	3	4
Segment angular displacement - pitch	6	2	4
Segment angular displacement - resultant	6	4	4
Segment angular displacement - roll	6	3	4
Segment angular displacement - yaw	6	1	4
Segment angular velocity - resultant	5	4	4
Segment angular velocity -x	5	1	4
Segment angular velocity -y	5	2	4
Segment angular velocity -z	5	3	4

TABLE 6. CAL/HRI 3-D DATA QUANTITIES AVAILABLE (continued)

Quantity Description	Cat. No.	Relative Col. No.	Number of Groups
Segment linear acceleration - resultant	1	4	4
Segment linear acceleration -x	1	1	4
Segment linear acceleration -y	1	2	4
Segment linear acceleration -z	1	3	4
Segment linear displacement - resultant	3	4	4
Segment linear displacement -x	3	1	4
Segment linear displacement -y	3	2	4
Segment linear displacement -z	3	3	4
Segment linear velocity - resultant	2	4	4
Segment linear velocity -x	2	1	4
Segment linear velocity -y	2	2	4
Segment linear velocity -z	2	3	4
Segment versus segment contact deflection	10	1	10
Segment versus segment contact friction force	10	3	10
Segment versus segment contact location of seg 1-x	10	5	10
Segment versus segment contact location of seg 1-y	10	6	10
Segment versus segment contact location of seg 1-z	10	7	10
Segment versus segment contact location of seg 2-x	10	8	10
Segment versus segment contact location of seg 2-y	10	9	10
Segment versus segment contact location of seg 2-z	10	10	10
Segment versus segment contact normal force	10	2	10
Segment versus segment contact resultant force	10	4	10

TABLE 7. CAL/HSRI VCL DIAGNOSTICS

Diagnostic	Conditions	Routine Name
Page number entered is illegal	Must head to category between 1 and 15	MODAT
Set index entered is illegal	Must not be greater than maximum number of groups per page	MODAT
Variable index entered is illegal	Must be greater than number of variables per group	MODAT
Your VCL input unit does not agree with unit from CVS model run for index _ Please enter correct conversion factor for this unit on the next line	Input error, a conversion factor was necessary	MODRUN
VCL input unit for index _ has more than 4 letters. Please reenter CP card	Input error, only four characters allowed	COMPAR

Note: All diagnostics referring to routine names INST, MODAT, PICKUP, SEARCH have been removed.

TABLE 8. CAL/HSRI VCL SUBPROGRAM TABLE

Routine Name	Routines Called	Description
CONPAR	INTMAR, RINF, UNPACK	processes run controls
KATIN		finds proper category number given page number
MODAT	RINF, INTMAK, KATIN, IUN, STOREN	gets data quantity out of binary storage and stores it
MODRUN	RINF, INTMAR	sets up reading out of binary storage
TSTRUN	INTMAK, RINF,	prepares to read experimental data from file and calculates units conversion factors
UNPACK		separates letters of unit names for comparison and deletes any periods

5.0 THE VCL PLOTTING PROGRAM (PLOTVCL)

PLOTVCL is the plot generation postprocessor for the VCL package which uses the TEKTRONIX PLOT-10 system to produce high-quality graphics output on a graphic terminal.

5.1 PLOTVCL Functional Description

PLOTVCL is a stand-alone program which reads plot description information from a binary input file and produces plots on the VDU with a minimum of user interaction.

In the initialization stage, the user is prompted for his terminal type and date transmission rate. This is followed by a request for the name of the file in which the plot data are stored.

Plotting begins immediately after the filename is entered and continues until the plot file is exhausted. Each plot is terminated by the prompt "Press return to continue", drawn along the bottom edge of the screen. The plot displayed will remain on the screen until the return key is passed.

When the end of the plot file is reached, the user is informed of the END-OF-FILE and asked whether another file is to be plotted. A "Yes" response restarts the program, while any other response ends execution.

5.2 PLOTVCL Examples

Three examples are included to illustrate output from the PLOTVCL Program. A run of a data set known as Tutorial Example N.2(T2D) produced hold files which were run through the VCL to produce plots under both the PRINT and OFF-LINE options. In this manner parallel examples of plots of Head Angle Verus Time (Table 9 and Figure 1), Head Acceleration Versus Time (Table 10 and Figure 2), and Head Angle Versus Head Acceleration (Table 11 and Figure 3) were obtained.

5.3 Plot Data File

The plot data file is a binary file which contains all of the information needed to define the plots requested during the VCL session. It is composed of pairs of records. The first record of each pair has two items of information: an indicator of plot type and the number of

points in the data record which follows. The second record, the data record, contains the actual values of the points to be plotted, along with pointers to axis labels, page number, and time increment between points, if appropriate. Table 12 gives a detailed description of the possible record pairs.

```
                    VALIDATION COMMAND LANGUAGE PROGRAM  PAGE  1

                                CARTESIAN PLOT
READ CARD NO.   10 +1
PC HEDANG.
 HEDANG  VERSUS TIME LABELED A
 TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE
   0.0   78.500    30.0    67.673    60.0    45.338    90.0     7.375   120.0    22.065   150.0    49.923   180.0    74.862
   5.0   78.500    35.0    64.108    65.0    40.770    95.0     5.886   125.0    26.573   155.0    54.319   185.0    78.806
  10.0   78.500    40.0    60.026    70.0    34.368   100.0     7.092   130.0    31.183   160.0    58.675   190.0    82.821
  15.0   78.500    45.0    55.800    75.0    26.799   105.0     9.764   135.0    35.923   165.0    62.867   195.0    86.688
  20.0   78.500    50.0    52.193    80.0    18.939   110.0    13.332   140.0    40.716   170.0    66.929   200.0    90.138
  25.0   78.500    55.0    48.908    85.0    11.944   115.0    17.581   145.0    45.407   175.0    70.930   205.0     0.000
  30.0   78.500    60.0    45.338    90.0     7.375   120.0    22.065   150.0    49.923   180.0    74.862   210.0     0.000
READ CARD NO.   11 +1
PP.
```

TABLE 9. PRINTER PLOT OUTPUT FOR HEAD ANGLE VERSUS TIME (Page 1 of 2).

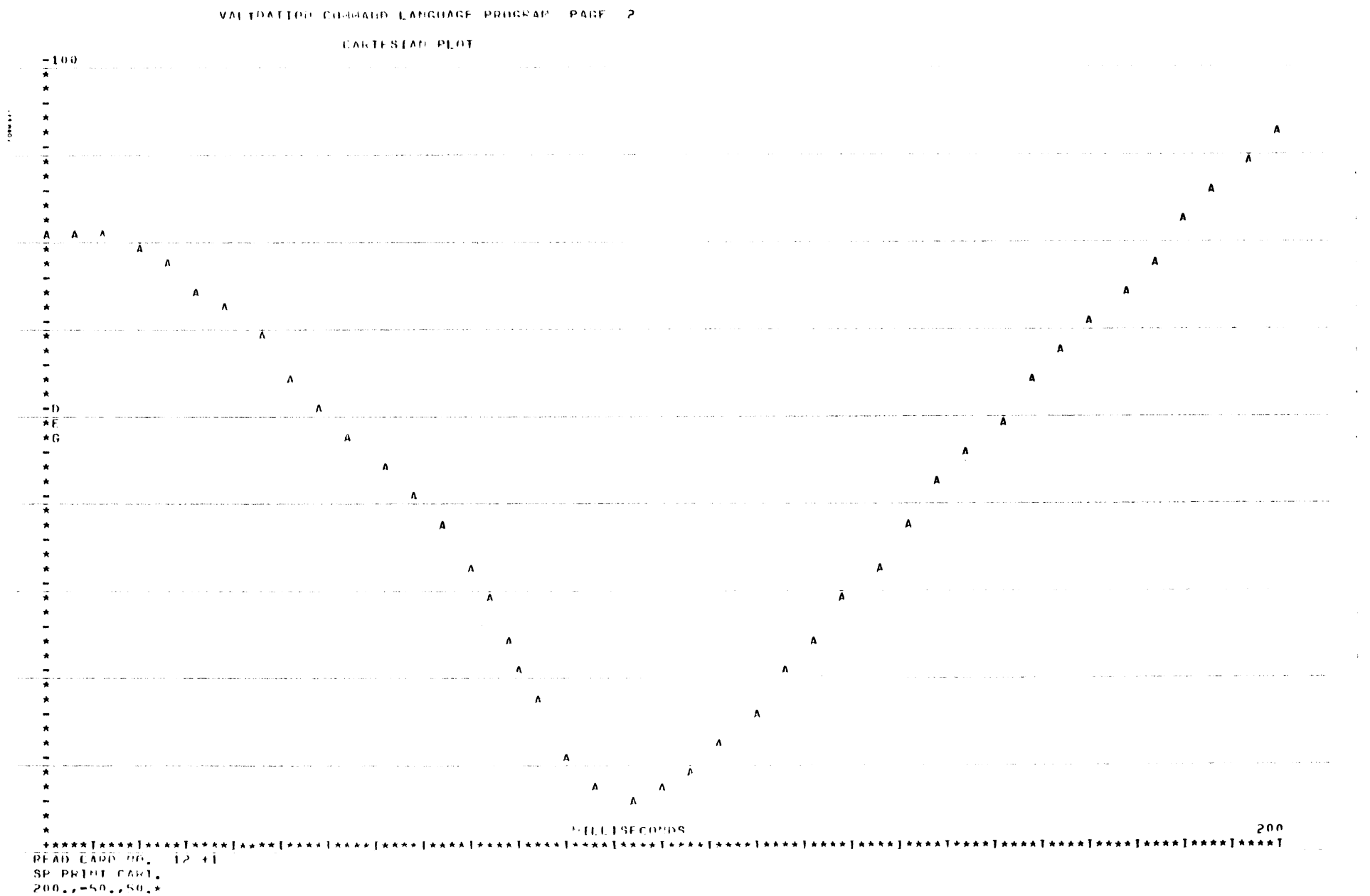


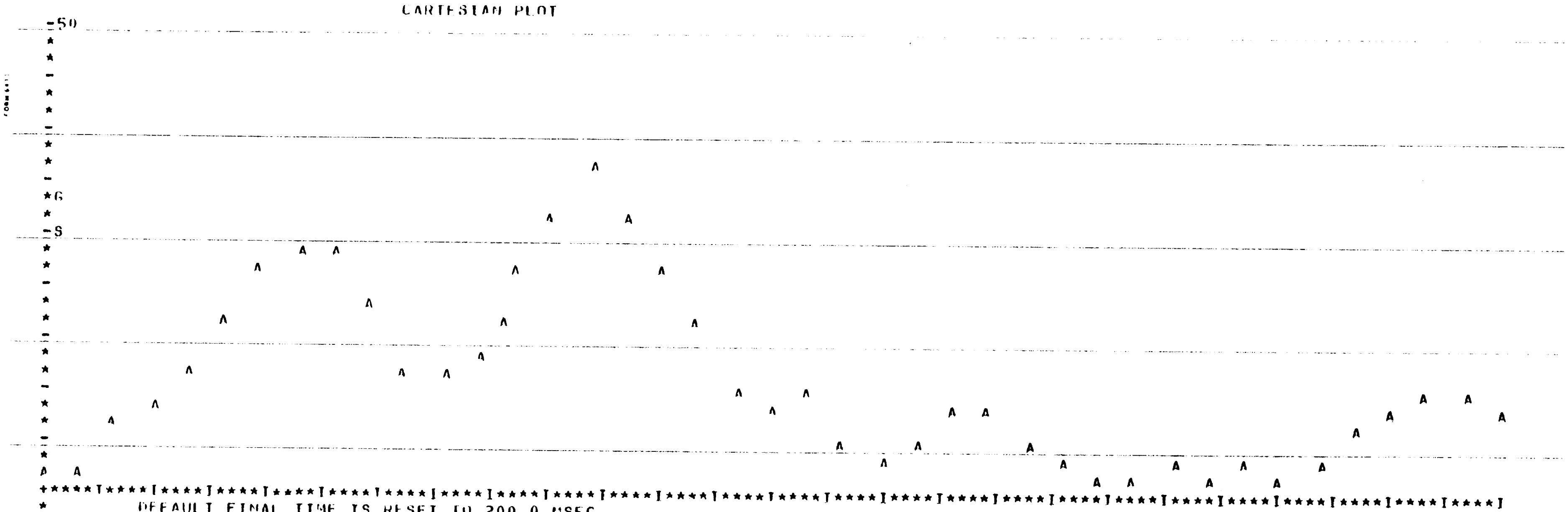
TABLE 9. PRINTER PLOT OUTPUT FOR HEAD ANGLE VERSUS TIME (Page 2 of 2).

CARTESIAN PLOT

```
READ CARD NO.  14 +1
PC HEADA.
 HEADA    VERSUS TIME LABELED A
 TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE    TIME     VALUE
   0.0     1.000    30.0    23.497    60.0    15.348    90.0    18.643   120.0     4.908   150.0     2.237   180.0     6.819
   5.0     1.000    35.0    25.780    65.0    23.430    95.0    11.616   125.0     8.922   155.0     3.171   185.0     8.456
  10.0     1.000    40.0    25.789    70.0    30.120   100.0     8.841   130.0     8.954   160.0     2.491   190.0    11.978
  15.0     1.000    45.0    20.559    75.0    35.306   105.0    10.239   135.0     6.365   165.0     4.253   195.0    11.957
  20.0     1.000    50.0    13.139    80.0    29.980   110.0     5.155   140.0     2.927   170.0     2.681   200.0     9.551
  25.0     1.000    55.0    13.228    85.0    24.723   115.0     3.637   145.0     1.654   175.0     4.038   205.0     0.000
  30.0     1.000    60.0    15.348    90.0    18.643   120.0     4.908   150.0     2.237   180.0     6.819   210.0     0.000
READ CARD NO.  15 +1
PP.
```

TABLE 10. PRINTER PLOT OUTPUT FOR HEAD ACCELERATION VERSUS TIME (Page 1 of 2).

```
VALIDATION COMMAND LANGUAGE PROGRAM  PAGE  4
```




```
*        DEFAULT FINAL TIME IS RESET TO 200.0 MSEC
OUTPUT QUANTITIES FOR THIS RUN ARE IN STANDARD UNITS.
NEXT FOUR LINES CONTAIN MODEL RUN DESCRIPTION
                MVMA 2-D TUTORIAL EXAMPLE #2
GM HYBRID II DUMMY  (PRELIMINARY DATA)     KNEE BAR          OCC. COMP. DISPL.
30MPH FRONT BARRIER  FORCE-LIM. HARNESS   NO LAP BELT
 83/03/17. 13.14.06.
QUANTITIES FROM THIS RUN ARE IN STANDARD UNITS.
FINAL TIME RECORDED IS 200.0 MSEC TIME INCREMENT IS    5.0 MSEC
ACTUAL NUMBER OF POINTS IS  41. NUMBER OF ELLIPSES = 13, OF LINES =  8
OF REGIONS =  9, OF INTERACTIONS = 17
     UNFILTERED ACCELS                  HEAD       RESULTANT
MODEL QUANTITY NAMED  HEADA    FROM   0.0 TO 200.0 AT    5.0 MSEC INTERVALS.
     BODY LINK ANGLES                HEAD
MODEL QUANTITY NAMED  HEDANG  FROM   0.0 TO 200.0 AT    5.0 MSEC INTERVALS.
FOR CARTESIAN PLOT,
SCALING PARAMETERS ARE:     0.0000  200.0000  100.0000    0.0000
     .6500    2.0000    -.5400   55.0000     .7692     .9259
FOR CARTESIAN PLOT,
SCALING PARAMETERS ARE:     0.0000  200.0000   50.0000  -50.0000
     .6500    2.0000    -.5400   28.0000     .7692     .9259
FOR PHASE PLANE TYPE PLOT,
SCALING P
                                        MILLISECONDS                              200
```

TABLE 10. PRINTER PLOT OUTPUT FOR HEAD ACCELERATION VERSUS TIME (Page 2 of 2).

VALIDATION CDASAM2 LANGUAGE PROGRAM PAGE 5

PHASE PLANE TYPE PLOT

```
READ CARD NO.  18 +1
PC HEDANG HEADA.
 HEDANG  AS Y VERSUS  HEADA   AS X.
```

INDEX	TIME	X	Y	INDEX	TIME	X	Y	INDEX	TIME	X	Y	INDEX	TIME	X	Y
1	0.0	78.5000	1.0000	12	55.0	48.9077	13.2277	23	110.0	13.3315	5.1546	34	165.0	62.8669	4.2532
2	5.0	78.4852	2.4210	13	60.0	45.3376	15.3481	24	115.0	17.5807	3.6371	35	170.0	66.9285	2.6806
3	10.0	78.1598	6.6079	14	65.0	40.7697	23.4305	25	120.0	22.0647	4.9079	36	175.0	70.9299	4.0377
4	15.0	76.6841	8.8666	15	70.0	34.3684	30.1198	26	125.0	26.5734	8.9217	37	180.0	74.8622	6.8164
5	20.0	73.9623	13.5683	16	75.0	26.7995	35.3064	27	130.0	31.1834	8.9543	38	185.0	78.8063	8.4564
6	25.0	70.8672	19.4442	17	80.0	18.9390	29.9798	28	135.0	35.9234	6.3648	39	190.0	82.8213	11.9779
7	30.0	67.6726	23.4967	18	85.0	11.9400	24.7229	29	140.0	40.7156	2.9271	40	195.0	86.6883	11.9566
8	35.0	64.1489	25.7796	19	90.0	7.3752	18.6427	30	145.0	45.4074	1.6536	41	200.0	90.1378	9.5515
9	40.0	60.0262	25.7894	20	95.0	5.8868	11.6162	31	150.0	49.9226	2.2369				
10	45.0	55.8004	26.5587	21	100.0	7.0025	8.8008	32	155.0	54.3194	3.1712				
11	50.0	52.1931	13.1387	22	105.0	9.7645	10.2391	33	160.0	58.6748	2.4908				
12	55.0	48.9077	13.2277	23	110.0	13.3315	5.1546	34	165.0	62.8669	4.2532				

```
READ CARD NO.  19 +1
PP.
```

TABLE 11. PRINTER PLOT OUTPUT FOR HEAD ANGLE VERSUS HEAD ACCELERATION (Page 1 of 2).

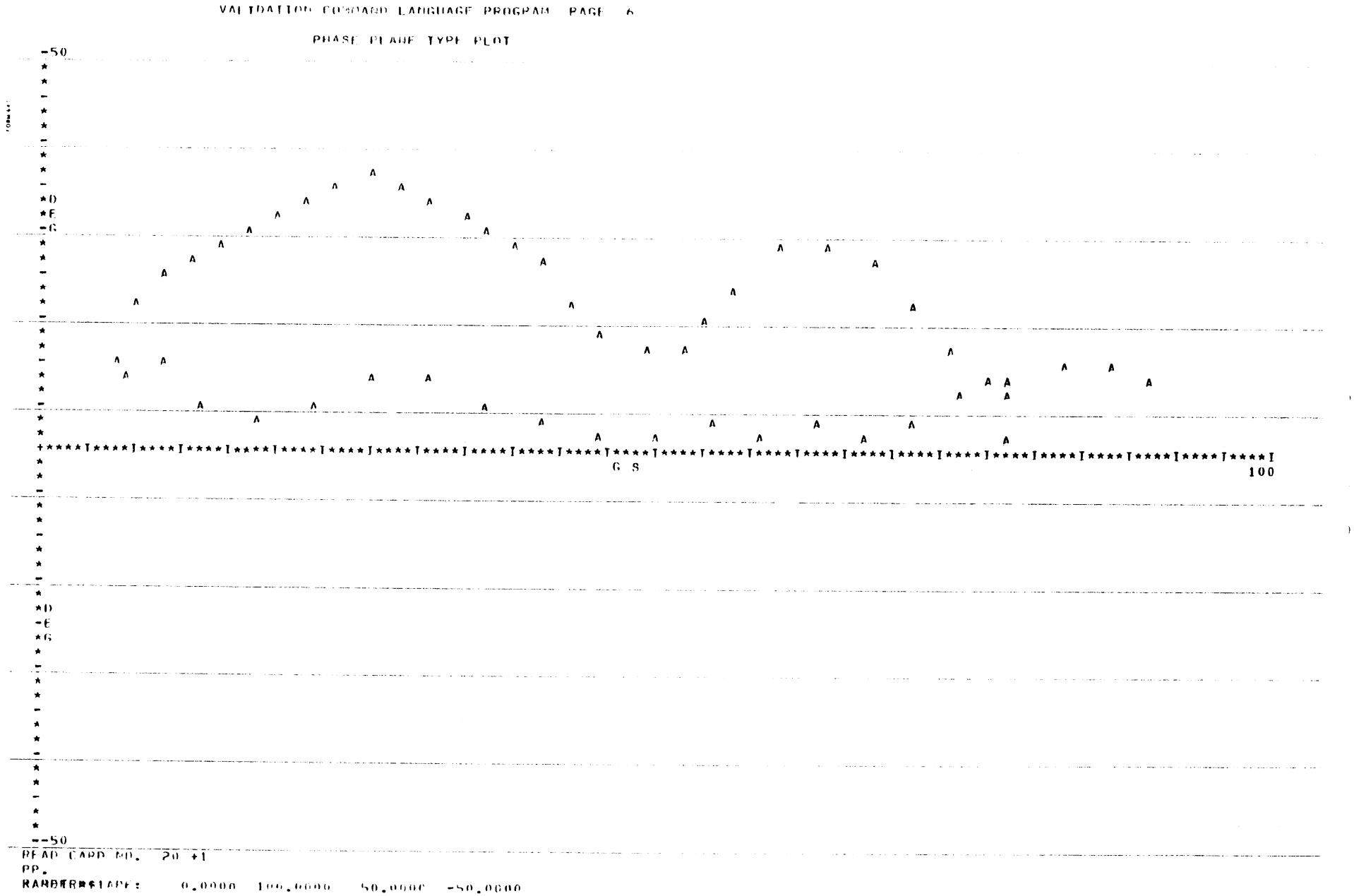


TABLE 11. PRINTER PLOT OUTPUT FOR HEAD ANGLE VERSUS HEAD ACCELERATION (Page 2 of 2).

TABLE 12. LAYOUT OF BINARY PLOT DATA FILE

Record Number	Item Name	Number of Words/Item	Type	Comments
1	ITYPE	1	Integer	1=Phase Plane Type Plot 2=Cartesian Plot 3=Deviation Plot 4=Overlay for (2) or (3) 5=Finish up (2) or (3)
1	NPT	1	Integer	Number of points in data record
2	x	NPT	Real	Values of data (x) [Phase Plane Plots Only]
2	y	NPT	Real	Values of Data (y)
2	xIndex	1	Integer	Pointer to x-Axis Unit Label [Phase Plane Plots Only]
2	yIndex	1	Integer	Pointer to y-Axis Unit Label
2	PAGENO	1	Integer	Aids in identifying plots
2	DELTAT	1	Real	Point-to-point time increment for cartesan and deviation plots

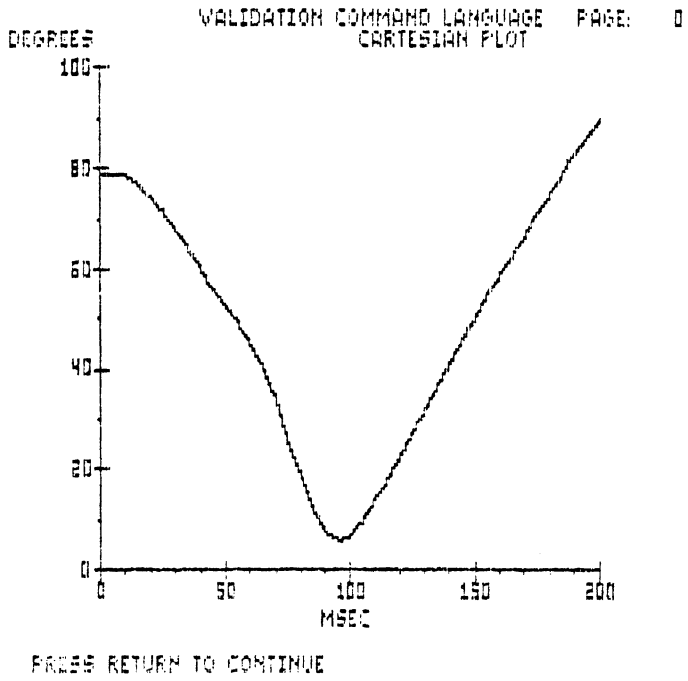


Fig. 1. CRT Facsimile of Head Angle versus Time.

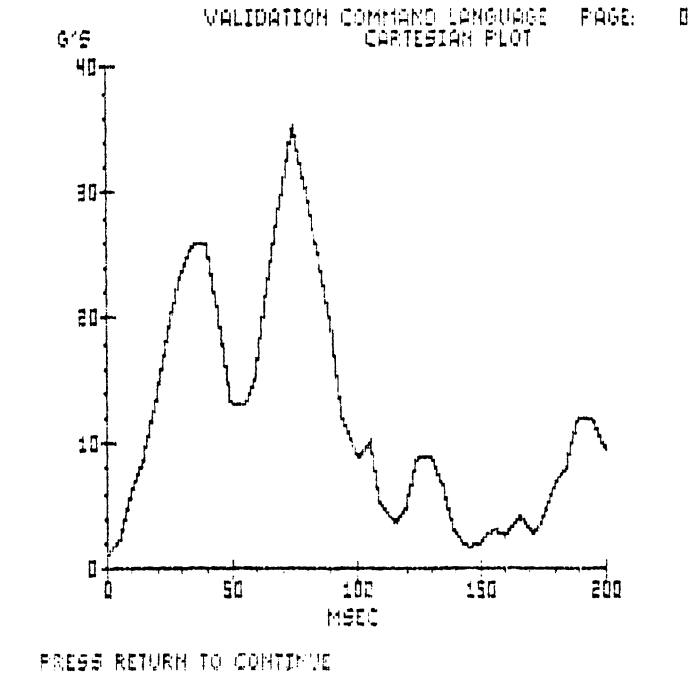


Fig. 2. CRT Facsimile of Head Acceleration versus Time.

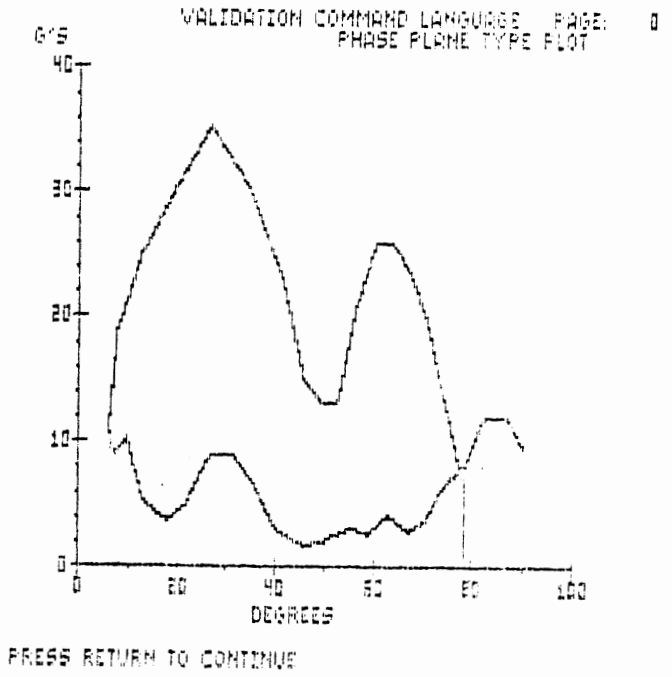


Fig. 3. CRT Facsimile of Head Angle versus Head Acceleration.

6.0 REFERENCES

1. Bennett, R.O., Becker, J.M., and Robbins, D.H., "Validation Command Language (1979 Version)," Report No. UM-HSRI-79-6, University of Michigan Transportation Research Institute, August 1979.

2. Bennett, R.O. and Robbins, D.H., "HSRI Version of the Improved Three Dimensional Computer Simulation of Vehicle Crash Victims," 3 Vols., Report Nos. UM-HSRI-82-8-1,2,3. Final Report on Contract No. DOT-HS-7-01659. University of Michigan Transportation Research Institute, March 1982.