92247 archive

ARTICULATED BUS DYNAMIC ANALYSIS

APPENDICES A, B, C, D

THE UNIVERSITY OF MICHIGAN
HIGHWAY SAFETY RESEARCH INSTITUTE

APPENDICES

APPENDIX A

VEHICLE PARAMETER SETS

This appendix contains five data sets corresponding to (1) the empty baseline vehicle with original axle load estimates, (2) the loaded baseline vehicle with original axle load estimates, (3) the empty baseline vehicle with subsequent axle load measurements, referred to here as "New Load Data," (4) a standard 35-foot bus data set (empty), and (5) the empty baseline vehicle data set but containing tire model parameters in place of tire data tables. The tire model was used for all low friction traction/braking maneuvers because corresponding tire data was not available and it also facilitated changes in data sets for the different road friction conditions.

Those parameters having the greatest uncertainty as to actual value and appearing in each of these data sets are identified by an asterisk (*) in data set #5 (sub-appendix A.5). Also, those parameters felt to have the least importance in affecting the simulation results are identified by a (+) in data set #5.

A.1 Empty Baseline Vehicle

CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH DEC 16'80 RUN#28

SIMULATION OPERATION PARAMETERS:

VEHICLE CONFIGURATION (NUMBER OF TRAILERS - ENTER 0 FOR A STRAIGHT TRUCK)	1
INITIAL VELOCITY (FT/SEC)	91.20
STEER TABLE (NUMBER OF LINES): POSITIVE -STEER ANGLE TABLE, NEGATIVE - PATH FOLLOWER TABLE	-4

CLOSED-LOOP PATH FOLLOWING MODE

X-Y PATH COORDINATES :

X (FEET)	Y (FEET)
0.0	0.0
200.00	0.0
350.00	12.00
1200.00	12.00

DRIVER TRANSPORT LAG (SEC) : 0.25
END OF PREVIEW INTERVAL (SEC) : 2.00

TREADLE PRESSURE TABLE (NUMBER OF LINES) 1
TABLE ENTRIES:

TIME (SEC)	PRESSURE (PSI)
0.0	0.0

MAXIMUM SIMULATION TIME (SEC)	8.00
TIME INCREMENT OF OUTPUT (SEC)	0.10

ROAD KEY = 0 : FLAT ROAD.

OUTPUT PAGE OPTION KEYS: 0 DELETES PAGES

SPRUNG MASS POSITION	SPRUNG MASS VELOCITY	SPRUNG MASS ACCELERATION	TIRE FORCES PAGES	BRAKE SUMMARY PAGES	LATERAL PAGES	UNSPRUNG MASS PAGES	TEMP PAGES
1	1	1	1	0	1	1	1

CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH DEC 16'80 RUN#28

TRACTOR PARAMETERS

WHEELBASE - DISTANCE FROM FRONT AXLE TO CENTER OF REAR SUSPENSION (IN)	235.00
BASE VEHICLE CURB WEIGHT CN FRONT SUSPENSION (LB)	6820.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	8315.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	39.40
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
PAYLOAD WEIGHT (LB)	0.0
*** ZERO ENTRY INDICATES NC PAYLOAD ***	
*** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***	
FIFTH WHEEL LOCATION (IN. AHEAD OF REAR SUSP. CENTER)	-78.30
FIFTH WHEEL HEIGHT ABOVE GROUND (IN)	27.50
TRACTOR FRAME STIFFNESS (IN-LB/DEG)	250000.00
TRACTOR FRAME TORSIONAL AXIS HEIGHT ABOVE GROUND (IN)	39.40

TRACTOR FRONT SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	508.00	508.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	26.00	26.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	5307.00
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	17.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.06
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	0.0
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	40.25
TRACK WIDTH (IN)	85.60
UNSPRUNG WEIGHT (LB)	802.00
STEERING GEAR RATIO (DEG STEERING WHEEL/DEG ROAD WHEEL)	38.40
STEERING STIFFNESS (IN-LB/DEG)	7500.00
TIE ROD STIFFNESS (IN-LB/DEG)	15000.00
MECHANICAL TRAIL (IN)	0.70
TORSIONAL WRAP-UP STIFFNESS (IN-LB/IN)	1000000.00
LATERAL OFFSET OF STEERING AXIS (IN)	3.00

TRACTOR FRONT TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
CORNERING STIFFNESS (LB/DEG/TIRE)	-1.00	-1.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	-2.00	-2.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	-720.00	-720.00
*** NEGATIVE ALIGNING MOMENT ENTRY ***		

*** ALIGNING MOMENT CURVE FIT PARAMETERS: (0.0 0.0 8.6000 0.0) (0.0 0.0 8.6000 0.0)

POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	20.47 150.00	20.47 150.00

CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH DEC 16'80 RUN#28

TRACTOR REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE		RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM		0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	880.00		880.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00		58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0		0.0
AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)		7000.00	
ROLL CENTER HEIGHT (IN. ABOVE GROUND)		23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)		0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)		75000.00	
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)		37.00	
TRACK WIDTH (IN)		76.40	
UNSPRUNG WEIGHT (LB)		1466.00	

TRACTOR REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE) *** NEGATIVE ENTRY INDICATES TABLE ENTERED *** *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***	-1.00	-1.00
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE) *** NEGATIVE ENTRY INDICATES TABLE ENTERED *** *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***	-2.00	-2.00
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	648.00	648.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

TRACTOR FRONT BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0200	0.0200
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	700.0000	700.0000
BRAKE HYSTERESIS KEY: 0 ENTRY INDICATES BRAKE HYSTERESIS OPTION NOT IN USE ON VEHICLE TRAIN		0
BRAKE PROPORTIONING KEY: 0 ENTRY INDICATES BRAKE PROPORTIONING OPTION NOT IN USE ON VEHICLE TRAIN		0

TRACTOR REAR BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0500	0.0500
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	1100.0000	1100.0000

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TRAILER NO. 1 PARAMETERS
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   WHEELBASE - DISTANCE FROM KINGPIN TO CENTER OF REAR SUSPENSION (IN)
   BASE VEHICLE KINGPIN STATIC LOAD (LB)                                        203.40
   BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)                            1938.00
   SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)                                   16267.00
   SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)                             43.30
   SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)                         93000.00
   SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)                          300000.00
   PAYLOAD WEIGHT (LB)                                                       300000.00
      *** ZERO ENTRY INDICATES NC PAYLOAD ***                                      0.0
      *** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***
TRAILER NO. 1 REAR SUSPENSION  AND AXLE PARAMETERS
--------------------------------------------                   LEFT SIDE        RIGHT SIDE
                                                                ---------        ----------
   SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM
   SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)                                  0
   SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)            1204.00          1204.00
   COULOMB FRICTION (LB/SIDE/AXLE)                               58.00            58.00
                                                                  0.0              0.0
   AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)                  -------------------------------
   ROLL CENTER HEIGHT (IN. ABOVE GROUND)                                 7000.00
   ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)                           23.00
   AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)                                0.0
   LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)                     75000.00
   TRACK WIDTH (IN)                                                        37.00
   UNSPRUNG WEIGHT (LB)                                                    76.40
TRAILER NO. 1 REAR TIRES  AND WHEELS                                     2205.00
--------------------------------                               LEFT SIDE        RIGHT SIDE
                                                                ---------        ----------

   DUAL TIRE SEPARATION (IN)
   CORNERING STIFFNESS   (LB/DEG/TIRE)                            13.22            13.22
      *** NEGATIVE ENTRY INDICATES TABLE ENTERED ***              -1.00            -1.00
      *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***
   LONGITUDINAL STIFFNESS   (LB/SLIP/TIRE)
      *** NEGATIVE ENTRY INDICATES TABLE ENTERED ***              -2.00            -2.00
      *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***
   CAMBER STIFFNESS (LB/DEG/TIRE)
   ALIGNING MOMENT   (IN-LB/DEG/TIRE)                               0.0              0.0
   TIRE SPRING RATE (LB/IN/TIRE)                                1052.00          1052.00
   TIRE LOADED RADIUS (IN)                                      5000.00          5000.00
   POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)                   20.00            20.00
                                                                 300.00           300.00
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CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH DEC 16'80 RUN#28

TRAILER NO. 1 REAR BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.1400	0.1400
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	1600.0000	1600.0000
ANTILOCK KEY: 1 INDICATES ANTILOCK WILL BE USED		-1

CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH   DEC 16'80 RUN#28

TRAILER NO. 1 PAYLOAD = 0.0 LBS.	EMPTY	LOADED
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	24.637	24.637
DISTANCE FROM TRAILER SPRUNG MASS CENTER TC GROUND (IN)	43.300	43.300
ROLL MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000
YAW MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000

TRACTOR PAYLOAD = 0.0 LBS	EMPTY	LOADED
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	109.911	109.911
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TC GROUND (IN)	39.400	39.400
ROLL MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000
YAW MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000

THE STATIC LOADS ON THE AXLES ARE:

AXLE NUMBER	LOAD
NS(1,1,1)	6174.277
NS(1,2,1)	10898.723
NS(2,2,1)	16266.996
TOTAL	33339.996

THE TRACTOR TOTAL MASS CENTER IS   129.106 INCHES BEHIND THE FRONT AXLE
THE TOTAL YAW MOMENT OF INERTIA IS   834064.500 IN-LB-SEC**2

THE FIRST TRAILER TOTAL MASS CENTER IS   181.747 INCHES BEHIND THE KINGPIN
THE TOTAL YAW MOMENT OF INERTIA IS   310047.250 IN-LB-SEC**2

MU-Y VS ALPHA TABLES

NO. OF LOADS	NO. OF VELOCITIES	TABLE NO.
3	1	-1

VELOCITY = 73.30 FT/SEC LOAD = 4000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.12
2.00	0.21
4.00	0.38
8.00	0.60
12.00	0.70
16.00	0.74

VELOCITY = 73.30 FT/SEC LOAD = 6000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.10
2.00	0.19
4.00	0.33
8.00	0.53
12.00	0.64
16.00	0.68

VELOCITY = 73.30 FT/SEC LOAD = 8000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.08
2.00	0.16
4.00	0.29
8.00	0.47
12.00	0.58
16.00	0.63

ROLL-OFF TABLE

	SLIP				
ALPHA	0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	0.90	0.30	0.10

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12.00	1.00	1.00	0.90	0.42	0.17
16.00	1.00	1.00	0.90	0.48	0.22

CANADIAN ARTIC BUS EMPTY---12'-SINGLE-LANE-CHANGE---100 KPH DEC 16'80 RUN#28

MU-X VS. SLIP TABLES

NO. OF LOADS	NO. OF VELOCITIES	TABLE NO.
3	1	-2

VELOCITY = 66.00 FT/SEC LOAD = 3560.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.32
0.10	0.64
0.20	0.81
0.30	0.81
1.00	0.58

VELOCITY = 66.00 FT/SEC LOAD = 6770.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.31
0.10	0.60
0.20	0.77
0.30	0.77
1.00	0.53

VELOCITY = 66.00 FT/SEC LOAD = 10210.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.25
0.10	0.53
0.20	0.70
0.30	0.71
1.00	0.49

ROLL-OFF TABLE

	SLIP				
ALPHA	0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	1.00	1.00	1.00
4.00	1.00	1.00	1.00	1.00	1.00
8.00	0.75	0.75	0.75	0.95	1.00

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16.00        0.40        0.40        0.45        0.85        0.95

##########################################################################################################
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***WARNING*** OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN UNIT 7 WHICH IS ATTACHED TO
              RUN.28. THE WRITE IS SEQUENTIAL AT LINE 1. FOR THIS AND ALL FUTURE OCCURRENCES OF THIS CONDITION, A FIELD OF *'S
              WILL BE WRITTEN.

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A.2 Loaded Baseline Vehicle

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

SIMULATION OPERATION PARAMETERS:

VEHICLE CONFIGURATION (NUMBER OF TRAILERS - ENTER 0 FOR A STRAIGHT TRUCK)	1
INITIAL VELOCITY (FT/SEC)	45.60
STEER TABLE (NUMBER OF LINES): POSITIVE -STEER ANGLE TABLE, NEGATIVE - PATH FOLLOWER TABLE	5

TABLE ENTRIES:

TIME (SEC)	LEFT WHEEL (DEG)	RIGHT WHEEL (DEG)
0.0	0.0	0.0
0.25	215.00	215.00
1.50	215.00	215.00
2.00	215.00	215.00
10.00	215.00	215.00

TREADLE PRESSURE TABLE (NUMBER OF LINES) 1

TABLE ENTRIES:

TIME (SEC)	PRESSURE (PSI)
0.0	0.0

MAXIMUM SIMULATION TIME (SEC)	4.00
TIME INCREMENT OF OUTPUT (SEC)	0.10

ROAD KEY = 0 : FLAT ROAD.

OUTPUT PAGE OPTION KEYS: 0 DELETES PAGES

SPRUNG MASS POSITION	SPRUNG MASS VELOCITY	SPRUNG MASS ACCELERATION	TIRE FORCES PAGES	BRAKE SUMMARY PAGES	LATERAL PAGES	UNSPRUNG MASS PAGES	TEMP PAGES
1	1	1	1	0	1	1	1

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

TRACTOR PARAMETERS

WHEELBASE - DISTANCE FROM FRONT AXLE TO CENTER OF REAR SUSPENSION (IN)	235.00
BASE VEHICLE CURB WEIGHT ON FRONT SUSPENSION (LB)	6820.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	8315.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	39.40
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
PAYLOAD WEIGHT (LB)	16202.00
PAYLOAD DISTANCE AHEAD OF REAR SUSPENSION CENTER(IN)	119.60
PAYLOAD CG HEIGHT (IN. ABOVE GROUND)	64.60
PAYLOAD ROLL MOMENT OF INERTIA(IN-LB-SEC**2)	35000.00
PAYLOAD PITCH MOMENT OF INERTIA(IN-LB-SEC**2)	560000.00
PAYLOAD YAW MOMENT OF INERTIA(IN-LB-SEC**2)	560000.00
FIFTH WHEEL LOCATION (IN. AHEAD OF REAR SUSP. CENTER)	-78.30
FIFTH WHEEL HEIGHT ABOVE GROUND (IN)	27.50
TRACTOR FRAME STIFFNESS (IN-LB/DEG)	250000.00
TRACTOR FRAME TORSIONAL AXIS HEIGHT ABOVE GROUND (IN)	39.40

TRACTOR FRONT SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	1012.00	1012.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	26.00	26.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	5307.00
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	17.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.06
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	0.0
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	40.25
TRACK WIDTH (IN)	85.60
UNSPRUNG WEIGHT (LB)	802.00
STEERING GEAR RATIO (DEG STEERING WHEEL/DEG ROAD WHEEL)	38.40
STEERING STIFFNESS (IN-LB/DEG)	7500.00
TIE ROD STIFFNESS (IN-LB/DEG)	15000.00
MECHANICAL TRAIL (IN)	0.70
TORSIONAL WRAP-UP STIFFNESS (IN-LB/IN)	1000000.00
LATERAL OFFSET OF STEERING AXIS (IN)	3.00

TRACTOR FRONT TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
CORNERING STIFFNESS (LB/DEG/TIRE) *** NEGATIVE ENTRY INDICATES TABLE ENTERED *** *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***	-1.00	-1.00
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE) *** NEGATIVE ENTRY INDICATES TABLE ENTERED *** *** ECHO WILL APPEAR ON TABLE INDEX PAGE ***	-2.00	-2.00

CAMBER STIFFNESS (LB/DEG/TIRE)

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*** ALIGNING MOMENT CURVE FIT PARAMETERS:  (   0.0      0.0      8.6000  0.0    ) (  0.0      0.0      8.6000  0.0    )
TIRE SPRING RATE (LB/IN/TIRE)                                                    5300.00                 5300.00
TIRE LOADED RADIUS (IN)                                                            20.47                   20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)                                      150.00                  150.00
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CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

TRACTOR REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE		RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM		0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	1729.00		1729.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	50.00		58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0		0.0
AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)		7000.00	
ROLL CENTER HEIGHT (IN. ABOVE GROUND)		23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)		0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)		75000.00	
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)		37.00	
TRACK WIDTH (IN)		76.40	
UNSPRUNG WEIGHT (LB)		1466.00	

TRACTOR REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE)	-1.00	-1.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	-2.00	-2.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	1512.00	1512.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

TRACTOR FRONT BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0200	0.0200
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	700.0000	700.0000
BRAKE HYSTERESIS KEY: 0 ENTRY INDICATES BRAKE HYSTERESIS OPTION NOT IN USE ON VEHICLE TRAIN		0
BRAKE PROPORTIONING KEY: 0 ENTRY INDICATES BRAKE PROPORTIONING OPTION NOT IN USE ON VEHICLE TRAIN		0

TRACTOR REAR BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0500	0.0500
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	1100.0000	1100.0000

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

TRAILER NO. 1 PARAMETERS

WHEELBASE - DISTANCE FROM KINGPIN TO CENTER OF REAR SUSPENSION (IN)	203.40
BASE VEHICLE KINGPIN STATIC LOAD (LB)	1938.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	16267.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	43.30
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	300000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	300000.00
PAYLOAD WEIGHT (LB)	10802.00
PAYLOAD DISTANCE AHEAD OF REAR SUSPENSION CENTER(IN)	58.90
PAYLOAD CG HEIGHT (IN. ABOVE GROUND)	64.60
PAYLOAD ROLL MOMENT OF INERTIA(IN-LB-SEC**2)	24000.00
PAYLOAD PITCH MOMENT OF INERTIA(IN-LB-SEC**2)	205000.00
PAYLOAD YAW MOMENT OF INERTIA(IN-LB-SEC**2)	200000.00

TRAILER NO. 1 REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE		RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM		0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	1742.00		1742.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00		58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0		0.0
AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)		7000.00	
ROLL CENTER HEIGHT (IN. ABOVE GROUND)		23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)		0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)		75000.00	
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)		37.00	
TRACK WIDTH (IN)		76.40	
UNSPRUNG WEIGHT (LB)		2205.00	

TRAILER NO. 1 REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE)	-1.00	-1.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	-2.00	-2.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	1572.00	1572.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.00	20.00
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

TRAILER NO. 1 REAR BRAKES

	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.1400	0.1400
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	1600.0000	1600.0000
ANTILOCK KEY: 1 INDICATES ANTILOCK WILL BE USED		-1

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

TRAILER NO. 1   PAYLOAD = 10802.000 LBS.

	EMPTY	LOADED
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	24.637	38.446
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO GROUND (IN)	43.300	51.885
ROLL MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	93000.000	124579.188
PITCH MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	532191.250
YAW MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	519612.000

TRACTOR   PAYLOAD = 16202.000 LBS

	EMPTY	LOADED
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	109.911	115.311
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO GROUND (IN)	39.400	53.446
ROLL MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	93000.000	139798.500
PITCH MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	1317541.000
YAW MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	1305743.000

THE STATIC LOADS ON THE AXLES ARE:

AXLE NUMBER	LOAD
NS(1,1,1)	13377.840
NS(1,2,1)	23025.176
NS(2,2,1)	23940.984
TOTAL	60344.000

THE TRACTOR TOTAL MASS CENTER IS   122.020 INCHES BEHIND THE FRONT AXLE
THE TOTAL YAW MOMENT OF INERTIA IS 1397872.000 IN-LB-SEC**2

THE FIRST TRAILER TOTAL MASS CENTER IS   167.877 INCHES BEHIND THE KINGPIN
THE TOTAL YAW MOMENT OF INERTIA IS   534413.563 IN-LB-SEC**2

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

MU-Y VS ALPHA TABLES

TABLE NO. -1

NO. OF LOADS	NO. OF VELOCITIES
3	1

VELOCITY = 73.30 FT/SEC LOAD = 4000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.12
2.00	0.21
4.00	0.38
8.00	0.60
12.00	0.70
16.00	0.74

VELOCITY = 73.30 FT/SEC LOAD = 6000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.10
2.00	0.19
4.00	0.33
8.00	0.53
12.00	0.64
16.00	0.68

VELOCITY = 73.30 FT/SEC LOAD = 8000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.08
2.00	0.16
4.00	0.29
8.00	0.47
12.00	0.58
16.00	0.63

ROLL-OFF TABLE

	SLIP				
ALPHA	0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	0.90	0.30	0.10

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12.00	1.00	1.00	0.90	0.42	0.17
16.00	1.00	1.00	0.90	0.48	0.22

CANADIAN ARTIC BUS LOADED--- RAMP STEER INPUT-215.DEG-50-KPH,DEC 16'80 RUN#29

MU-X VS. SLIP TABLES

TABLE NO. -2

NO. OF LOADS	NO. OF VELOCITIES
3	1

VELOCITY = 66.00 FT/SEC LOAD = 3560.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.32
0.10	0.64
0.20	0.81
0.30	0.81
1.00	0.58

VELOCITY = 66.00 FT/SEC LOAD = 6770.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.31
0.10	0.60
0.20	0.77
0.30	0.77
1.00	0.53

VELOCITY = 66.00 FT/SEC LOAD = 10210.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.25
0.10	0.53
0.20	0.70
0.30	0.71
1.00	0.49

ROLL-OFF TABLE

ALPHA	SLIP 0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	1.00	1.00	1.00
4.00	1.00	1.00	1.00	1.00	1.00

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        16.00         0.40         0.40         0.45         0.05         0.95

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***WARNING*** OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN UNIT 7 WHICH IS ATTACHED TO
              RUN.29. THE WRITE IS SEQUENTIAL AT LINE 1. FOR THIS AND ALL FUTURE OCCURRENCES OF THIS CONDITION, A FIELD OF *'S
              WILL BE WRITTEN.

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CANADIAN ARTIC BUS, EMPTY, B-I-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

A.3 Empty Vehicle with "New Load Data"

SIMULATION OPERATION PARAMETERS:

VEHICLE CONFIGURATION (NUMBER OF TRAILERS - ENTER 0 FOR A STRAIGHT TRUCK) 1
INITIAL VELOCITY (FT/SEC) 45.60
STEER TABLE (NUMBER OF LINES): POSITIVE -STEER ANGLE TABLE, NEGATIVE - PATH FOLLOWER TABLE 3
TABLE ENTRIES:

TIME (SEC)	LEFT WHEEL (DEG)	RIGHT WHEEL (DEG)
0.0	0.0	0.0
1.50	120.00	120.00
10.00	120.00	120.00

TREADLE PRESSURE TABLE (NUMBER OF LINES) 4
TABLE ENTRIES:

TIME (SEC)	PRESSURE (PSI)
0.0	0.0
3.00	0.0
3.25	22.00
12.00	22.00

MAXIMUM SIMULATION TIME (SEC) 7.50
TIME INCREMENT OF OUTPUT (SEC) 0.10

ROAD KEY = 0 : FLAT ROAD.

OUTPUT PAGE OPTION KEYS: 0 DELETES PAGES

SPRUNG MASS POSITION	SPRUNG MASS VELOCITY	SPRUNG MASS ACCELERATION	TIRE FORCES PAGES	BRAKE SUMMARY PAGES	LATERAL PAGES	UNSPRUNG MASS PAGES	TEMP PAGES
1	1	1	1	1	1	1	1

CANADIAN ARTIC BUS, EMPTY, B-1-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

TRACTOR PARAMETERS

WHEELBASE - DISTANCE FROM FRONT AXLE TO CENTER OF REAR SUSPENSION (IN)	235.00
BASE VEHICLE CURB WEIGHT ON FRONT SUSPENSION (LB)	7008.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	8047.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	39.40
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00
PAYLOAD WEIGHT (LB)	0.0
*** ZERO ENTRY INDICATES NO PAYLOAD ***	
*** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***	
FIFTH WHEEL LOCATION (IN. AHEAD OF REAR SUSP. CENTER)	-78.30
FIFTH WHEEL HEIGHT ABOVE GROUND (IN)	27.50
TRACTOR FRAME STIFFNESS (IN-LB/DEG)	250000.00
TRACTOR FRAME TORSIONAL AXIS HEIGHT ABOVE GROUND (IN)	39.40

TRACTOR FRONT SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	508.00	508.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	26.00	26.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	5307.00
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	17.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.06
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	0.0
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	40.25
TRACK WIDTH (IN)	85.60
UNSPRUNG WEIGHT (LB)	802.00
STEERING GEAR RATIO (DEG STEERING WHEEL/DEG ROAD WHEEL)	38.40
STEERING STIFFNESS (IN-LB/DEG)	7500.00
TIE ROD STIFFNESS (IN-LB/DEG)	15000.00
MECHANICAL TRAIL (IN)	0.70
TORSIONAL WRAP-UP STIFFNESS (IN-LB/IN)	1000000.00
LATERAL OFFSET OF STEERING AXIS (IN)	3.00

TRACTOR FRONT TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
CORNERING STIFFNESS (LB/DEG/TIRE)	-201.00	-201.00
*** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***		
*** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	20000.00	20000.00
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	720.00	720.00
TIRE SPRING RATE (LB/IN/TIRE)	5300.00	5300.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	[illegible]	[illegible]

CANADIAN ARTIC BUS, EMPTY, B-1-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

TRACTOR REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE		RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM		0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	880.00		880.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00		58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0		0.0
AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)		7000.00	
ROLL CENTER HEIGHT (IN. ABOVE GROUND)		23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)		0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)		75000.00	
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)		37.00	
TRACK WIDTH (IN)		76.40	
UNSPRUNG WEIGHT (LB)		1466.00	

TRACTOR REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE)	-202.00	-202.00

*** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***
*** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***

	LEFT SIDE	RIGHT SIDE
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	20000.00	20000.00
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	648.00	648.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

TRACTOR FRONT BRAKES

	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0200	0.0200
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	-15.0000	-15.0000

*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***

BRAKE HYSTERESIS KEY: 0 ENTRY INDICATES BRAKE HYSTERESIS OPTION NOT IN USE ON VEHICLE TRAIN 0
BRAKE PROPORTIONING KEY: 0 ENTRY INDICATES BRAKE PROPORTIONING OPTION NOT IN USE ON VEHICLE TRAIN 0

TRACTOR REAR BRAKES

	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0500	0.0500
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	-16.0000	-16.0000

*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***

CANADIAN ARTIC BUS, EMPTY, B-1-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

TRAILER NO. 1 PARAMETERS

WHEELBASE - DISTANCE FROM KINGPIN TO CENTER OF REAR SUSPENSION (IN)	203.40
BASE VEHICLE KINGPIN STATIC LOAD (LB)	1045.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	17160.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	43.30
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	300000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	300000.00
PAYLOAD WEIGHT (LB)	0.0

*** ZERO ENTRY INDICATES NO PAYLOAD ***
*** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***

TRAILER NO. 1 REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM	0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	1204.00	1204.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00	58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	7000.00
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	23.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.0
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	75000.00
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	37.00
TRACK WIDTH (IN)	76.40
UNSPRUNG WEIGHT (LB)	2205.00

TRAILER NO. 1 REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE)	-203.00	-203.00

*** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***
*** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***

	LEFT SIDE	RIGHT SIDE
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	20000.00	20000.00
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	1052.00	1052.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.00	20.00
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

CANADIAN ARTIC BUS, EMPTY, B-I-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

TRAILER NO. 1 REAR BRAKES

	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.1400	0.1400
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	-17.0000	-17.0000

*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***

ANTILOCK KEY: 1 INDICATES ANTILOCK WILL BE USED -1

CANADIAN ARTIC BUS, EMPTY, B-1-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

TRAILER NO. 1 PAYLOAD = 0.0 LBS.

	EMPTY	LOADED
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	13.285	13.285
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO GROUND (IN)	43.300	43.300
ROLL MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000
YAW MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000

TRACTOR PAYLOAD = 0.0 LBS

	EMPTY	LOADED
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	114.054	114.054
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO GROUND (IN)	39.400	39.400
ROLL MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000
YAW MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000

THE STATIC LOADS ON THE AXLES ARE:

AXLE NUMBER	LOAD
NS(1,1,1)	6659.816
NS(1,2,1)	9440.184
NS(2,2,1)	17159.996
TOTAL	33259.996

THE TRACTOR TOTAL MASS CENTER IS 125.609 INCHES BEHIND THE FRONT AXLE
THE TOTAL YAW MOMENT OF INERTIA IS 835255.500 IN-LB-SEC**2

THE FIRST TRAILER TOTAL MASS CENTER IS 191.724 INCHES BEHIND THE KINGPIN
THE TOTAL YAW MOMENT OF INERTIA IS 307885.938 IN-LB-SEC**2

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
3	0.0	0.0	-15
	7.00	0.0	
	100.00	100000.00	

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
3	0.0	0.0	-16
	7.00	0.0	
	100.00	200000.00	

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
4	0.0	0.0	-17
	1.00	0.0	
	7.00	20000.00	
	100.00	220000.00	

CANADIAN ARTIC BUS, EMPTY, B-I-T,22 PSI,50-KPH, MU=0.3, OPEN LOOP, RUN #113

SEMI-EMPERICAL TIRE MODEL PARAMETERS

TIRE MODEL NO. -201.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	415.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.30	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.25	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.50	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.70	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	3500.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

TIRE MODEL NO. -202.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	320.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.30	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.25	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.50	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.40	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	2500.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

TIRE MODEL NO. -203.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	463.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.30	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.25	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.50	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.80	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	4000.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

WARNING OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN UNIT 7 WHICH IS ATTACHED TO RUN.113. THE WRITE IS SEQUENTIAL AT LINE 1. FOR THIS AND ALL FUTURE OCCURRENCES OF THIS CONDITION, A FIELD OF ...

A.4 Standard Bus (Single-Unit), Empty

STANDARD-35'-BUS,STEP-STEER-RESPONSE,100-KPH, RUN #112, JAN 14 '81

SIMULATION OPERATION PARAMETERS:

VEHICLE CONFIGURATION (NUMBER OF TRAILERS - ENTER 0 FOR A STRAIGHT TRUCK) 0
INITIAL VELOCITY (FT/SEC) 91.20
STEER TABLE (NUMBER OF LINES): POSITIVE -STEER ANGLE TABLE, NEGATIVE - PATH FOLLOWER TABLE 5
TABLE ENTRIES:

TIME (SEC)	LEFT WHEEL (DEG)	RIGHT WHEEL (DEG)
0.0	0.0	0.0
0.25	40.00	40.00
0.40	40.00	40.00
0.60	40.00	40.00
10.00	40.00	40.00

TREADLE PRESSURE TABLE (NUMBER OF LINES) 1
TABLE ENTRIES:

TIME (SEC)	PRESSURE (PSI)
0.0	0.0

MAXIMUM SIMULATION TIME (SEC) 4.00
TIME INCREMENT OF OUTPUT (SEC) 0.10

ROAD KEY = 0 : FLAT ROAD.

OUTPUT PAGE OPTION KEYS: 0 DELETES PAGES

SPRUNG MASS POSITION	SPRUNG MASS VELOCITY	SPRUNG MASS ACCELERATION	TIRE FORCES PAGES	BRAKE SUMMARY PAGES	LATERAL PAGES	UNSPRUNG MASS PAGES	TEMP PAGES
1	1	1	1	0	1	1	1

STANDARD-35'-BUS,STEP-STEER-RESPONSE,100-KPH, RUN #112, JAN 14 '81

TRUCK PARAMETERS

WHEELBASE - DISTANCE FROM FRONT AXLE TO CENTER OF REAR SUSPENSION (IN)	235.00
BASE VEHICLE CURB WEIGHT ON FRONT SUSPENSION (LB)	5330.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	14095.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	39.40
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	120000.00
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	960000.00
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	960000.00
PAYLOAD WEIGHT (LB)	0.0

*** ZERO ENTRY INDICATES NO PAYLOAD ***
*** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***

TRUCK FRONT SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	508.00	508.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	26.00	26.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	5307.00
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	17.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.06
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	0.0
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	40.25
TRACK WIDTH (IN)	85.60
UNSPRUNG WEIGHT (LB)	802.00
STEERING GEAR RATIO (DEG STEERING WHEEL/DEG ROAD WHEEL)	38.40
STEERING STIFFNESS (IN-LB/DEG)	7500.00
TIE ROD STIFFNESS (IN-LB/DEG)	15000.00
MECHANICAL TRAIL (IN)	0.70
TORSIONAL WRAP-UP STIFFNESS (IN-LB/IN)	1000000.00
LATERAL OFFSET OF STEERING AXIS (IN)	3.00

TRUCK FRONT TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
CORNERING STIFFNESS (LB/DEG/TIRE)	-1.00	-1.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	-2.00	-2.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	-720.00	-720.00
*** NEGATIVE ALIGNING MOMENT ENTRY ***		
*** ALIGNING MOMENT CURVE FIT PARAMETERS: (0.0 0.0 8.6000 0.0)	(0.0 0.0	8.6000 0.0)
TIRE SPRING RATE (LB/IN/TIRE)	5300.00	5300.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	150.00	150.00

STANDARD-35'-BUS,STEP-STEER-RESPONSE,100-KPH, RUN #112, JAN 14 '81

TRUCK REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE		RIGHT SIDE
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM		0	
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	880.00		880.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00		58.00
COULOMB FRICTION (LB/SIDE/AXLE)	0.0		0.0
AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)		7000.00	
ROLL CENTER HEIGHT (IN. ABOVE GROUND)		23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)		0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)		75000.00	
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)		37.00	
TRACK WIDTH (IN)		76.40	
UNSPRUNG WEIGHT (LB)		1466.00	

TRUCK REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
DUAL TIRE SEPARATION (IN)	13.22	13.22
CORNERING STIFFNESS (LB/DEG/TIRE)	-1.00	-1.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	-2.00	-2.00
*** NEGATIVE ENTRY INDICATES TABLE ENTERED ***		
*** ECHO WILL APPEAR ON TABLE INDEX PAGE ***		
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0
ALIGNING MOMENT (IN-LB/DEG/TIRE)	648.00	648.00
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00
TIRE LOADED RADIUS (IN)	20.47	20.47
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00

TRUCK FRONT BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0200	0.0200
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	700.0000	700.0000
BRAKE HYSTERESIS KEY: 0 ENTRY INDICATES BRAKE HYSTERESIS OPTION NOT IN USE ON VEHICLE TRAIN		0
BRAKE PROPORTIONING KEY: 0 ENTRY INDICATES BRAKE PROPORTIONING OPTION NOT IN USE ON VEHICLE TRAIN		0

TRUCK REAR BRAKES	LEFT SIDE	RIGHT SIDE
TIME LAG (SEC)	0.0500	0.0500
RISE TIME (SEC)	0.2500	0.2500
BRAKE TORQUE (IN-LB/PSI/BRAKE)	1100.0000	1100.0000
ANTILOCK KEY: 1 INDICATES ANTILOCK WILL BE USED		-1

STANDARD-35'-BUS,STEP-STEER-RESPONSE,100-KPH, RUN #112, JAN 14 '81

TRUCK PAYLOAD = 0.0 LBS

	EMPTY	LOADED
DISTANCE FROM TRUCK SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	62.020	62.020
DISTANCE FROM TRUCK SPRUNG MASS CENTER TO GROUND (IN)	39.400	39.400
ROLL MOMENT OF INERTIA OF TRUCK SPRUNG MASS (IN-LB-SEC**2)	120000.000	120000.000
PITCH MOMENT OF INERTIA OF TRUCK SPRUNG MASS (IN-LB-SEC**2)	960000.000	960000.000
YAW MOMENT OF INERTIA OF TRUCK SPRUNG MASS (IN-LB-SEC**2)	960000.000	960000.000

THE STATIC LOADS ON THE AXLES ARE:

AXLE NUMBER	LOAD
NS(1,1,1)	5330.004
NS(1,2,1)	14094.996
TOTAL	19425.000

THE TRUCK TOTAL MASS CENTER IS 170.519 INCHES BEHIND THE FRONT AXLE
THE TOTAL YAW MOMENT OF INERTIA IS 1048779.000 IN-LB-SEC**2

MU-Y VS ALPHA TABLES

NO. OF LOADS	NO. OF VELOCITIES	TABLE NO.
3	1	-1

VELOCITY = 73.30 FT/SEC LOAD = 4000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.12
2.00	0.21
4.00	0.38
8.00	0.60
12.00	0.70
16.00	0.74

VELOCITY = 73.30 FT/SEC LOAD = 6000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.10
2.00	0.19
4.00	0.33
8.00	0.53
12.00	0.64
16.00	0.68

VELOCITY = 73.30 FT/SEC LOAD = 8000.00 LB

ALPHA (DEG)	MU - Y
0.0	0.0
1.00	0.08
2.00	0.16
4.00	0.29
8.00	0.47
12.00	0.58
16.00	0.63

ROLL-OFF TABLE

	SLIP				
ALPHA	0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	0.90	0.30	0.10

12.00	1.00	1.00	0.90	0.42	0.17
16.00	1.00	1.00	0.90	0.48	0.22

MU-X VS. SLIP TABLES

NO. OF LOADS	NO. OF VELOCITIES	TABLE NO.
3	1	-2

VELOCITY = 66.00 FT/SEC LOAD = 3560.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.32
0.10	0.64
0.20	0.81
0.30	0.81
1.00	0.58

VELOCITY = 66.00 FT/SEC LOAD = 6770.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.31
0.10	0.60
0.20	0.77
0.30	0.77
1.00	0.53

VELOCITY = 66.00 FT/SEC LOAD = 10210.00 LB

SLIP	MU - X
0.0	0.0
0.04	0.25
0.10	0.53
0.20	0.70
0.30	0.71
1.00	0.49

ROLL-OFF TABLE

	SLIP				
ALPHA	0.0	0.04	0.10	0.50	1.00
0.0	1.00	1.00	1.00	1.00	1.00
4.00	1.00	1.00	1.00	1.00	1.00
8.00	0.75	0.75	0.75	0.95	1.00

```
[illegible]       0.30         0.50         0.60         0.90         0.95
  16.00           0.40         0.40         0.45         0.85         0.95

####################################################################################################
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***WARNING*** OUTPUT FIELD WIDTH TOO SMALL. CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN UNIT 7 WHICH IS ATTACHED TO
              RUN.112. THE WRITE IS SEQUENTIAL AT LINE 1. FOR THIS AND ALL FUTURE OCCURRENCES OF THIS CONDITION, A FIELD OF *'S
              WILL BE WRITTEN.

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***WARNING*** VARIABLE (OR ARRAY ELEMENT) IN OUTPUT LIST IS UNDEFINED. CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN
              UNIT 8 WHICH IS ATTACHED TO *DUMMY*. THE WRITE IS SEQUENTIAL AT RECORD NUMBER 2. FOR THIS AND ALL FUTURE
              OCCURRENCES OF THIS CONDITION, A FIELD OF U'S WILL BE WRITTEN.

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A.5 Empty Baseline Vehicle with Tire Model

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

SIMULATION OPERATION PARAMETERS:

VEHICLE CONFIGURATION (NUMBER OF TRAILERS - ENTER 0 FOR A STRAIGHT TRUCK)	1
INITIAL VELOCITY (FT/SEC)	91.10
STEER TABLE (NUMBER OF LINES): POSITIVE -STEER ANGLE TABLE, NEGATIVE - PATH FOLLOWER TABLE	3

TABLE ENTRIES:

TIME (SEC)	LEFT WHEEL (DEG)	RIGHT WHEEL (DEG)
0.0	0.0	0.0
1.50	50.00	50.00
12.00	50.00	50.00

TREADLE PRESSURE TABLE (NUMBER CF LINES)	4

TABLE ENTRIES:

TIME (SEC)	PRESSURE (PSI)
0.0	0.0
3.00	0.0
3.25	44.00
12.00	44.00

MAXIMUM SIMULATION TIME (SEC)	7.50
TIME INCREMENT OF OUTPUT (SEC)	0.10

ROAD KEY = 0 : FLAT ROAD.

OUTPUT PAGE OPTION KEYS: 0 DELETES PAGES

SPRUNG MASS POSITION	SPRUNG MASS VELOCITY	SPRUNG MASS ACCELERATION	TIRE FORCES PAGES	BRAKE SUMMARY PAGES	LATERAL PAGES	UNSPRUNG MASS PAGES	TEMP PAGES
1	1	1	1	1	1	1	1

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

TRACTOR PARAMETERS

WHEELBASE - DISTANCE FROM FRONT AXLE TO CENTER OF REAR SUSPENSION (IN)	235.00
BASE VEHICLE CURB WEIGHT ON FRONT SUSPENSION (LB)	6820.00
BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)	8315.00
SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)	39.40
SPRUNG MASS ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	93000.00 *
SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00 *
SPRUNG MASS YAW MOMENT OF INERTIA (IN-LB-SEC**2)	744000.00 *
PAYLOAD WEIGHT (LB)	0.0
*** ZERO ENTRY INDICATES NO PAYLOAD ***	
*** FIVE PAYLOAD DESCRIPTION PARAMETERS ARE NOT ENTERED ***	
FIFTH WHEEL LOCATION (IN. AHEAD OF REAR SUSP. CENTER)	-78.30
FIFTH WHEEL HEIGHT ABOVE GROUND (IN)	27.50
TRACTOR FRAME STIFFNESS (IN-LB/DEG)	250000.00 * +
TRACTOR FRAME TORSIONAL AXIS HEIGHT ABOVE GROUND (IN)	39.40

TRACTOR FRONT SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	508.00	508.00
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	26.00	26.00 * +
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	5307.00 +
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	17.00
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.06 * +
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	0.0
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	40.25
TRACK WIDTH (IN)	85.60
UNSPRUNG WEIGHT (LB)	802.00
STEERING GEAR RATIO (DEG STEERING WHEEL/DEG ROAD WHEEL)	38.40
STEERING STIFFNESS (IN-LB/DEG)	7500.00 *
TIE ROD STIFFNESS (IN-LB/DEG)	15000.00 *
MECHANICAL TRAIL (IN)	0.70 *
TORSIONAL WRAP-UP STIFFNESS (IN-LB/IN)	1000000.00 *
LATERAL OFFSET OF STEERING AXIS (IN)	3.00 *

TRACTOR FRONT TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE
CORNERING STIFFNESS (LB/DEG/TIRE)	-201.00	-201.00
*** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***		
*** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***		
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	20000.00	20000.00
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0 * +
ALIGNING MOMENT (IN-LB/DEG/TIRE)	720.00	720.00
TIRE SPRING RATE (LB/IN/TIRE)	5300.00	5300.00
TIRE LOADED RADIUS (IN)	20.47	20.47

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

TRACTOR REAR SUSPENSION AND AXLE PARAMETERS

	LEFT SIDE	RIGHT SIDE	
SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM	0		
SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)	880.00	880.00	
SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)	58.00	58.00	* +
COULOMB FRICTION (LB/SIDE/AXLE)	0.0	0.0	

AXLE ROLL MOMENT OF INERTIA (IN-LB-SEC**2)	7000.00	+
ROLL CENTER HEIGHT (IN. ABOVE GROUND)	23.00	
ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)	0.0	
AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)	75000.00	*
LATERAL DISTANCE BETWEEN SUSPENSION SPRINGS (IN)	37.00	
TRACK WIDTH (IN)	76.40	
UNSPRUNG WEIGHT (LB)	1466.00	

TRACTOR REAR TIRES AND WHEELS

	LEFT SIDE	RIGHT SIDE	
DUAL TIRE SEPARATION (IN)	13.22	13.22	
CORNERING STIFFNESS (LB/DEG/TIRE)	-202.00	-202.00	

*** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***
*** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***

	LEFT SIDE	RIGHT SIDE	
LONGITUDINAL STIFFNESS (LB/SLIP/TIRE)	20000.00	20000.00	
CAMBER STIFFNESS (LB/DEG/TIRE)	0.0	0.0	*
ALIGNING MOMENT (IN-LB/DEG/TIRE)	648.00	648.00	
TIRE SPRING RATE (LB/IN/TIRE)	5000.00	5000.00	
TIRE LOADED RADIUS (IN)	20.47	20.47	
POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)	300.00	300.00	+

```
TRACTOR FRONT BRAKES                                              LEFT SIDE        RIGHT SIDE
--------------------                                              ---------        ----------

     TIME LAG (SEC)                                                  0.0200           0.0200  * +
     RISE TIME (SEC)                                                 0.2500           0.2500  * +
     BRAKE TORQUE (IN-LB/PSI/BRAKE)                                -15.0000         -15.0000  *
          ***  NEGATIVE ENTRY INDICATES TABLE ENTERED ***
          ***  ECHO WILL APPEAR ON TABLE INDEX PAGE ***
     BRAKE HYSTERESIS KEY: 0 ENTRY INDICATES BRAKE HYSTERESIS OPTION NOT IN USE ON VEHICLE TRAIN     0
     BRAKE PROPORTIONING KEY: 0 ENTRY INDICATES BRAKE PROPORTIONING OPTION NOT IN USE ON VEHICLE TRAIN     0
TRACTOR REAR BRAKES                                               LEFT SIDE        RIGHT SIDE
-------------------                                               ---------        ----------

     TIME LAG (SEC)                                                  0.0500           0.0500  * +
     RISE TIME (SEC)                                                 0.2500           0.2500  * +
     BRAKE TORQUE (IN-LB/PSI/BRAKE)                                -16.0000         -16.0000  *
          ***  NEGATIVE ENTRY INDICATES TABLE ENTERED ***
          ***  ECHO WILL APPEAR ON TABLE INDEX PAGE ***
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CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

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TRAILER NO. 1 PARAMETERS
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     WHEELBASE - DISTANCE FROM KINGPIN TO CENTER OF REAR SUSPENSION (IN)
     BASE VEHICLE KINGPIN STATIC LOAC (IB)                                          203.40
     BASE VEHICLE CURB WEIGHT ON REAR SUSPENSION (LB)                              1938.00
     SPRUNG MASS CG HEIGHT (IN. ABOVE GROUND)                                     16267.00
     SPRUNG MASS ROLL MCMENT OF INERTIA (IN-LB-SEC**2)                               43.30
     SPRUNG MASS PITCH MOMENT OF INERTIA (IN-LB-SEC**2)                           93000.00 *
     SPRUNG MASS YAW MOMENT CF INERTIA (IN-LB-SEC** 2)                           300000.00 *
     PAYLOAD WEIGHT (LB)                                                         300000.00 *
          *** ZERO ENTRY INDICATES NO PAYLOAD ***                                      0.0
          *** FIVE PAYLOAD DESCRIPTICN PARAMETERS ARE NOT ENTERED ***

TRAILER NO. 1 REAR SUSPENSICN  AND AXLE PARAMETERS              LEFT SIDE       RIGHT SIDE
----------------------------------------------                  ---------       ----------

     SUSPENSION KEY - 0 INDICATES SINGLE AXLE, 1 INDICATES FOUR SPRING, 2 WALKING BEAM     0
     SUSPENSION SPRING RATE (LB/IN/SIDE/AXLE)                      1204.00
     SUSPENSION VISCOUS DAMPING (LB-SEC/IN/SIDE/AXLE)                58.00         1204.00
     COULOMB FRICTION (LB/SIDE/AXLE)                                  0.0            58.00 * +
                                                                                      0.0
                                                               -------------------------------
     AXLE ROLL MOMENT OF INERTIA (IN-LE-SEC**2)                            7000.00 +
     ROLL CENTER HEIGHT (IN. ABOVE GRCUND)                                   23.00
     ROLL STEER COEFFICIENT (DEG. STEER/DEG. ROLL)                            0.0
     AUXILIARY ROLL STIFFNESS (IN-LB/DEG/AXLE)                            75000.00 *
     LATERAL DISTANCE DETWEEN SUSPENSION SPRINGS (IN)                        37.00
     TRACK WIDTH (IN)                                                        76.40
     UNSPRUNG WEIGHT (LB)                                                  2205.00

TRAILER NO. 1 REAR TIRES  AND WHEELS                            LEFT SIDE       RIGHT SIDE
-------------------------------                                 ---------       ----------

     DUAL TIRE SEPARATION (IN)                                       13.22
     CORNERING STIFFNESS  (LB/DEG/TIRE)                            -203.00           13.22
          *** CALF LESS THAN -200. INDICATES TIRE MODEL IS BEING USED ***           -203.00
          *** MODEL PARAMETERS WILL BE ECHOED FOLLOWING THE TABLE ECHOES ***

     LONGITUDINAL STIFFNESS  (LB/SLIP/TIRE)
     CAMBER STIFFNESS (LB/DEG/TIRE)                               20000.00        20000.00
     ALIGNING MOMENT  (IN-LB/DEG/TIRE)                                0.0             0.0 *
     TIRE SPRING RATE (LB/IN/TIRE)                                 1052.00         1052.00
     TIRE LOADED RADIUS (IN)                                       5000.00         5000.00
     POLAR MOMENT OF INERTIA (IN-LB-SEC**2/WHEEL)                    20.00           20.00
                                                                    300.00          300.00 +
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CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

```
TRAILER NO. 1 REAR BRAKES                                          LEFT SIDE      RIGHT SIDE
-------------------------                                          ---------      ----------

    TIME LAG (SEC)                                                    0.1400          0.1400  * +
    RISE TIME (SEC)                                                   0.2500          0.2500  * +
    BRAKE TORQUE (IN-LB/PSI/BRAKE)                                  -17.0000        -17.0000  *
         ***  NEGATIVE ENTRY INDICATES TABLE ENTERED ***
         ***  ECHO WILL APPEAR ON TABLE INDEX PAGE ***

    ANTILOCK KEY:  1 INDICATES ANTILOCK WILL BE USED                                  -1
```

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

TRAILER NO. 1 PAYLOAD = 0.0 LBS.

	EMPTY	LOADED
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	24.637	24.637
DISTANCE FROM TRAILER SPRUNG MASS CENTER TO GROUND (IN)	43.300	43.300
ROLL MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000
YAW MOMENT OF INERTIA OF TRAILER SPRUNG MASS (IN-LB-SEC**2)	300000.000	300000.000

TRACTOR PAYLOAD = 0.0 LBS

	EMPTY	LOADED
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO REAR SUSPENSION (IN)	109.911	109.911
DISTANCE FROM TRACTOR SPRUNG MASS CENTER TO GROUND (IN)	39.400	39.400
ROLL MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	93000.000	93000.000
PITCH MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000
YAW MOMENT OF INERTIA OF TRACTOR SPRUNG MASS (IN-LB-SEC**2)	744000.000	744000.000

THE STATIC LOADS ON THE AXLES ARE:

AXLE NUMBER	LOAD
NS(1,1,1)	6174.277
NS(1,2,1)	10898.723
NS(2,2,1)	16266.996
TOTAL	33339.996

THE TRACTOR TOTAL MASS CENTER IS 129.106 INCHES BEHIND THE FRONT AXLE
THE TOTAL YAW MOMENT OF INERTIA IS 834064.500 IN-LB-SEC**2

THE FIRST TRAILER TOTAL MASS CENTER IS 181.747 INCHES BEHIND THE KINGPIN
THE TOTAL YAW MOMENT OF INERTIA IS 310047.250 IN-LB-SEC**2

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
3			-15 *
	0.0	0.0	
	7.00	0.0	
	100.00	100000.00	

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
3			-16 *
	0.0	0.0	
	7.00	0.0	
	100.00	200000.00	

PRESSURE VS TORQUE TABLES

NO. OF LINES	PRESSURE (PSI)	TORQUE (IN-LB)	TABLE NO
4			-17 *
	0.0	0.0	
	1.00	0.0	
	7.00	20000.00	
	100.00	220000.00	

CANADIAN ARTIC BUS EMPTY,100 KPH,BRAKING-IN-A-TURN-,44-PSI,50--DEG,RUN#55,JAN-05

SEMI-EMPERICAL TIRE MODEL PARAMETERS

TIRE MODEL NO. -201.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	415.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.60	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.40	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.30	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.70	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	3500.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

TIRE MODEL NO. -202.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	320.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.60	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.40	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.30	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.40	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	2500.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

TIRE MODEL NO. -203.00

VARIABLE DESCRIPTION	INITIAL VALUE	D(VAR)/DLOAD	D(VAR)/DVELOCITY
NOMINAL CORNERING STIFFNESS (LB/DEG/TIRE	463.00	0.0	0.0
PEAK FRICTION VALUE (PER TIRE)	0.60	0.0	0.0
LOCKED WHEEL FRICTION VALUE (PER TIRE)	0.40	0.0	0.0
SLIP VALUE AT PEAK FRICTION (PER TIRE)	0.30	0.0	0.0
NOMINAL PNEUMATIC TRAIL (IN/TIRE)	1.80	0.0	0.0
LATERAL STIFFNESS (LB/IN/TIRE)	2500.00	0.0	0.0
NOMINAL VERTICAL LOAD (LB/TIRE)	4000.00	N/A	N/A
NOMINAL VELOCITY (FT/SEC/TIRE)	40.00	N/A	N/A

##
##

CONDITION OCCURRED DURING A FORMATTED WRITE ON FORTRAN UNIT 7 WHICH IS ATTACHED TO

APPENDIX B

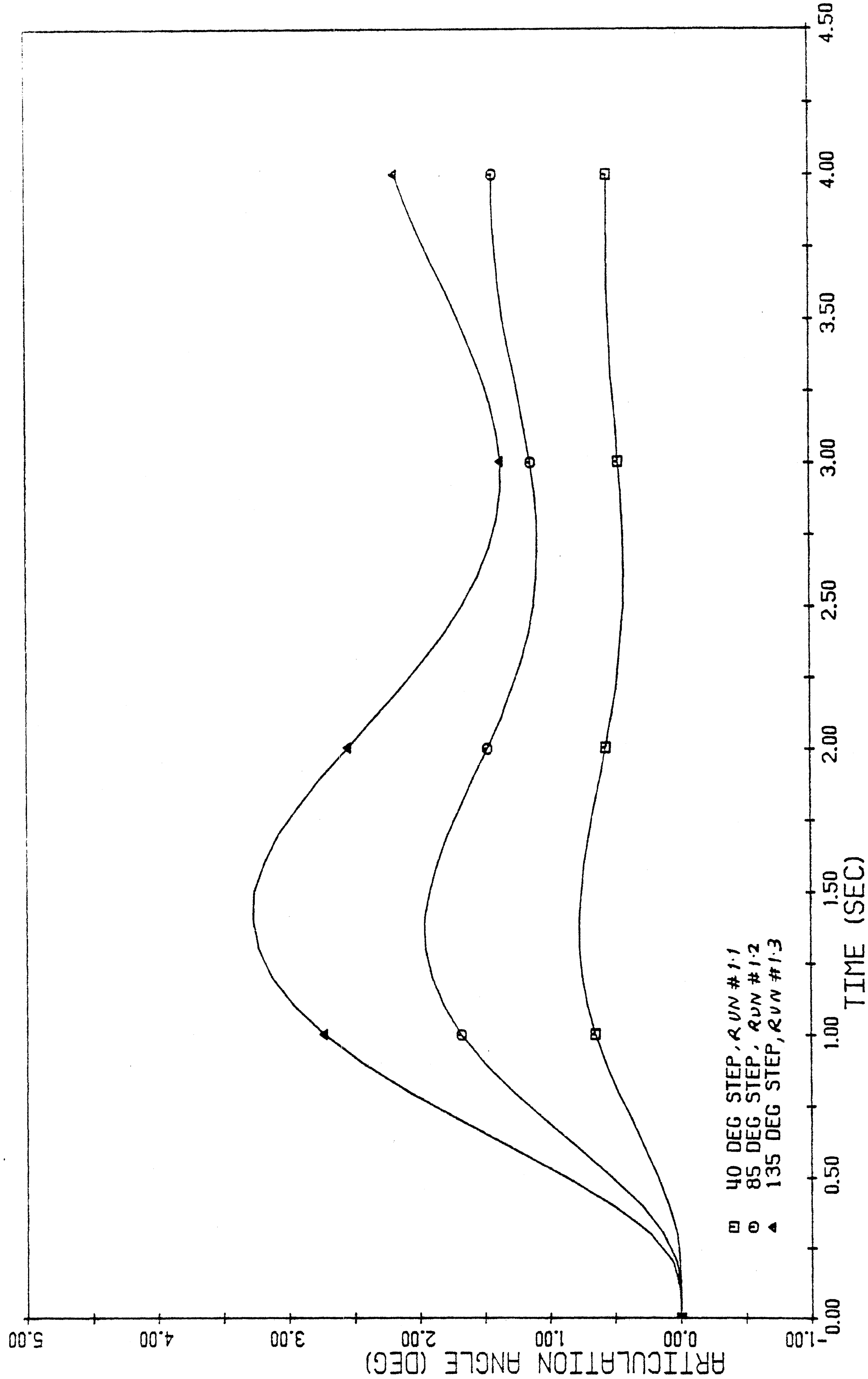
TIME HISTORY PLOTS AND SIMULATION RUN DESCRIPTIONS

This appendix contains time history plots for each of the simulated vehicle maneuvers. Each set of plots, corresponding to a specific maneuver (ramp-step, pulse-steer, etc.), is separated by a table which describes the particular runs which follow. Each simulation run is identified by a Run # and further described with regard to loading condition, speed, maneuvering type, and whether or not the articulation controller and retarder were in use.

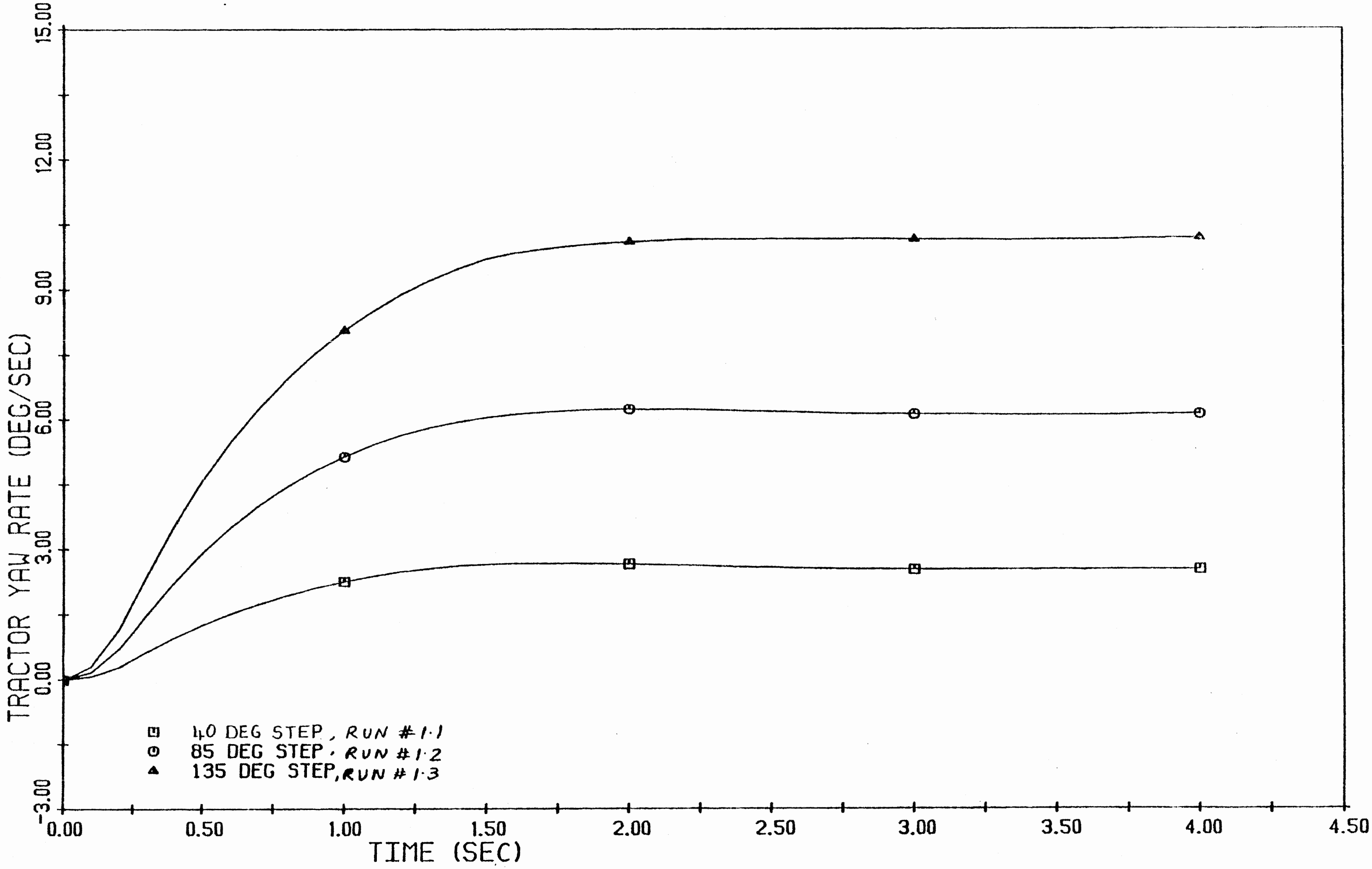
Table 1. Ramp/Step Input

Run #	Calculation #	Loading Condition	Speed (KPH)	Maneuver	Articulation Controller
1.1	11	E	100	40° step	Yes
1.2	12	E	100	85° "	Yes
1.3	13	E	100	135° "	Yes
1.4	30	E	50	120° "	Yes
1.5	36	E	50	220° "	Yes
1.6	8	L	100	85° "	Yes
1.7	9	L	100	175° "	Yes
1.8	10	L	100	270° "	Yes
1.9	29	L	50	215° "	Yes
1.10	35	L	50	300° "	Yes
1.11	7	L	100	85° "	No
1.12*	112	E	100	40° "	N/A

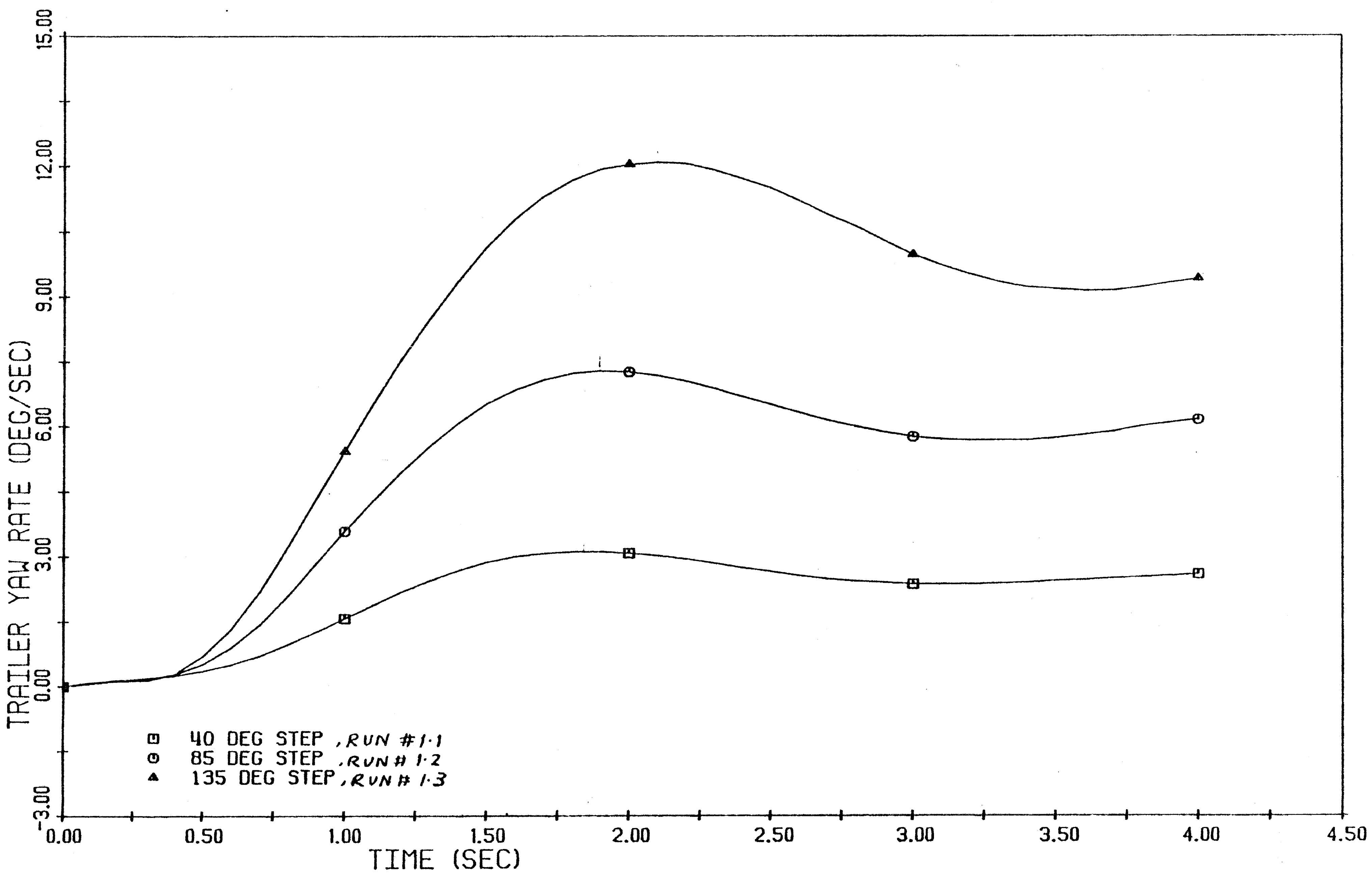
*Standard 35-foot Bus



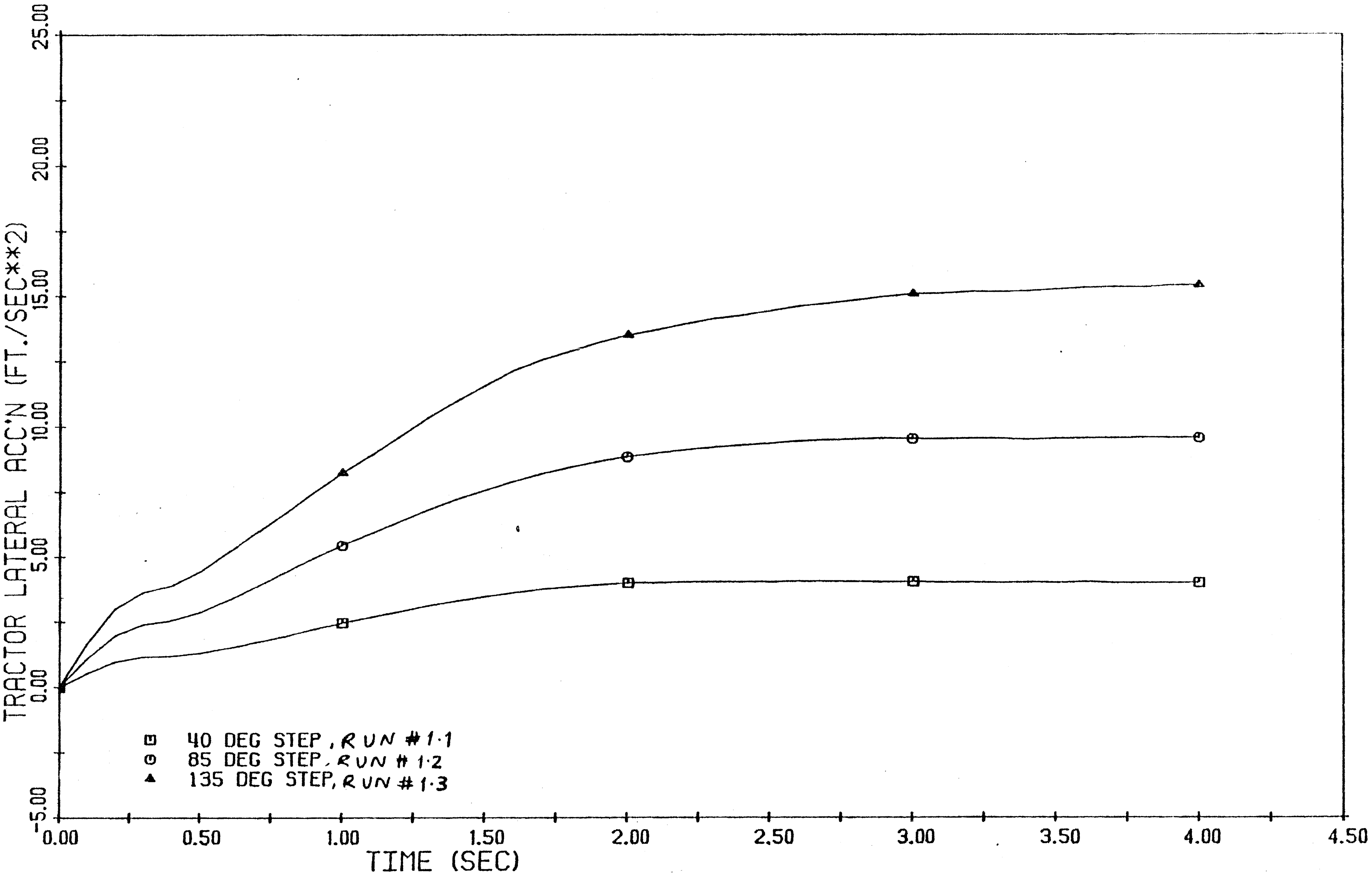
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH.



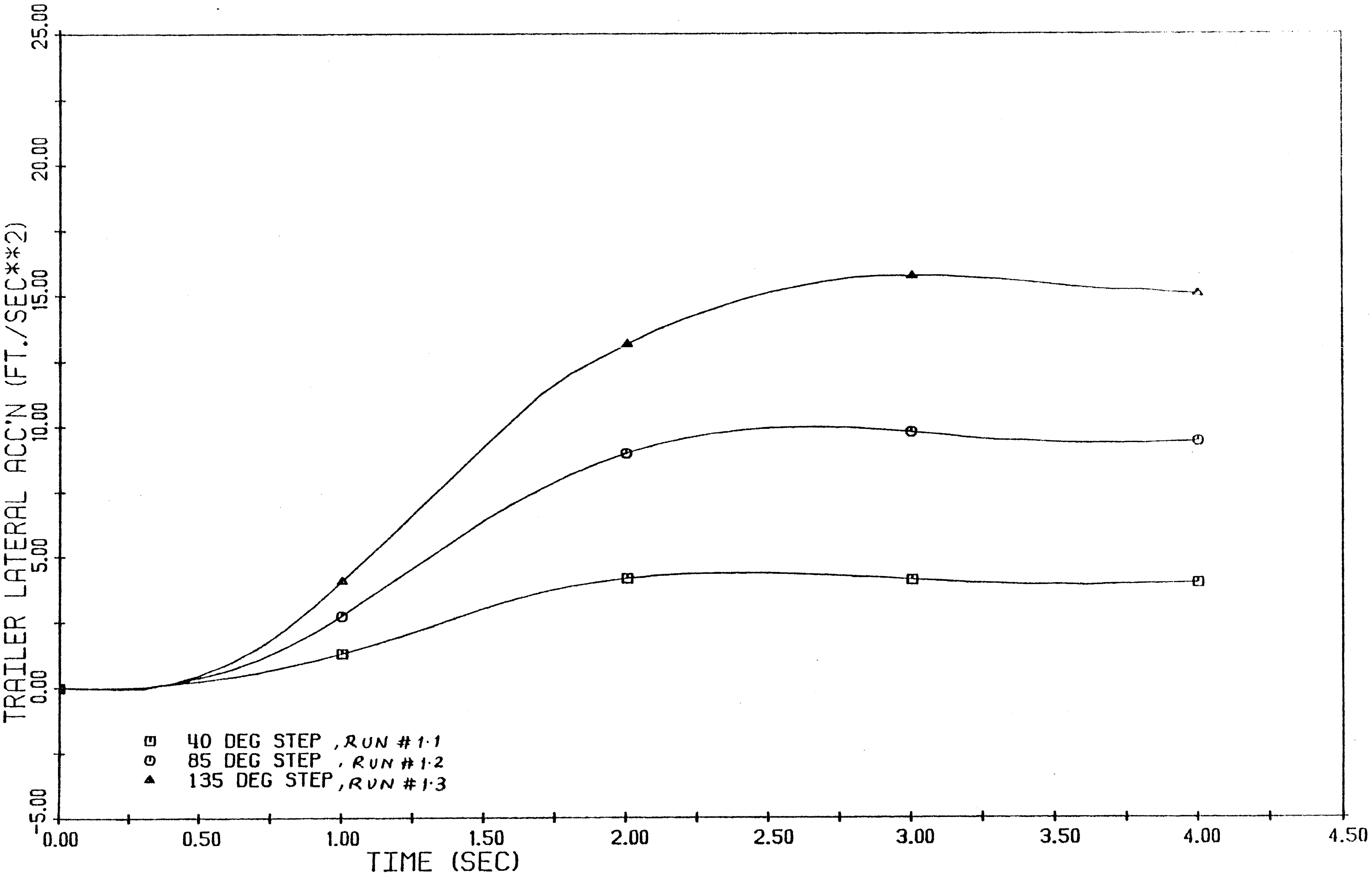
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH,



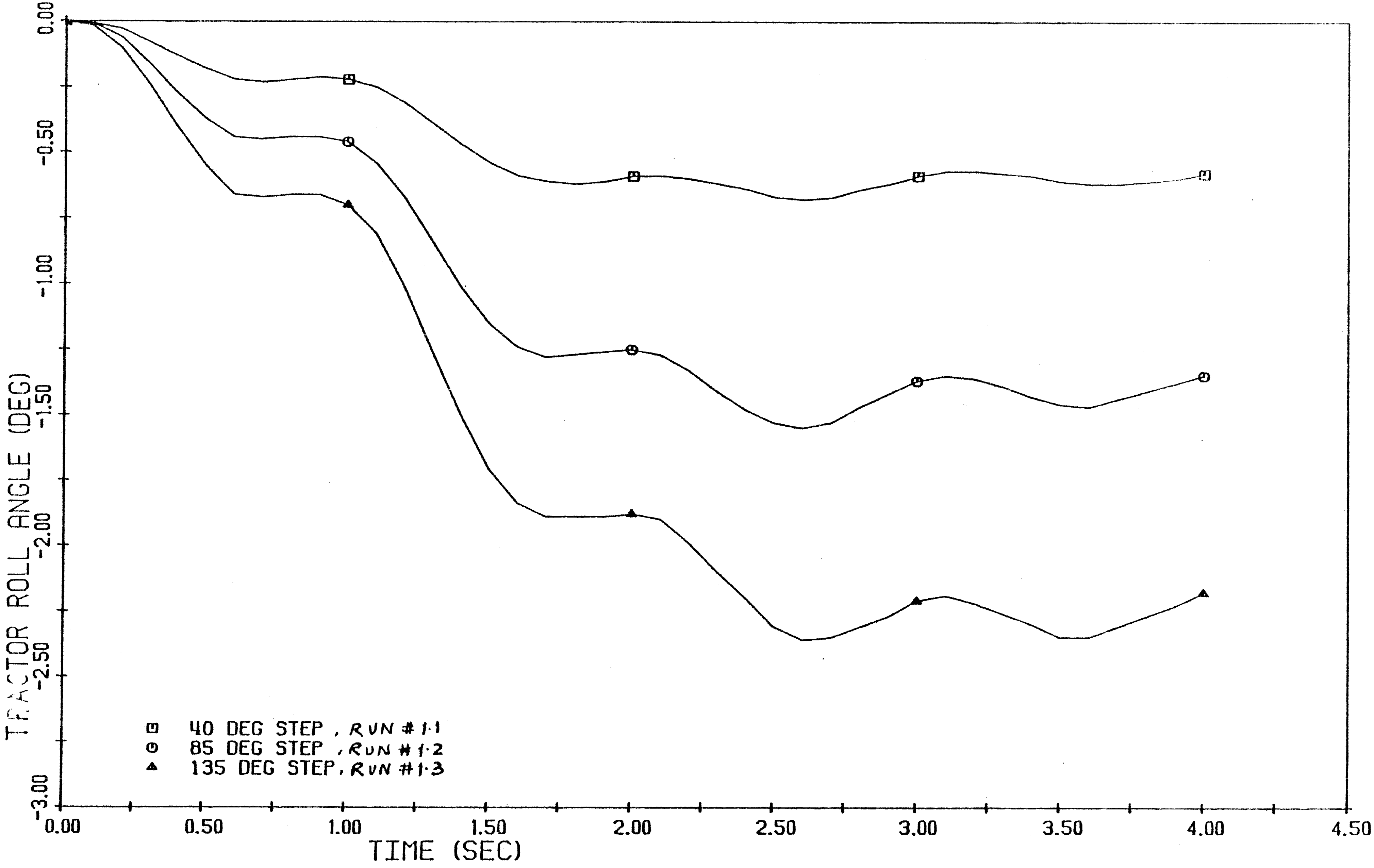
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH.



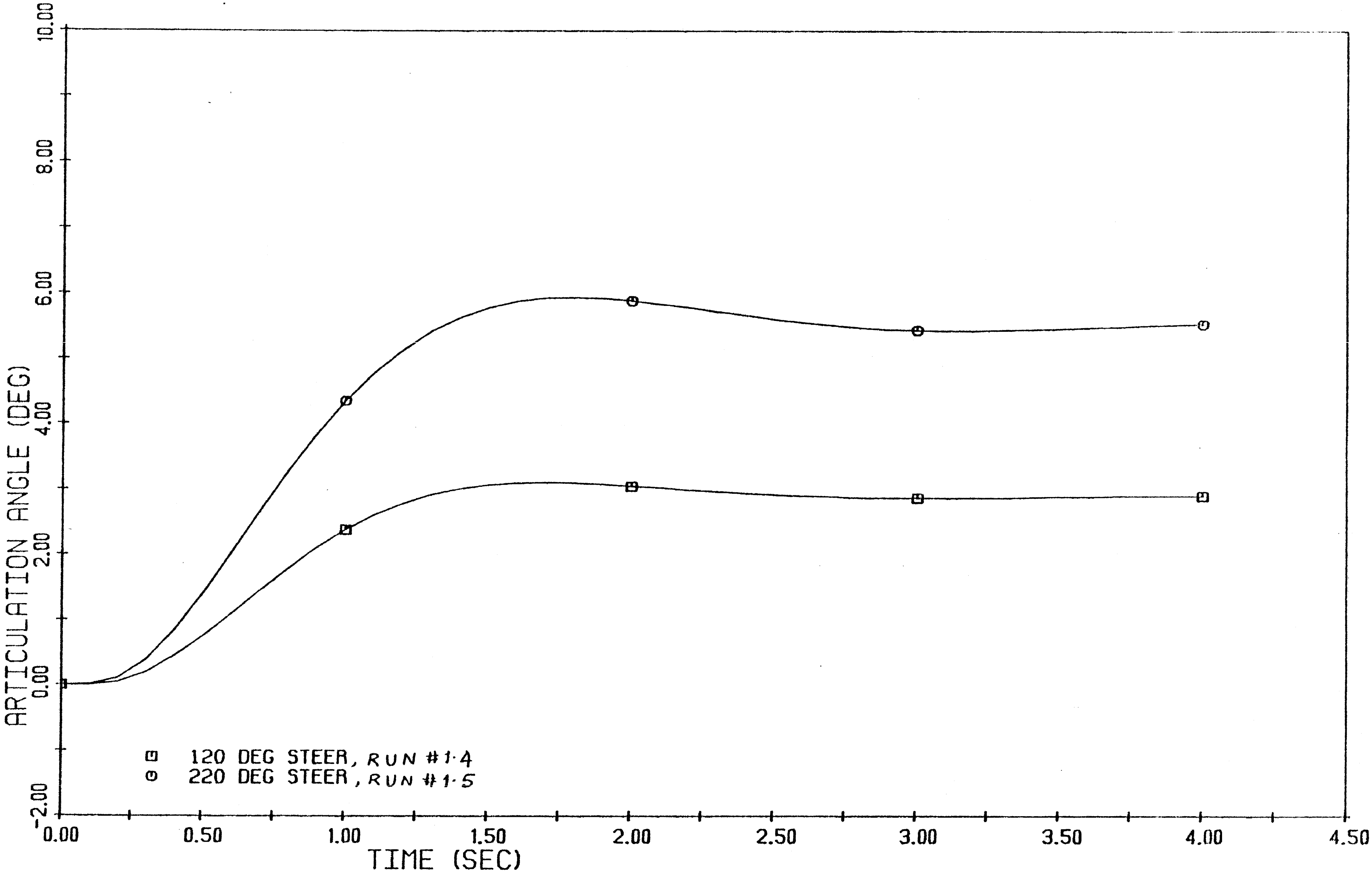
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH,



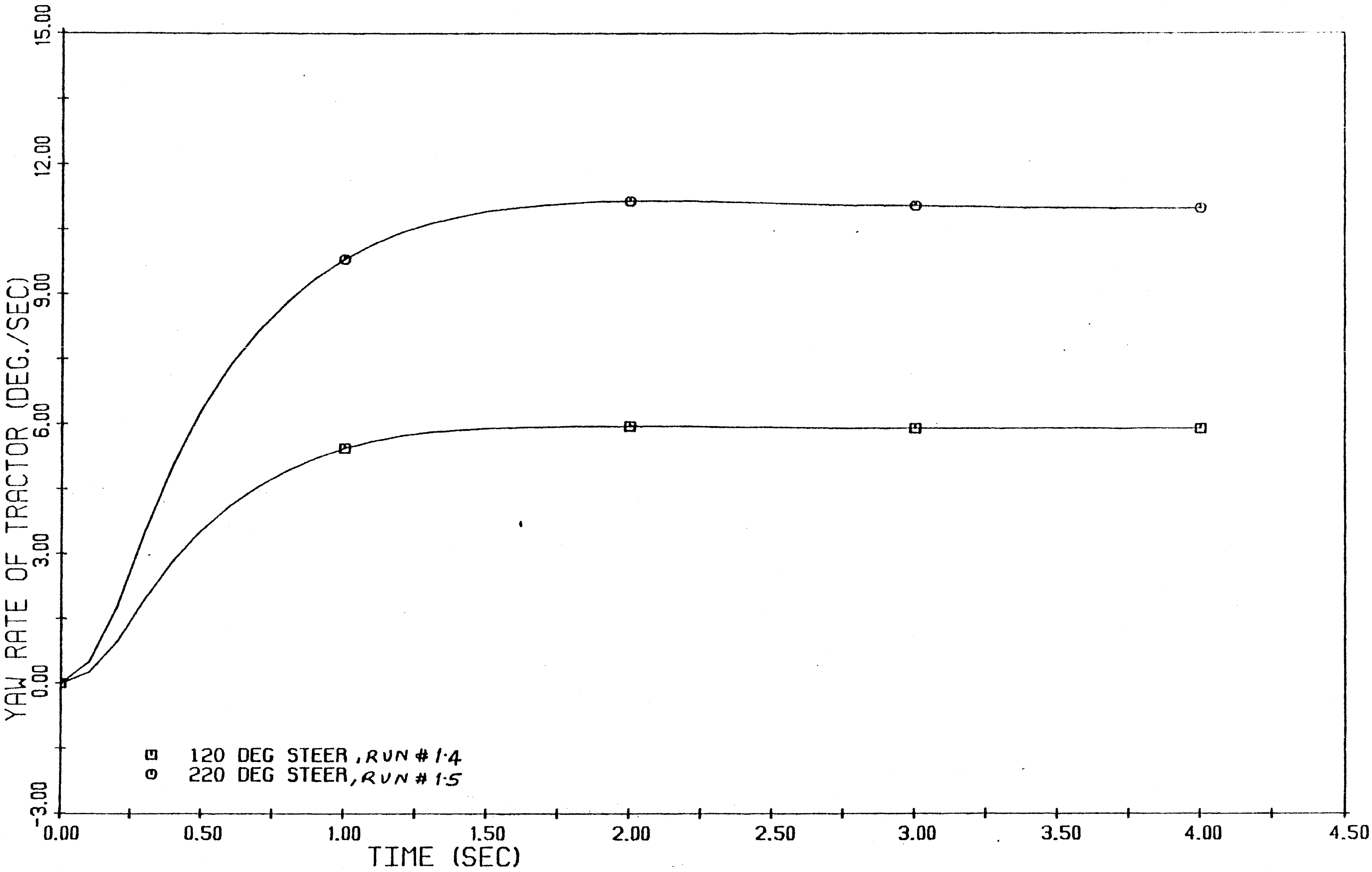
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH,



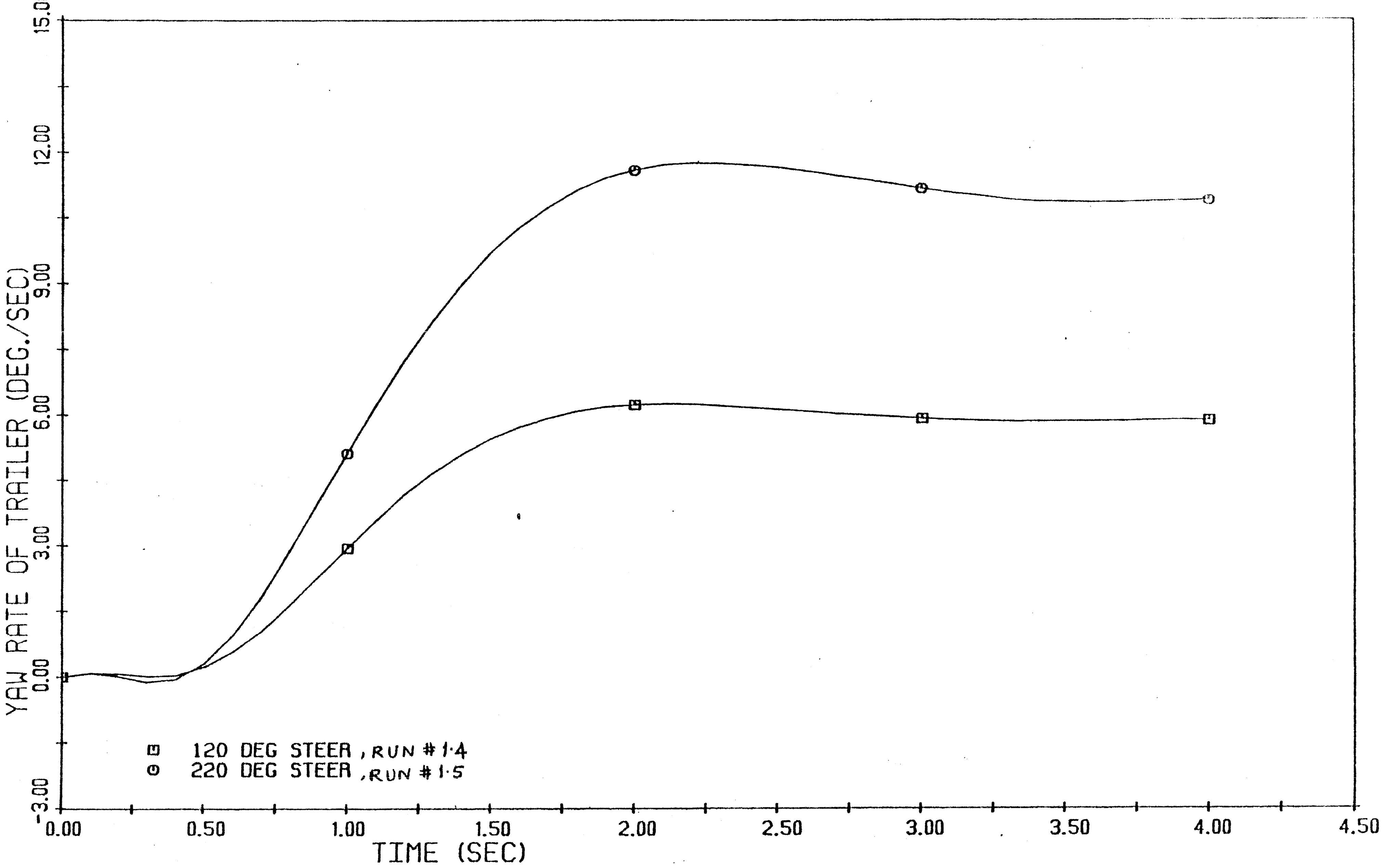
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, EMPTY, 100 KPH.



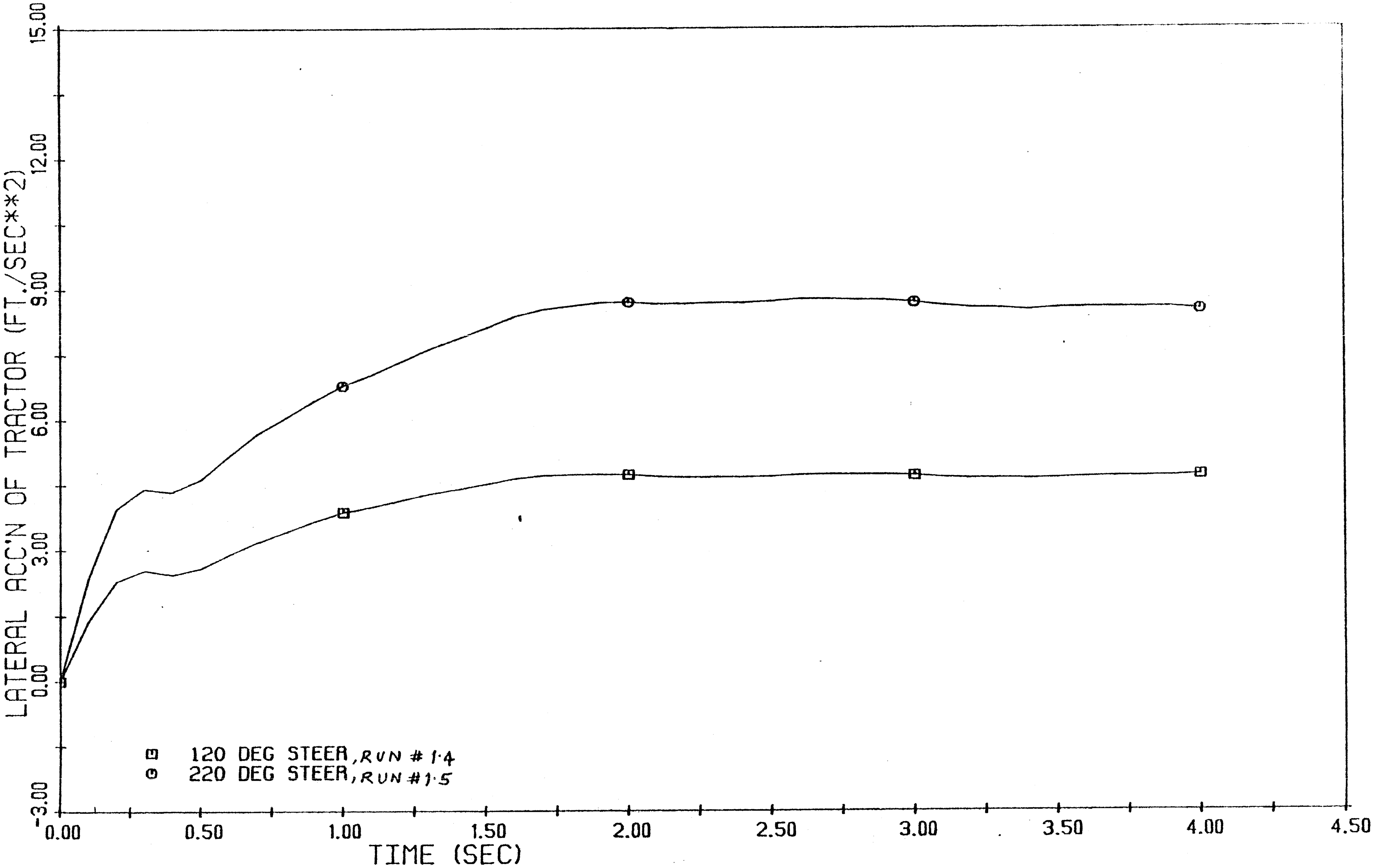
CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS,



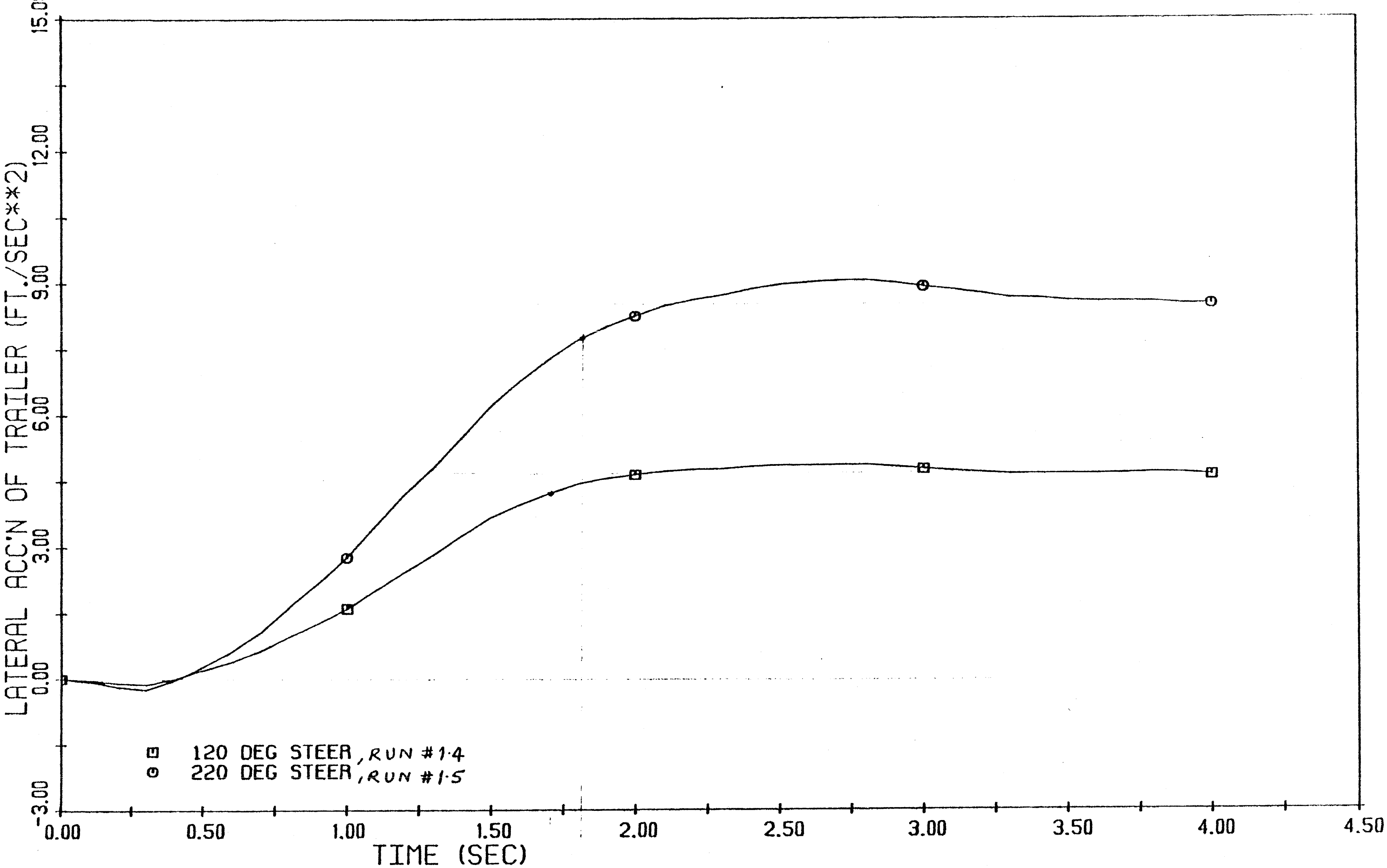
CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS,



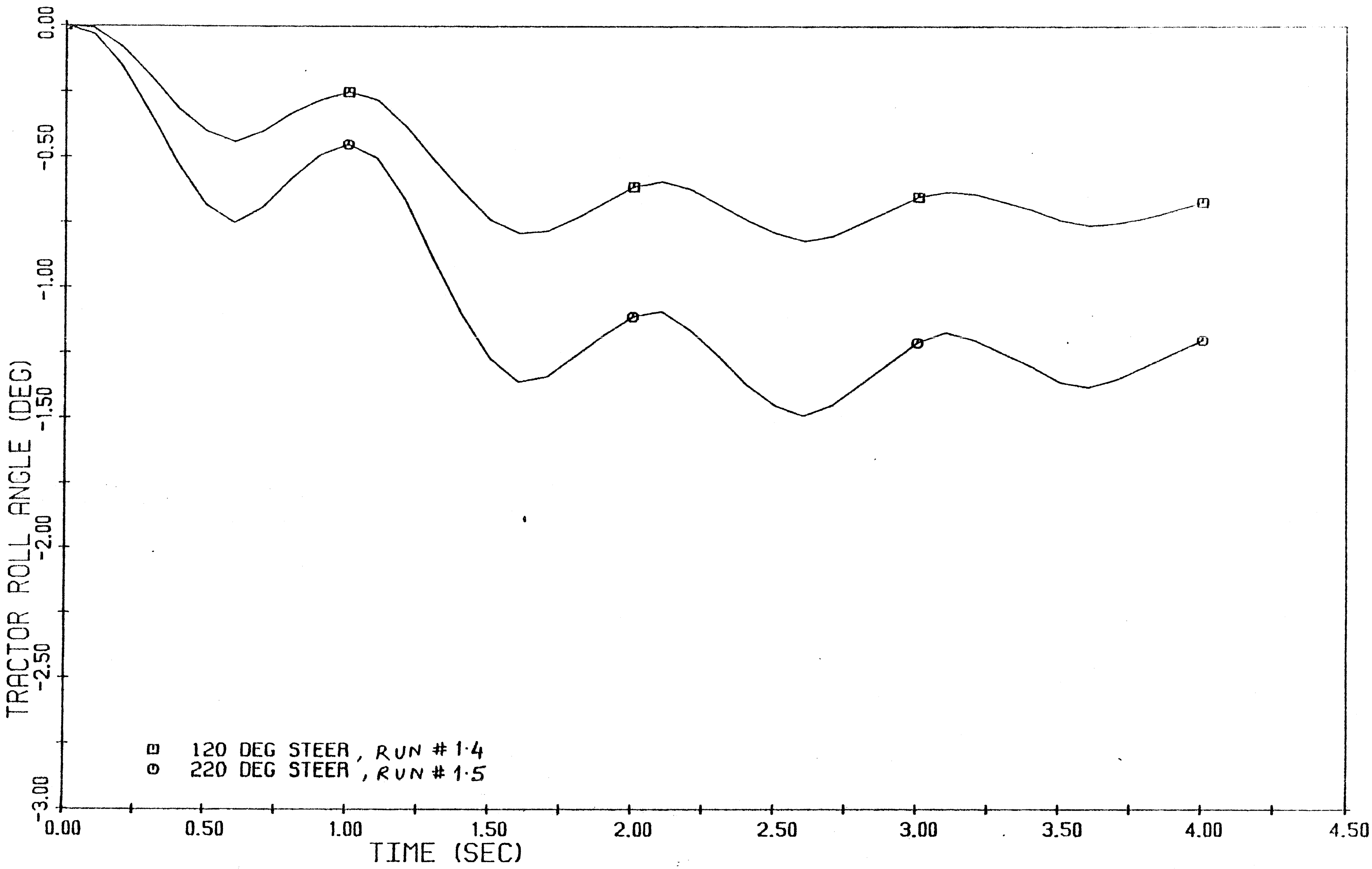
CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS,



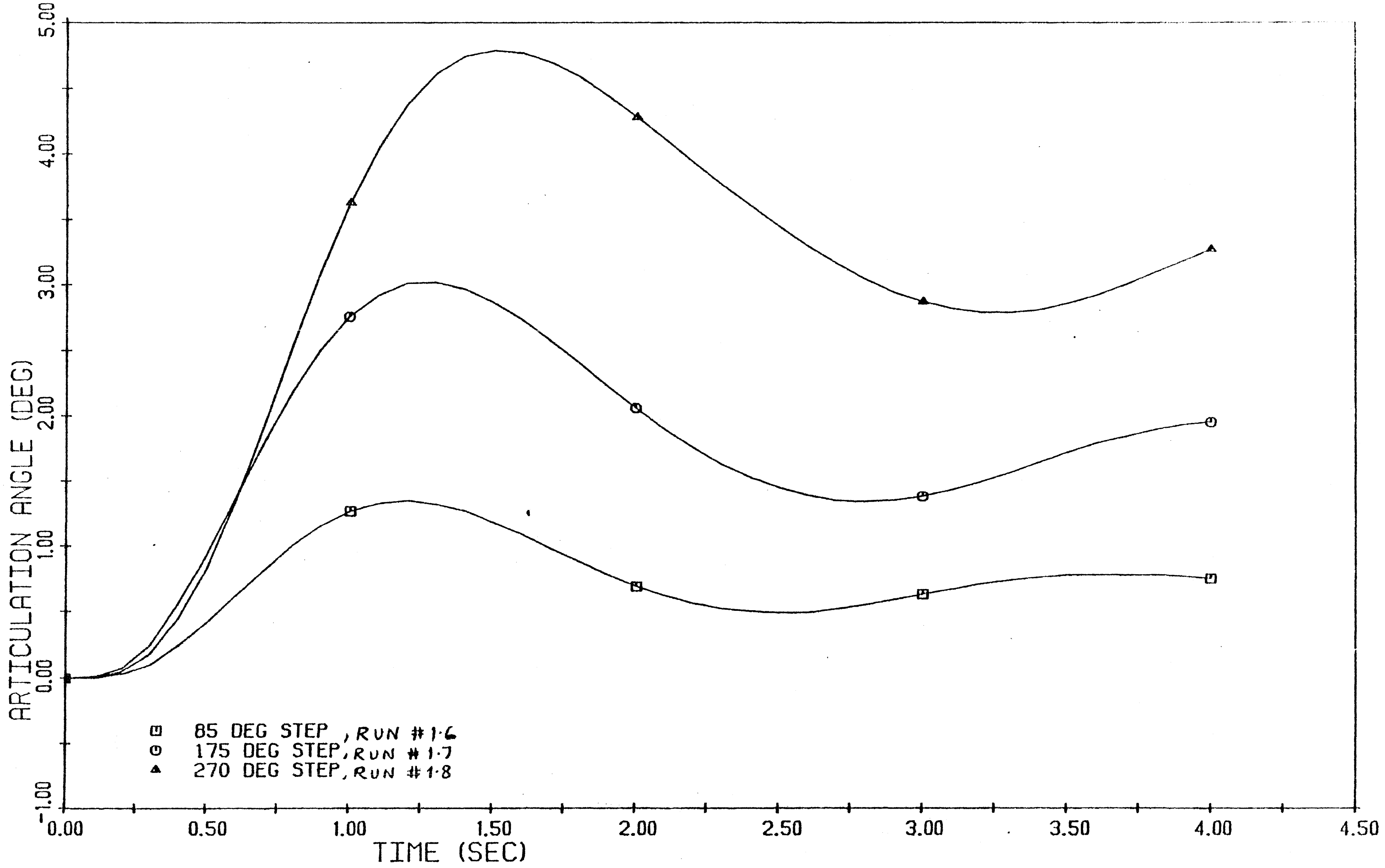
CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS.



CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS,



CANADIAN ARTIC BUS, EMPTY, 50 KPH, STEP STEER MANEUVERS,



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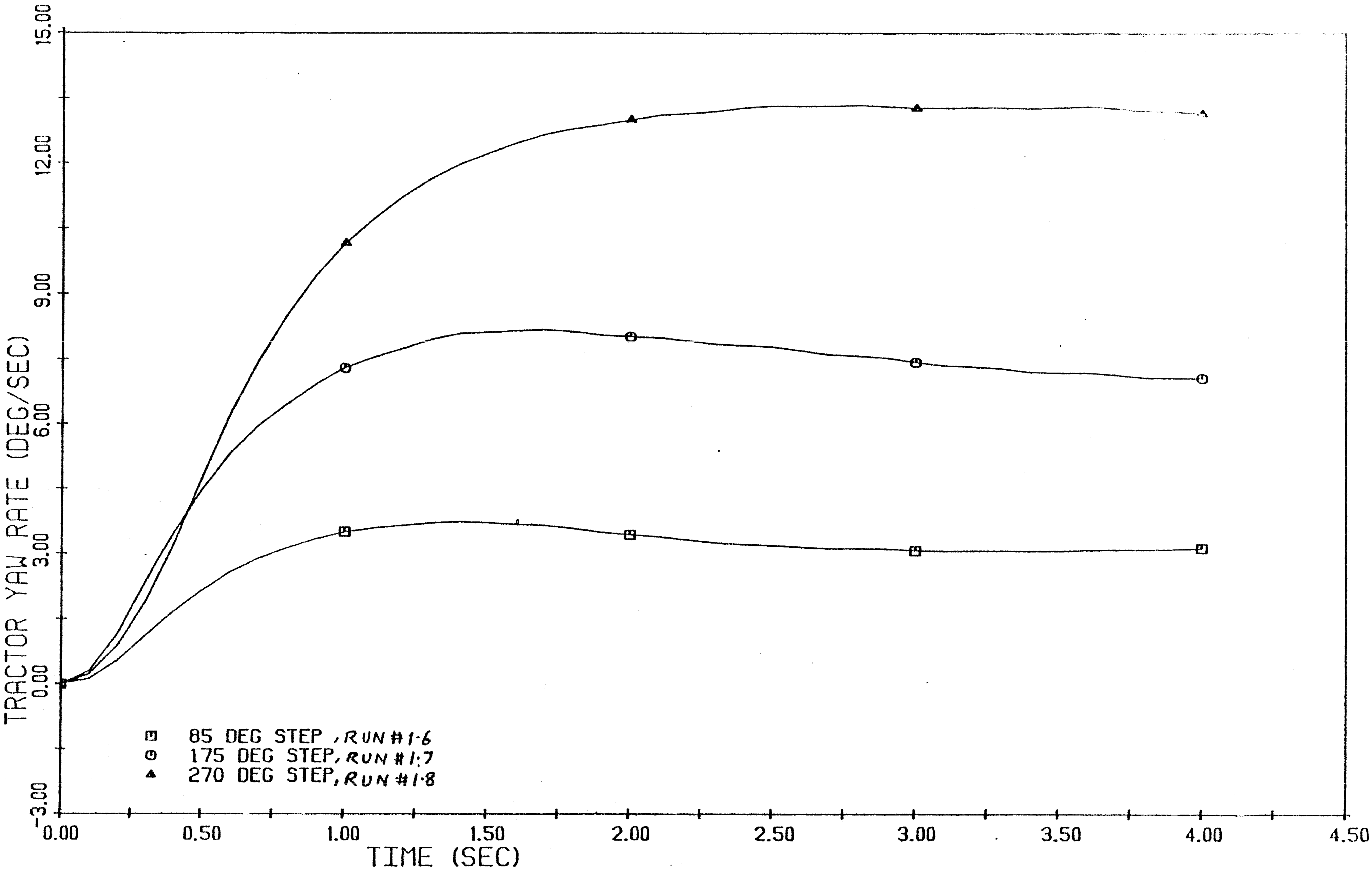
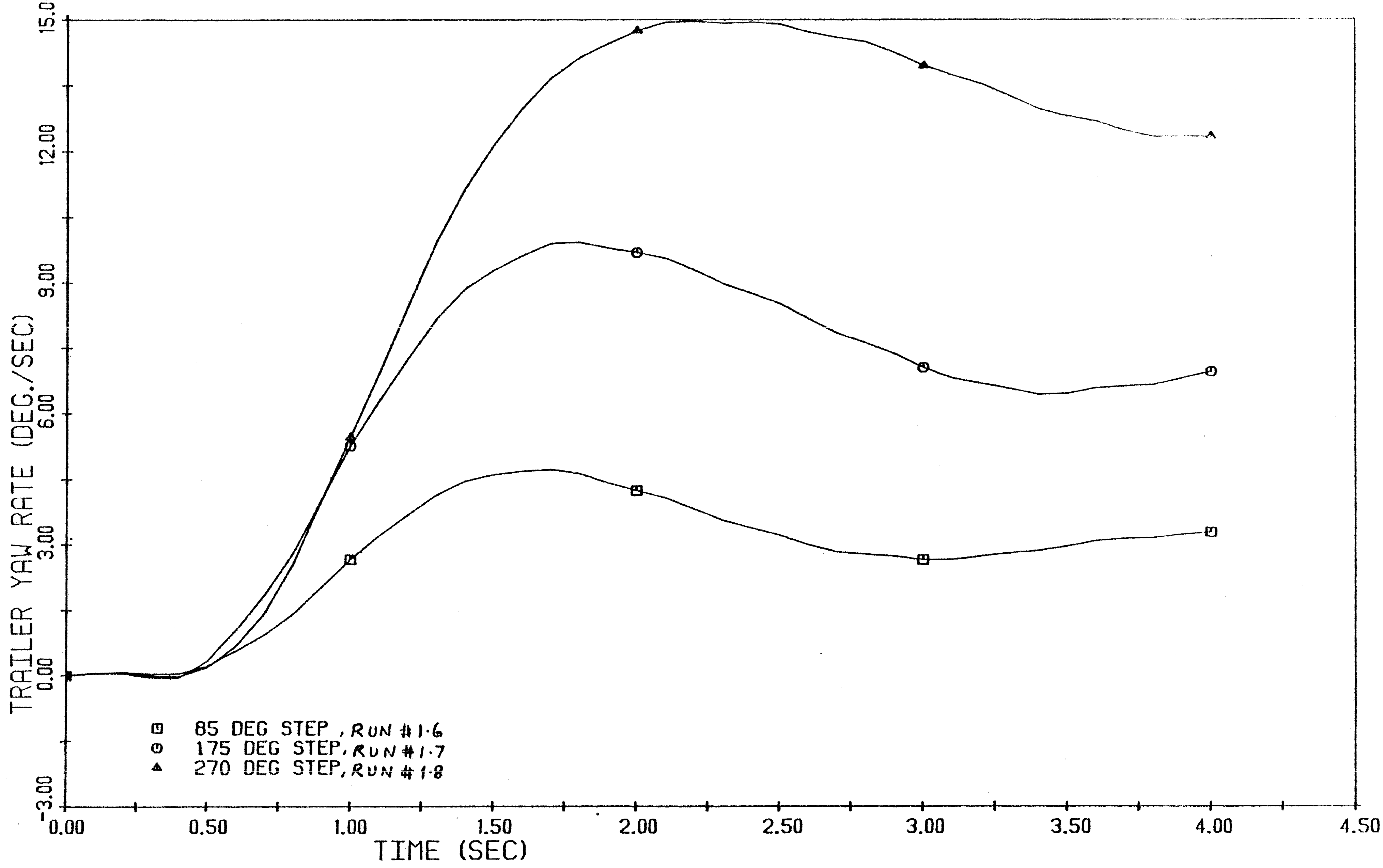
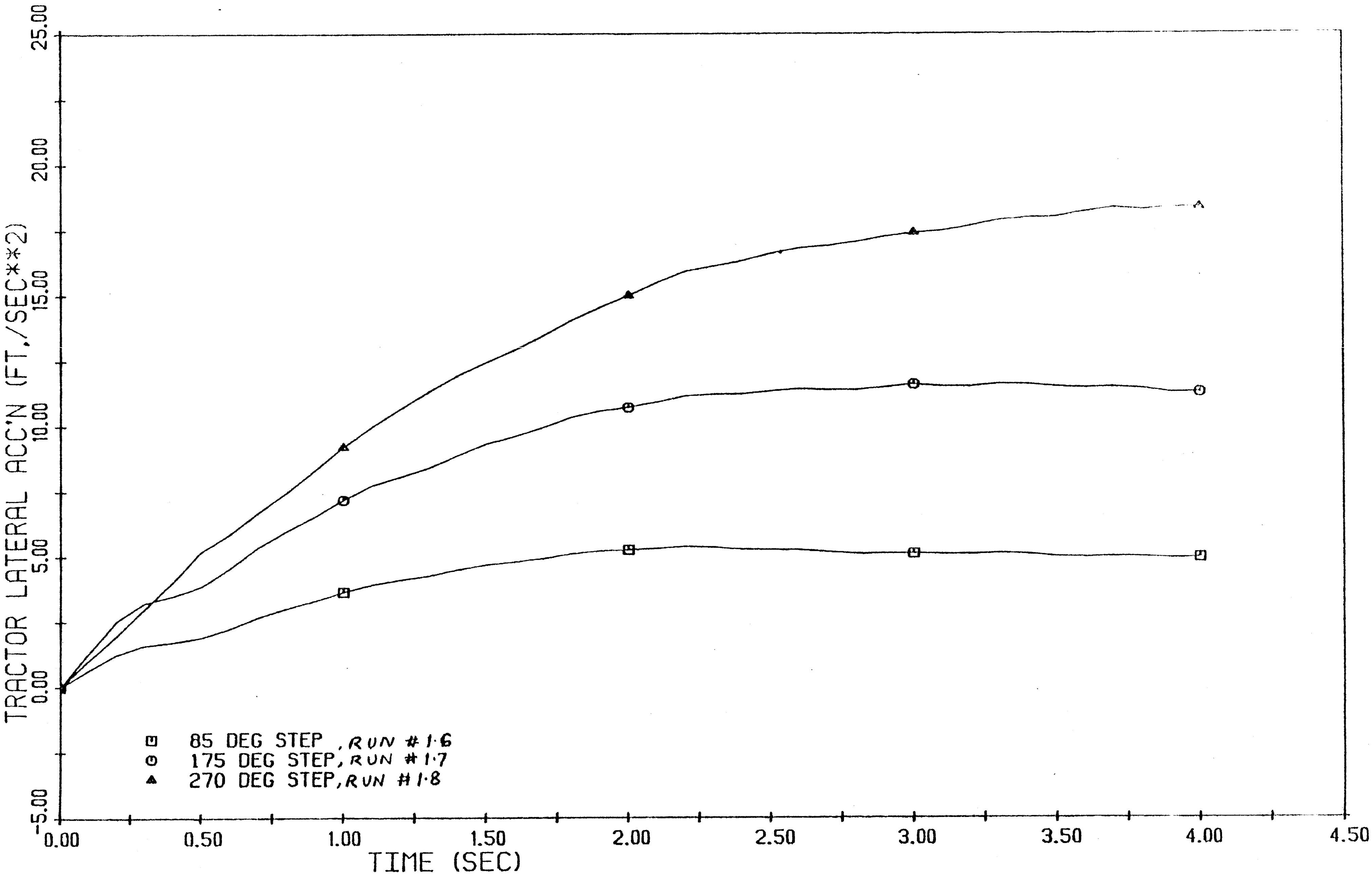
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, LOADED, 100 KPH.



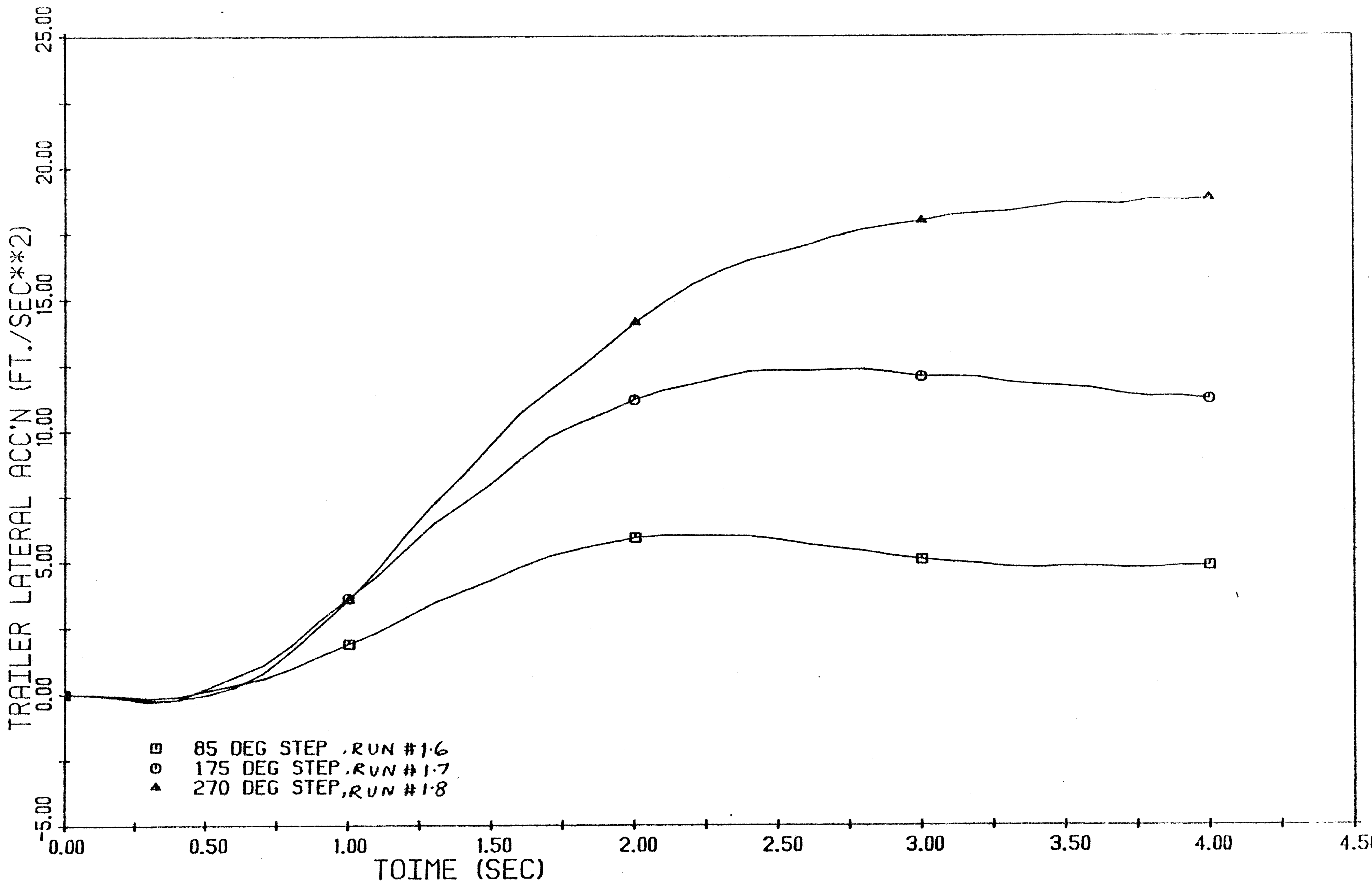
CANADIAN BUS, STEP STEER MANEUVERS, 100 KPH, LOADED.



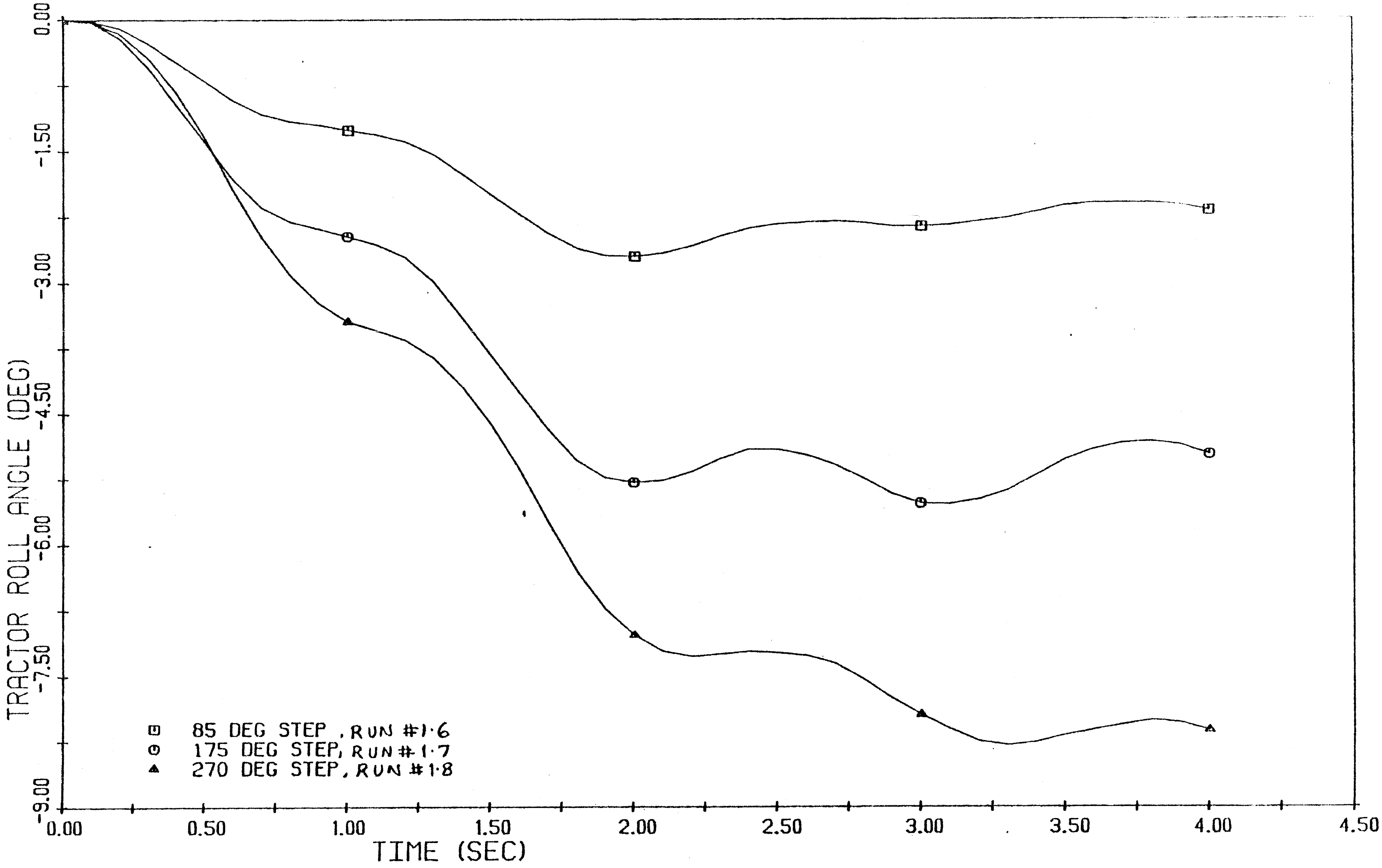
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, LOADED, 100 KPH,



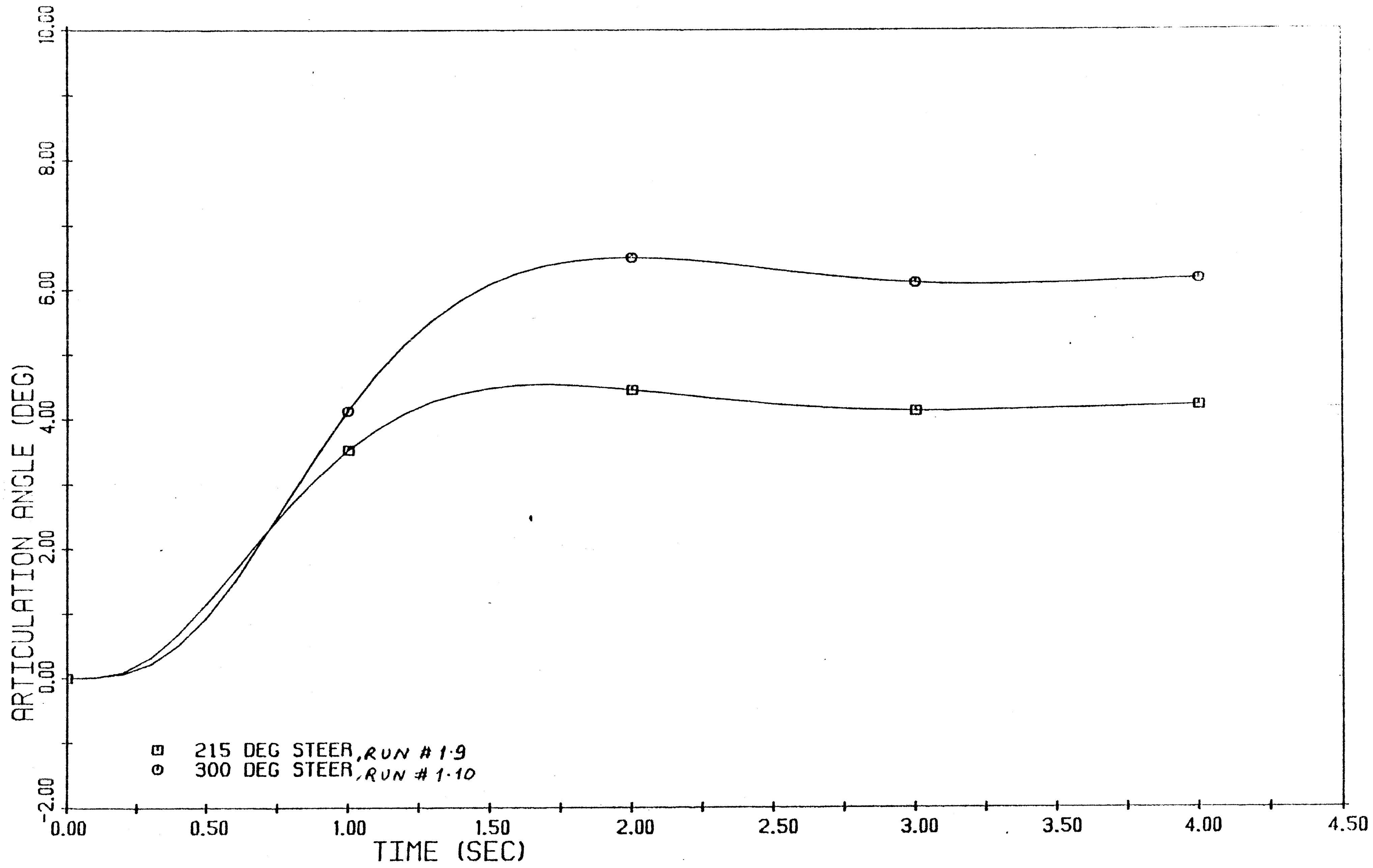
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, LOADED, 100 KPH,



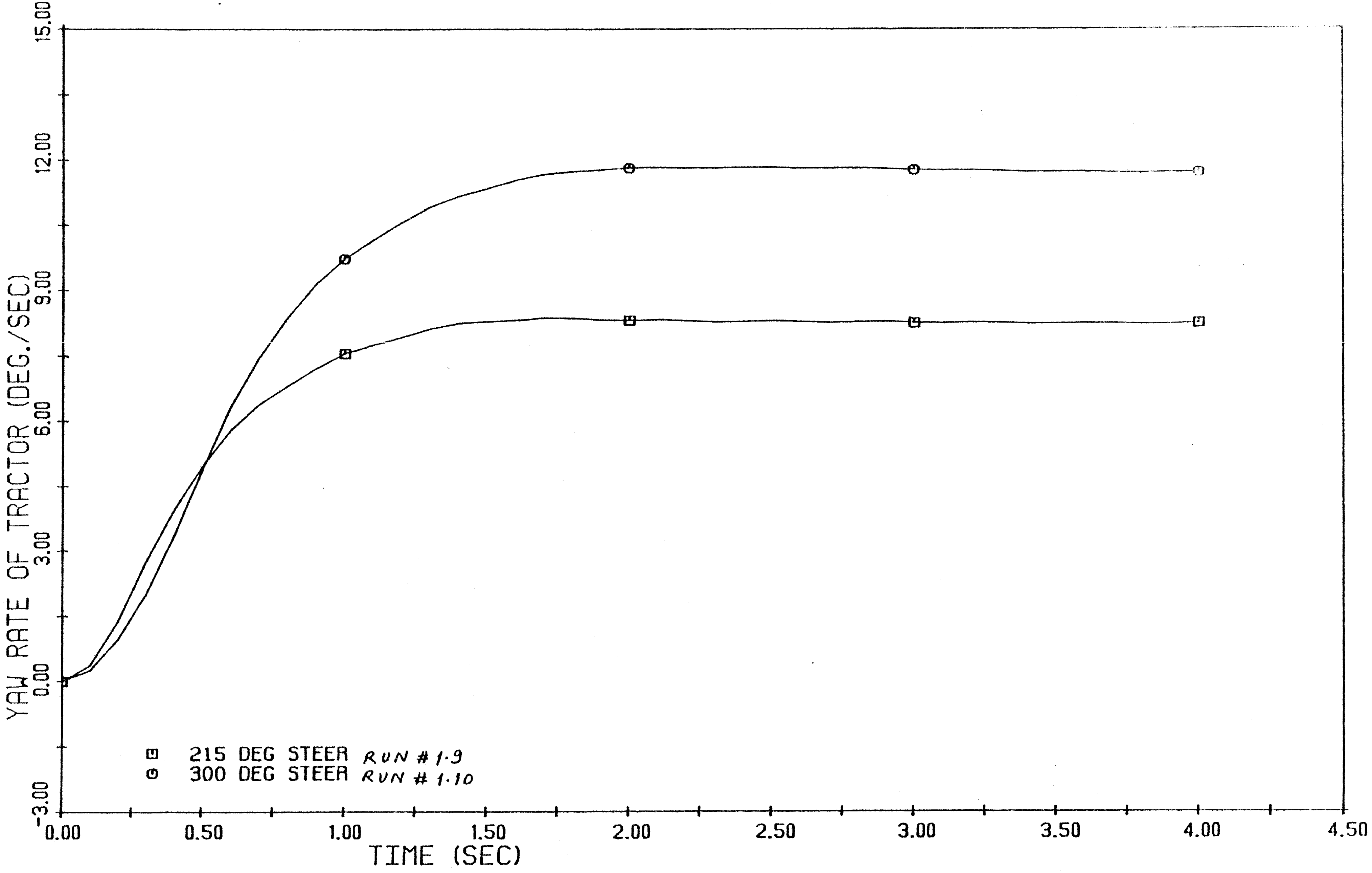
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, LOADED, 100 KPH,



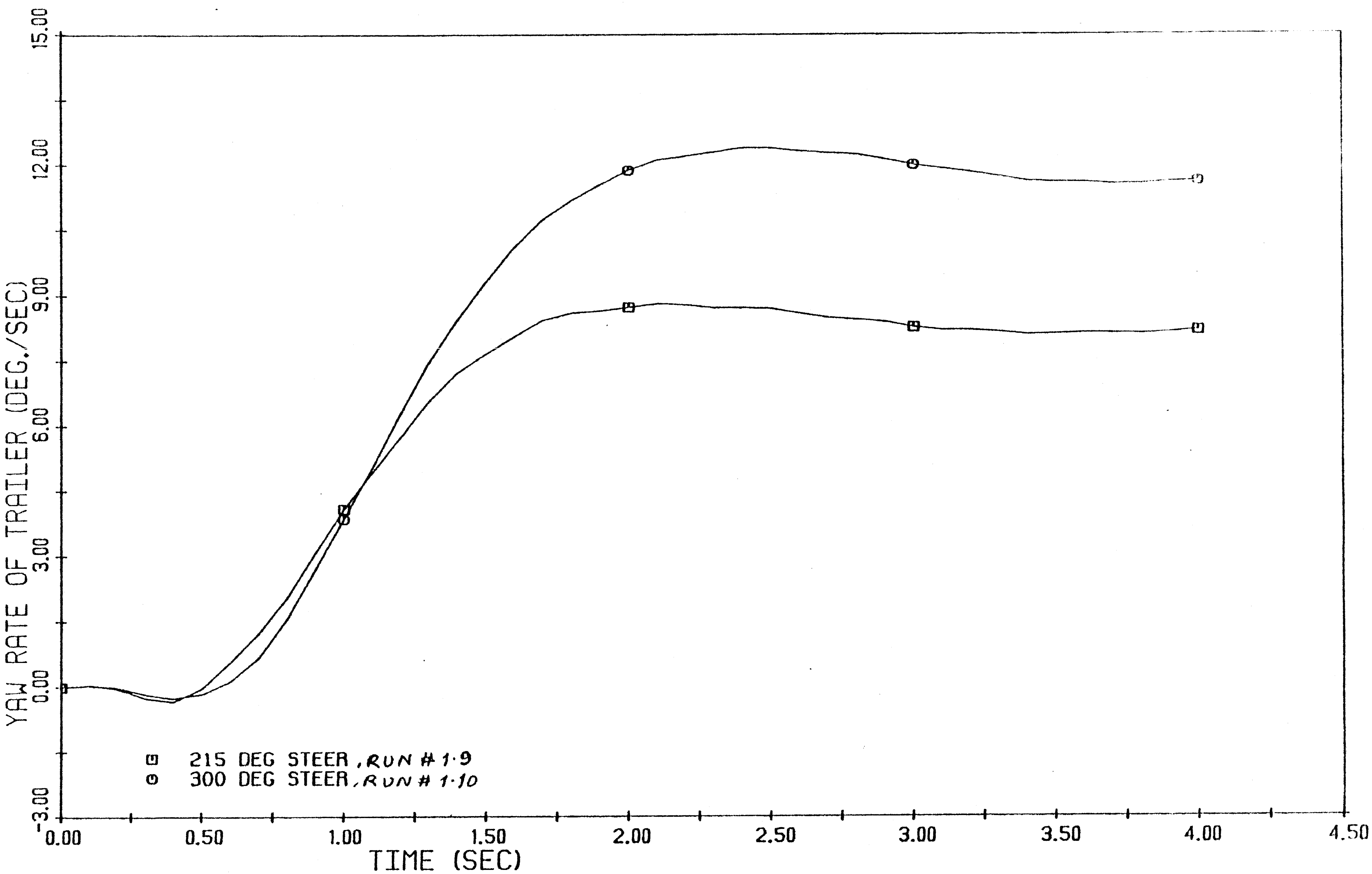
CANADIAN ARTICULATED BUS, STEP STEER MANEUVERS, LOADED, 100 KPH,



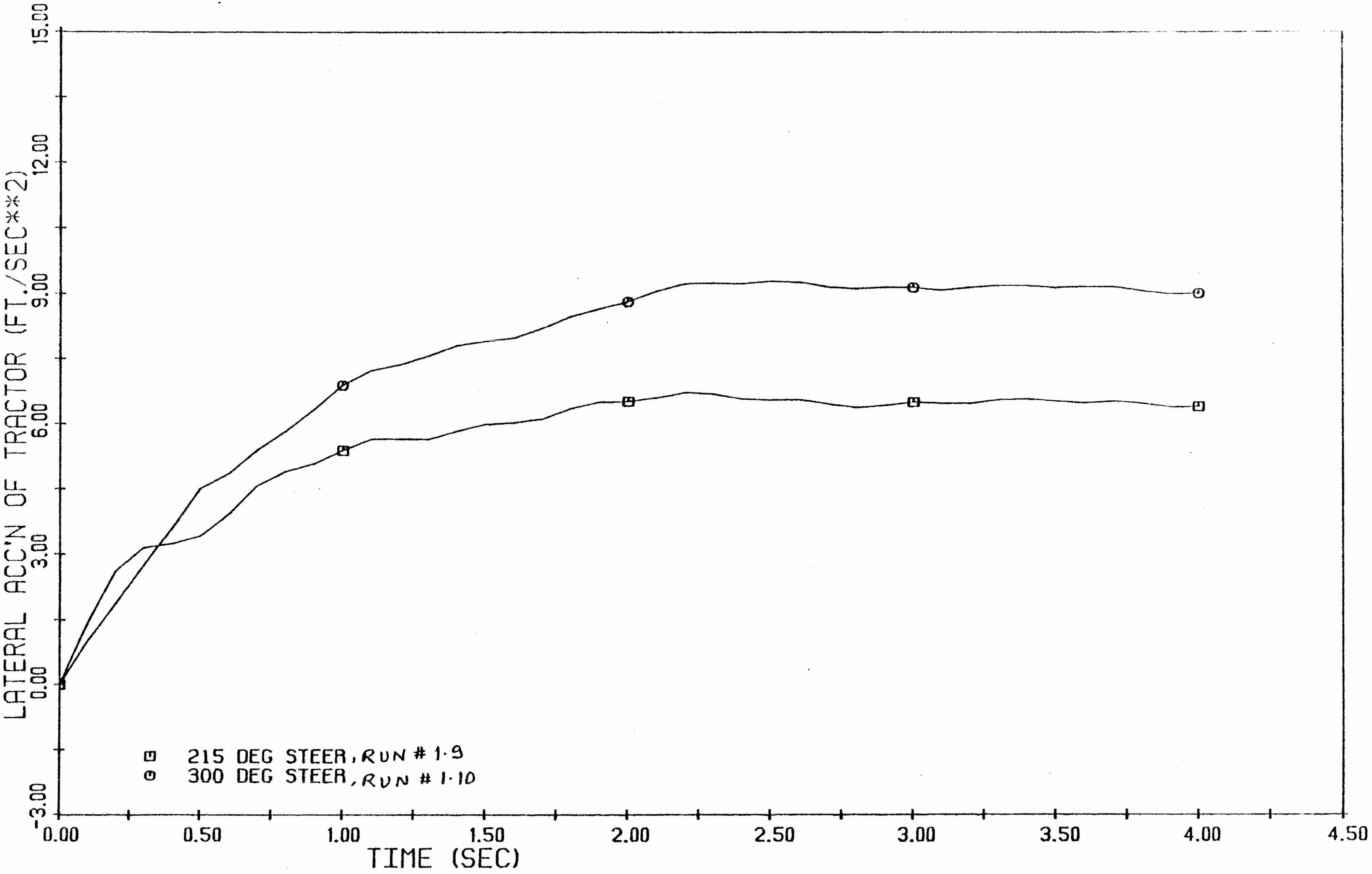
CANADIAN ARTIC BUS, LOADED, 50 KPH, STEP STEER MANEUVERS,



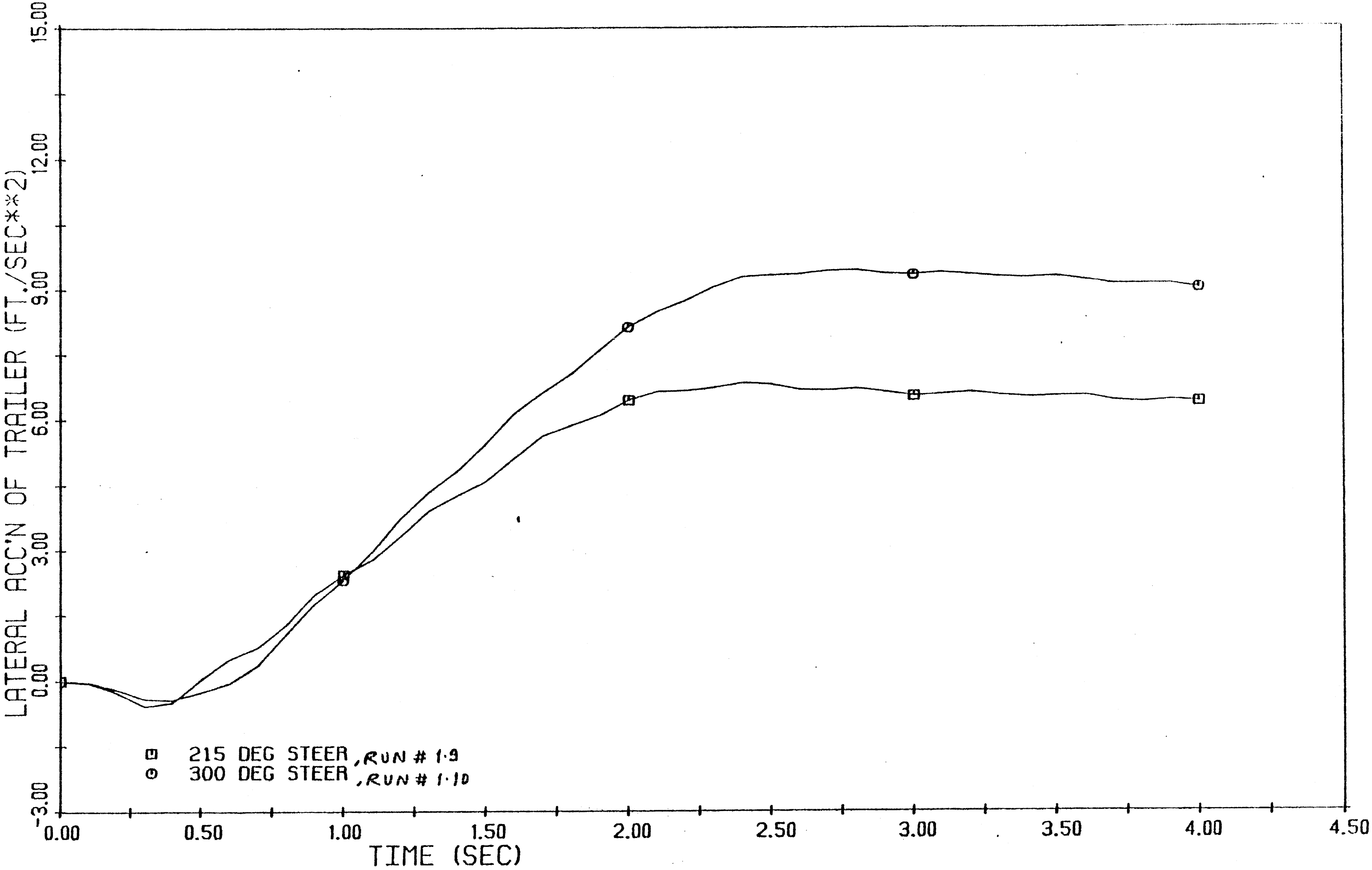
CANADIAN ARTIC BUS, LOADED, 50 KPH, STEP STEER MANEUVERS,



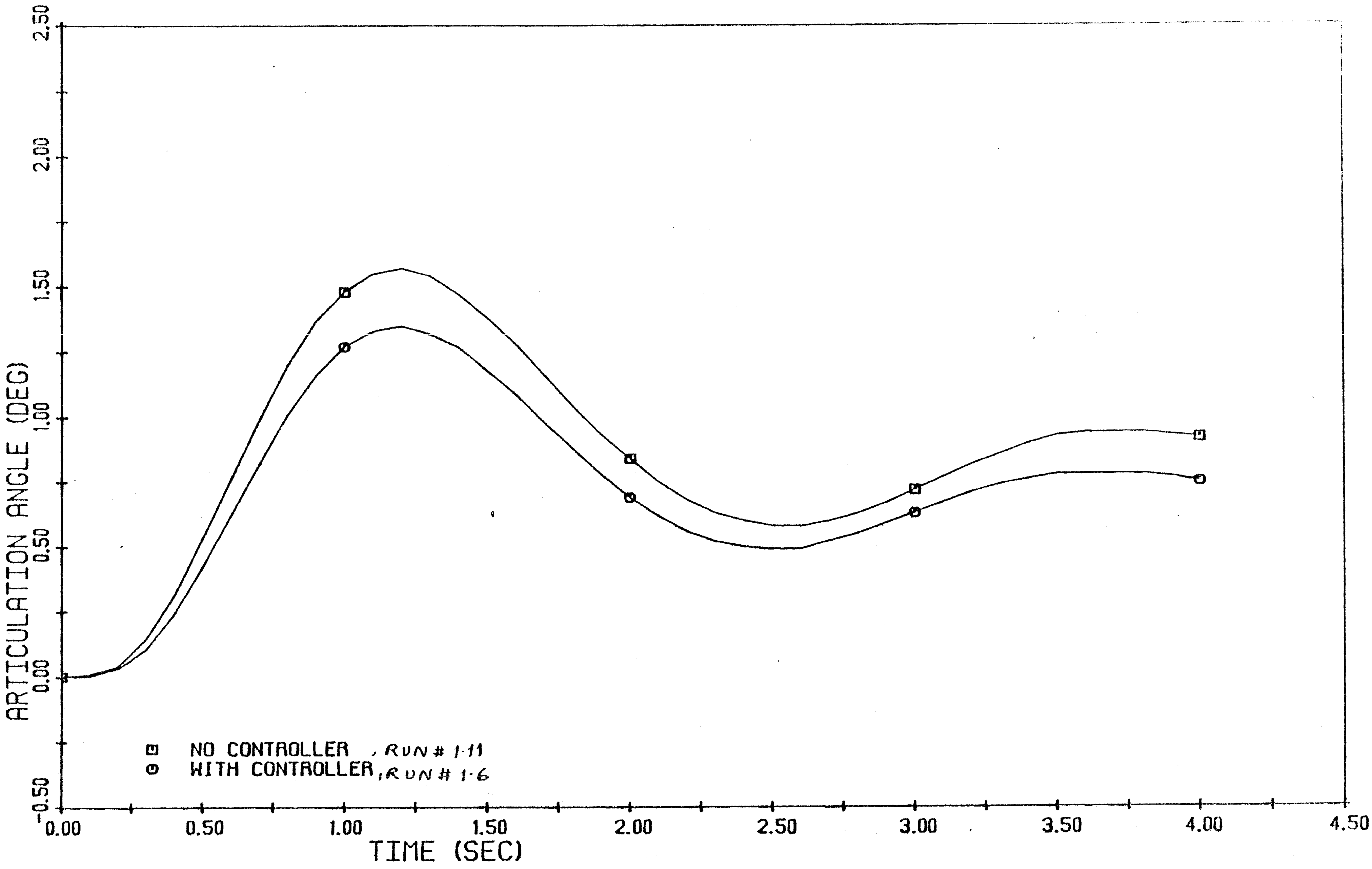
CANADIAN ARTIC BUS, LOADED, 50 KPH, STEP STEER MANEUVERS,



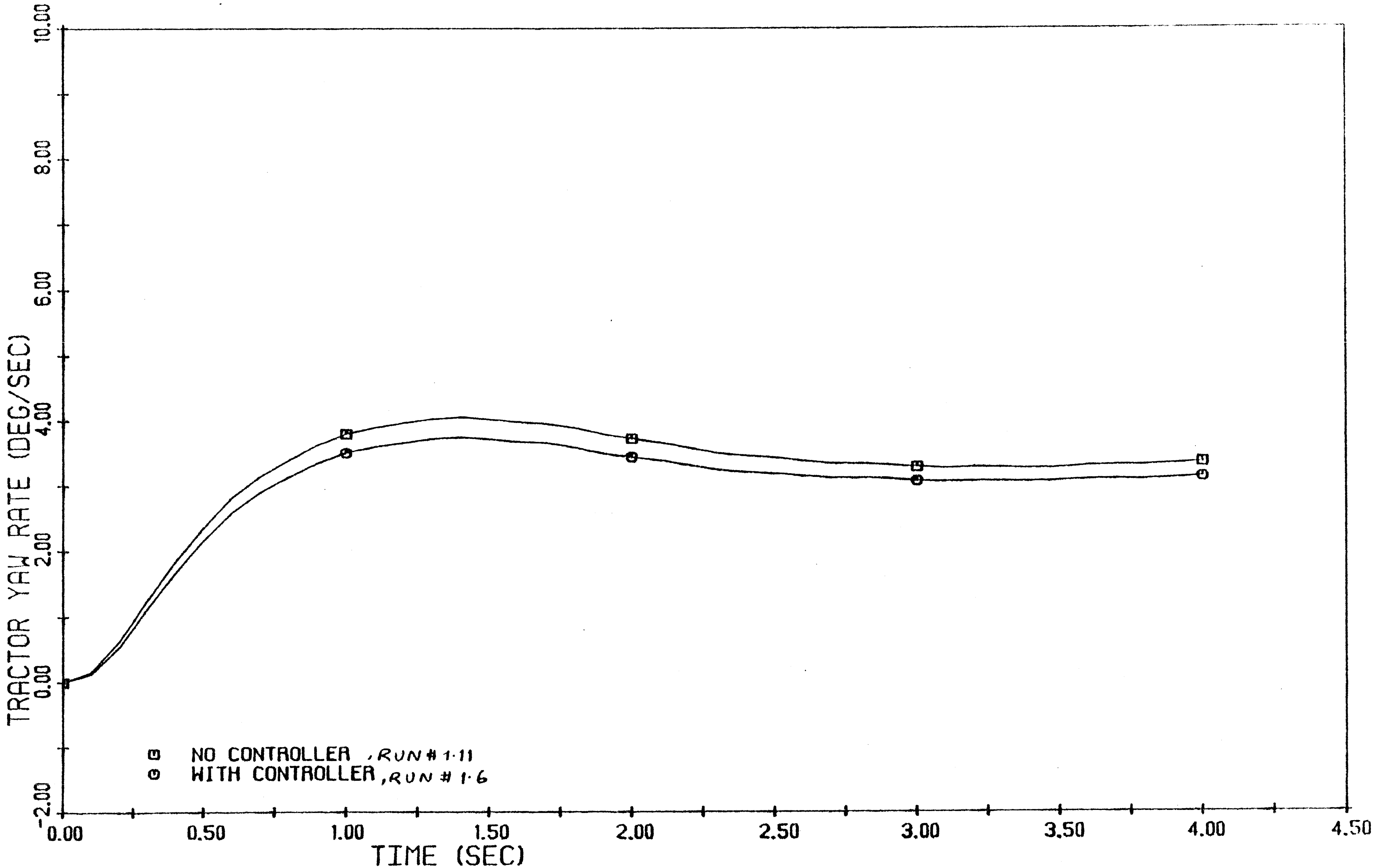
CANADIAN ARTIC BUS, LOADED, 50 KPH, STEP STEER MANEUVERS,



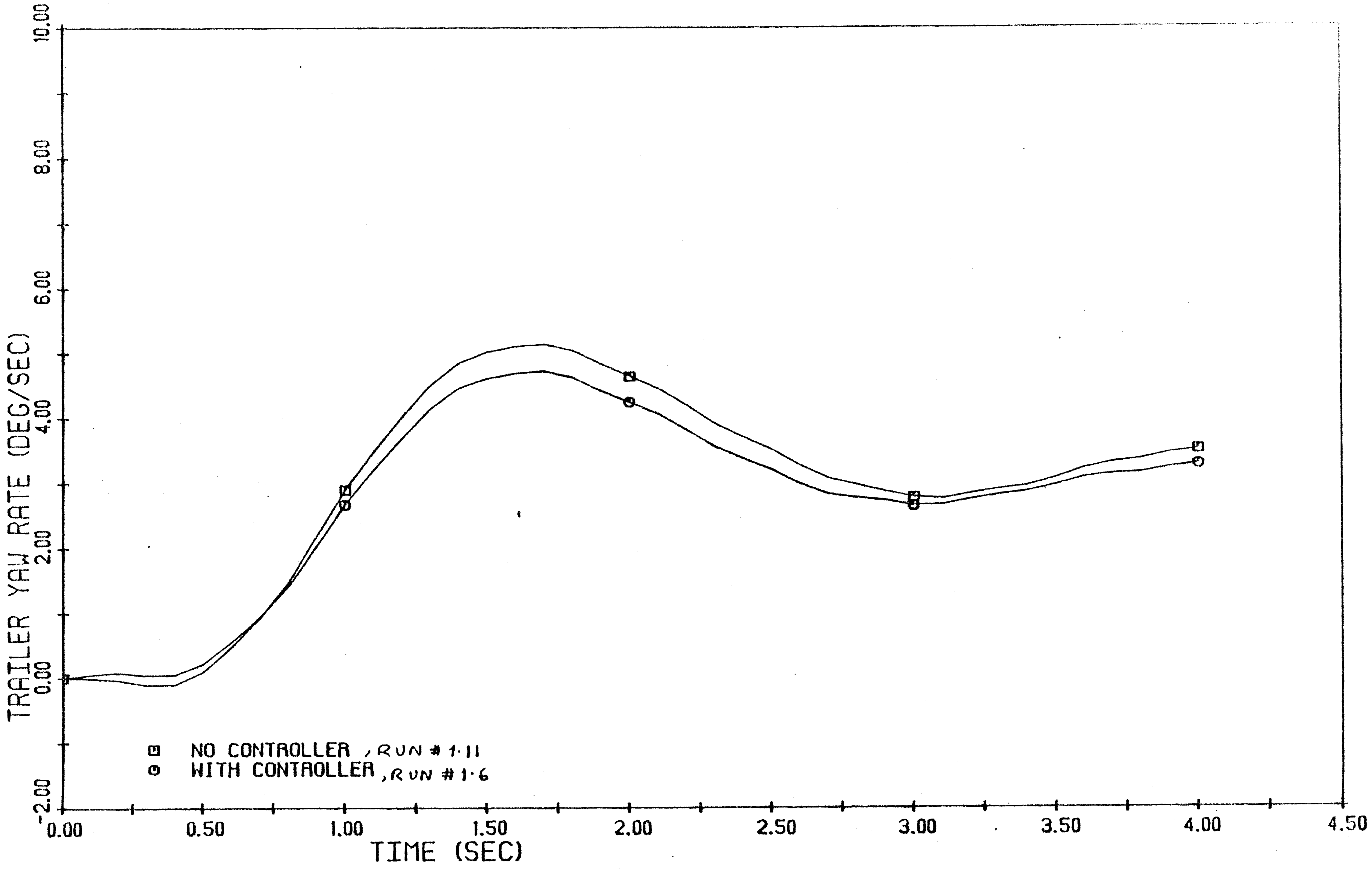
CANADIAN ARTIC BUS, LOADED, 50 KPH, STEP STEER MANEUVERS,



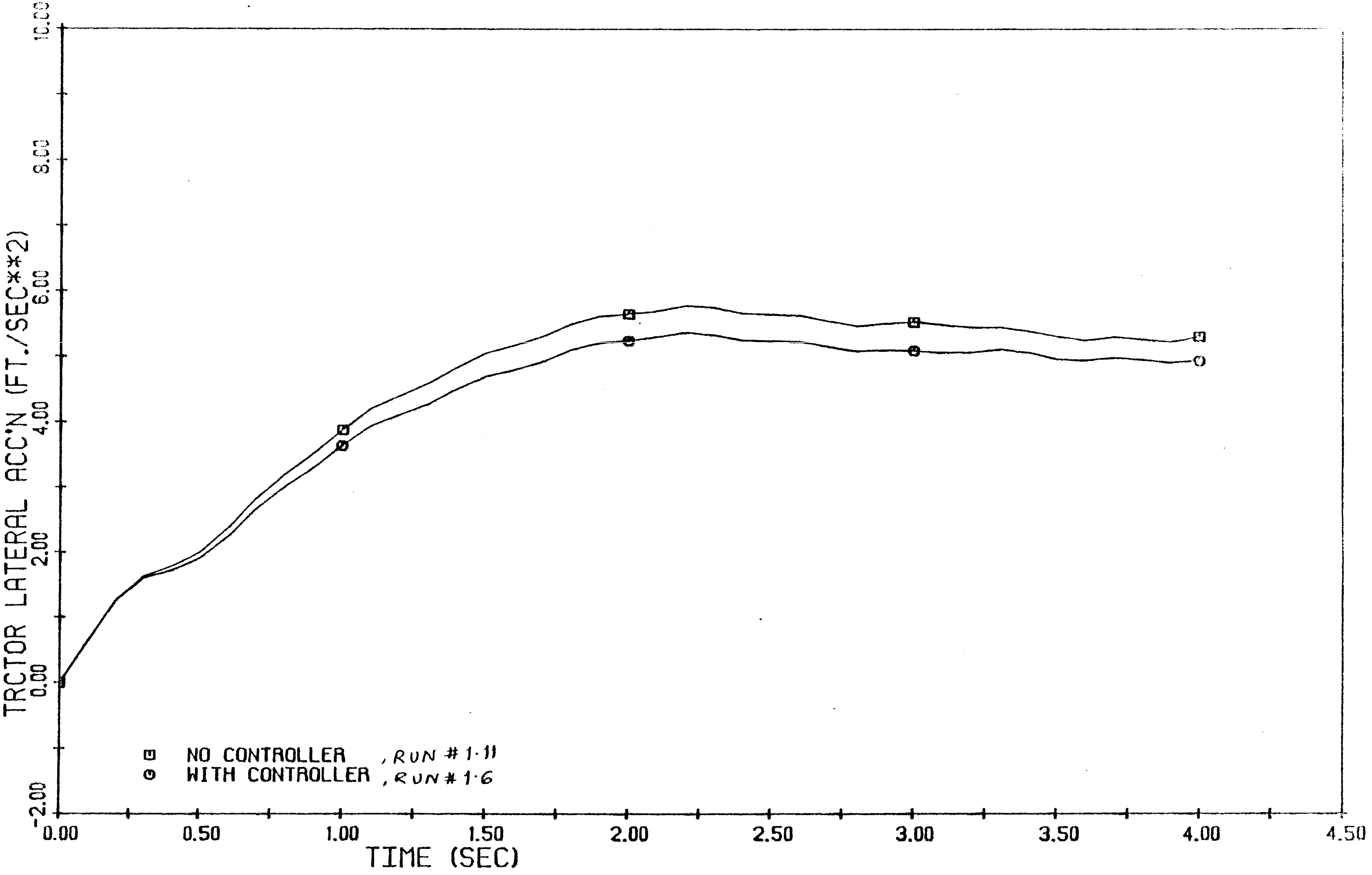
INFLUENCE OF ARTICULATION CONTROLLER, CANADIAN BUS, LOAED,1[illegible] KPH



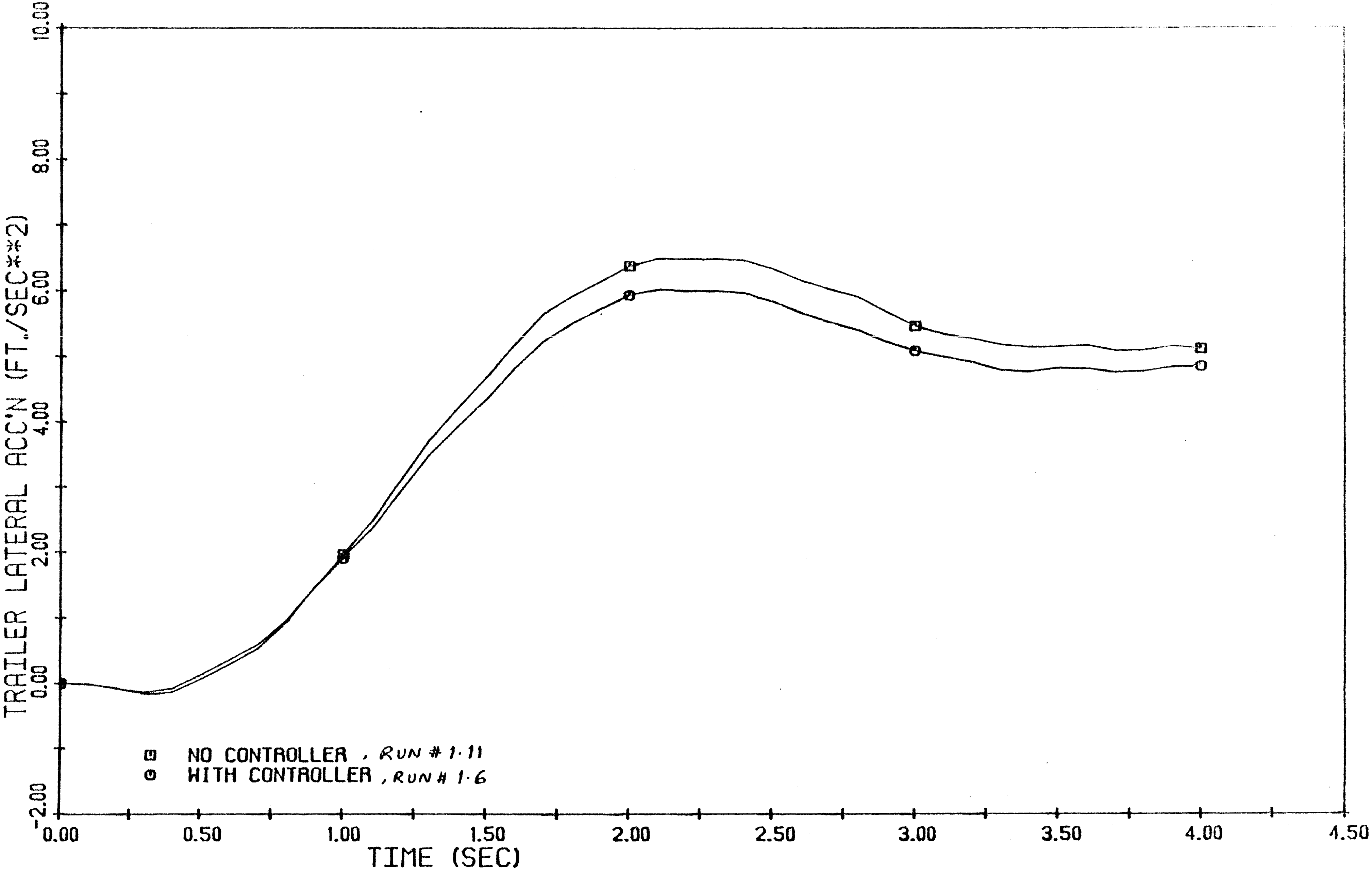
INFLUENCE OF ARTICULATION CONTROLLER, CANADIAN BUS, LOADED, 100 KPH



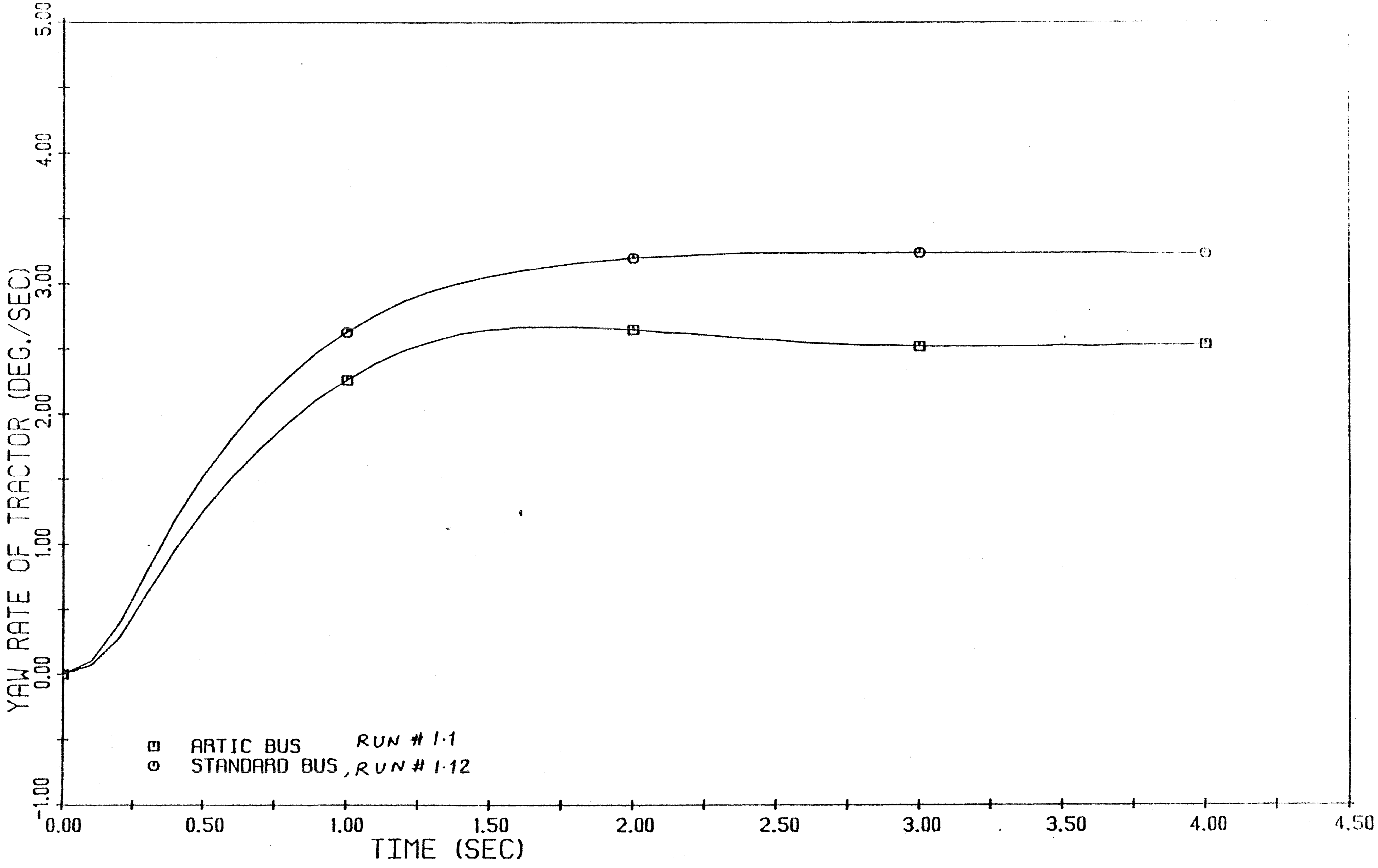
INFLUENCE OF ARTICULATION CONTROLLER, CANADIAN BUS, LOADED, 100 KPH



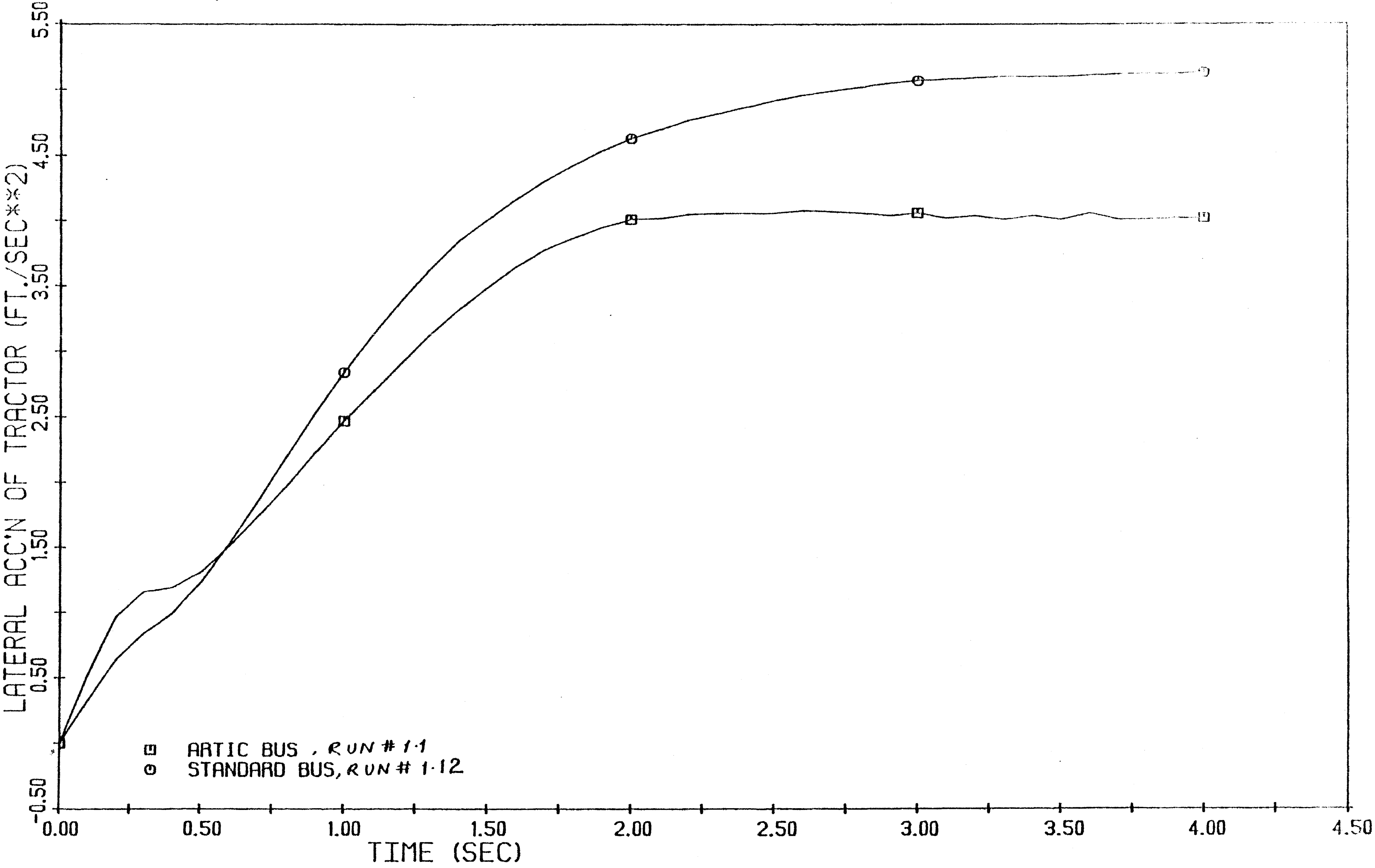
INFLUENCE OF ARTICULATION CONTROLLER, CANADIAN BUS, LOADED, 100 KPH



INFLUENCE OF ARTICULATION CONTROLLER, CANADIAN BUS, LOADED, 100 KPH



COMPARISON OF ARTIC BUS WITH STANDARD BUS, 100 KPH, EMPTY, 40 DEG STEP

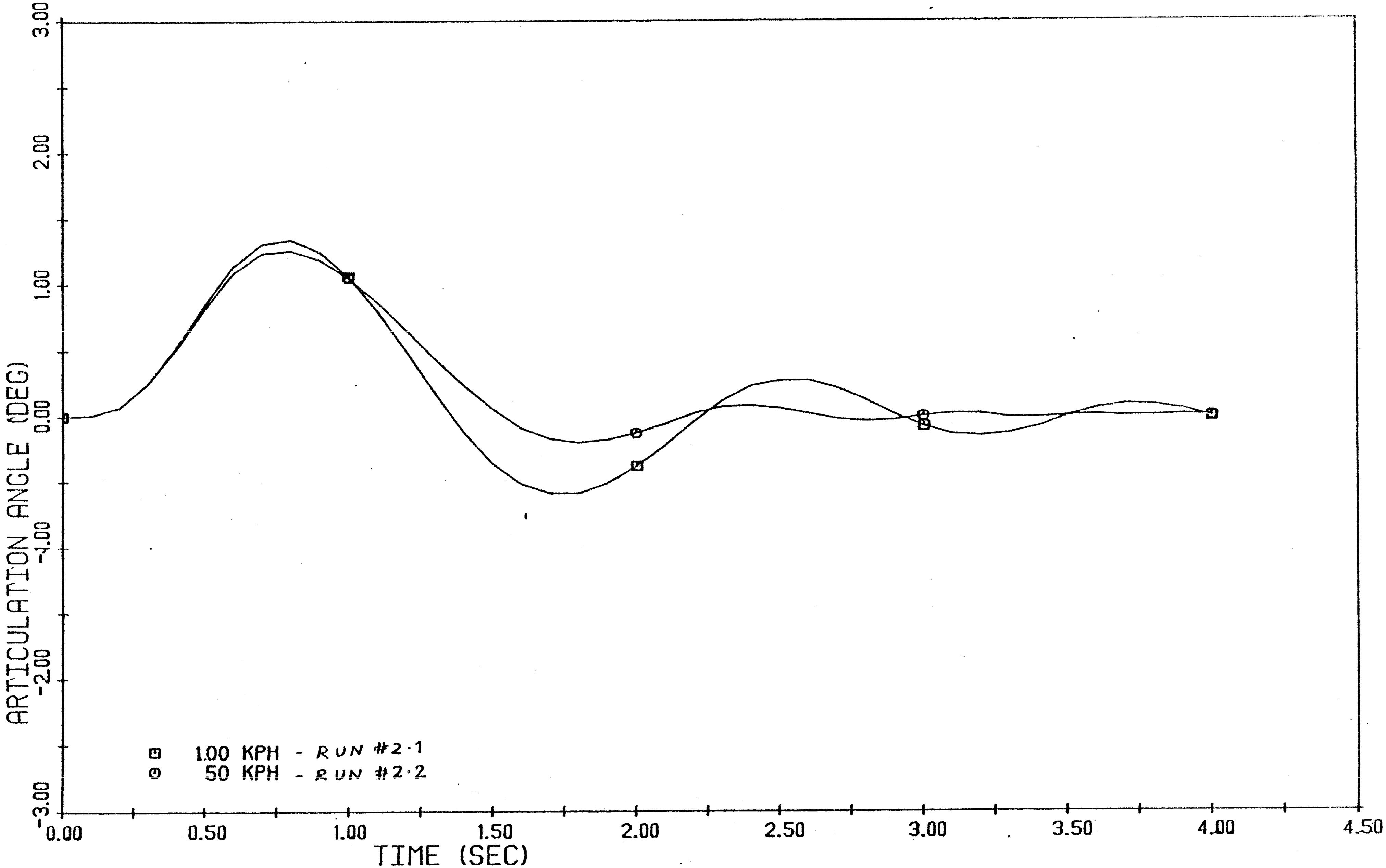


COMPARISON OF ARTIC BUS WITH STANDARD BUS, 100 KPH, EMPTY, 40 DEG STEP

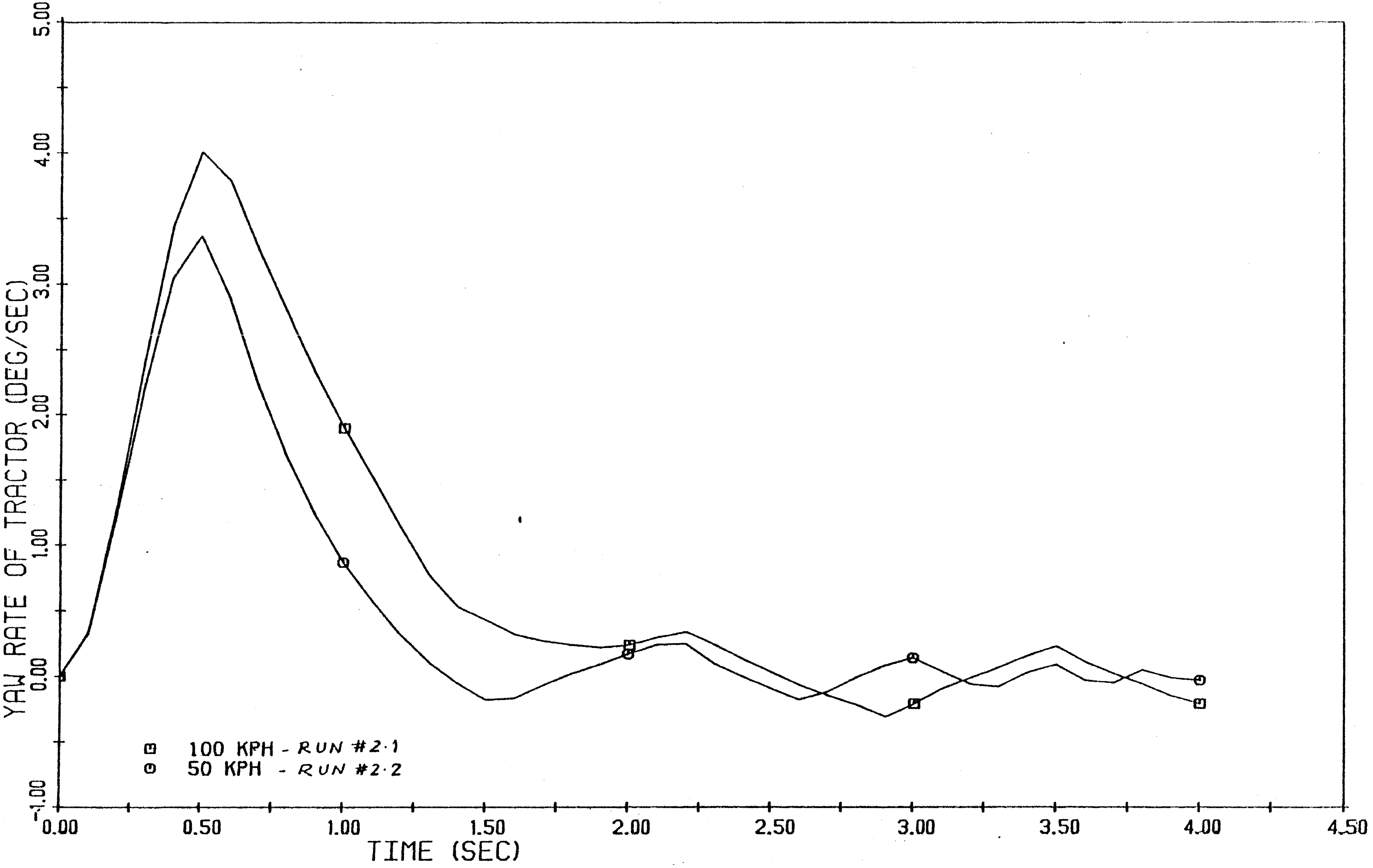
Table 2. Pulse-Steer Input

Run #	Calculation #	Loading Condition	Speed (KPH)	Maneuver	Articulation Controller
2.1	33	E	100	120° Pulse Steer	Yes
2.2	34	E	50	"	Yes
2.3	31	L	100	"	Yes
2.4	32	L	50	"	Yes
2.5	110	E	100	"	No
2.6*	111	E	100	"	Yes

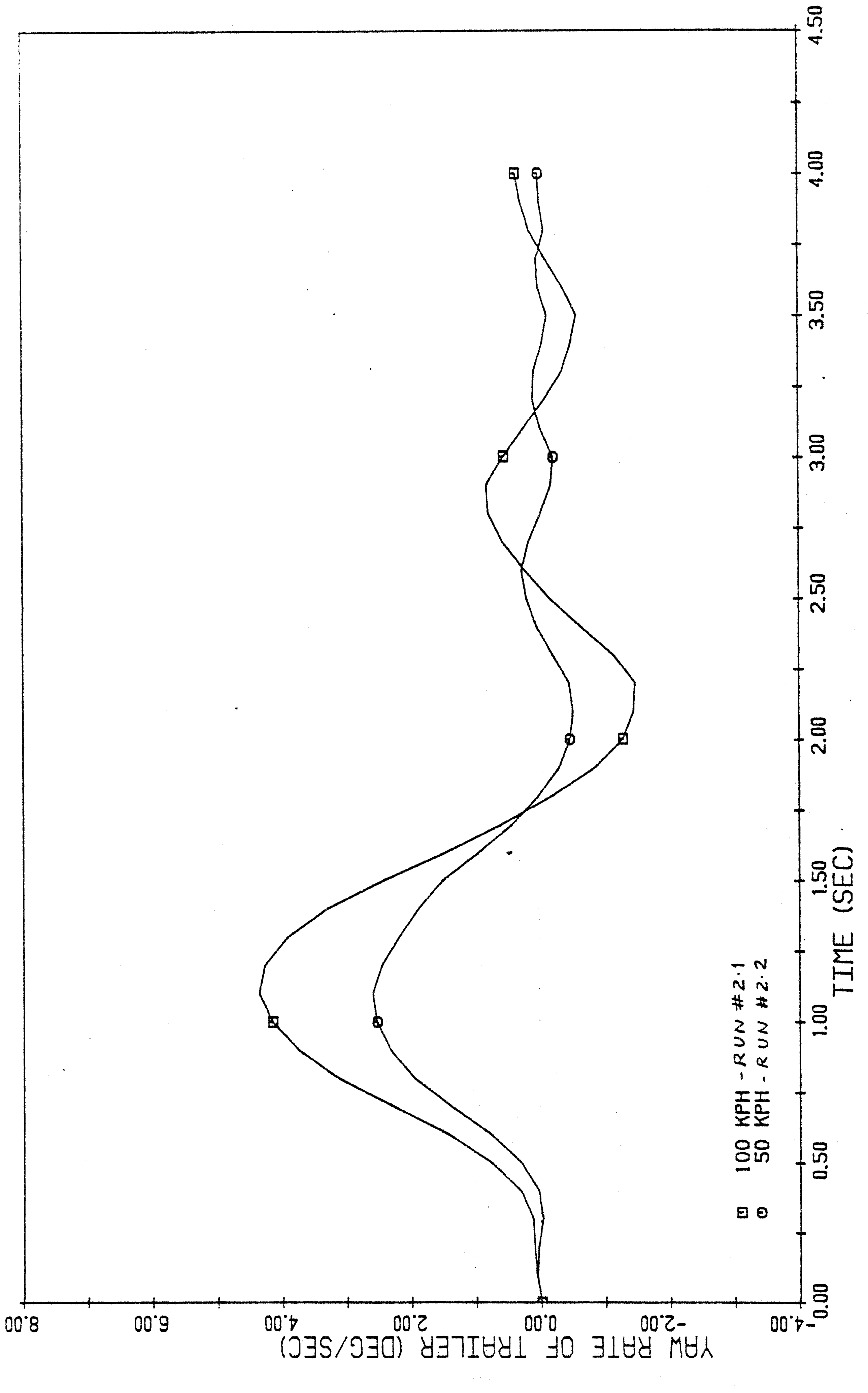
*Same as Run #2.1, with new load data



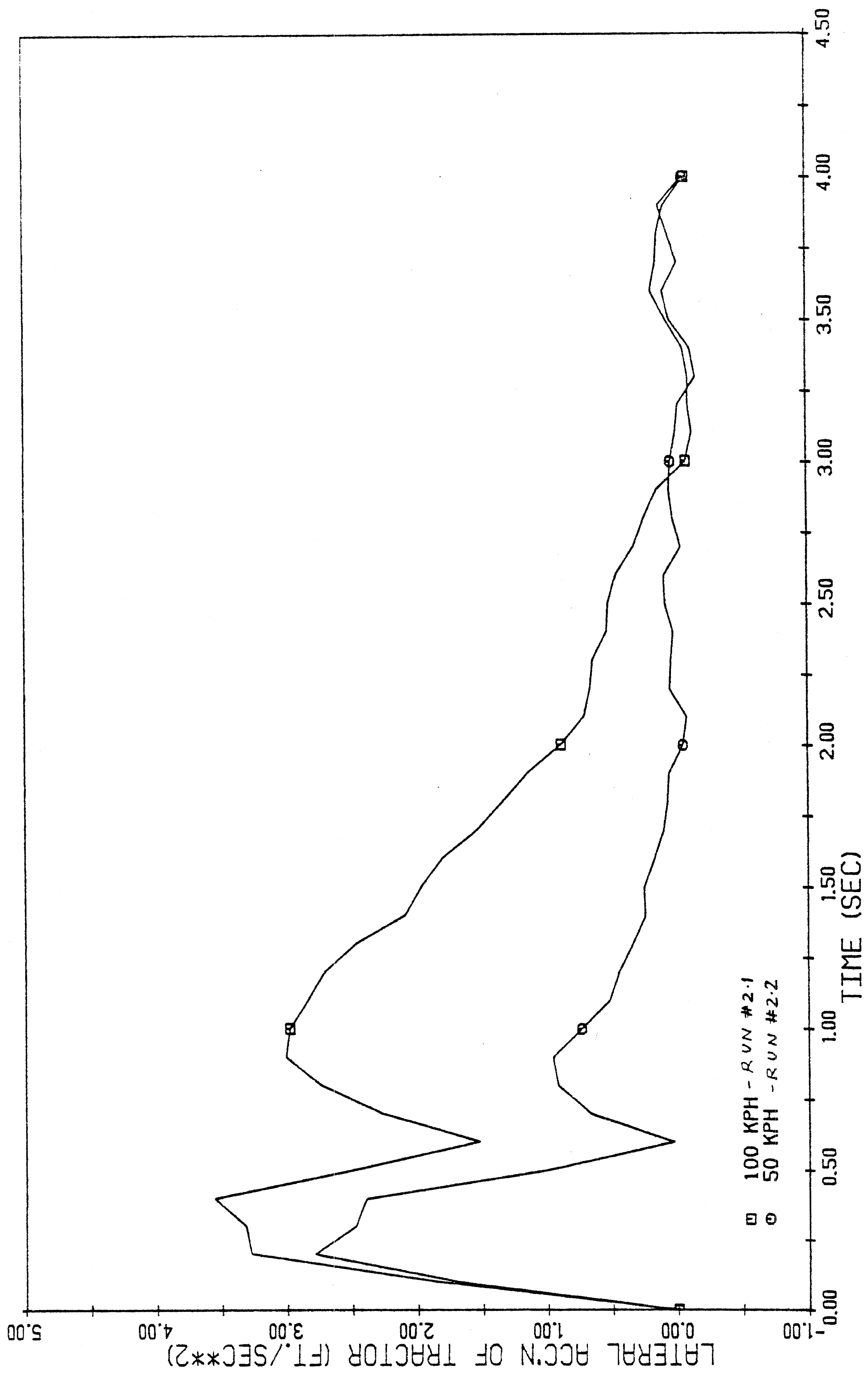
CANADIAN ARTICULATED BUS, EMPTY, RESPONSE TO A PULSE STEER INPUT



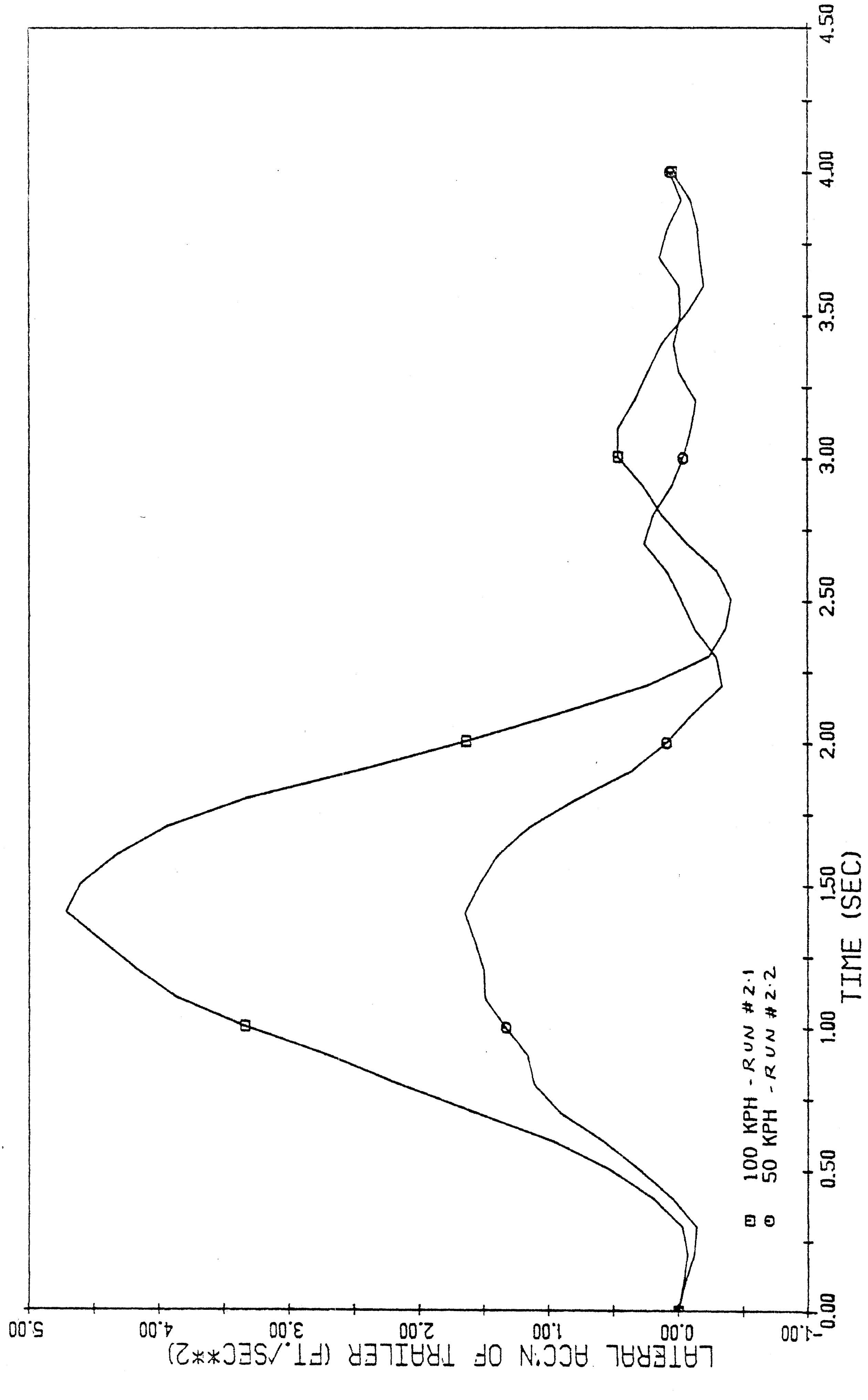
CANADIAN ARTICULATED BUS, EMPTY, RESPONSE TO A PULSE STEER INPUT



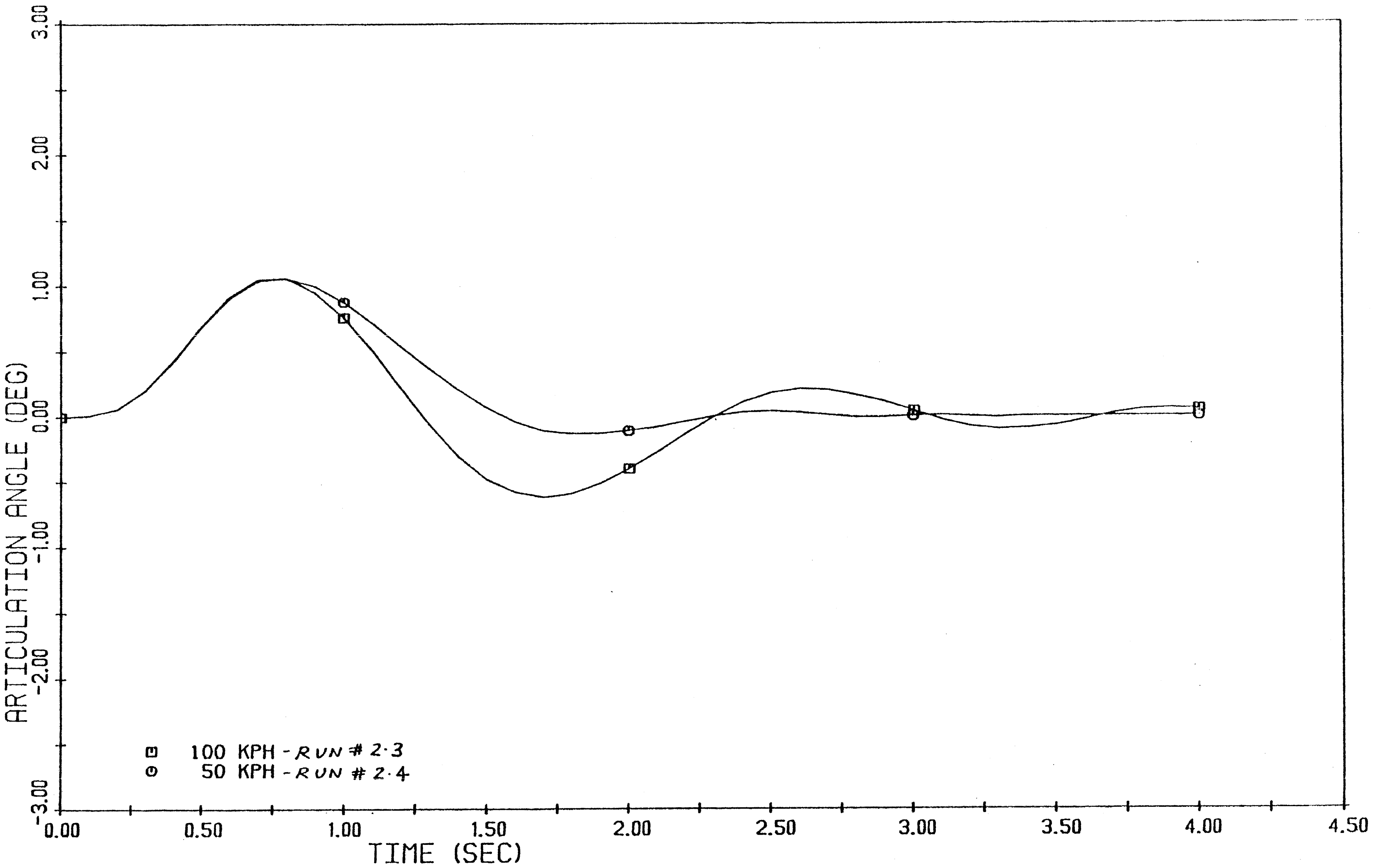
CANADIAN ARTICULATED BUS, EMPTY, RESPONSE TO A PULSE STEER INPUT



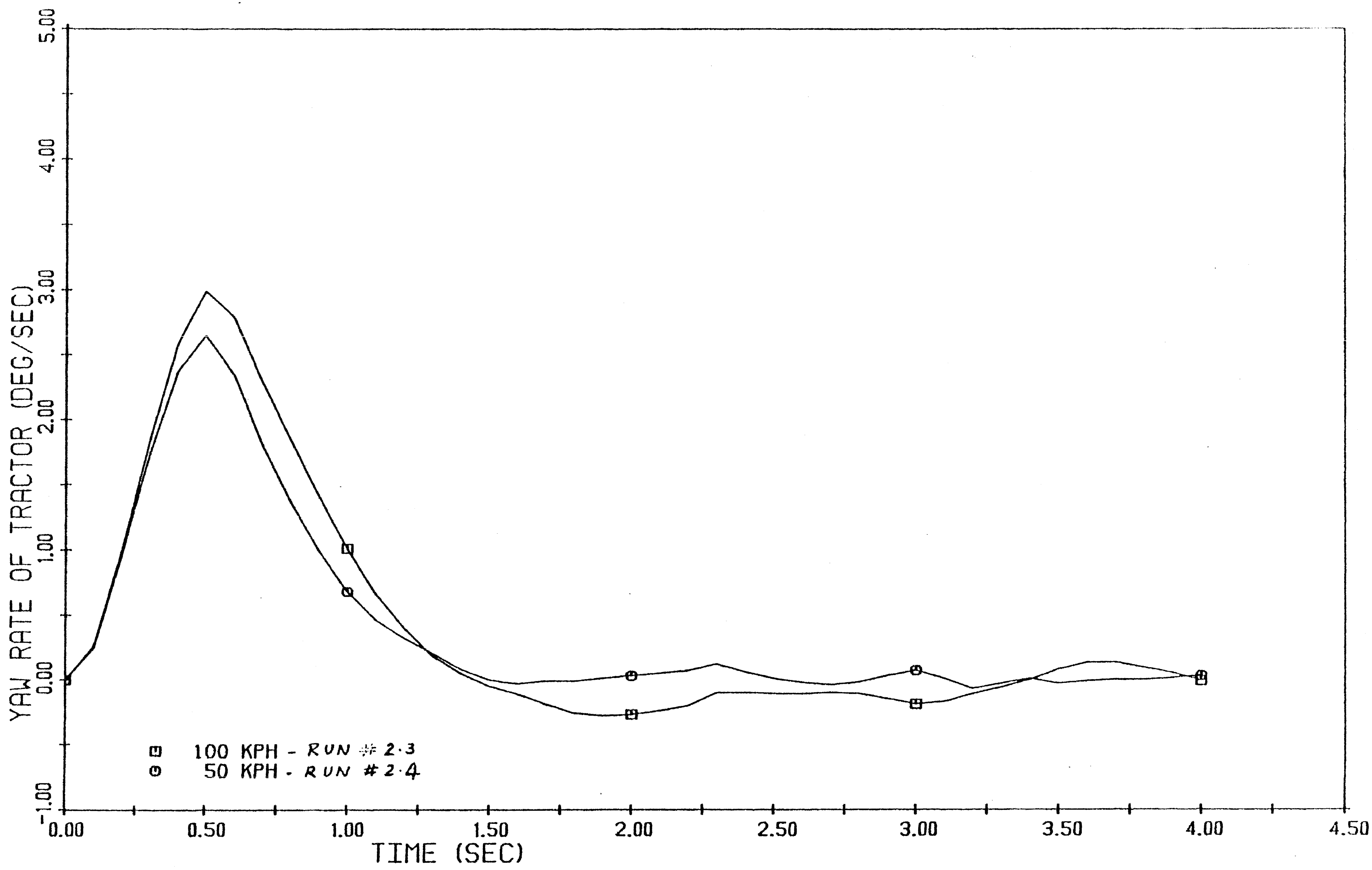
CANADIAN ARTICULATED BUS, EMPTY, RESPONSE TO A PULSE STEER INPUT



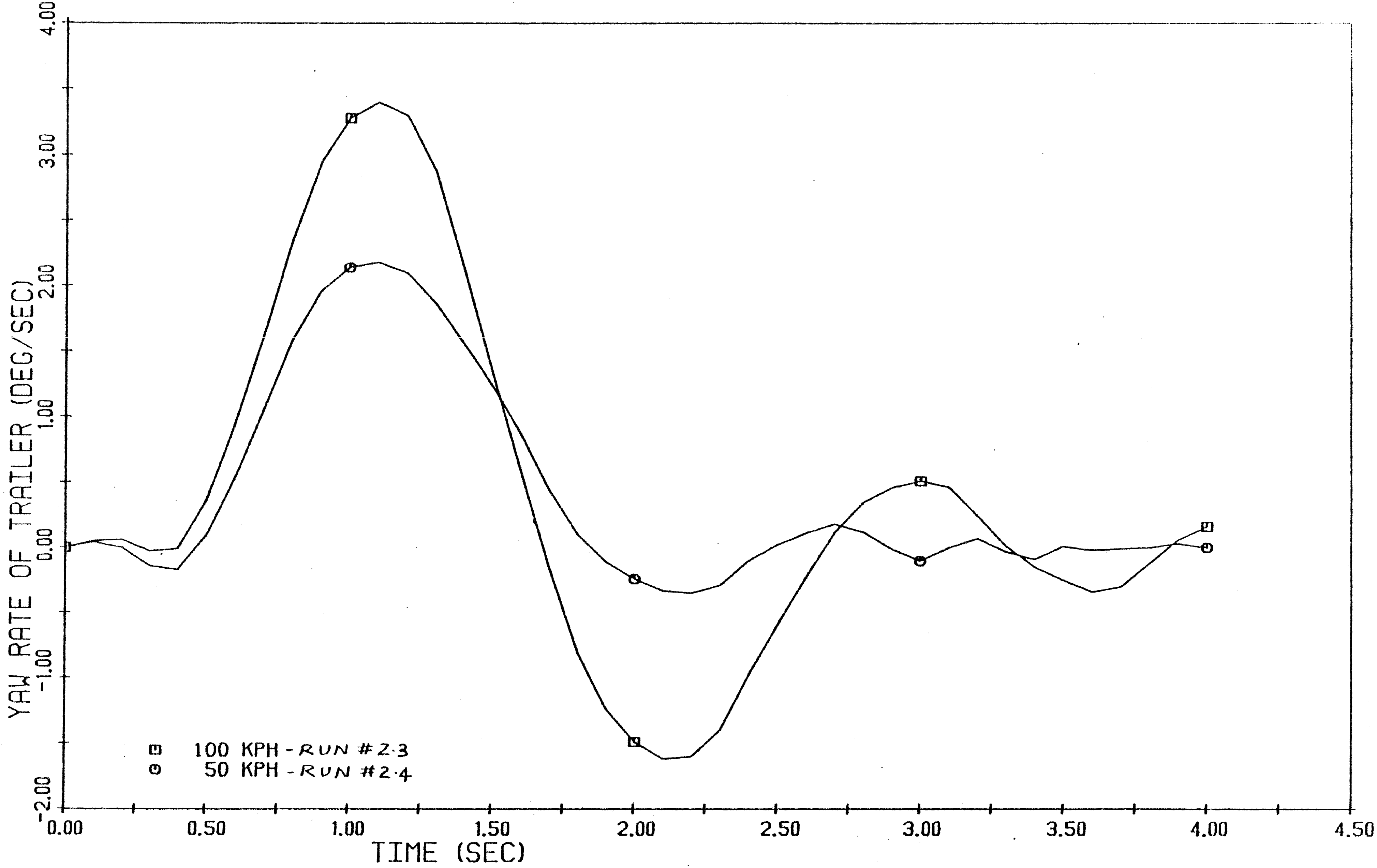
CANADIAN ARTICULATED BUS, EMPTY, RESPONSE TO A PULSE STEER INPUT



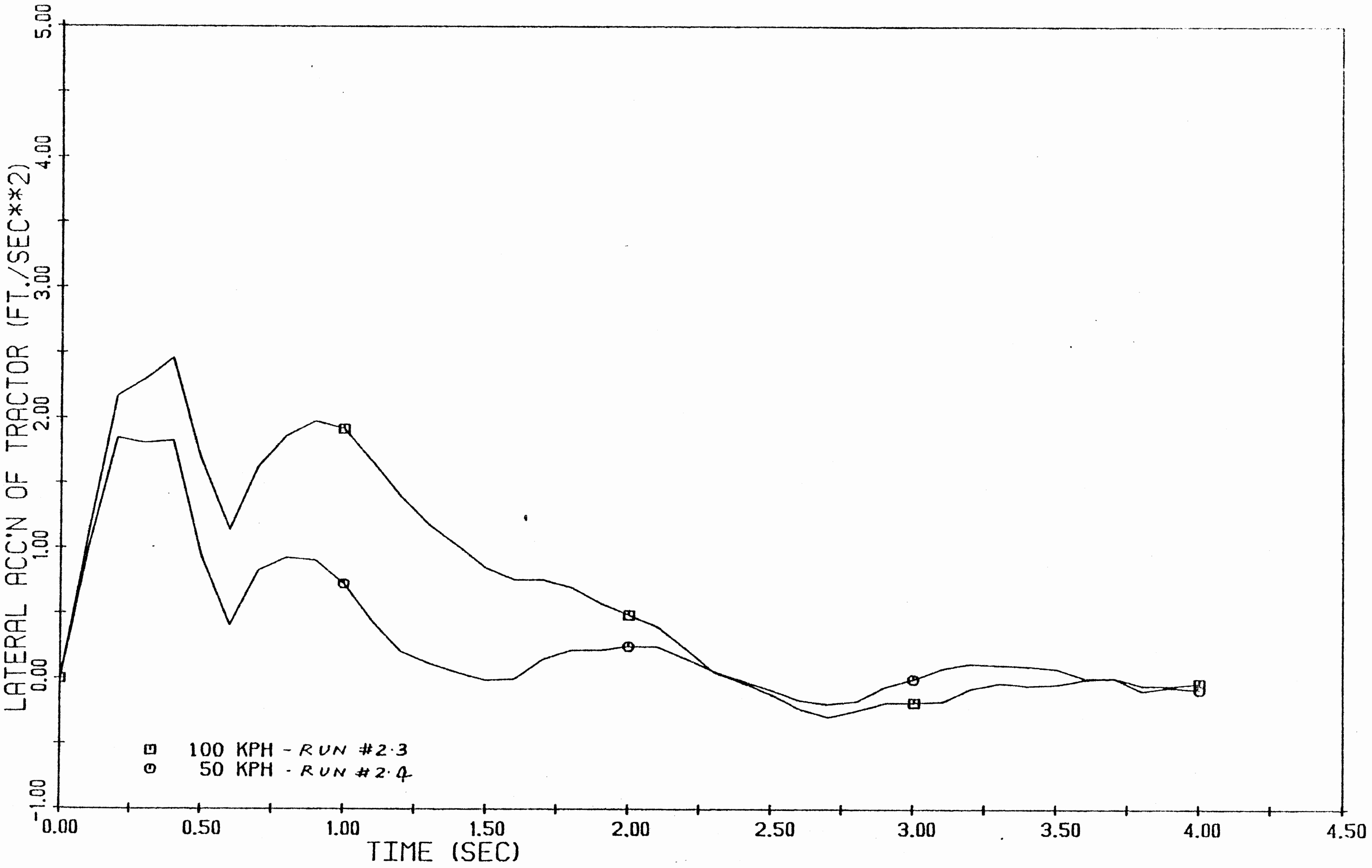
CANADIAN ARTICULATED BUS, LOADED, RESPONSE TO A PULSE STEER INPUT



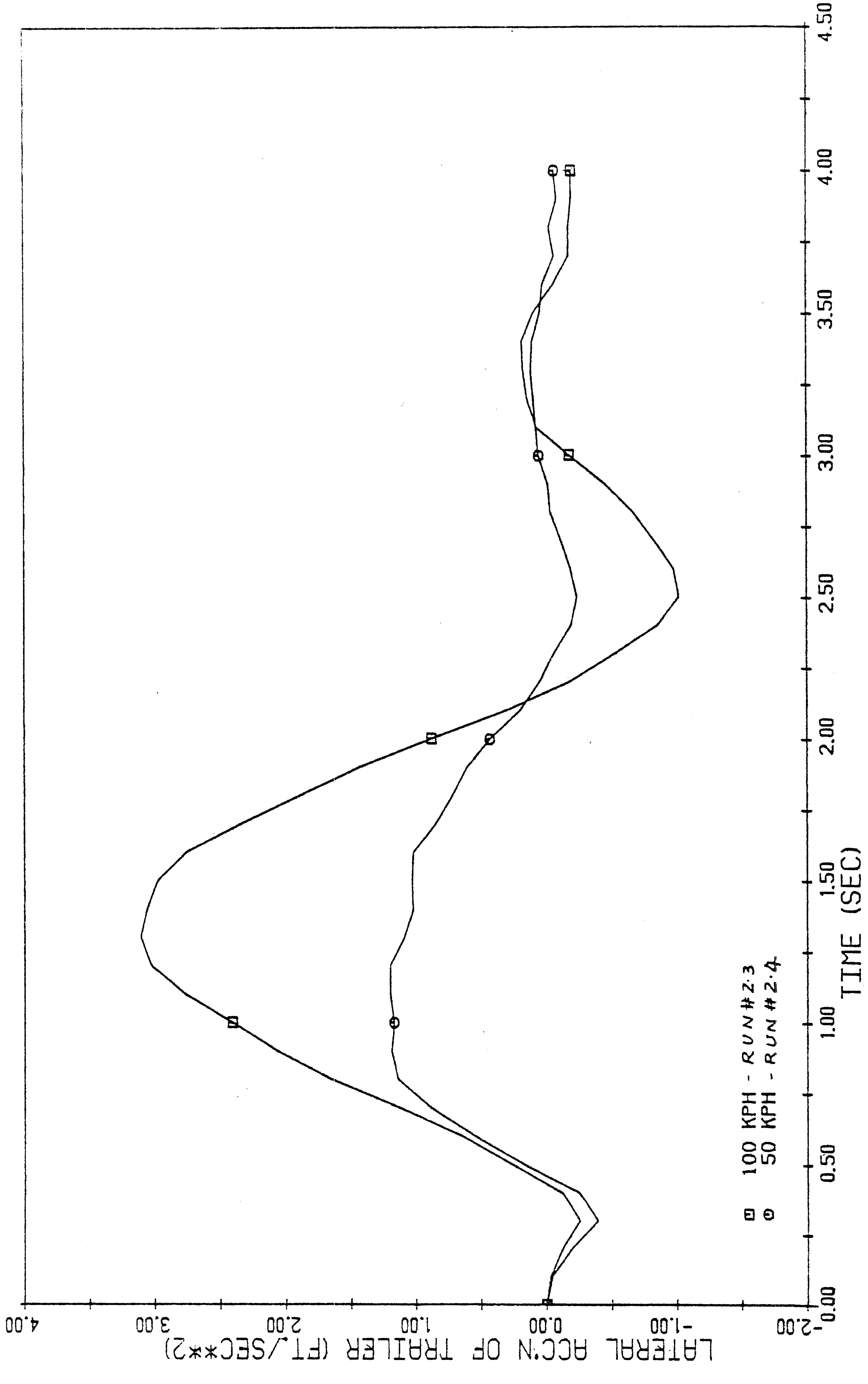
CANADIAN ARTICULATED BUS, LOADED, RESPONSE TO A PULSE STEER INPUT



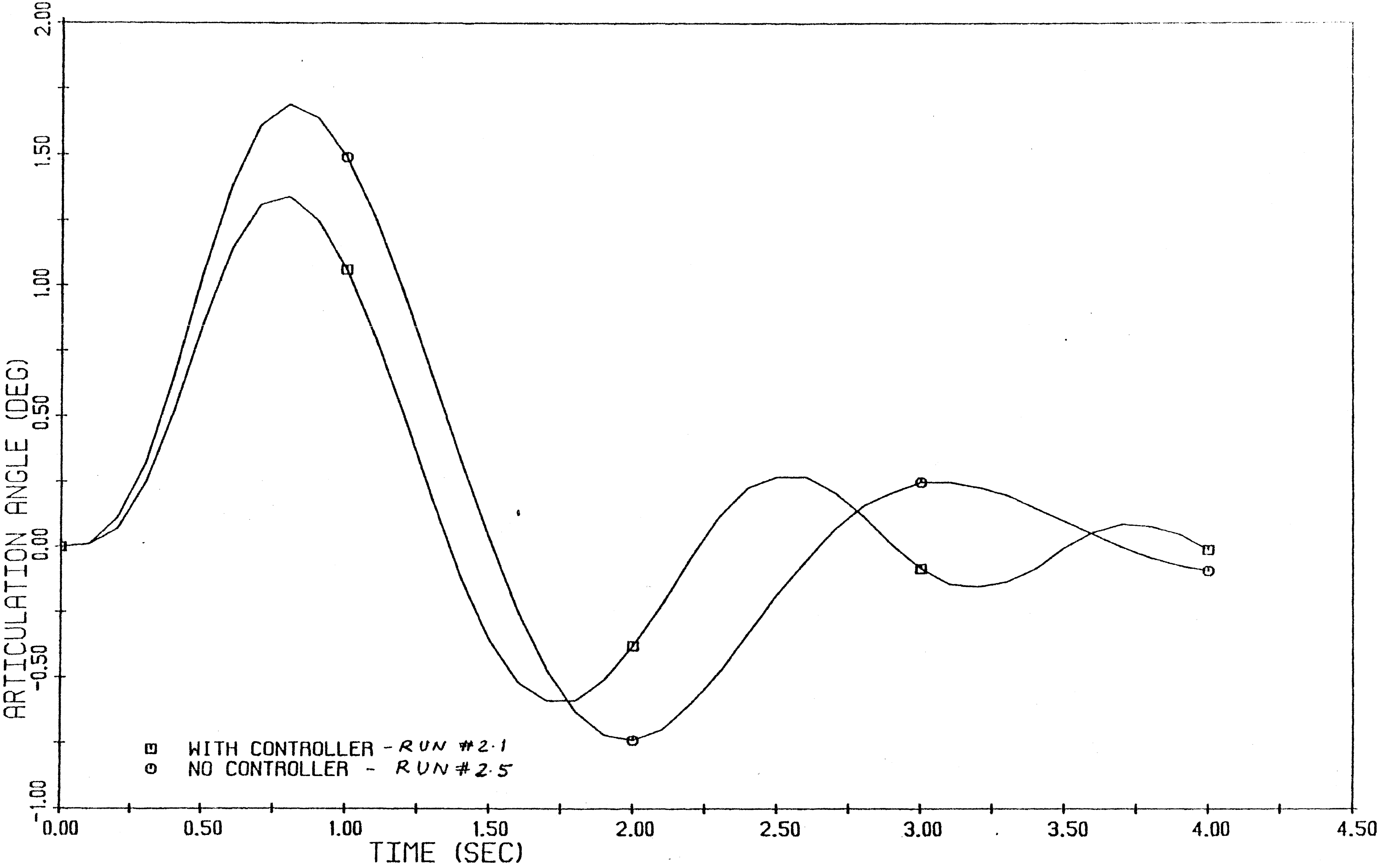
CANADIAN ARTICULATED BUS, LOADED, RESPONSE TO A PULSE STEER INPUT



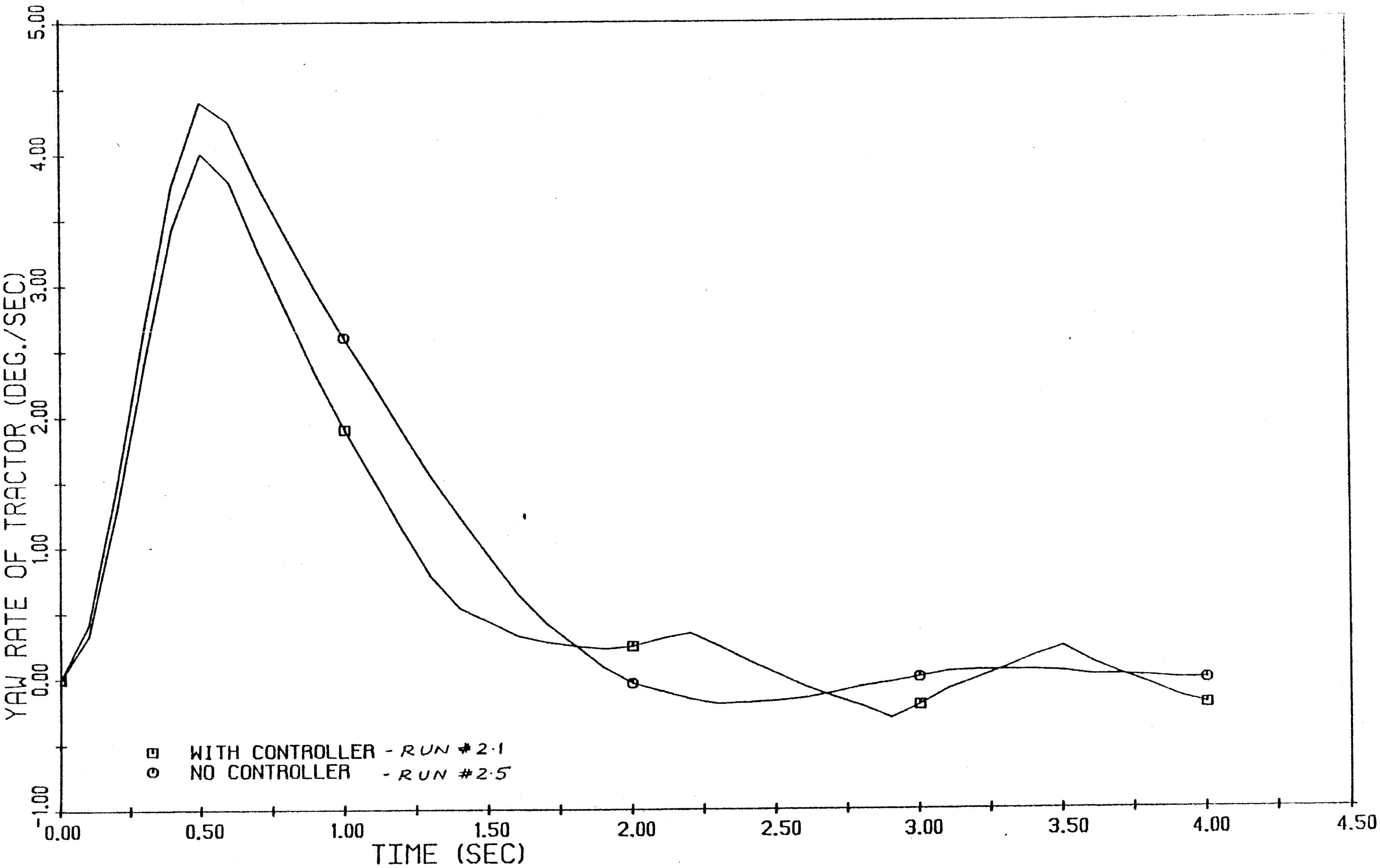
CANADIAN ARTICULATED BUS, LOADED, RESPONSE TO A PULSE STEER INPUT



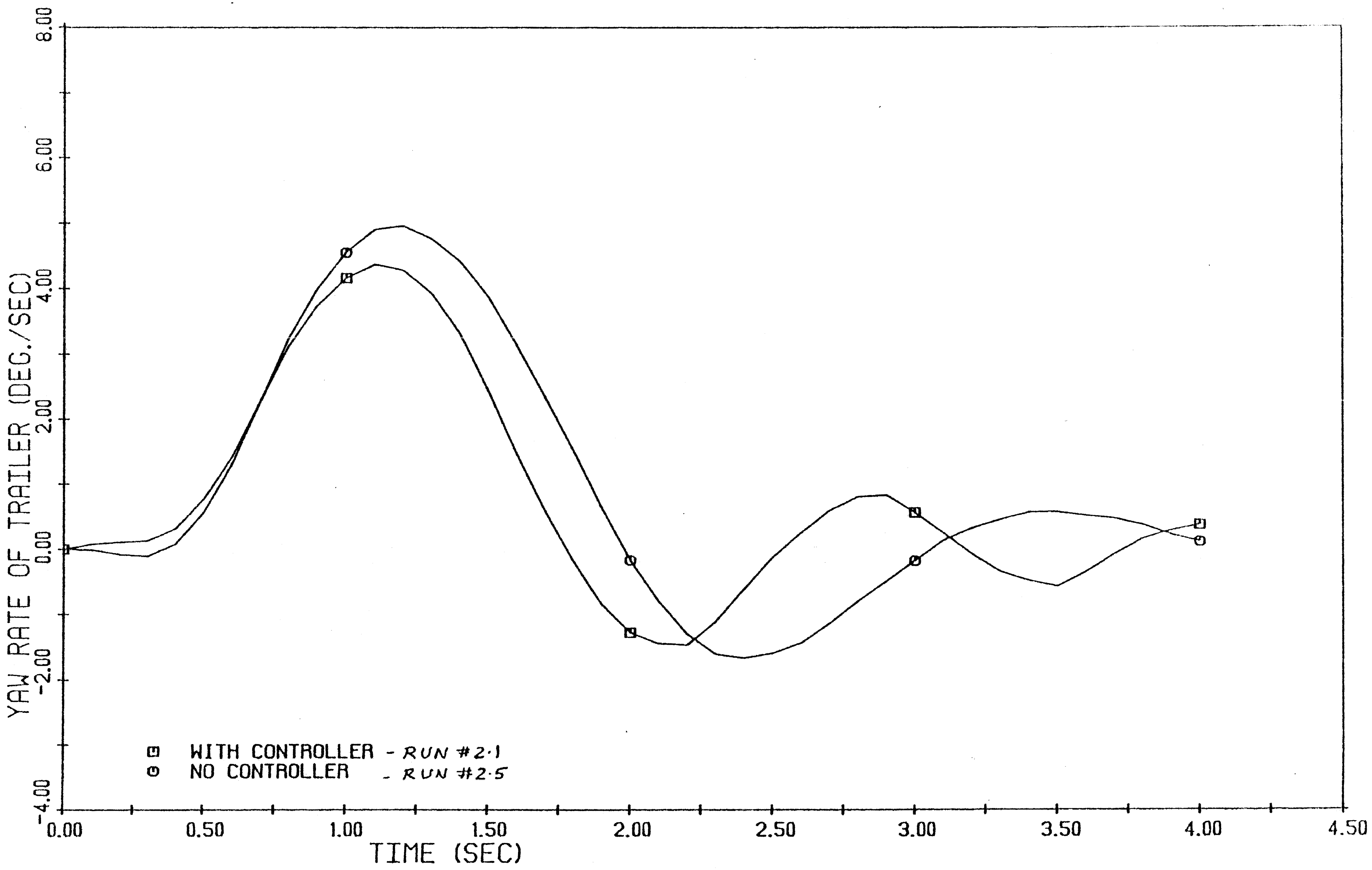
CANADIAN ARTICULATED BUS, LOADED, RESPONSE TO A PULSE STEER INPUT



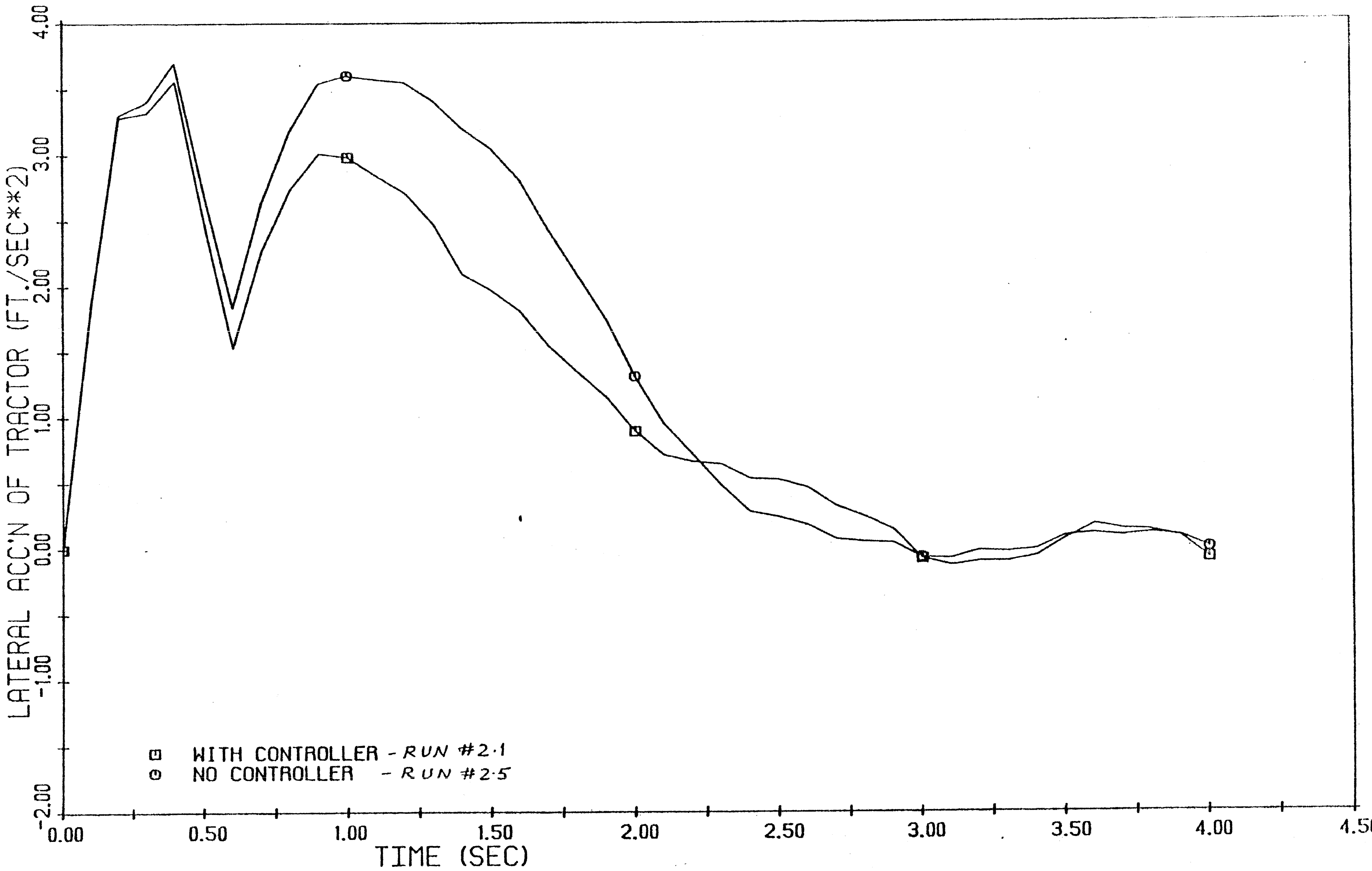
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF CONTROLLER, 100 KPH



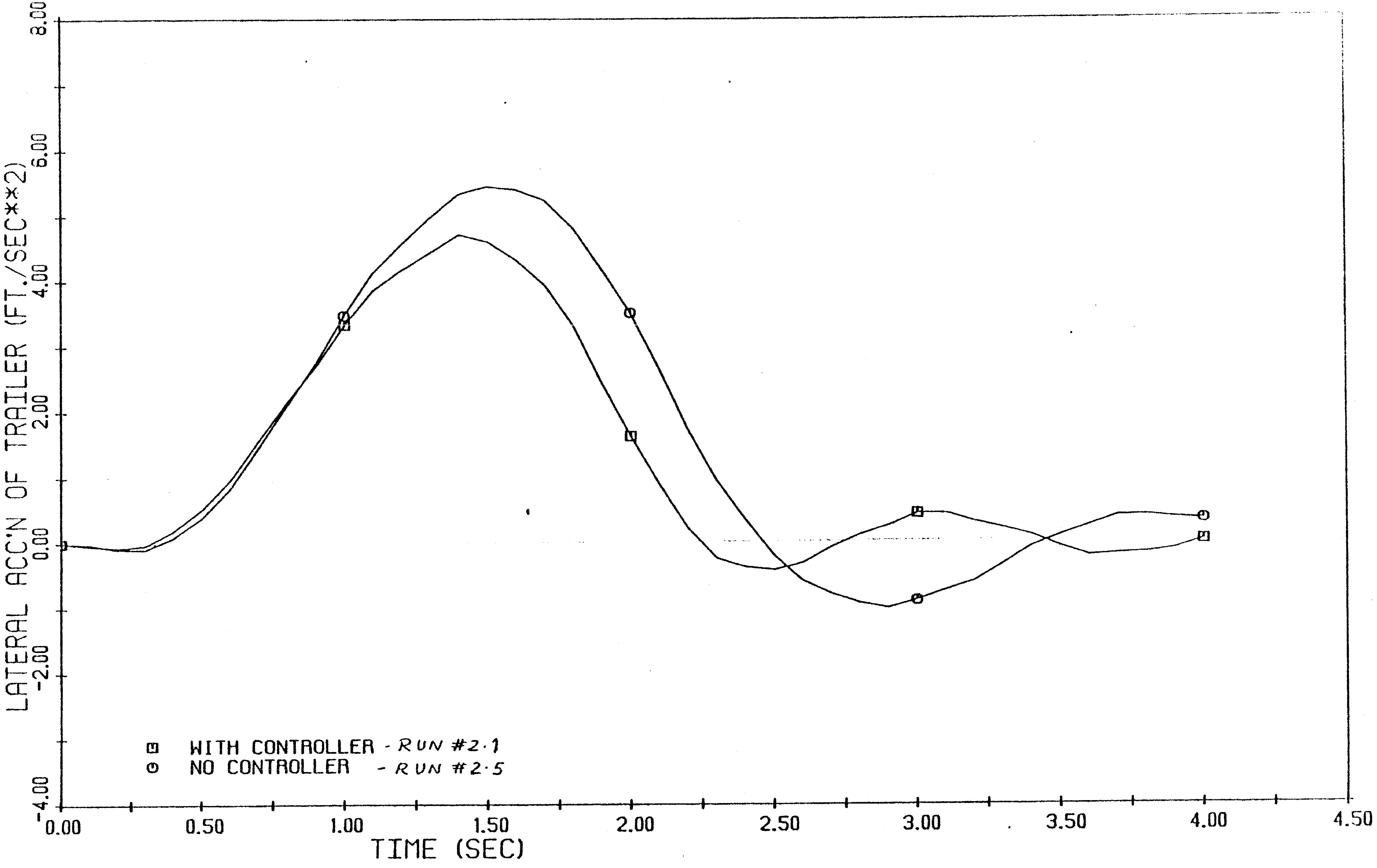
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF CONTROLLER, 100 KPH



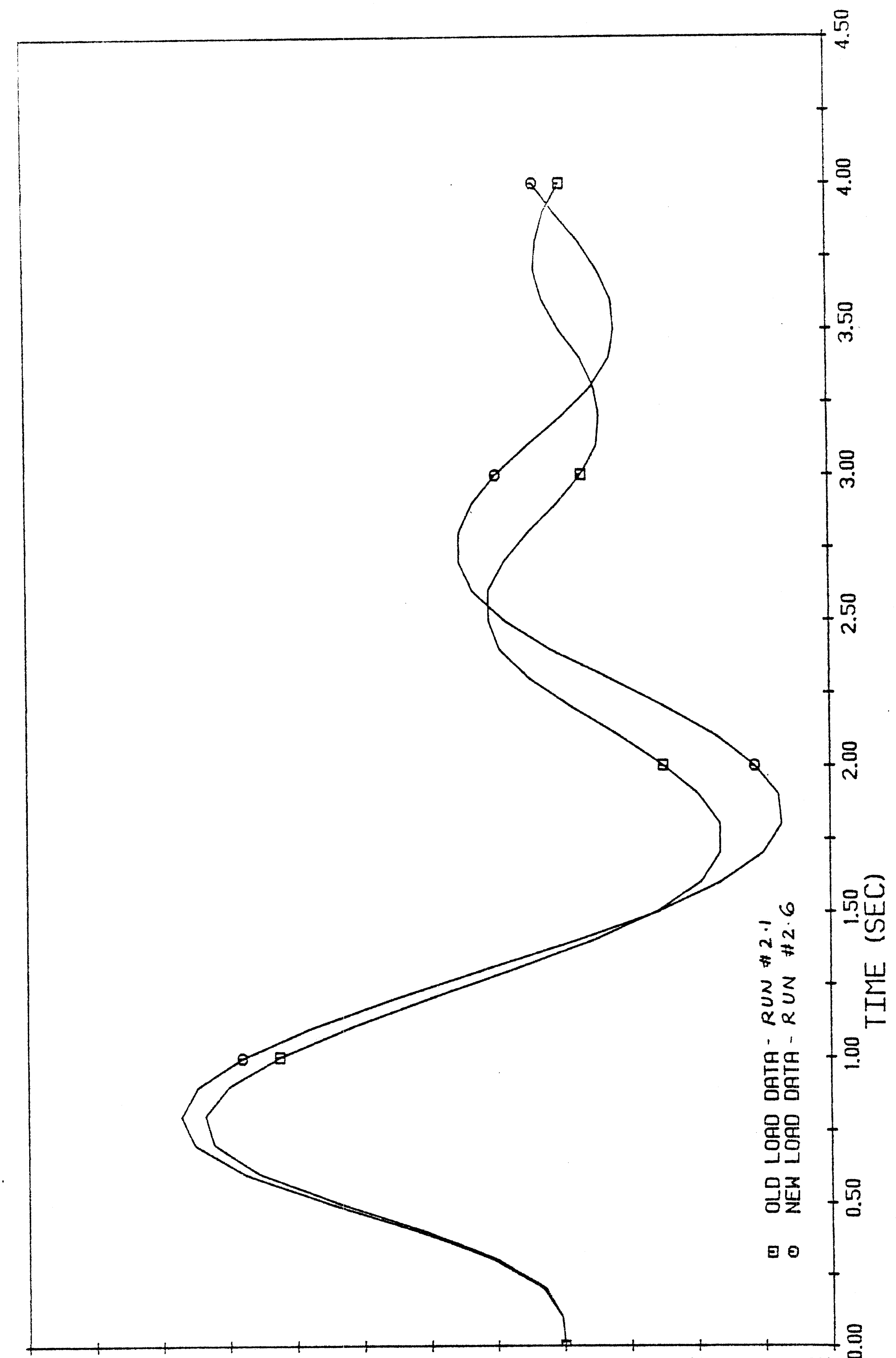
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF CONTROLLER, 100 KPH



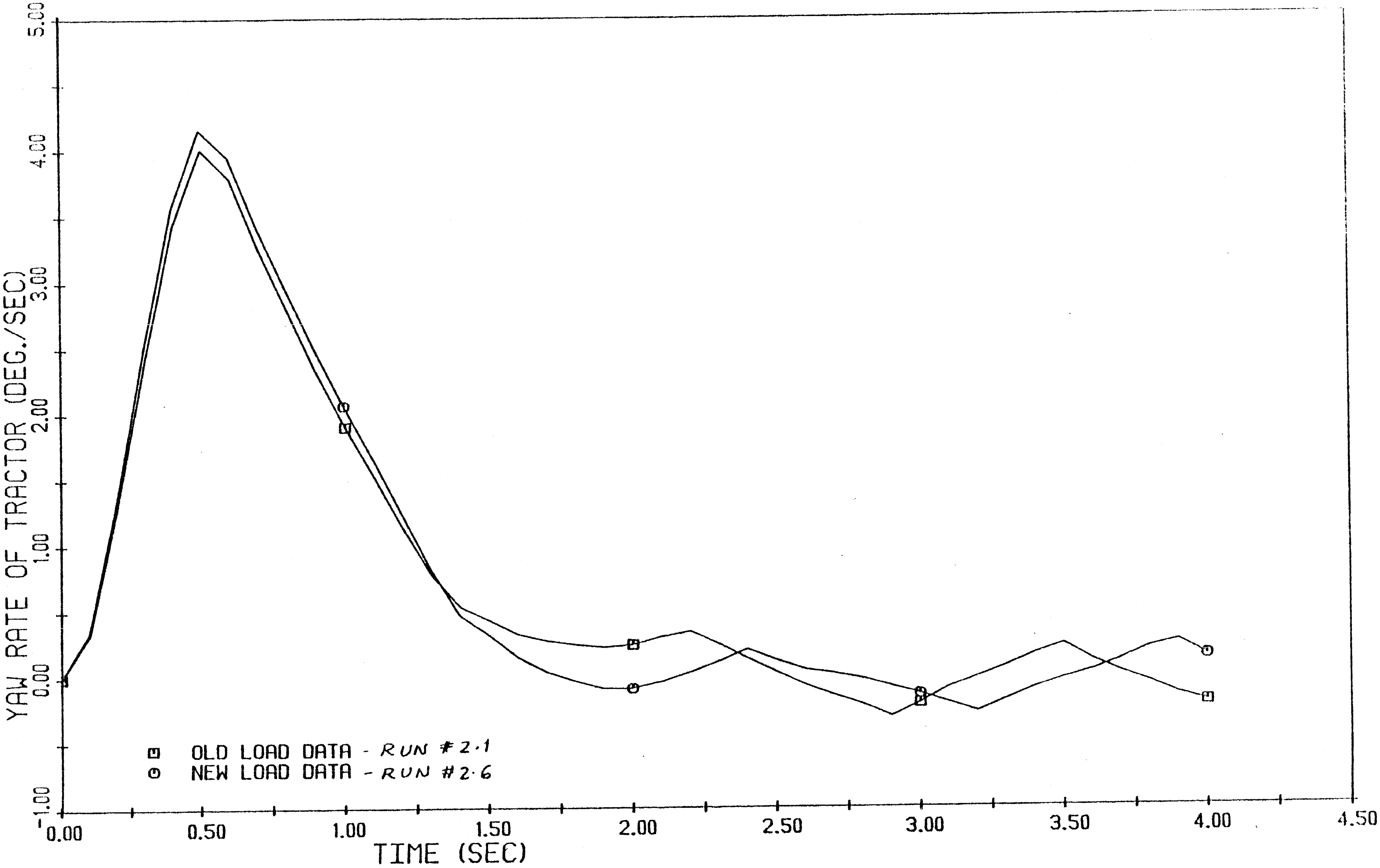
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF CONTROLLER, 100 KPH



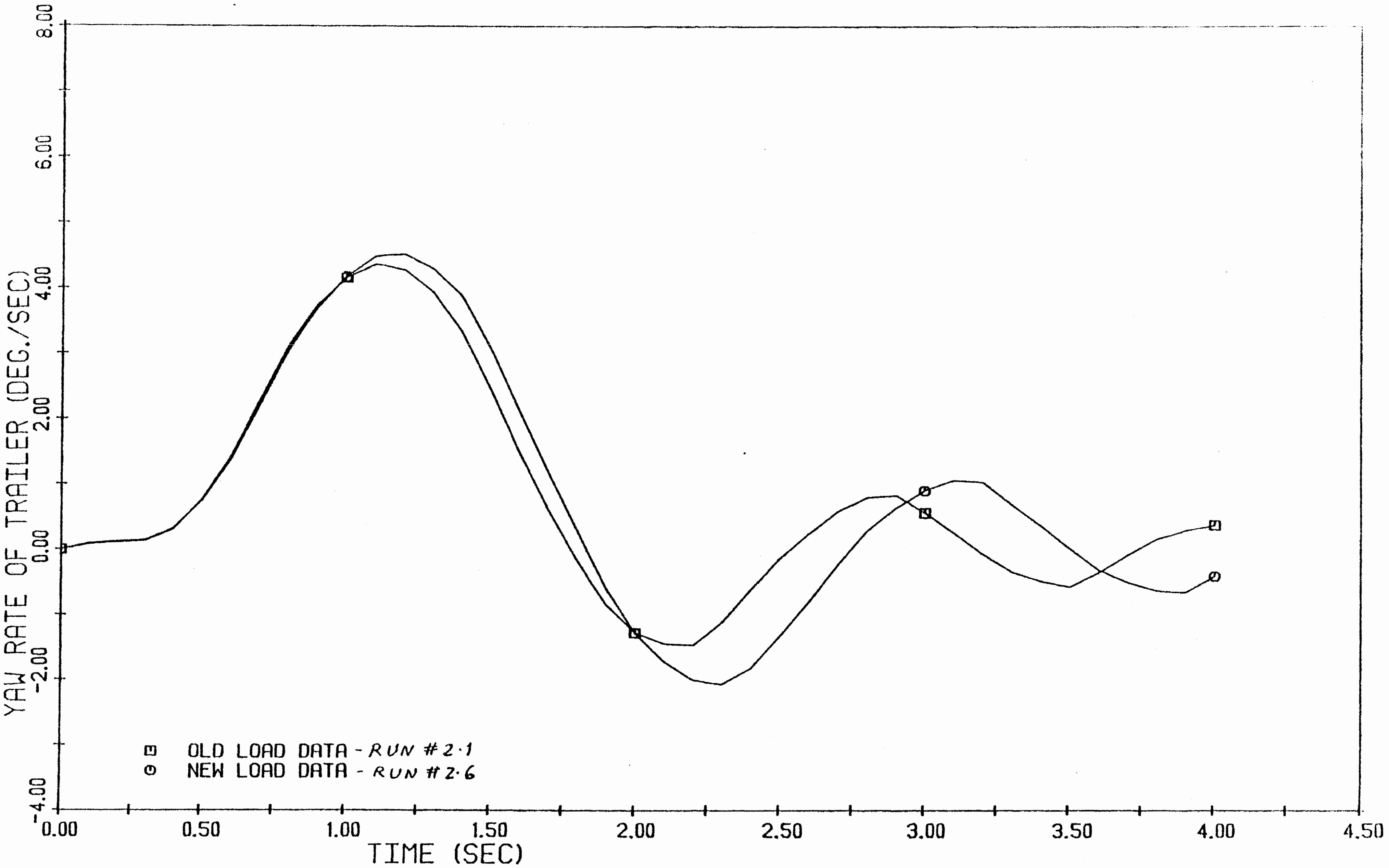
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF CONTROLLER, 100 KPH



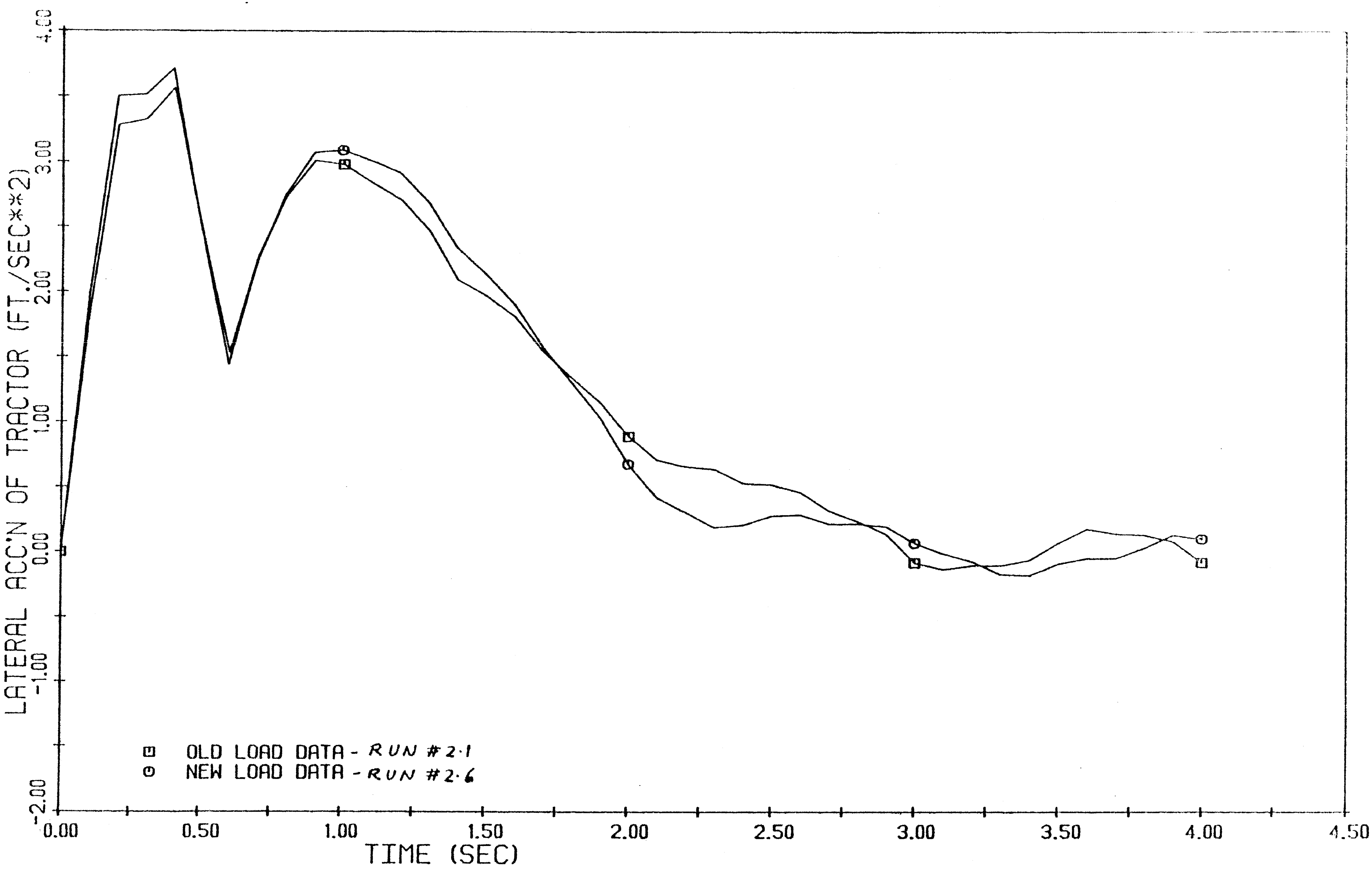
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF LOAD DISTRIBUTION



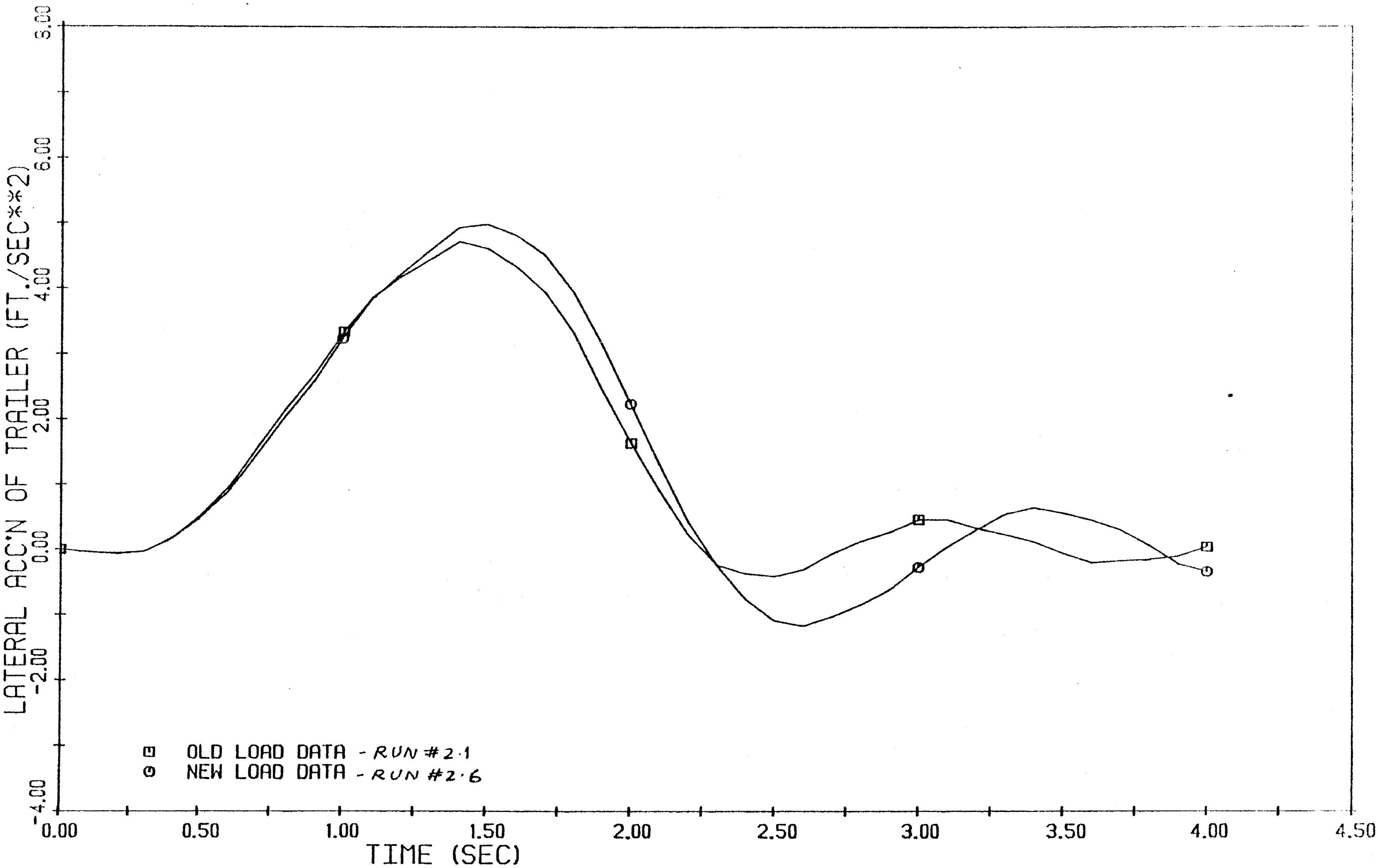
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF LOAD DISTRIBUTION



CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF LOAD DISTRIBUTION



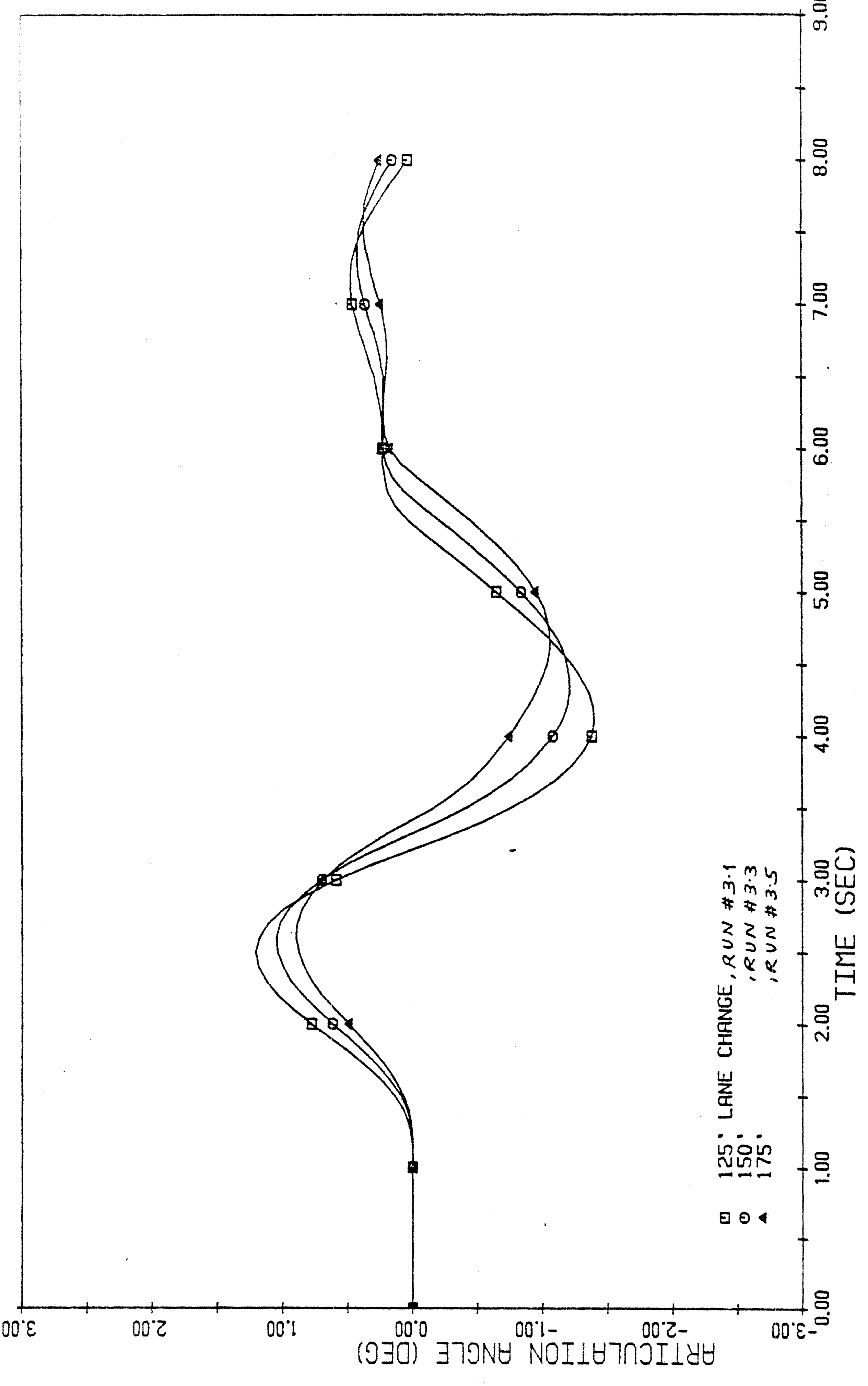
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF LOAD DISTRIBUTION



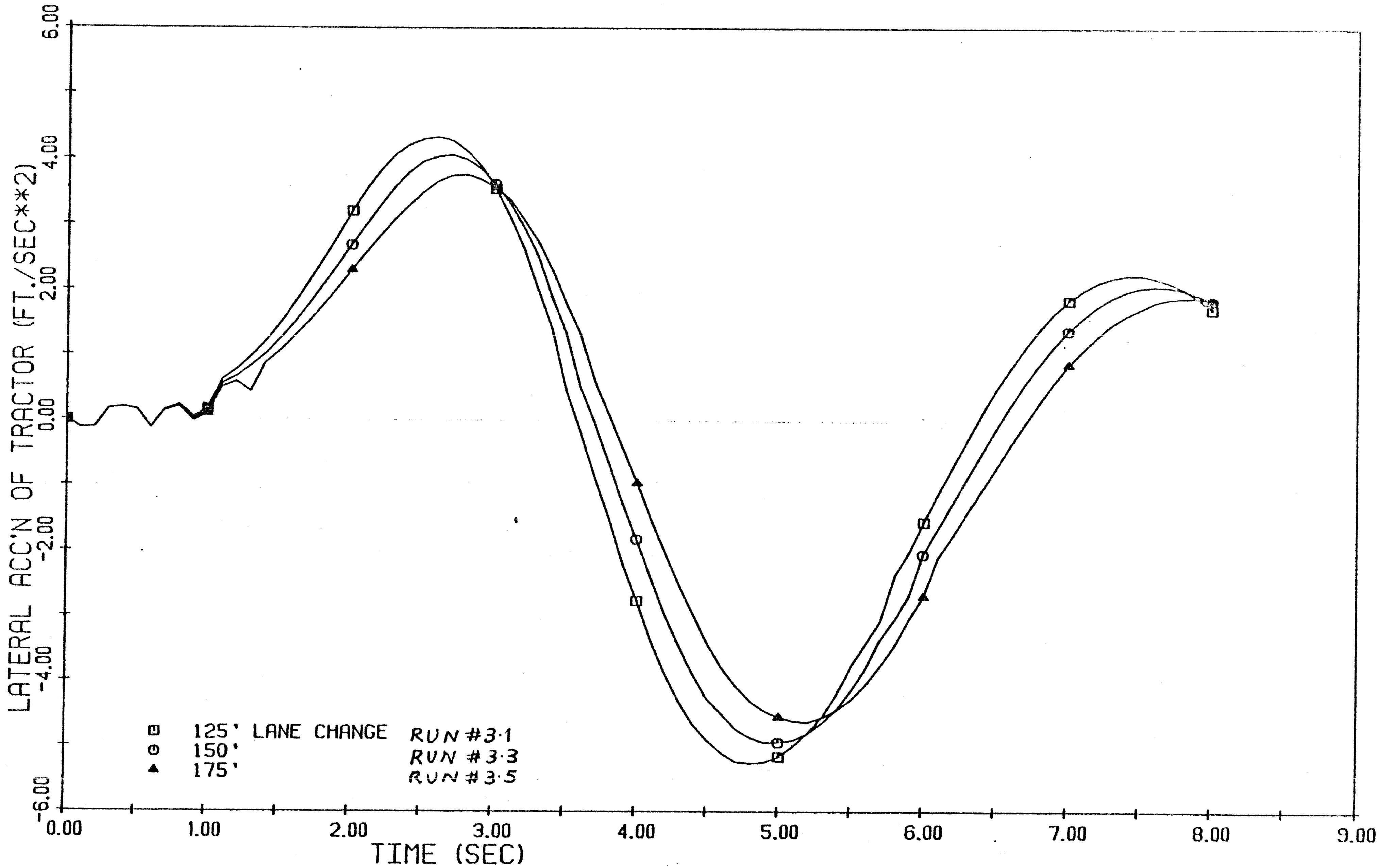
CANADIAN ARTIC BUS, EMPTY, PULSE STEER, INFLUENCE OF LOAD DISTRIBUTION

Table 3. Twelve-Foot Lane-Change Maneuver

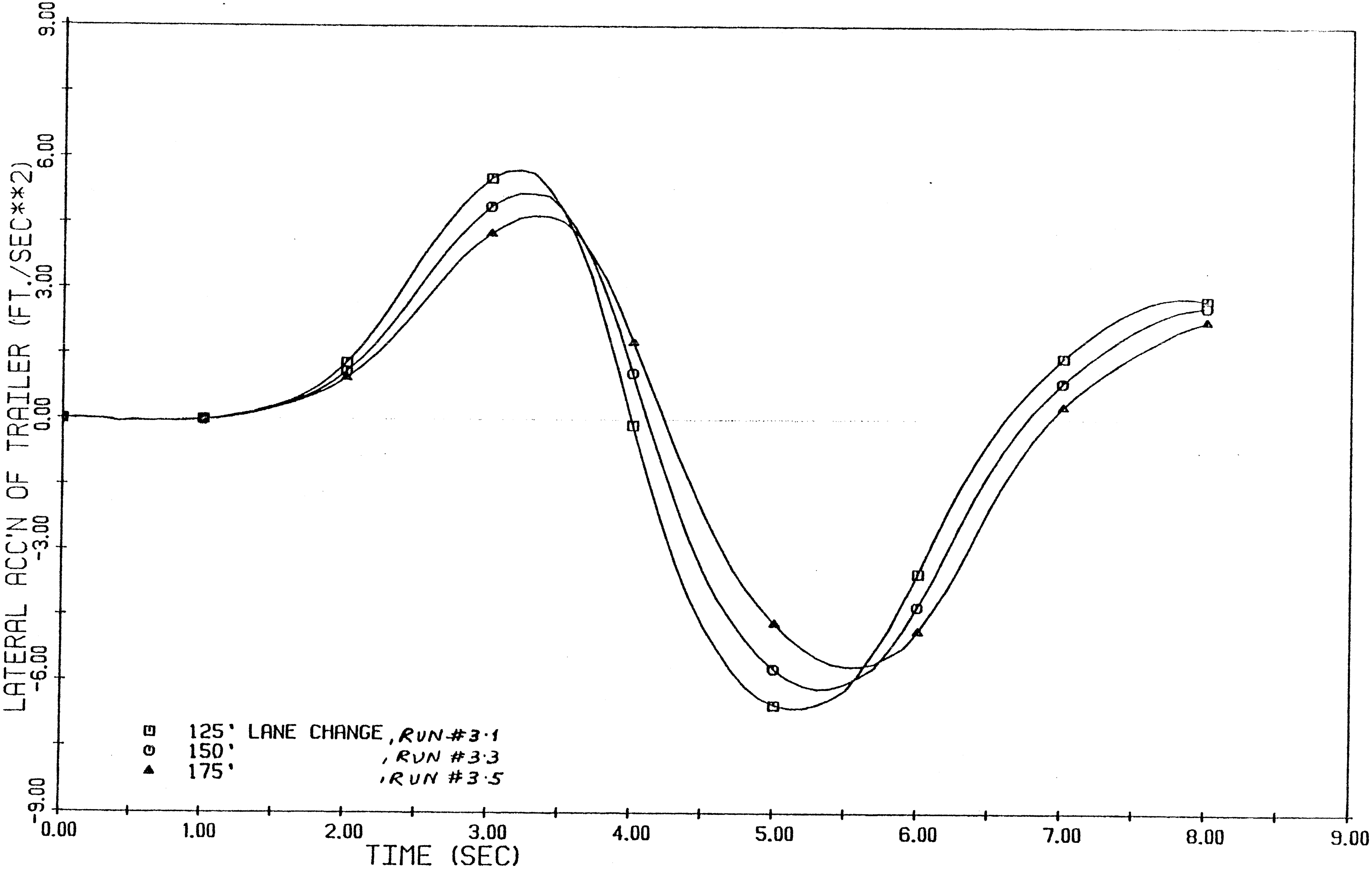
Run #	Calculation #	Loading Condition	Speed (KPH)	Maneuver	Articulation Controller	Comments
3.1	25	E	100	Lane Change Dist. = 125'	Yes	τ=0.25, Prev.=1.75
3.2	24	E	100	150'	Yes	τ=0.25, Prev.=1.50
3.3	26	E	100	150'	Yes	τ=0.25, Prev.=1.75
3.4	28	E	100	150'	Yes	τ=0.25, Prev.=2.0
3.5	27	E	100	175'	Yes	τ=0.25, Prev.=1.75
3.6	21	L	100	125'	Yes	τ=0.25, Prev.=1.75
3.7	20	L	100	150'	Yes	τ=0.25, Prev.=1.5
3.8	22	L	100	150'	Yes	τ=0.25, Prev.=1.75
3.9	19	L	100	150'	Yes	τ=0.25, Prev.=2.0
3.10	23	L	100	175'	Yes	τ=0.25, Prev.=1.75



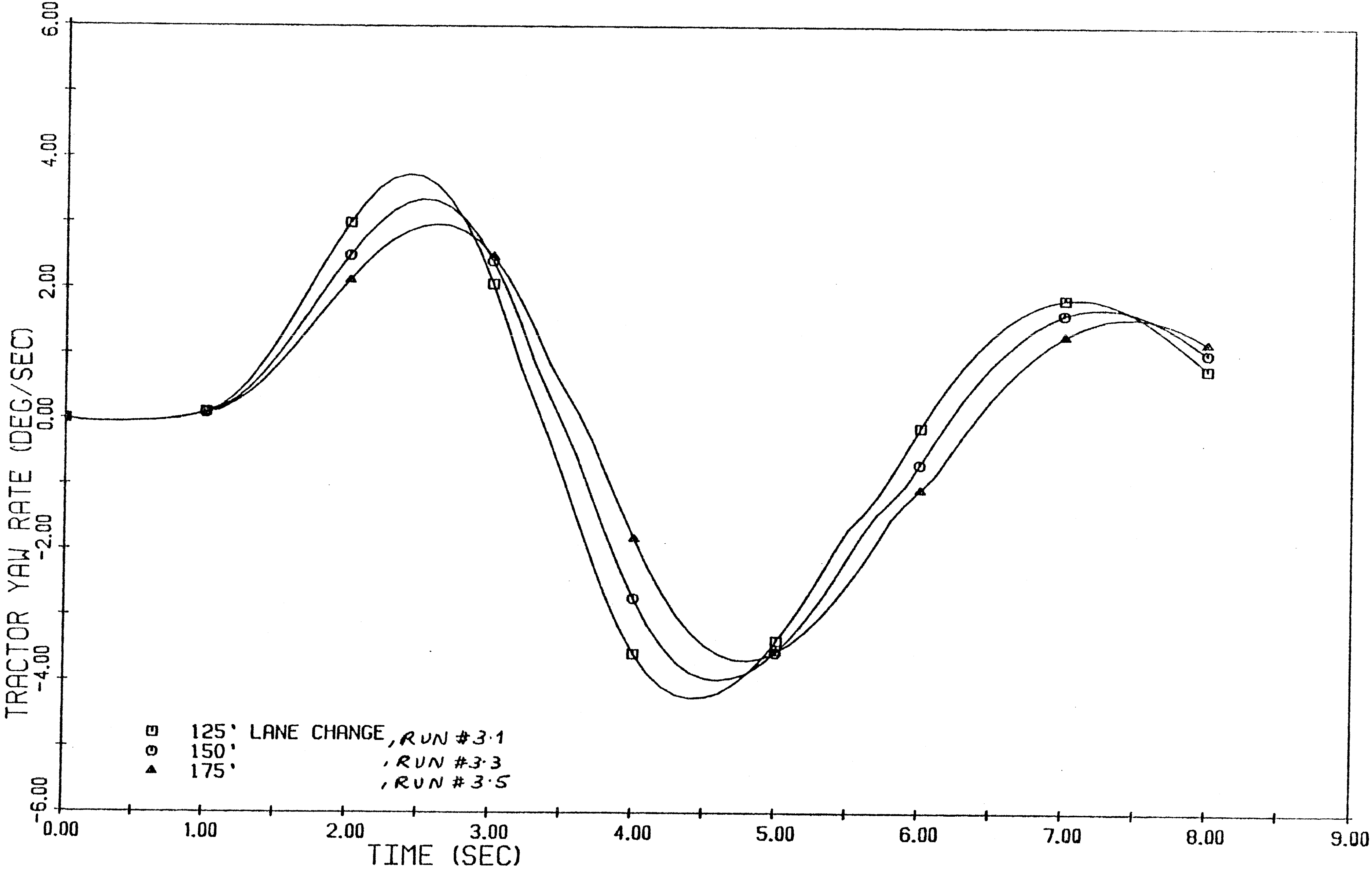
CANADIAN ARTIC BUS, EMPTY, 12' LCHANGE, 100 KPH, INFLUENCE OF LANE CHANGE



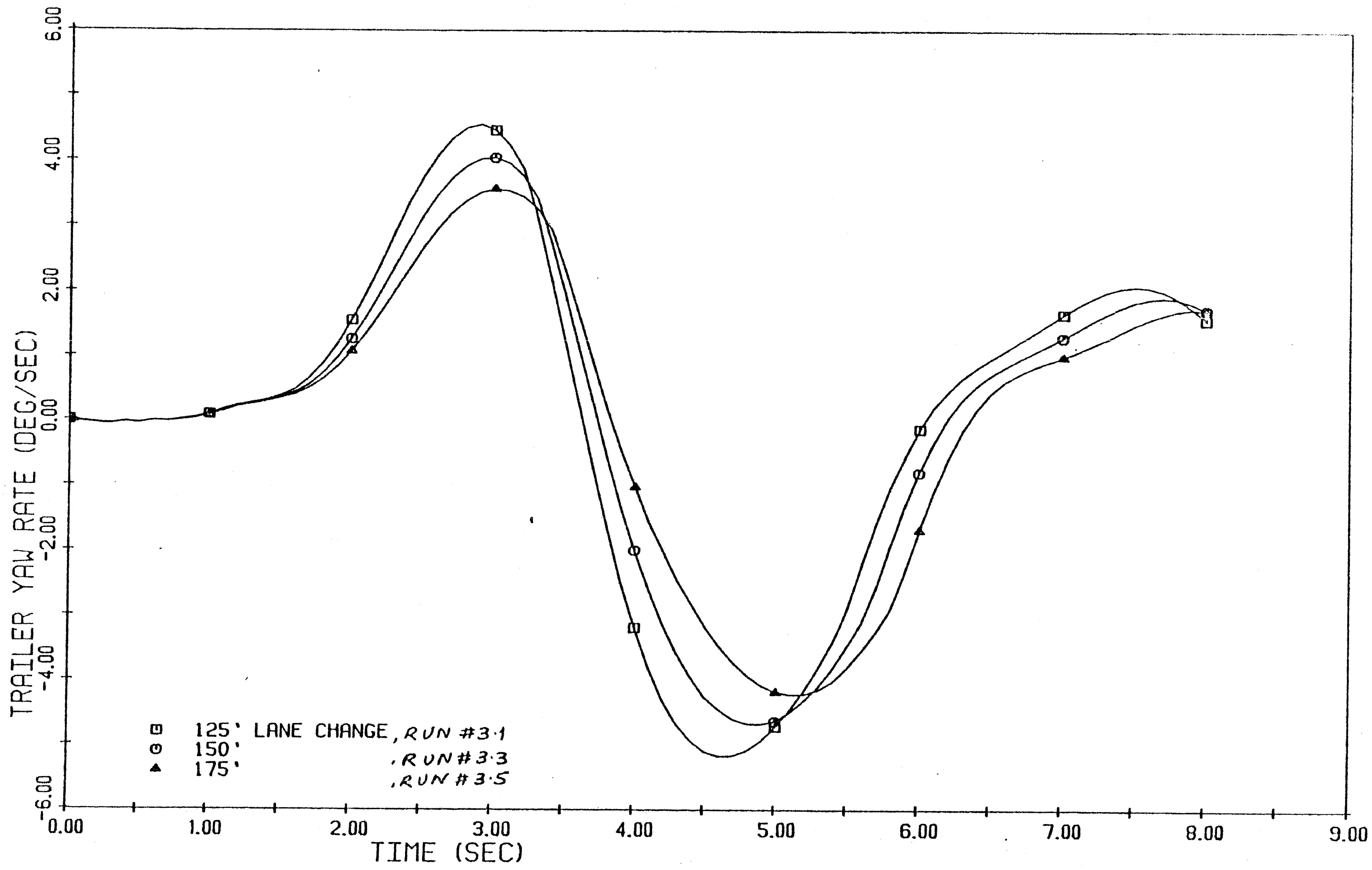
CANADIAN ARTIC BUS, EMPTY, 12' LCHANGE, 100 KPH, INFLUENCE OF LANE CHANGE DISTANC



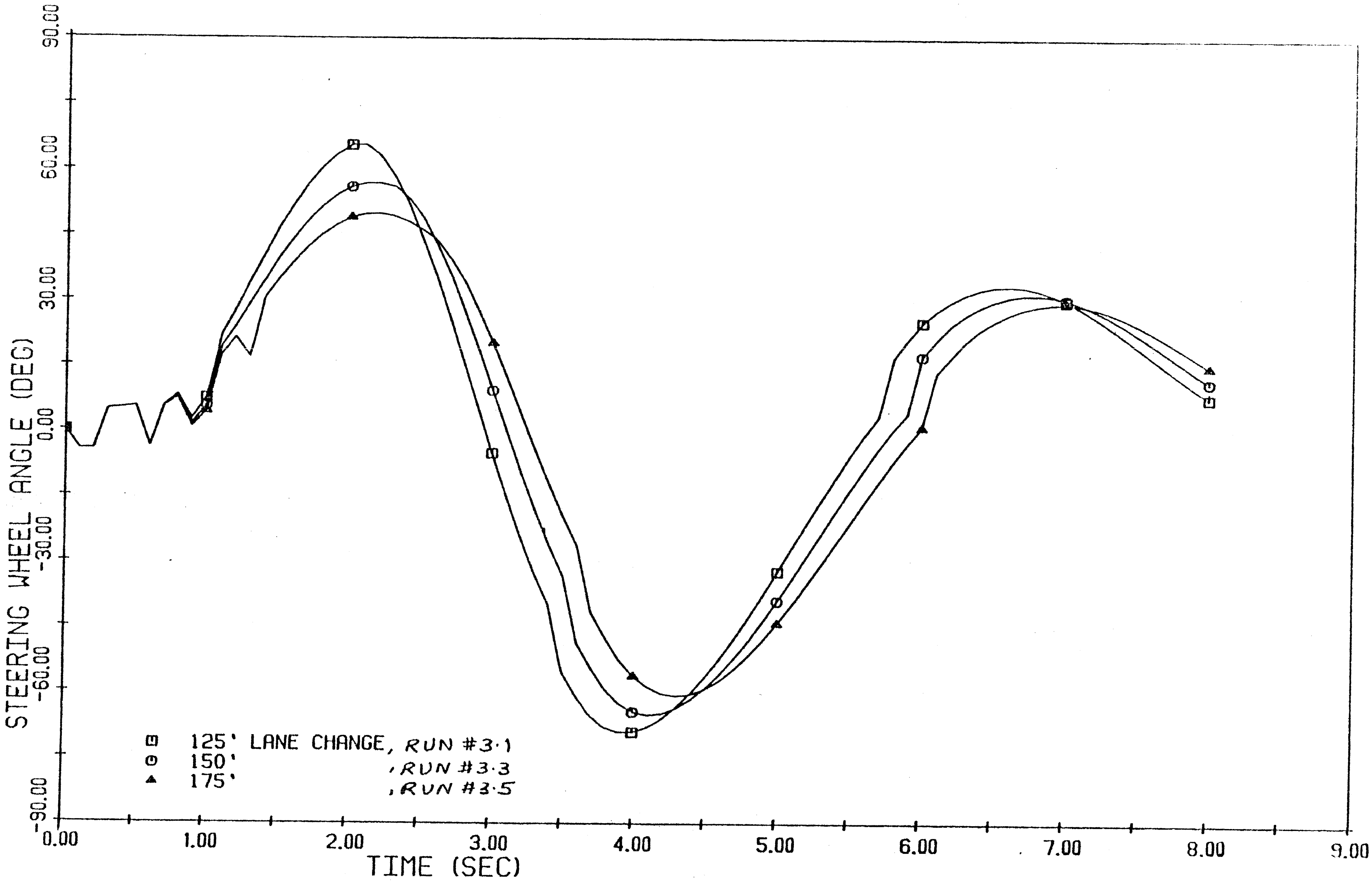
CANADIAN ARTIC BUS, 12' LCHANGE, 100 KPH, INFLUENCE OF LANE CHANGE DISTANCE



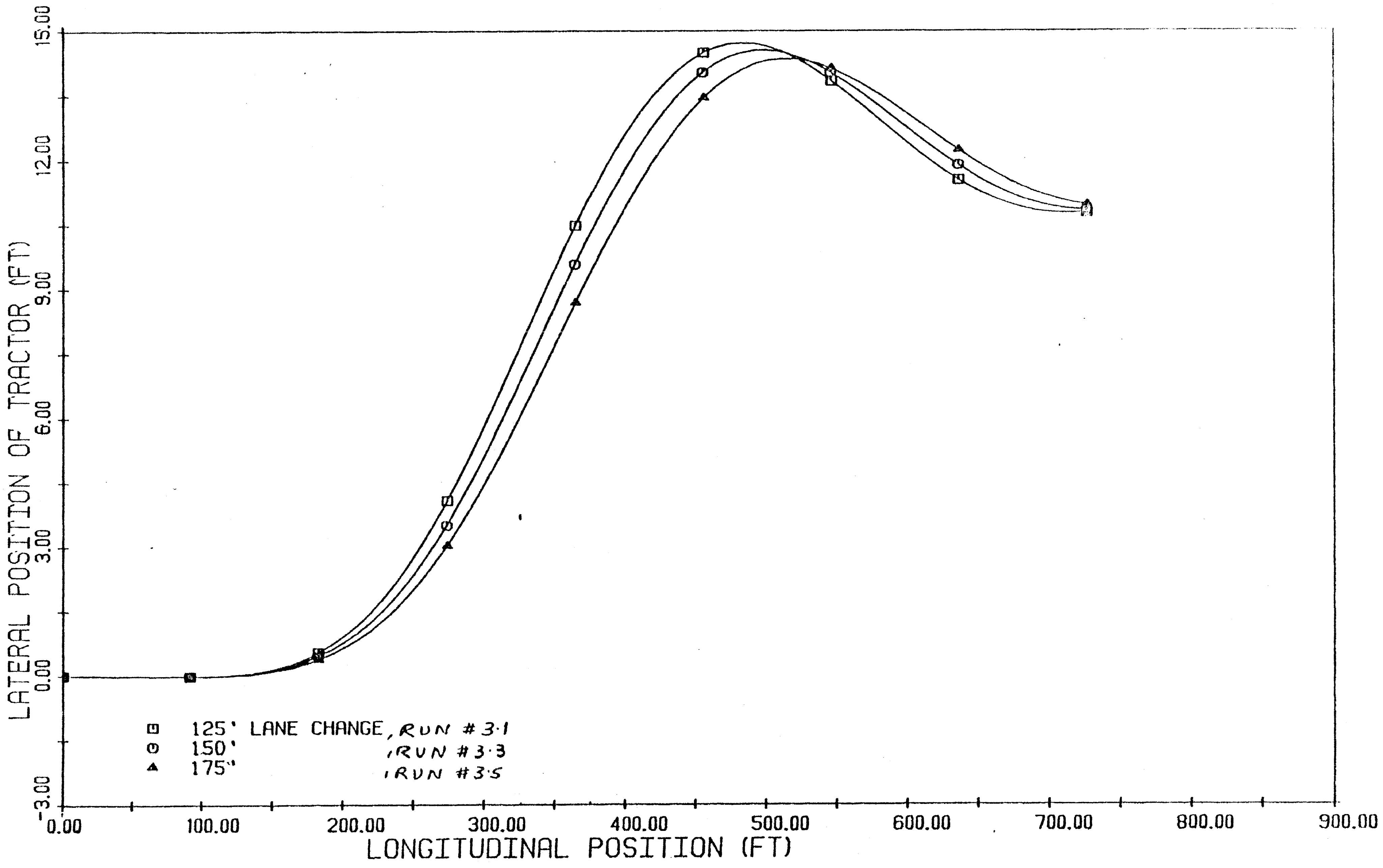
CANADIAN ARTIC BUS, *EMPTY*, 100 KPH, INFLUENCE OF LANE CHANGE DISTANCE



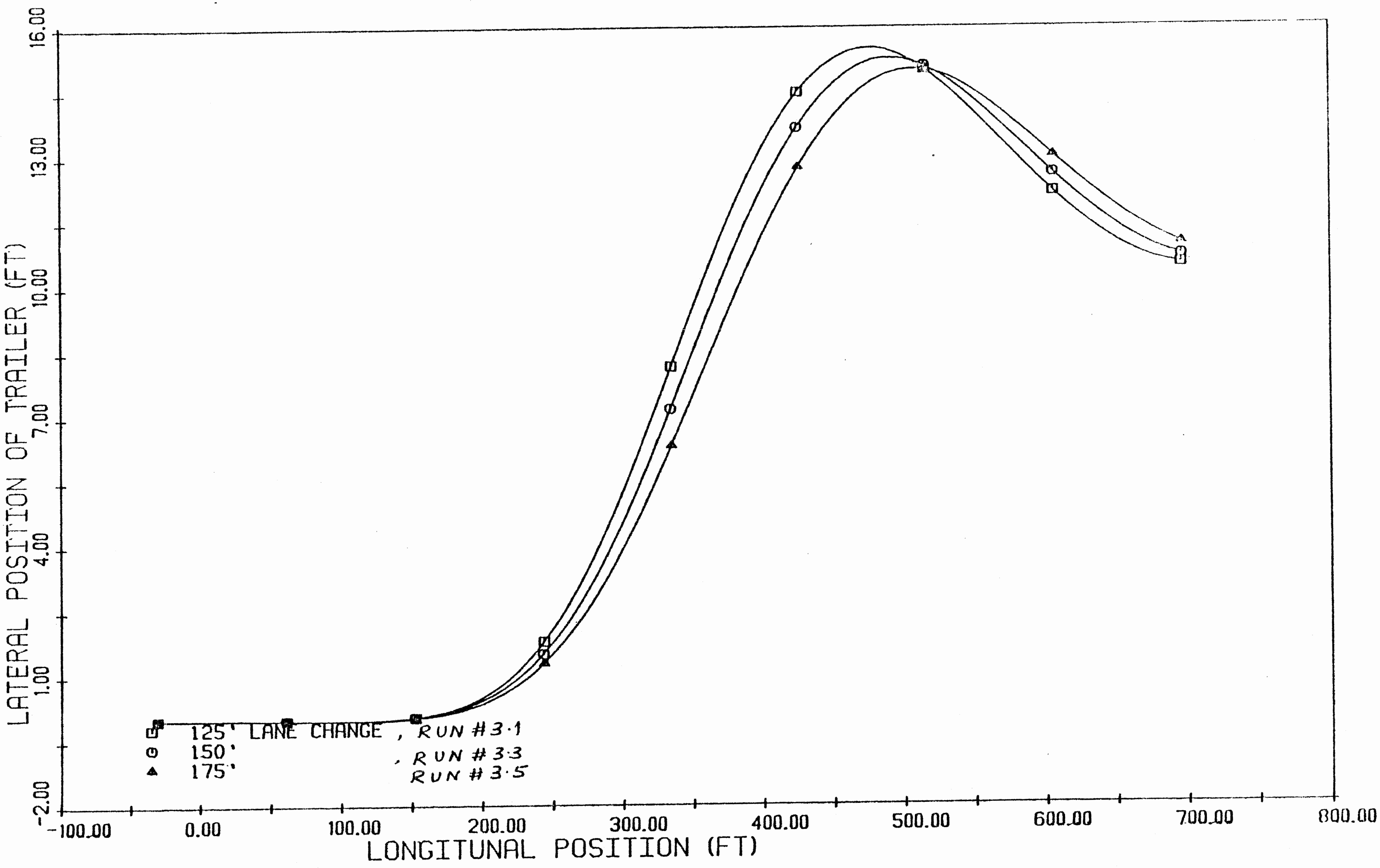
CANADIAN ARTIC BUS, EMPTY , 12' LCHANGE, 100 KPH, INFLUENCE OF LANE CHANGE



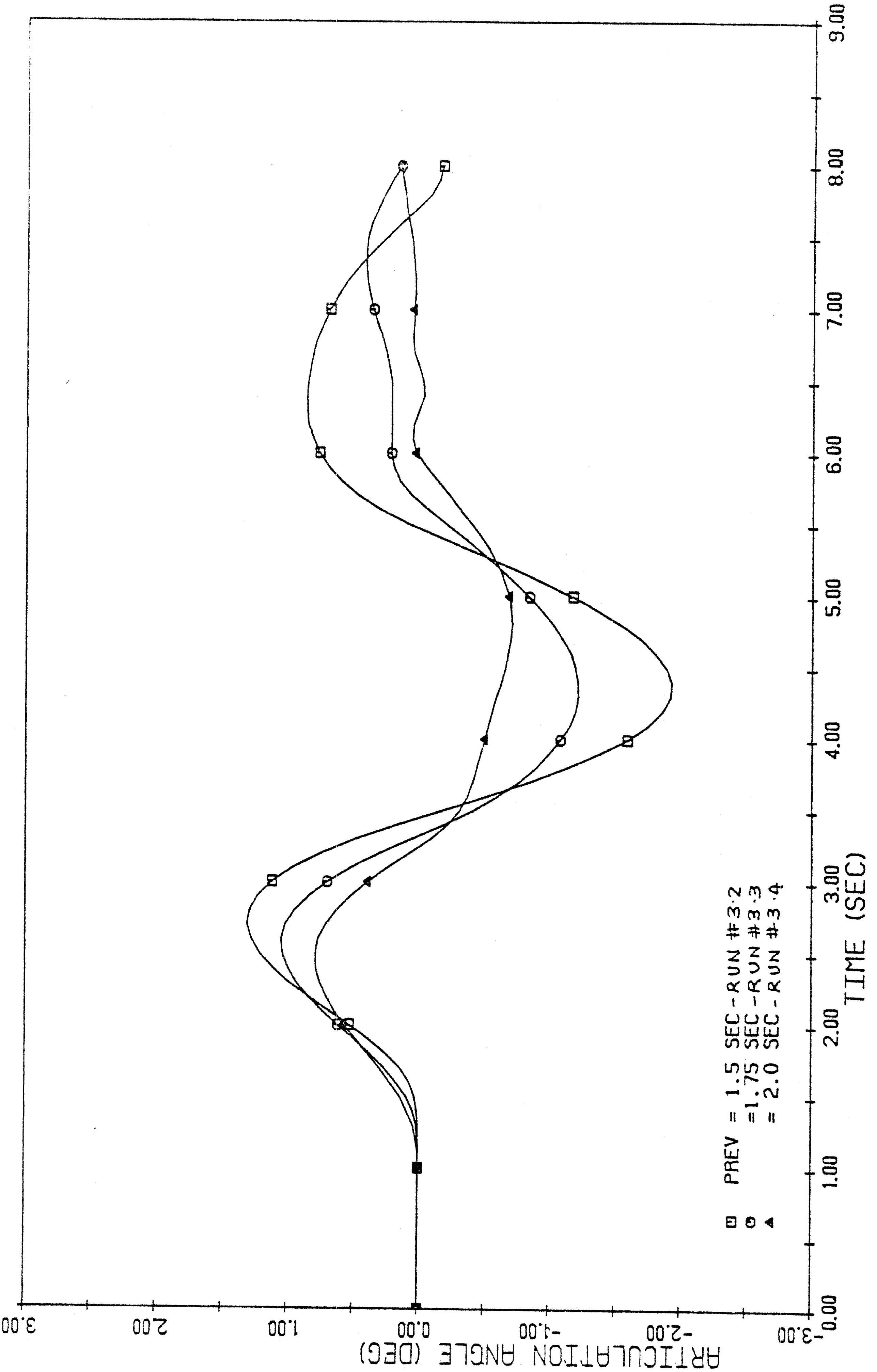
CANADIAN ARTIC BUS, EMPTY, 100 KPH, 12' LCHANGE, INFLUENCE OF LANE CHANGE



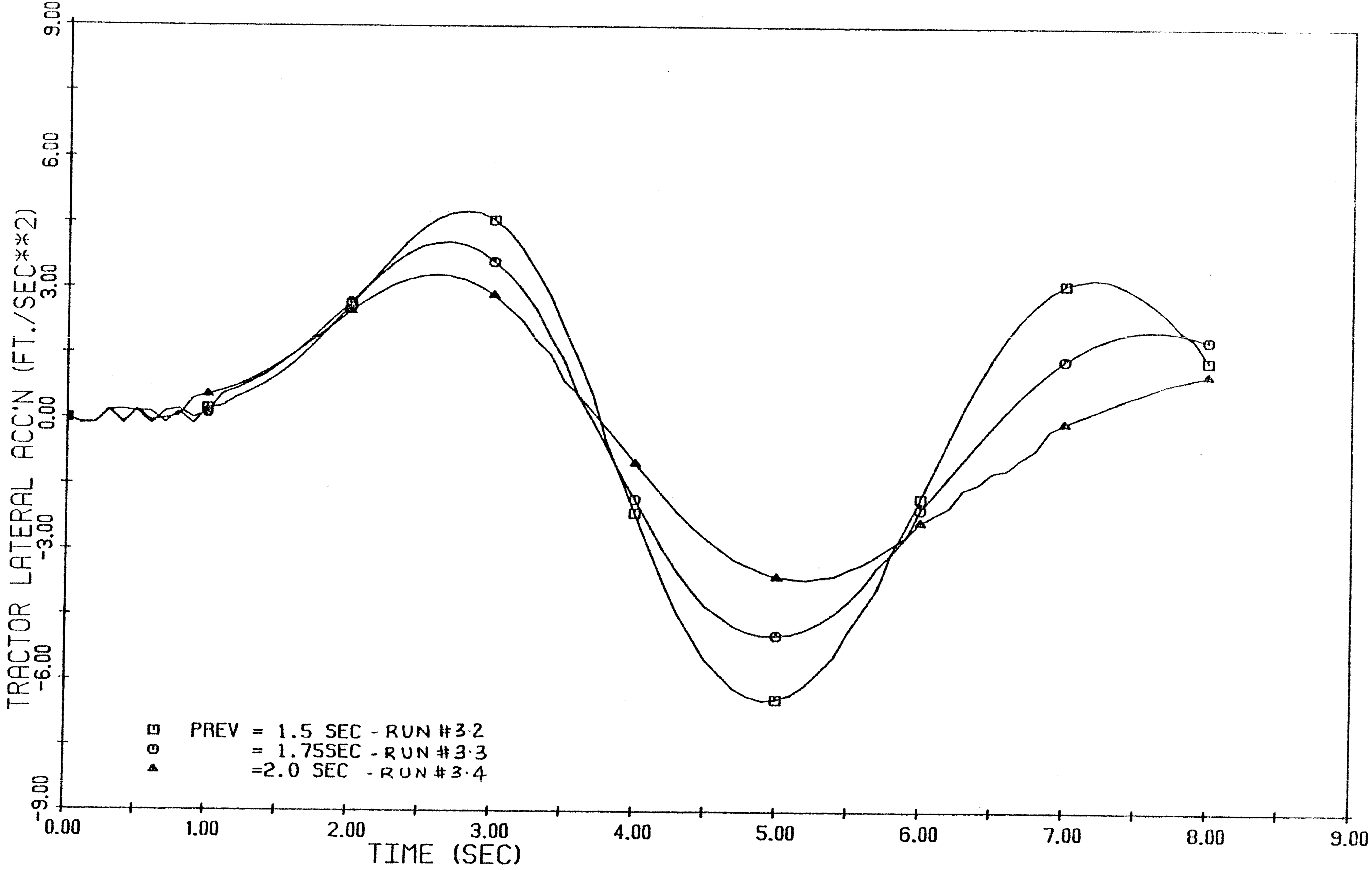
CANADIAN ARTIC BUS, EMPTY, 100 KPH, 12' LCHANGE, INFLUENCE OF LANE CHANGE



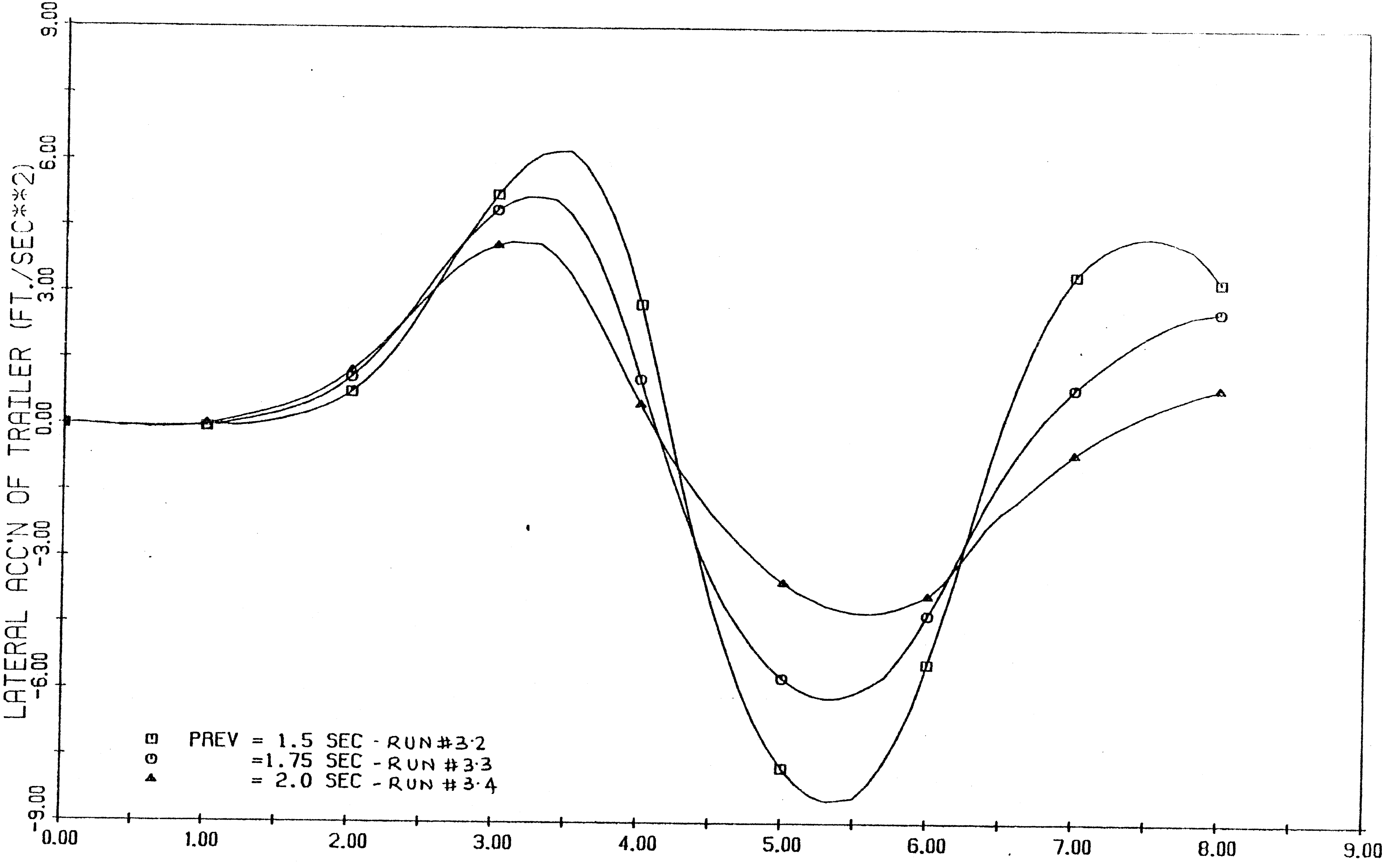
CANADIAN ARTIC BUS, EMPTY, 100 KPH, 12' LCHANGE, INFLUENCE OF LANE CHANGE



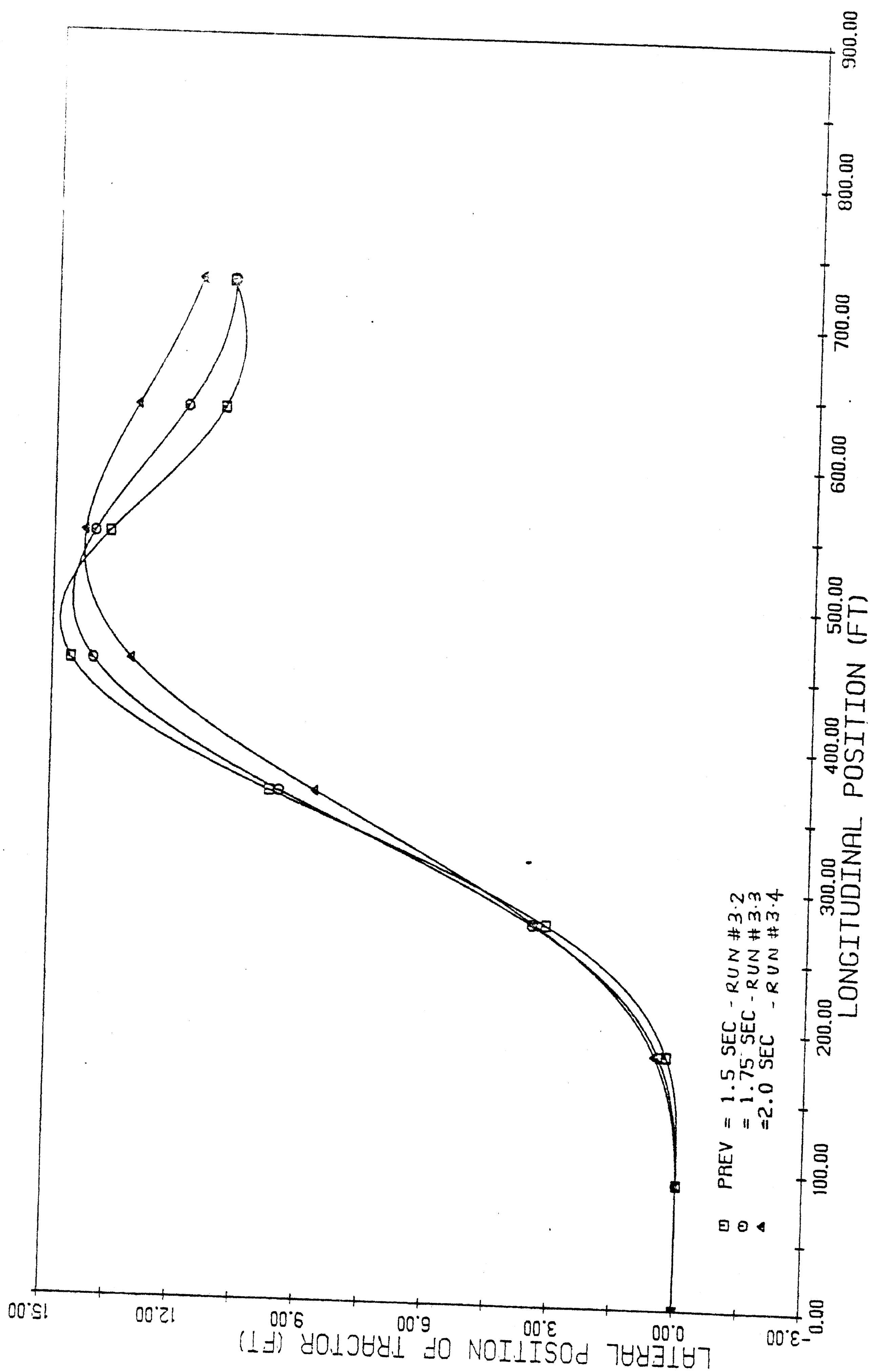
CANADIAN ARTIC BUS, EMPTY, INFLUENCE OF PREV INTERVAL, 12' LCHANGE, 150'



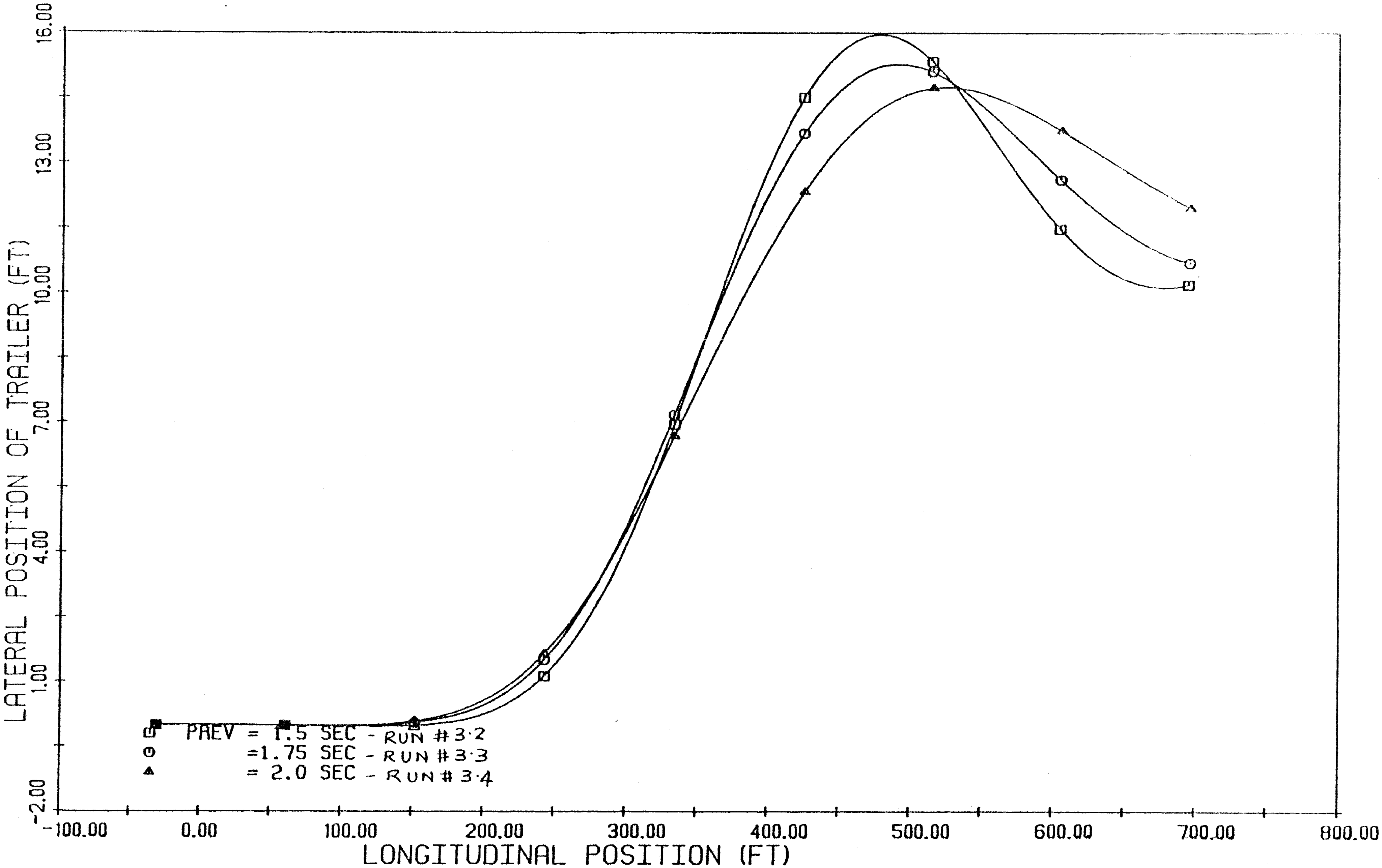
CANADIAN ARTIC BUS, EMPTY, INFLUENCE OF PREV INTERVAL, 12' LCHANGE, 150'



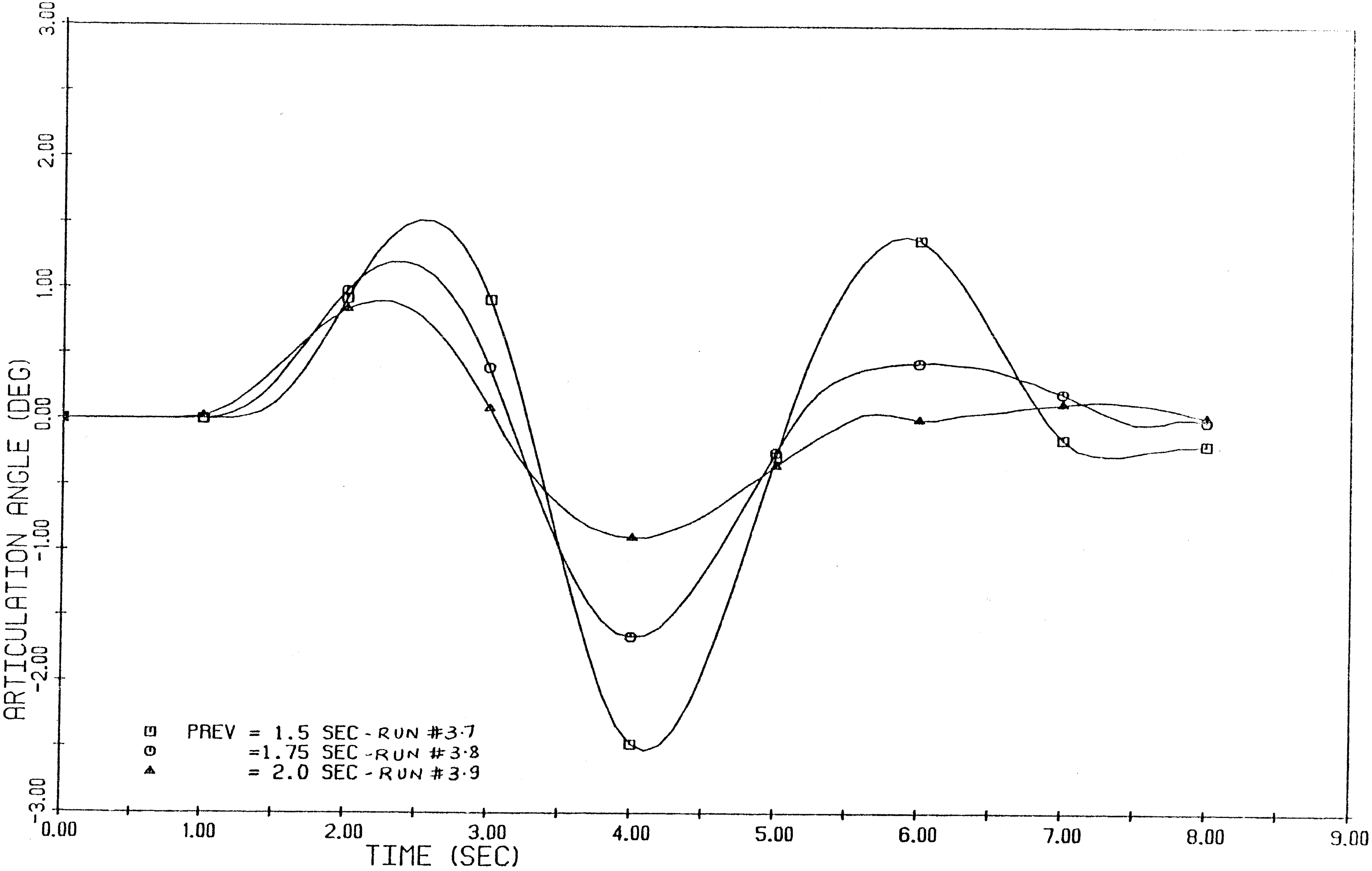
CANADIAN ARTIC BUS, EMPTY, INFLUENCE OF PREV INTERVAL, 12' LCHANGE, 150',



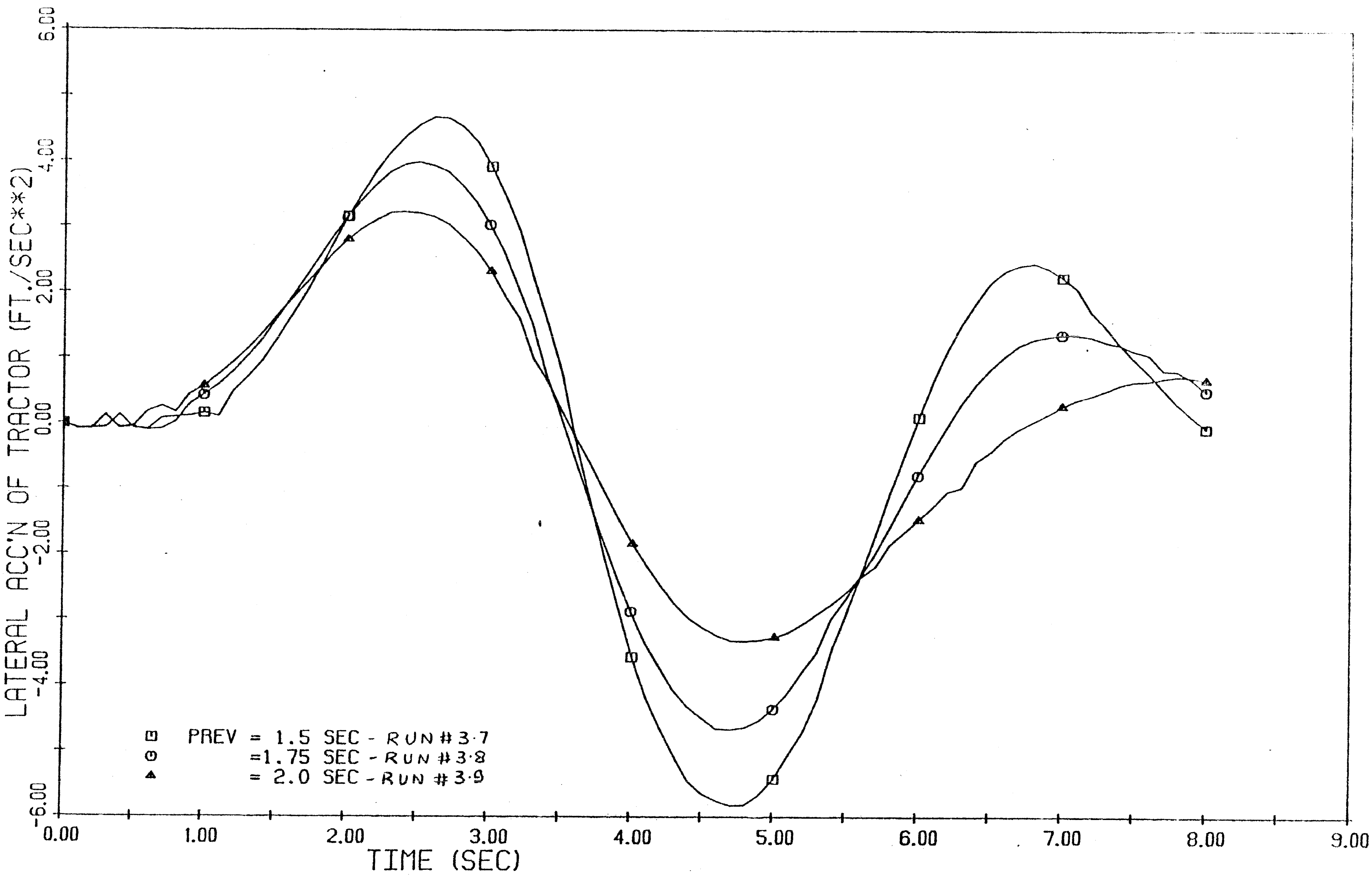
CANADIAN ARTIC BUS, EMPTY, INFLUENCE OF PREV INTERVAL, 12' LCHANGE, 150',



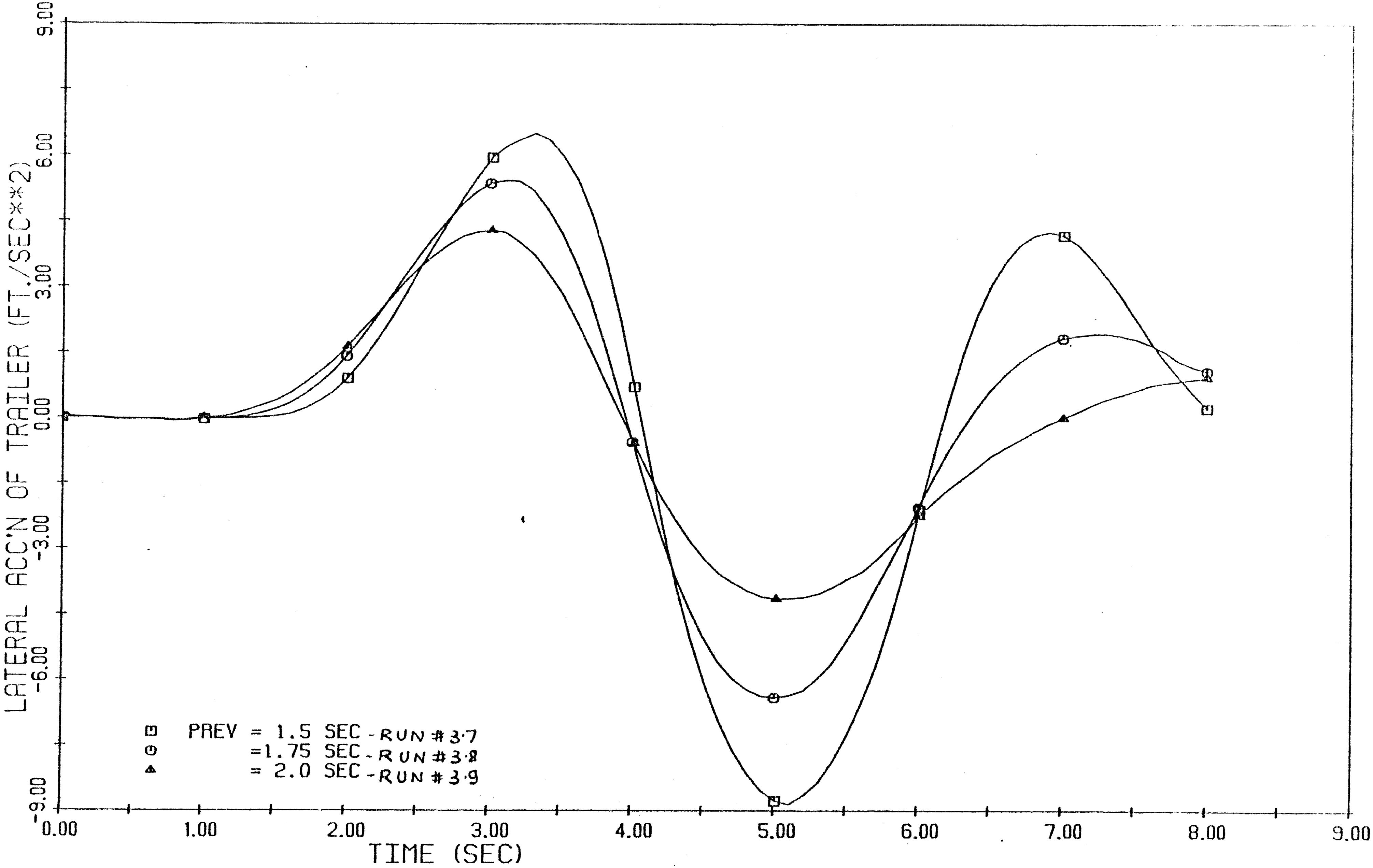
CANADIAN ARTIC BUS, INFLUENCE OF PREV INTERVAL, 12' LCHANGE, 150', E



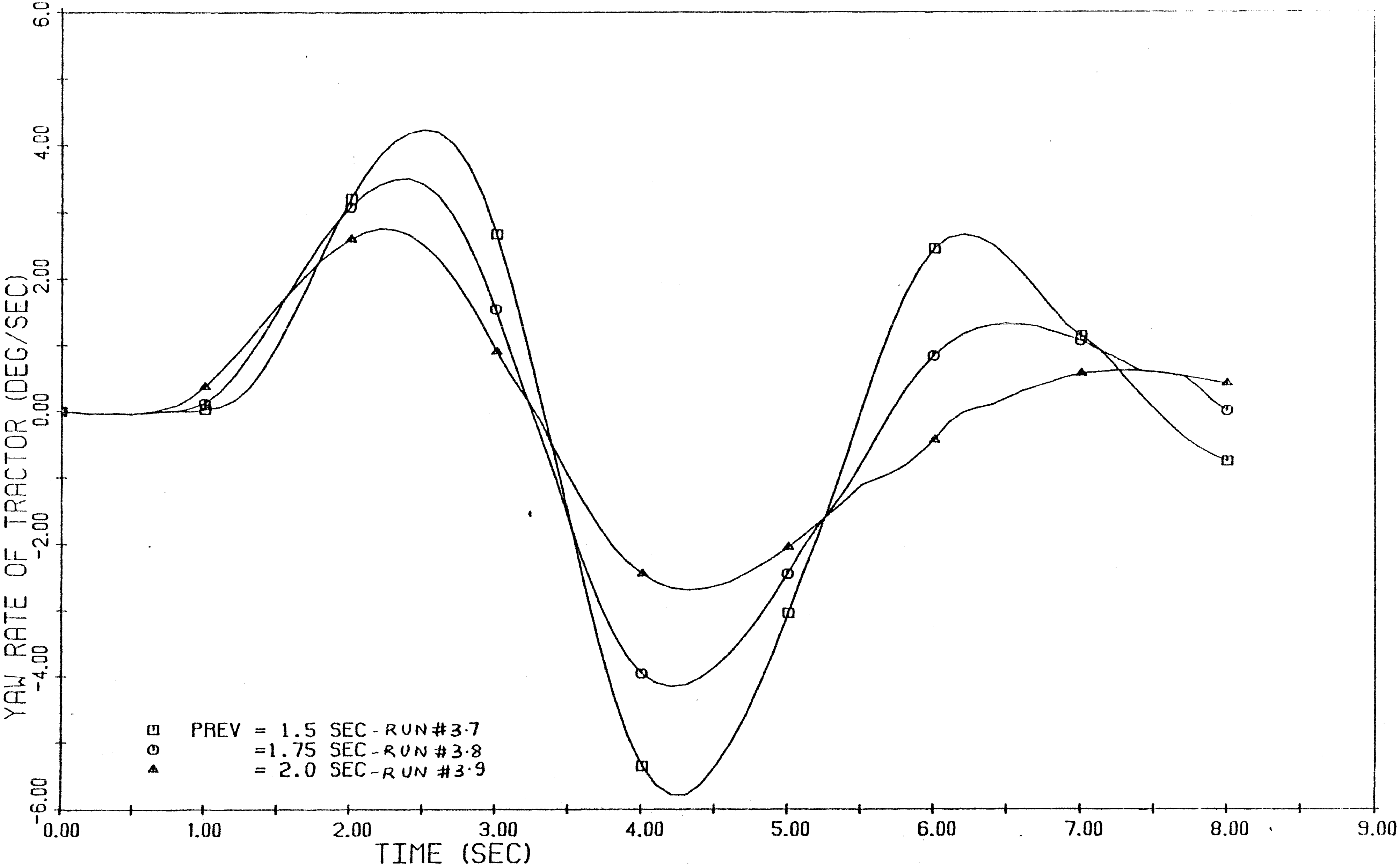
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



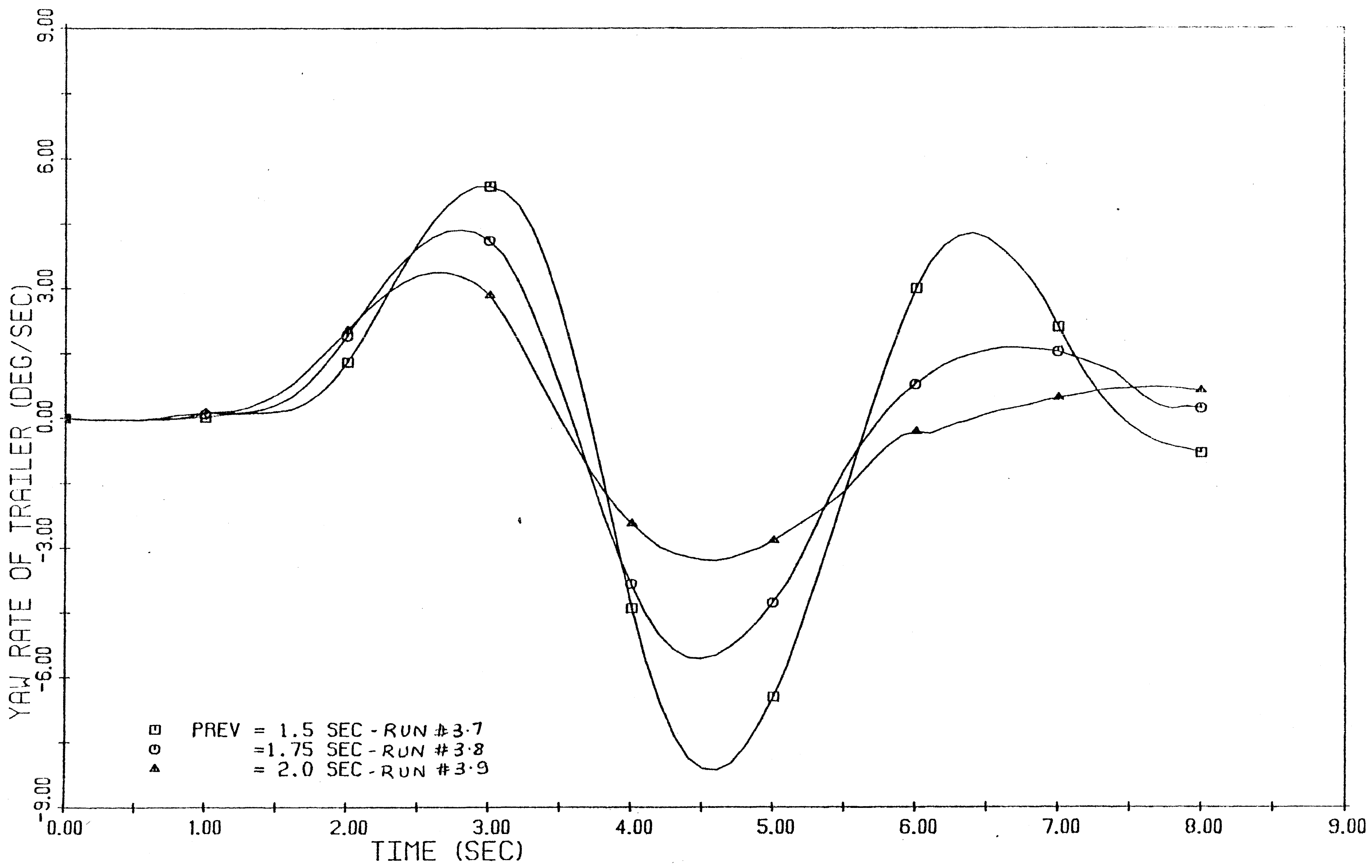
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



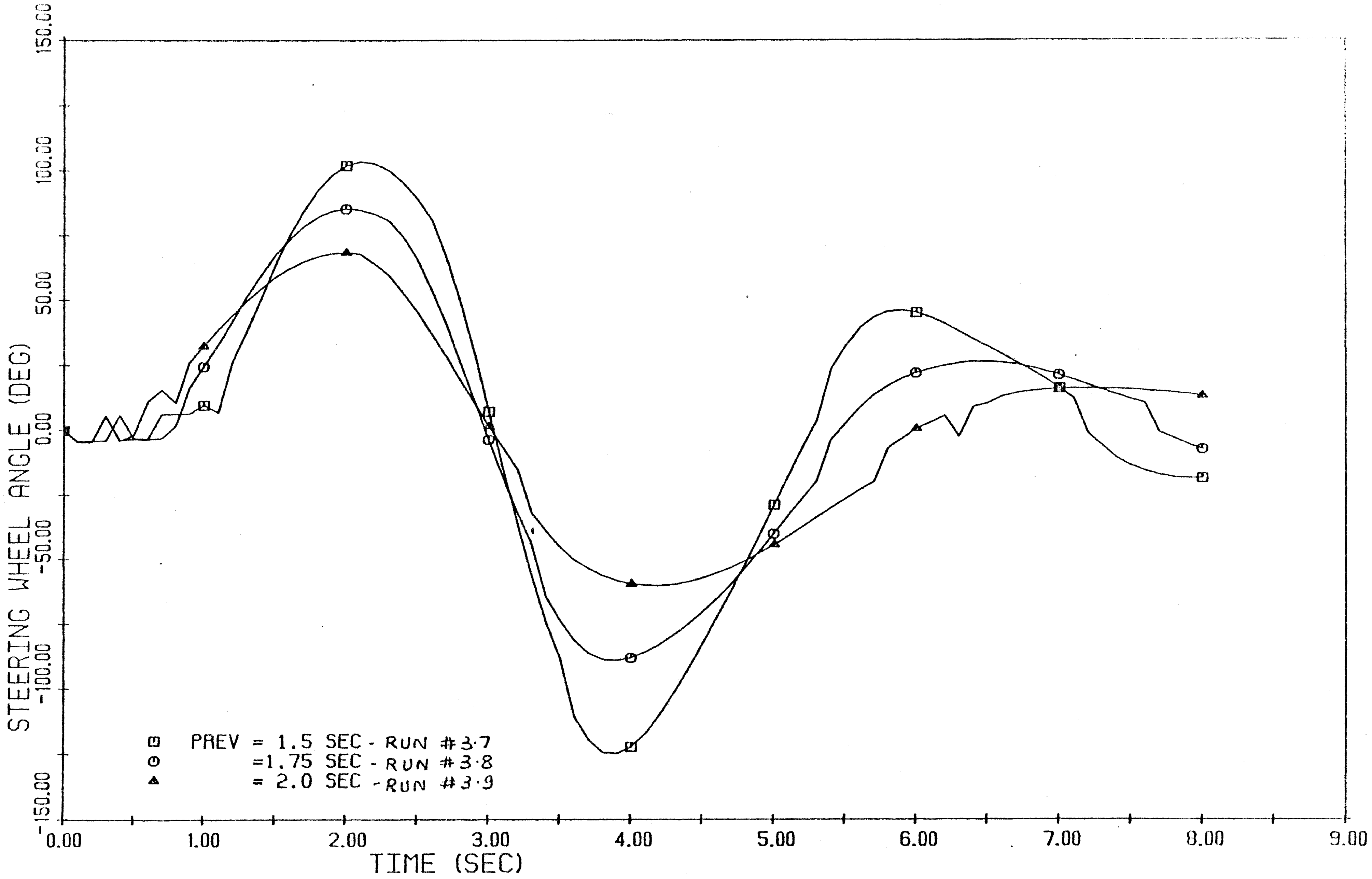
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



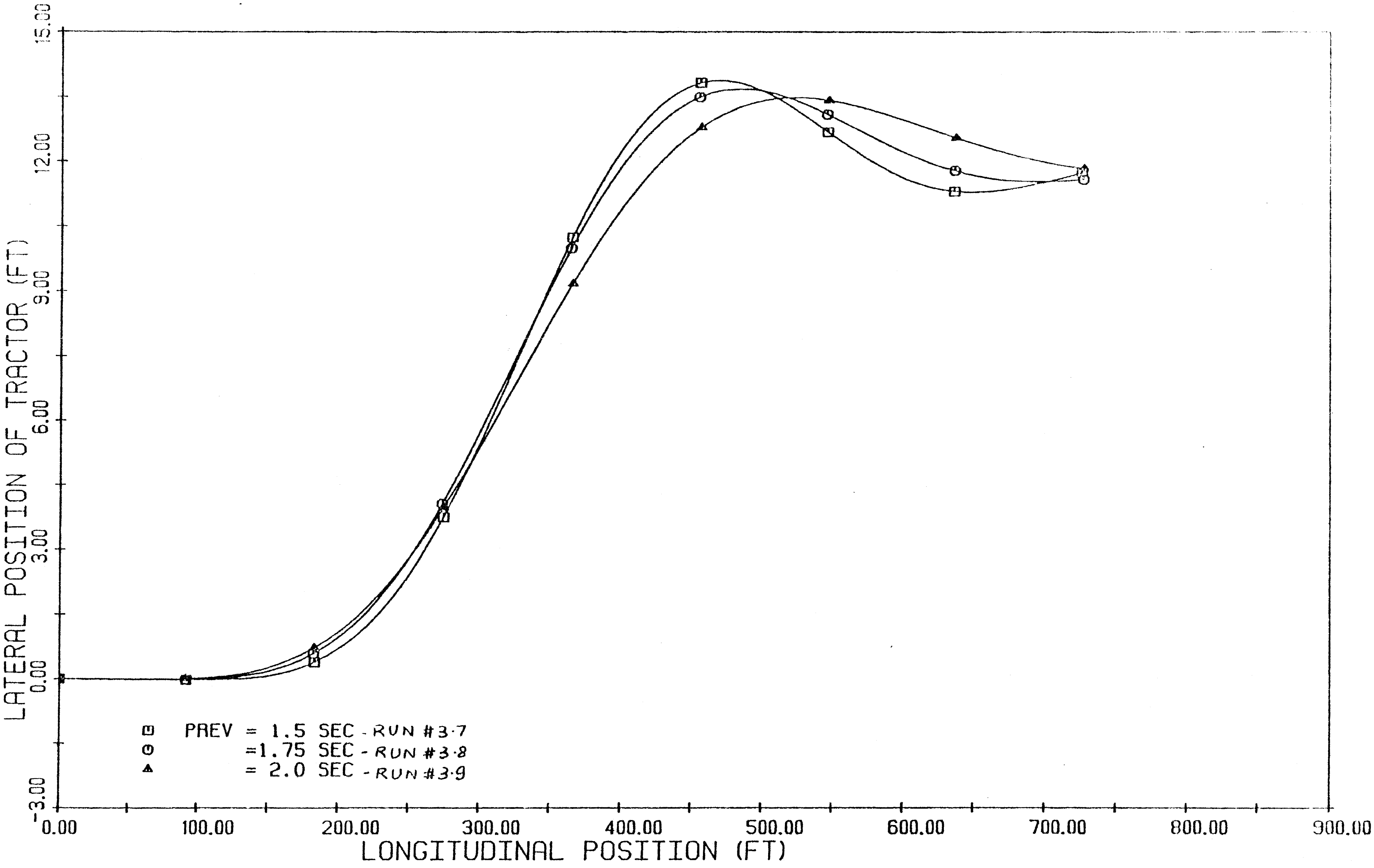
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



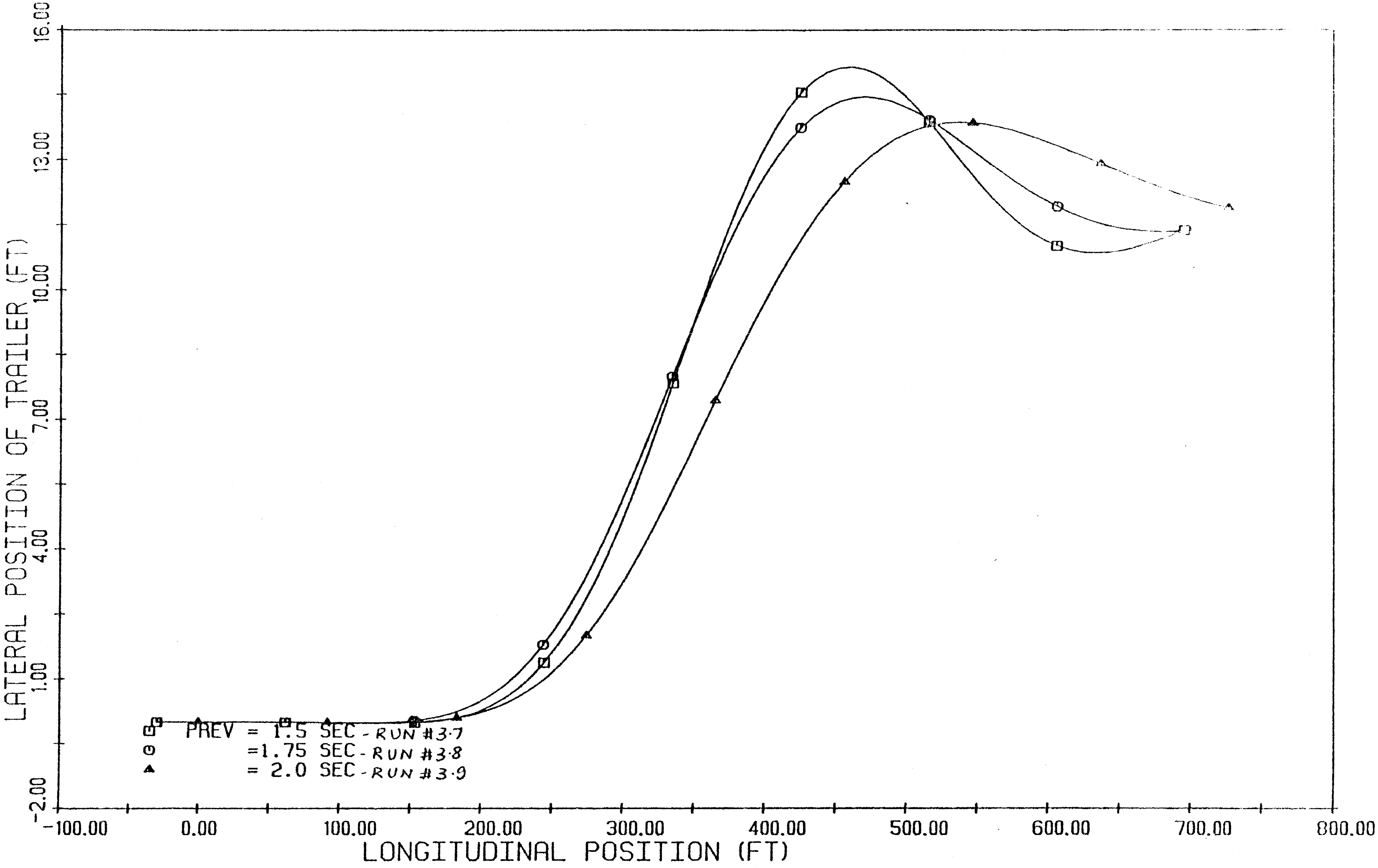
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



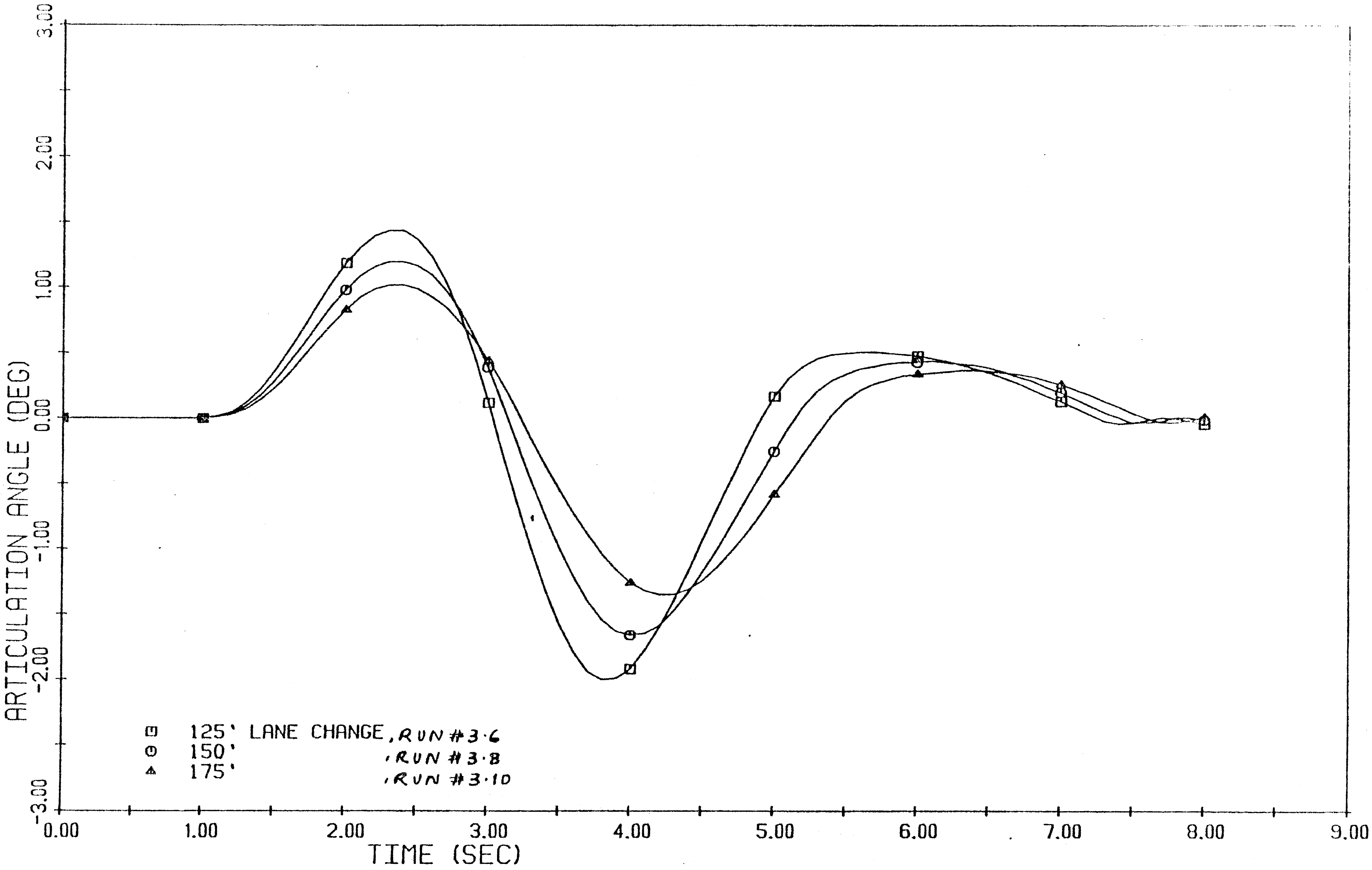
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



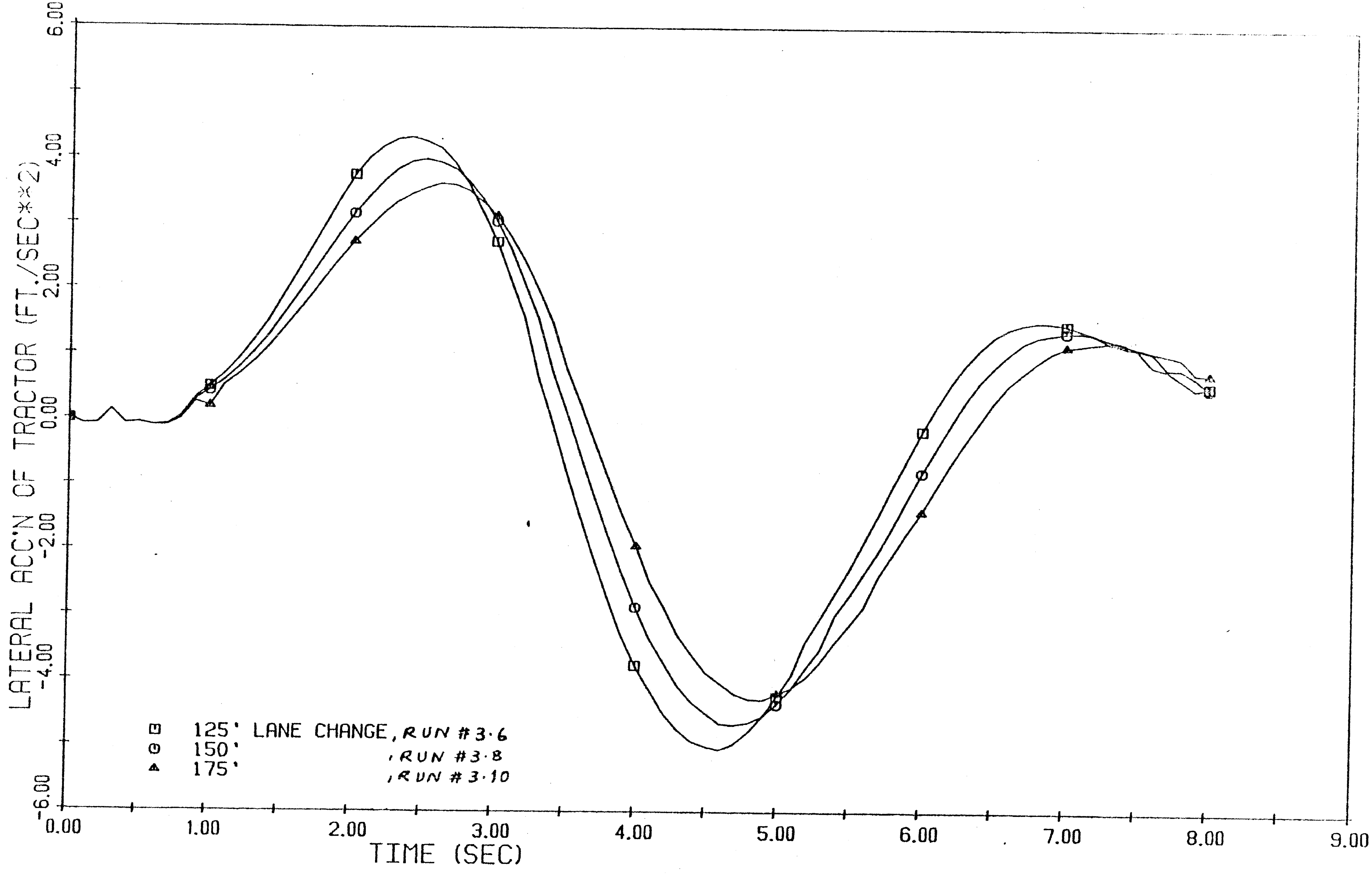
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



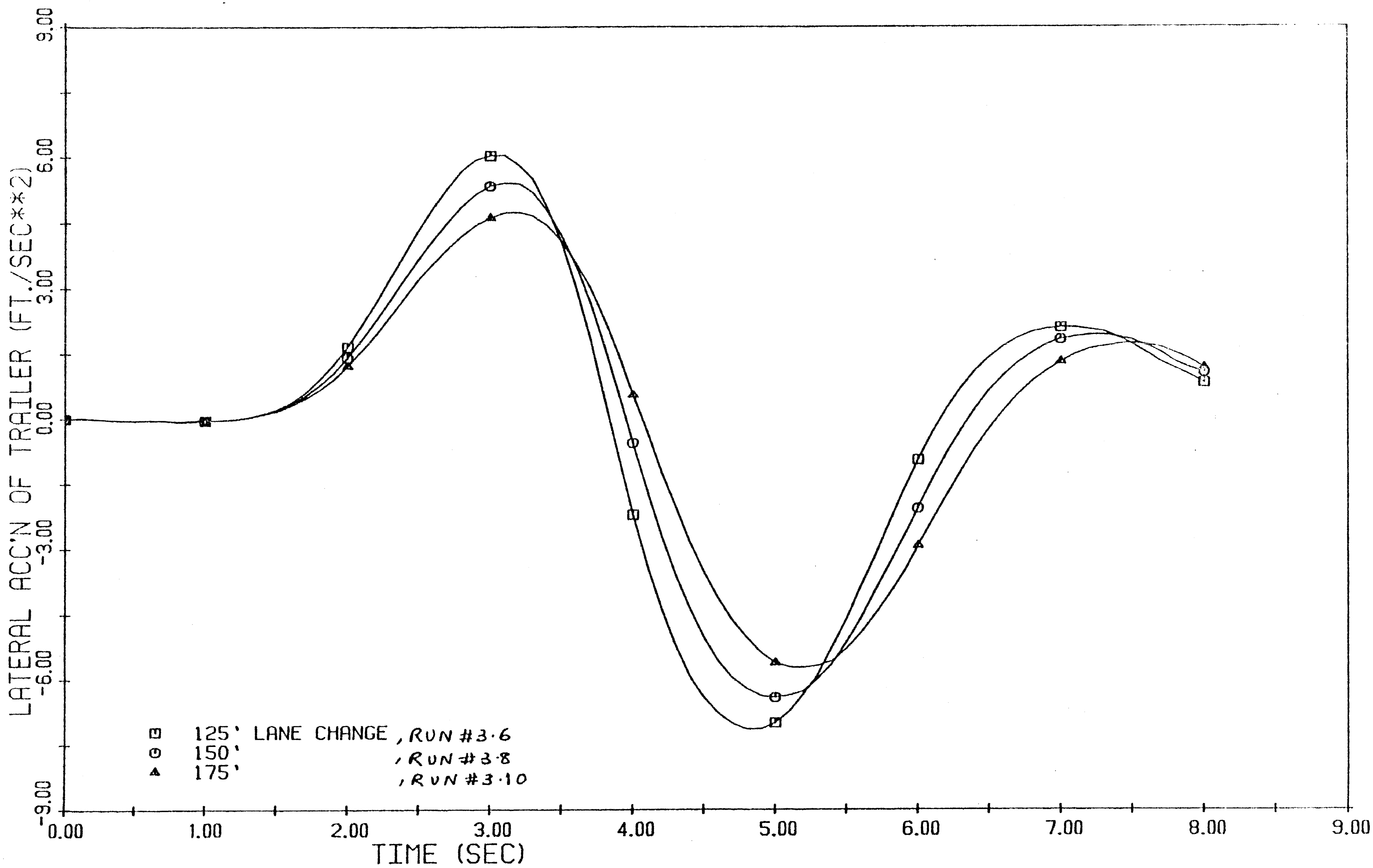
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF PREV INTERVAL, 12' LANE CHANGE,



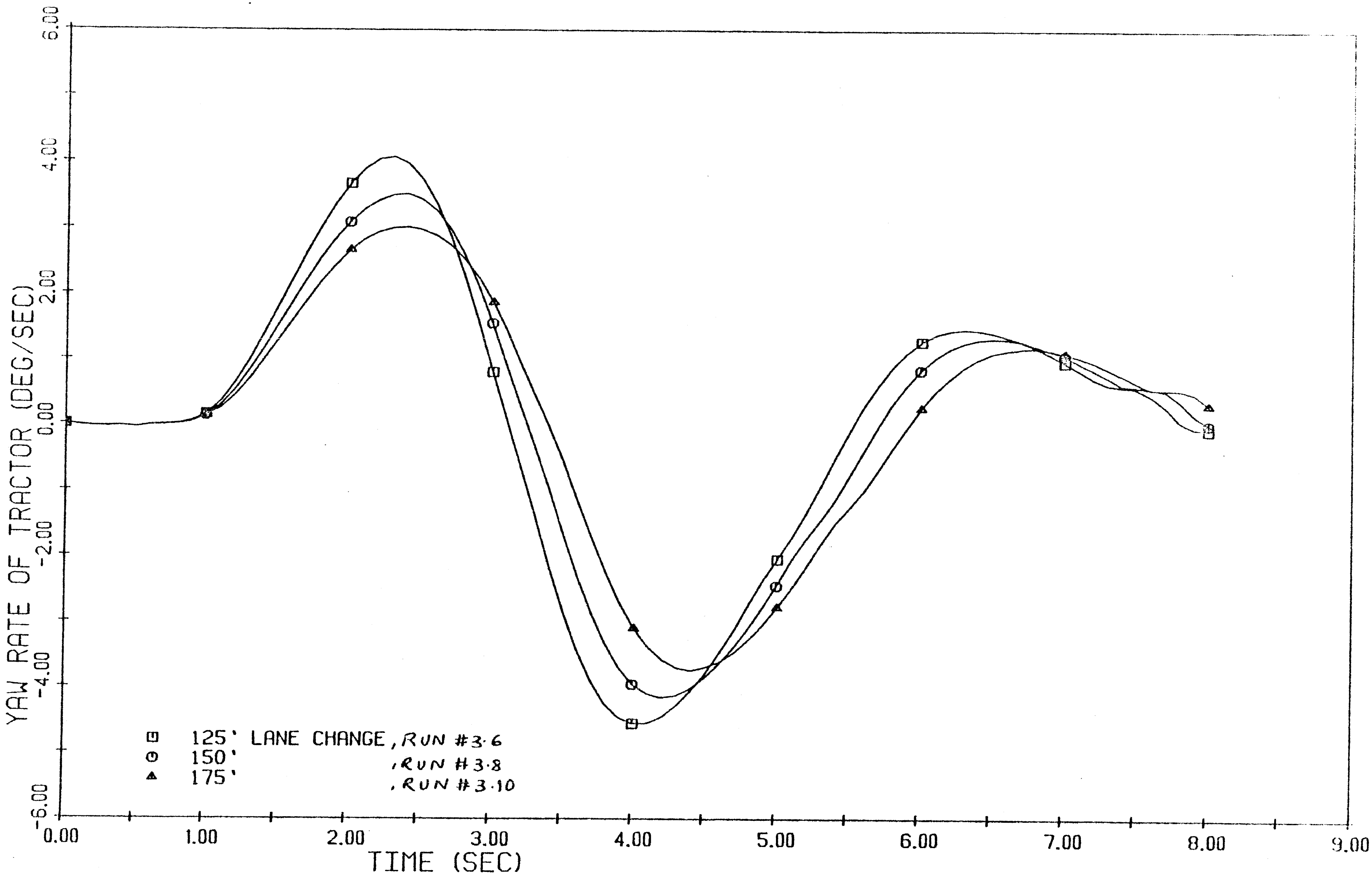
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



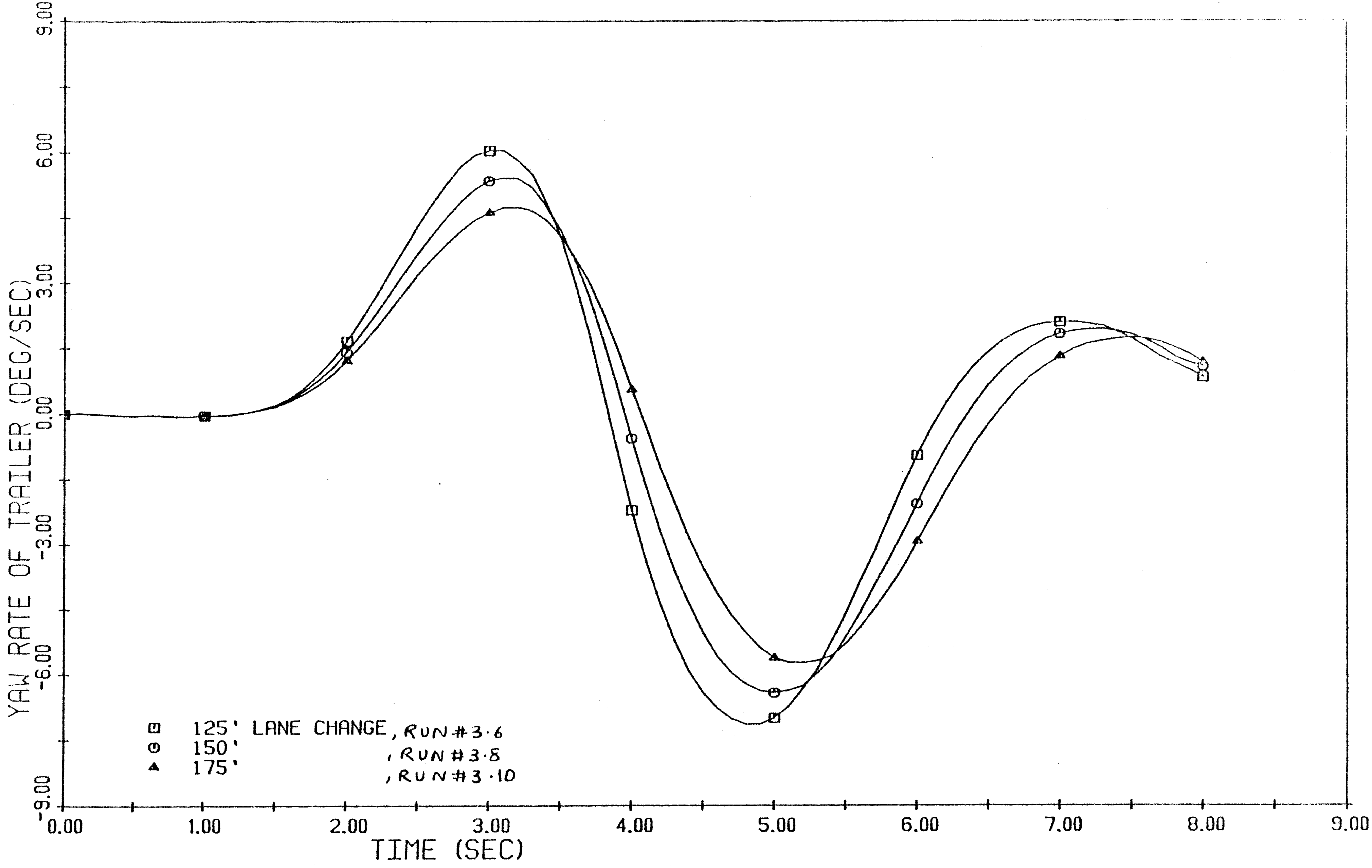
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



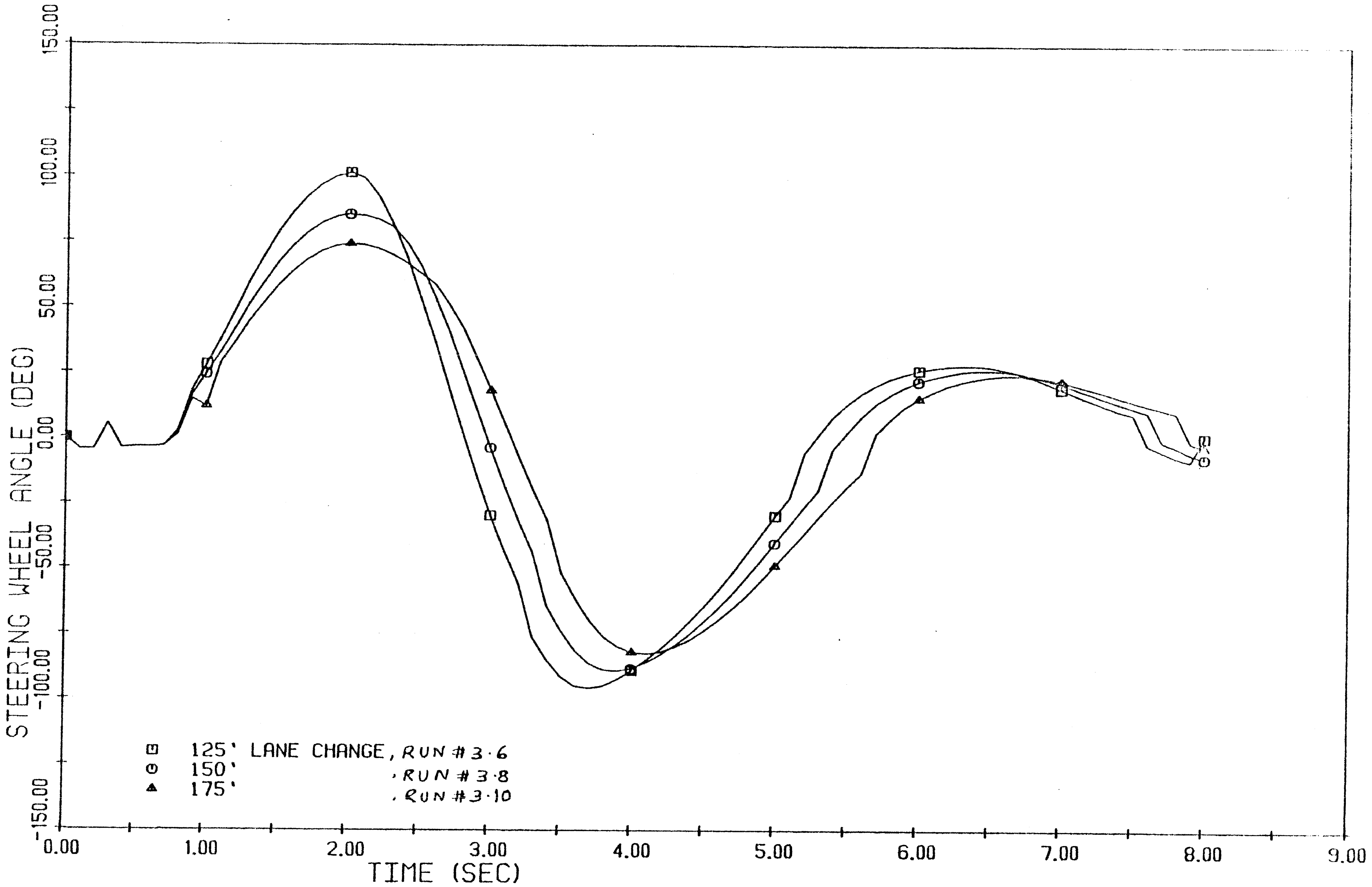
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



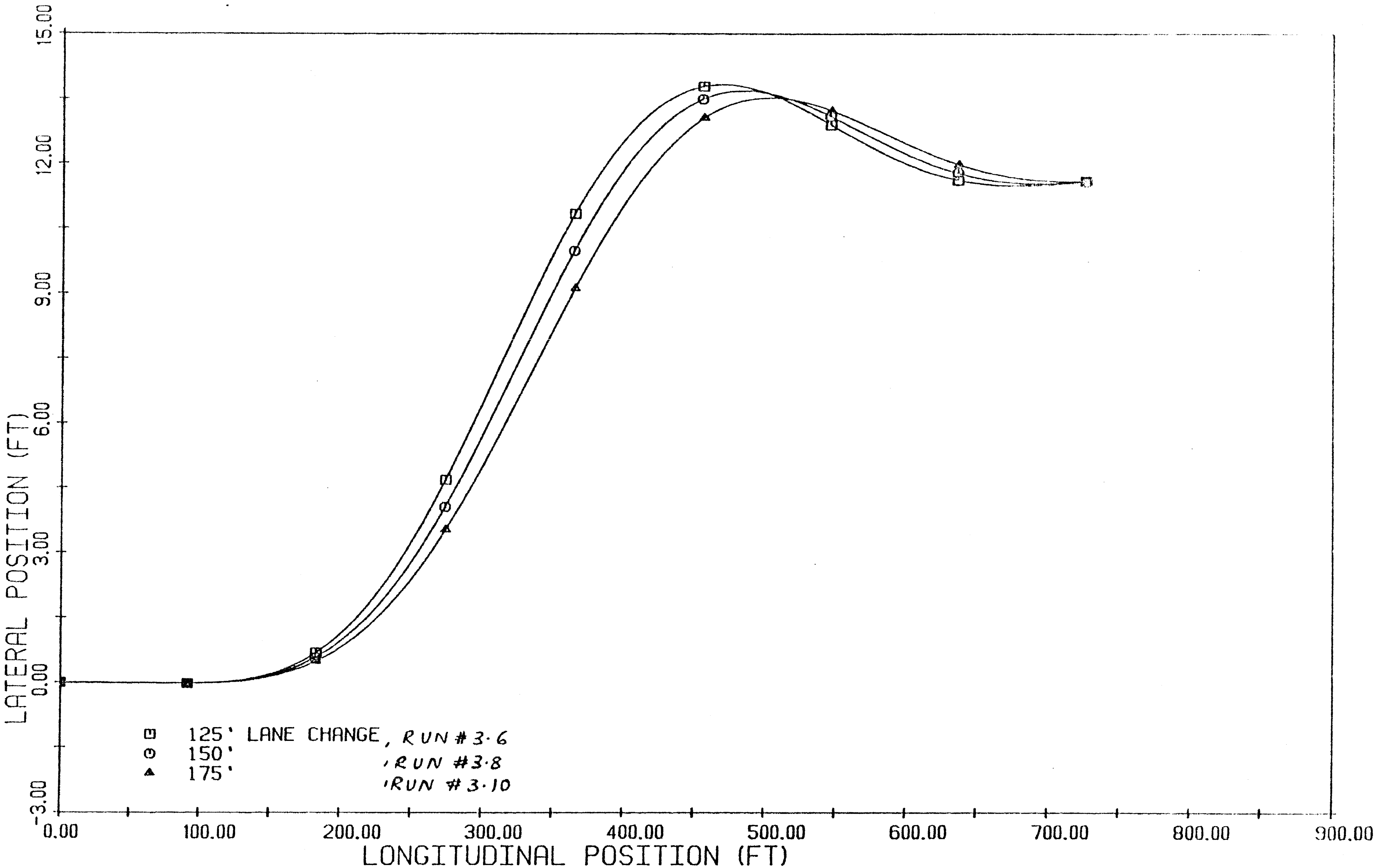
CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE



CANADIAN ARTIC BUS; LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE

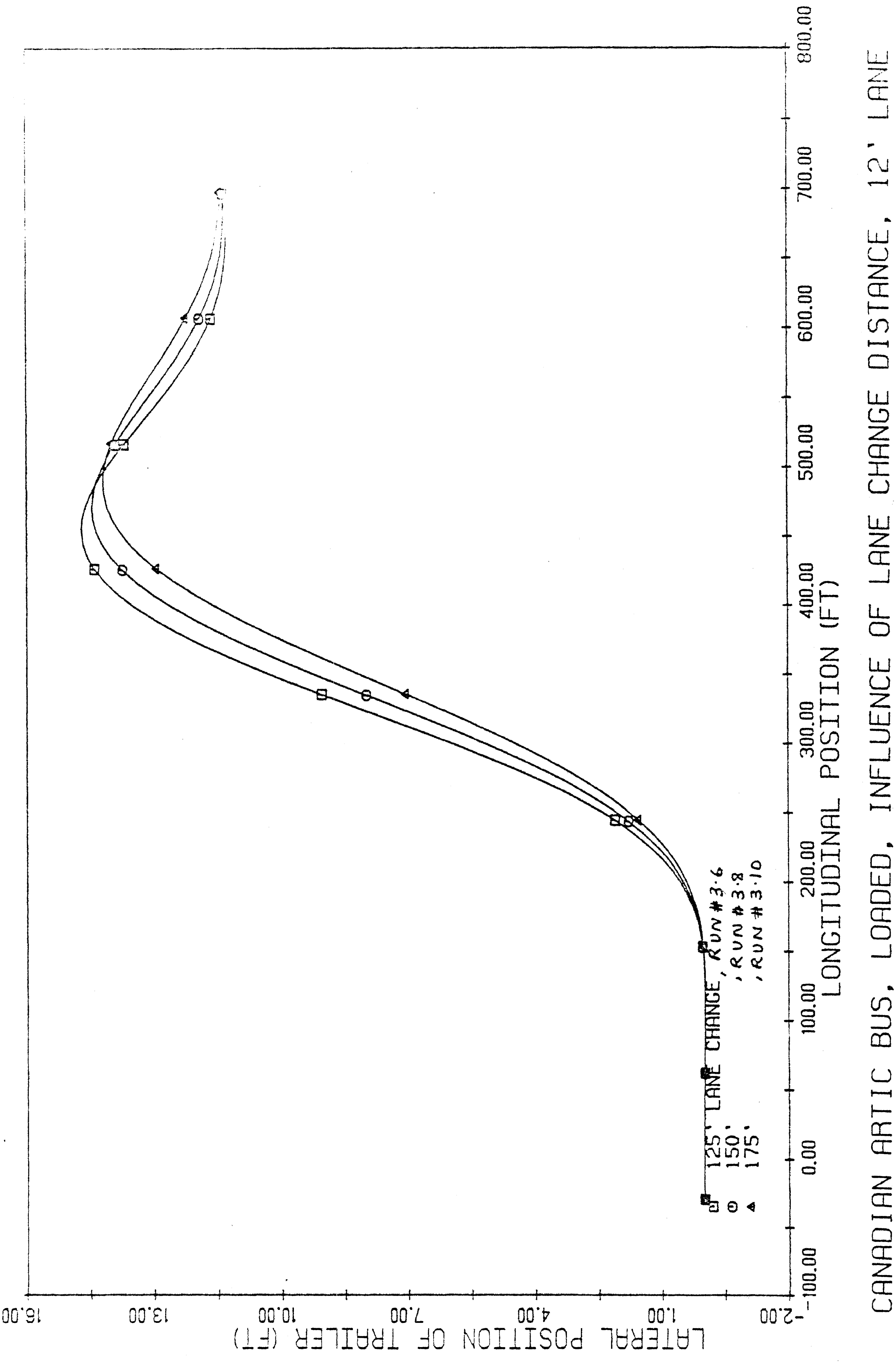
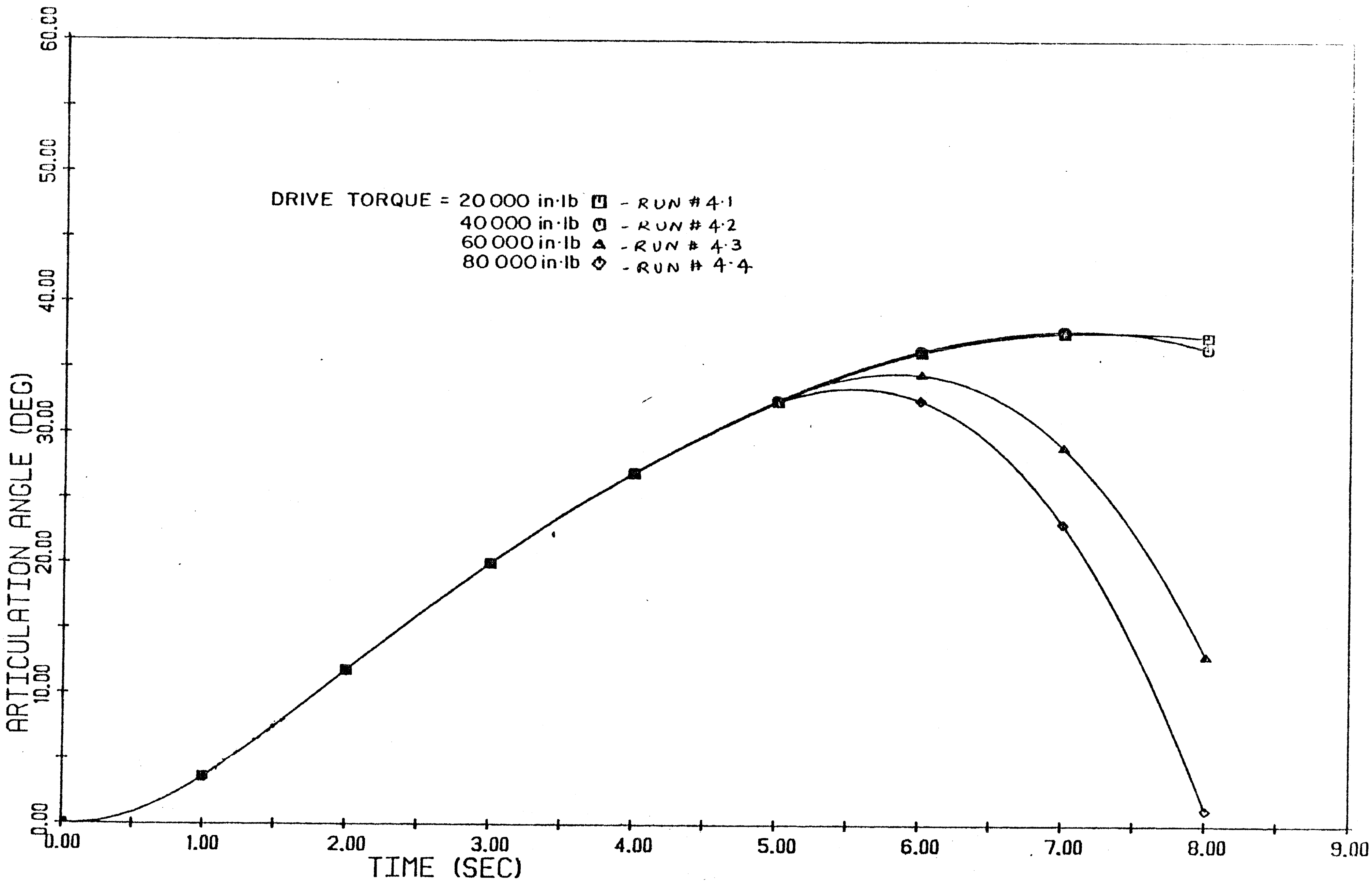

CANADIAN ARTIC BUS, LOADED, INFLUENCE OF LANE CHANGE DISTANCE, 12' LANE
LONGITUDINAL POSITION (FT)
LATERAL POSITION OF TRAILER (FT)
125' LANE CHANGE, RUN #3.6
150', RUN #3.8
175', RUN #3.10
-100.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
-2.00
1.00
4.00
7.00
10.00
13.00
16.00

Table 4. Cornering with Acceleration on a Low Friction Surface
Speed = 10 ft/sec, Maneuver = 1460° Steer Input

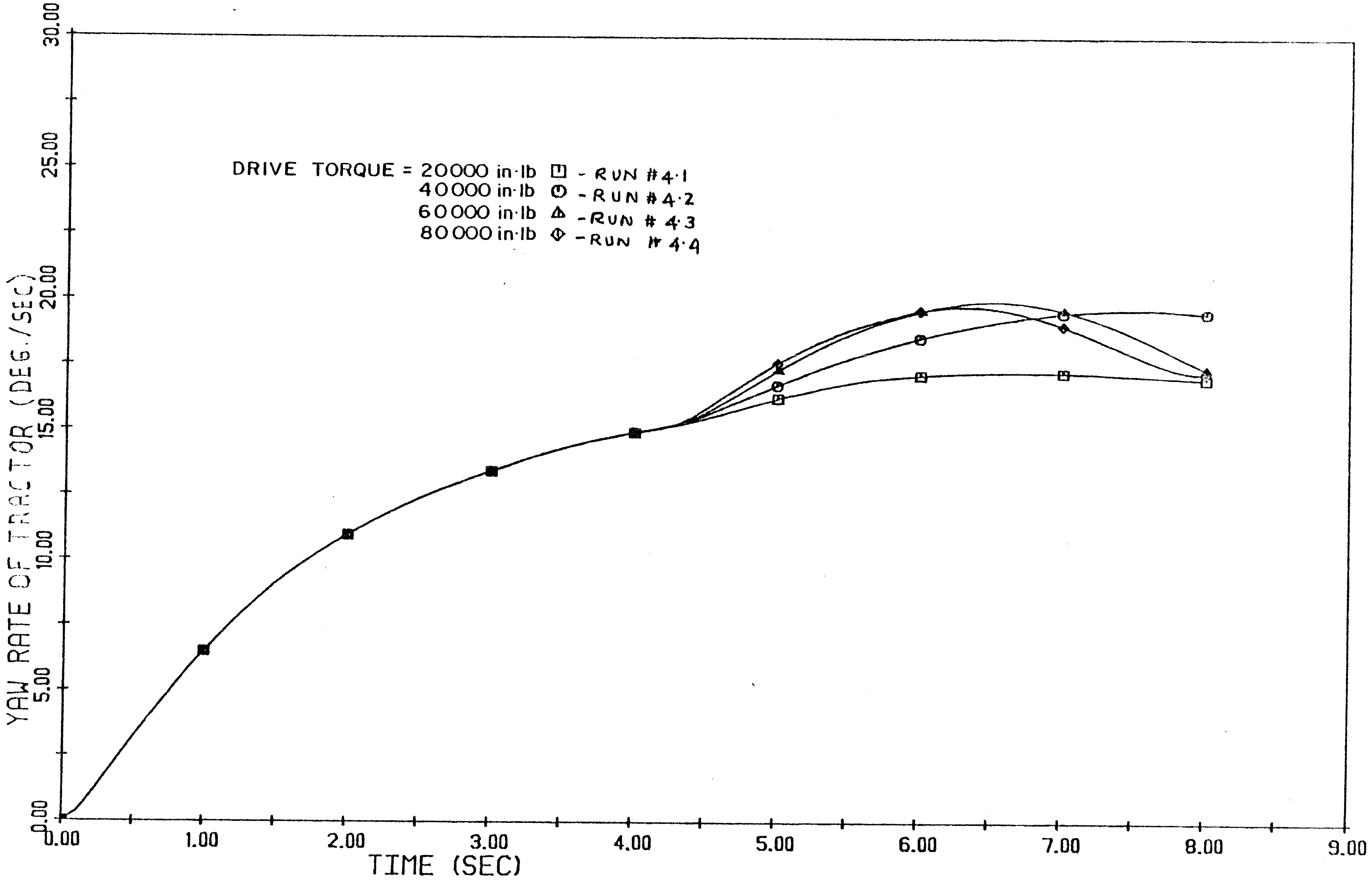
Run #	Calculation #	Loading Condition	Articulation Controller	Drive Torque in-lb
4.1	37	E	Yes	20,000
4.2	38	E	Yes	40,000
4.3	39	E	Yes	60,000
4.4	40	E	Yes	80,000
4.5	41	L	Yes	28,800
4.6	42	L	Yes	57,600
4.7	43	L	Yes	86,400
4.8	44	L	Yes	115,200
4.9*	109	E	No	40,000
4.10**	114	E	No	80,000

*Same as #4.2 without controller

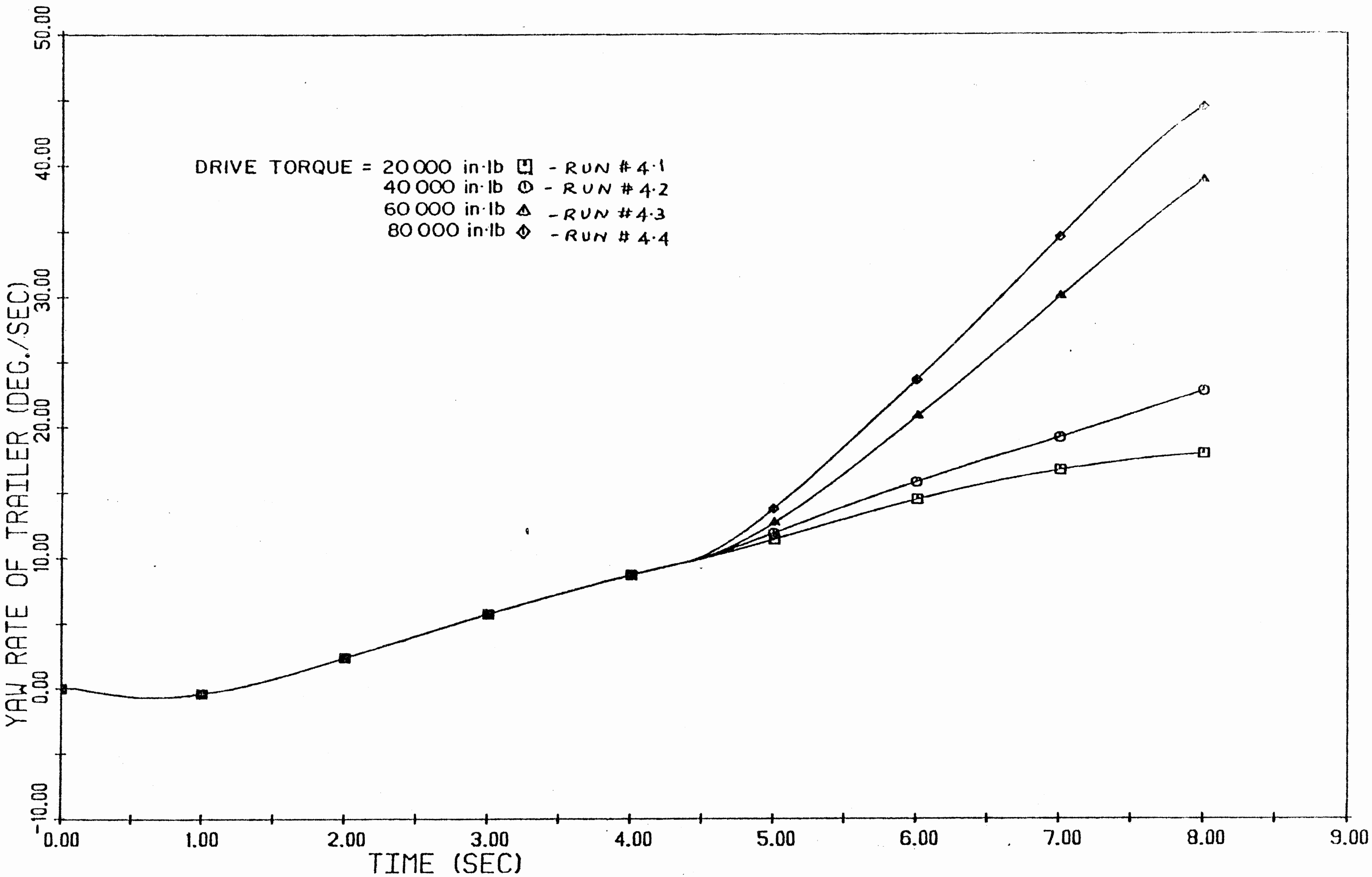
**Same as #4.4 without controller



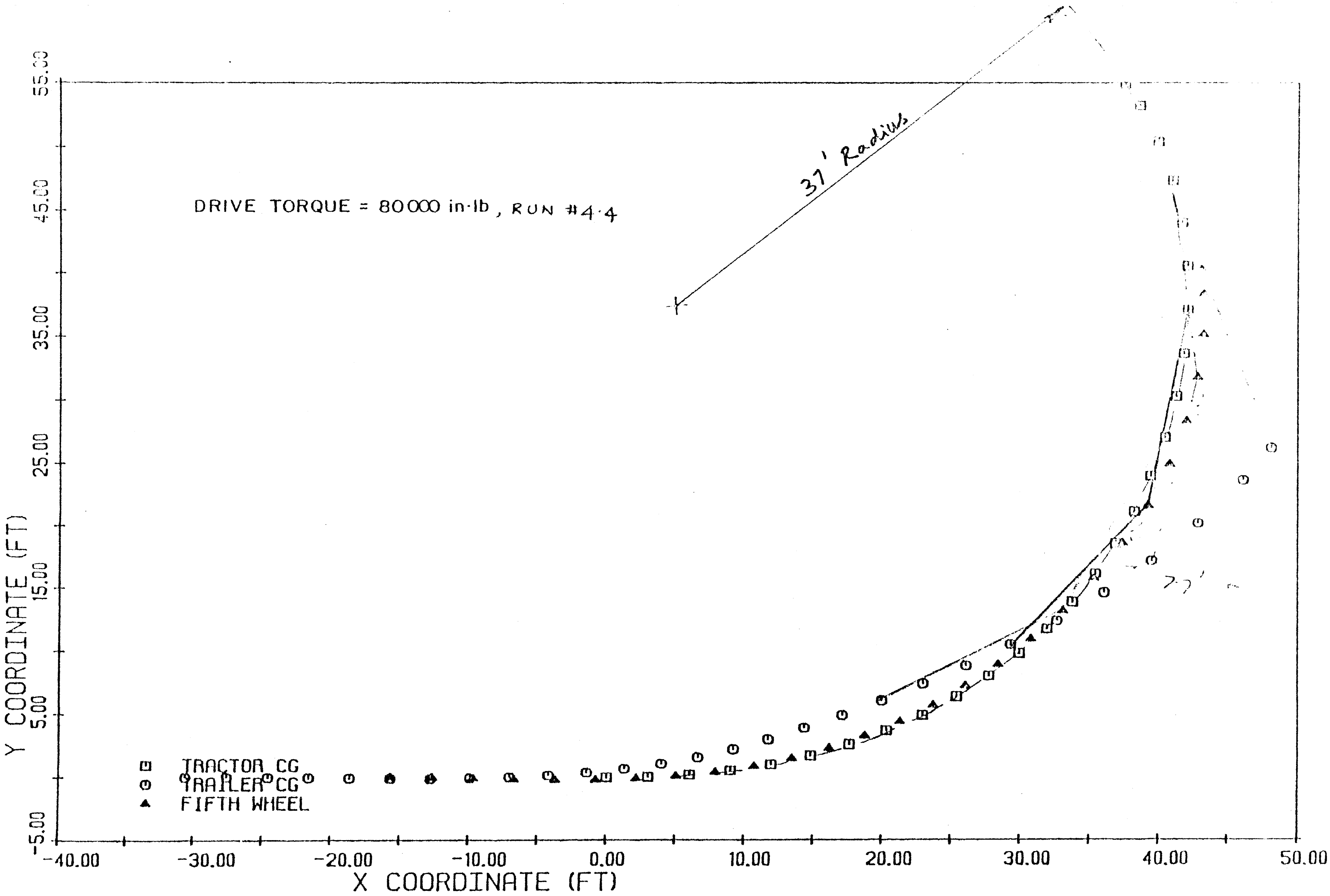
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN A TURN.



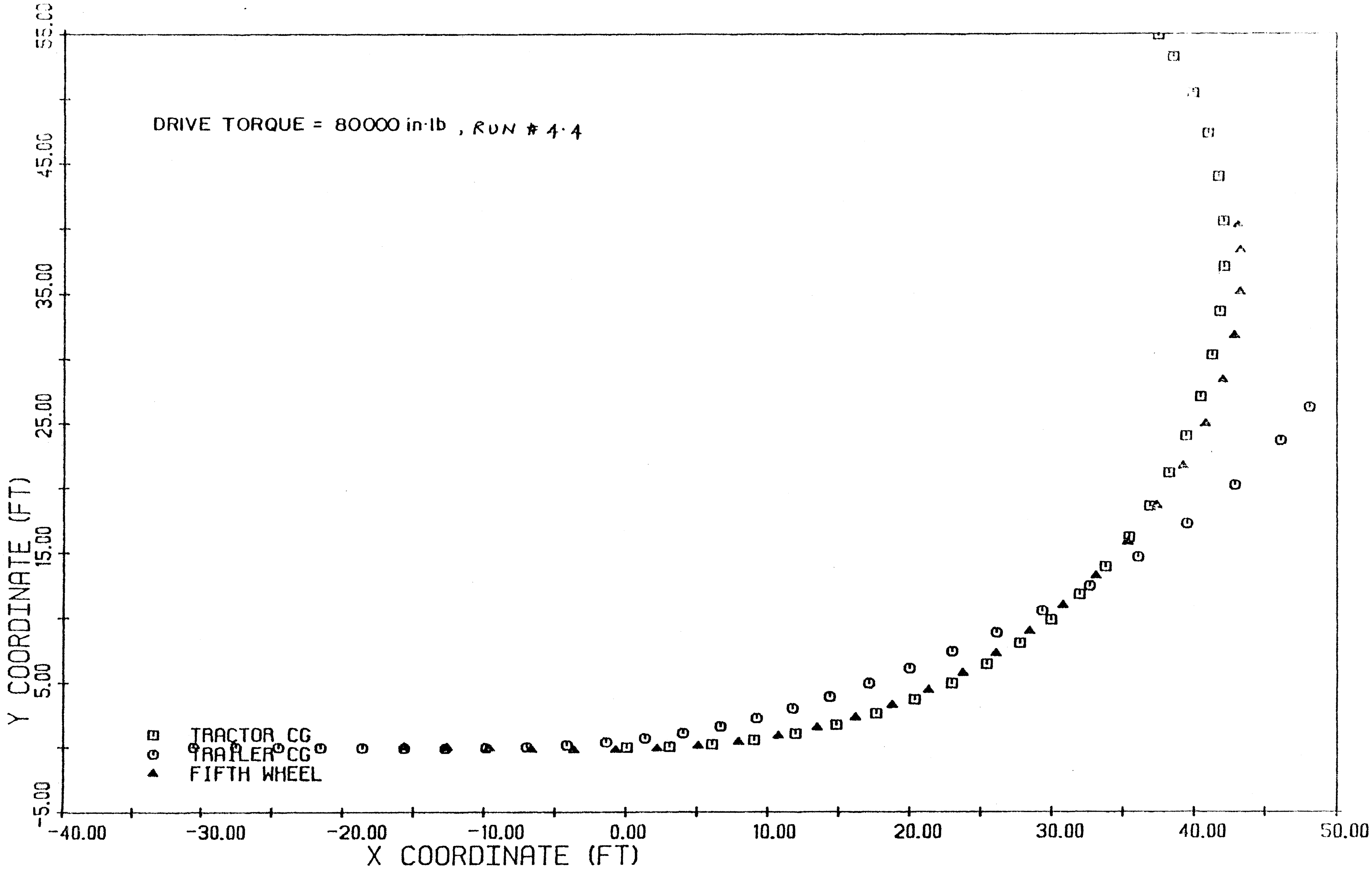
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN A TURN,



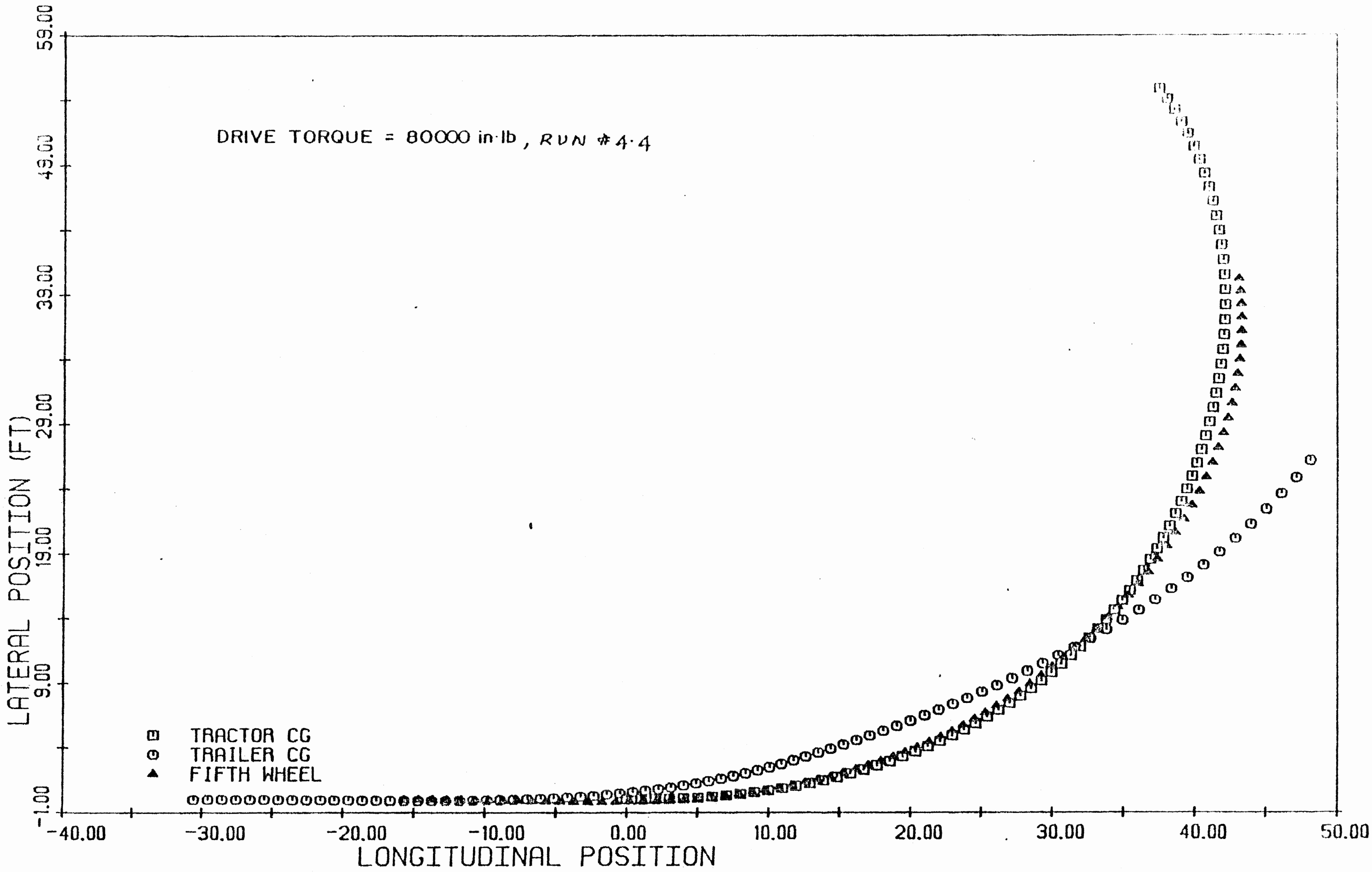
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN ATURN ,



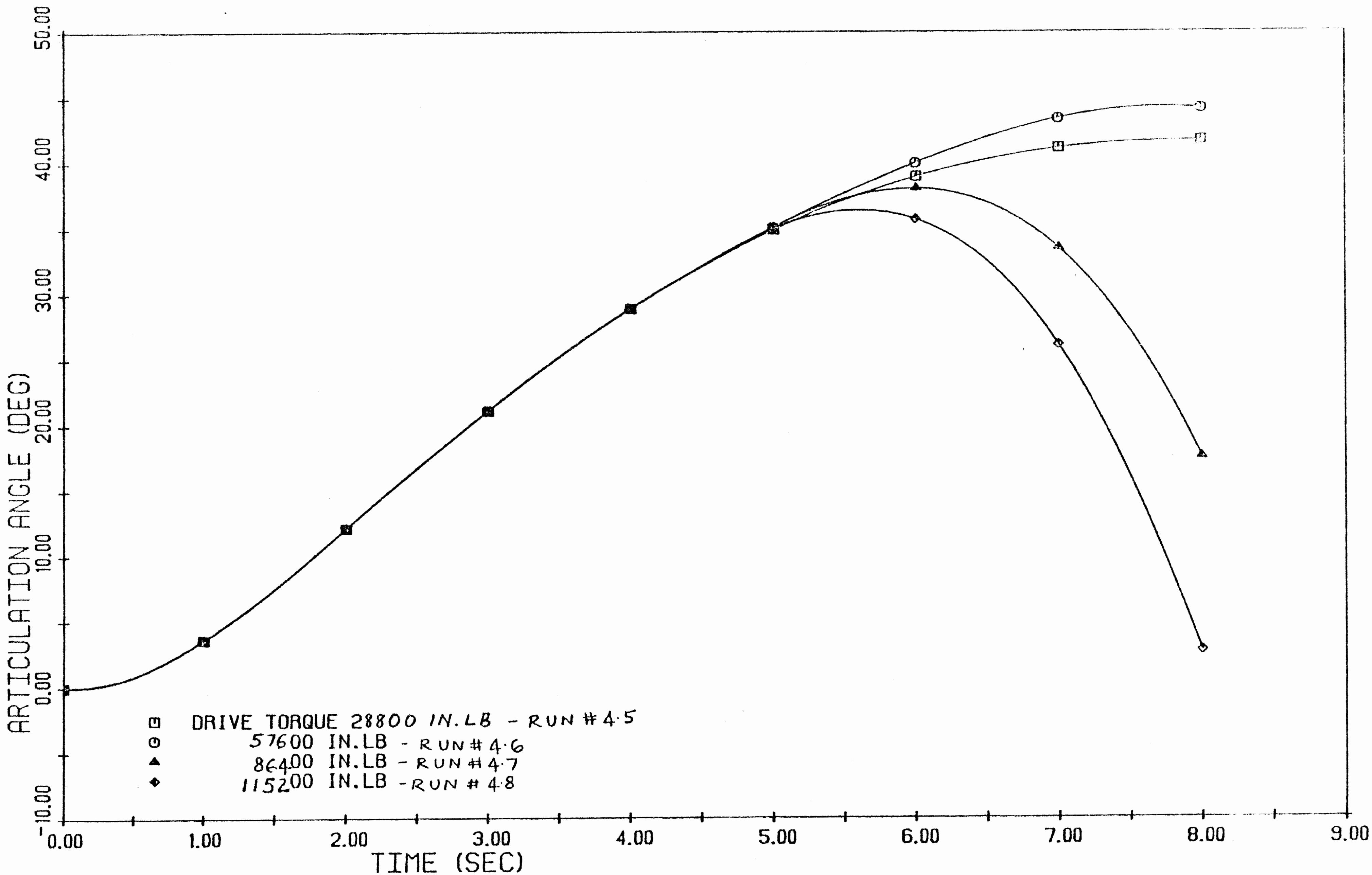
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN A TURN



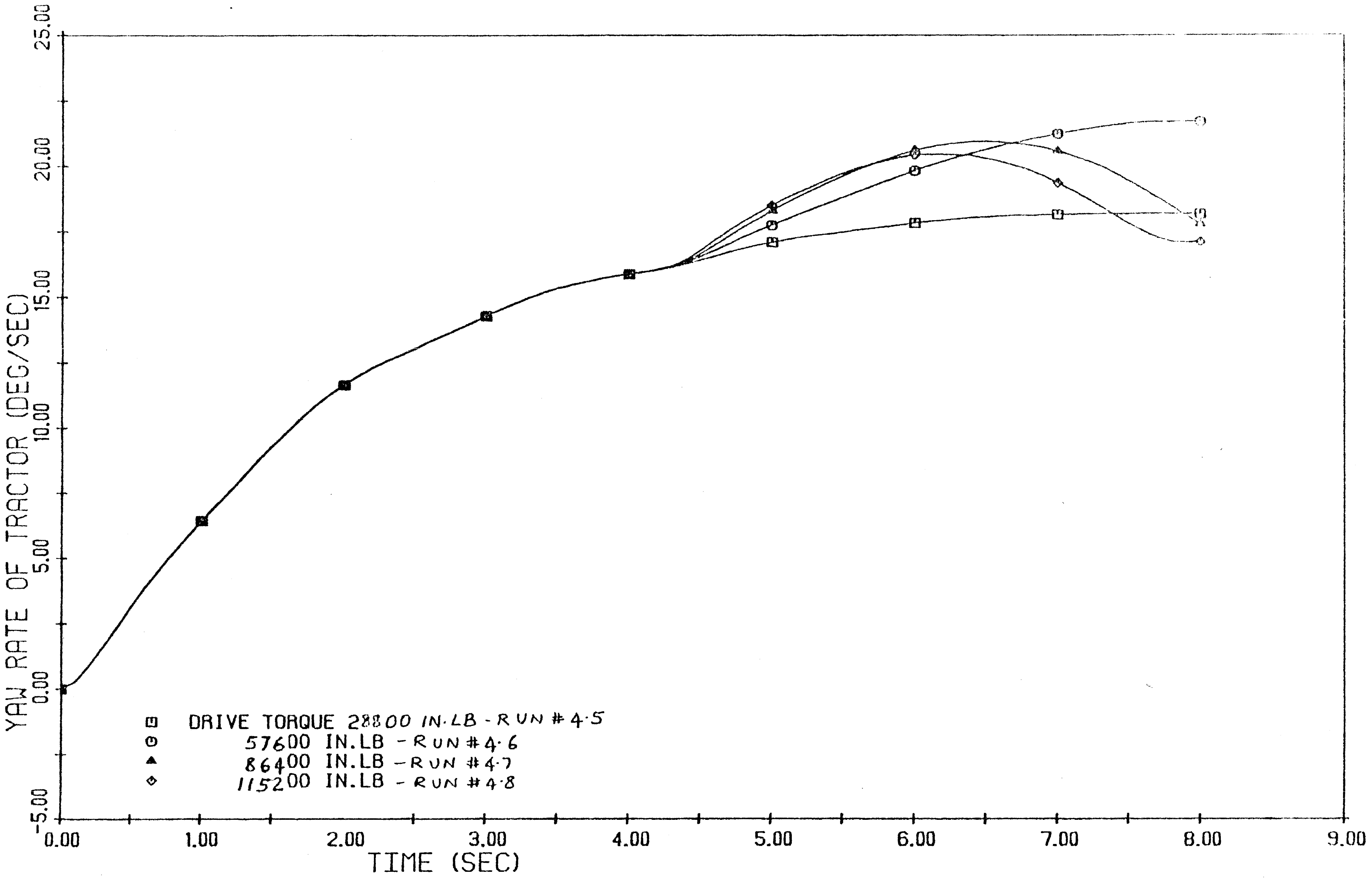
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN A TURN



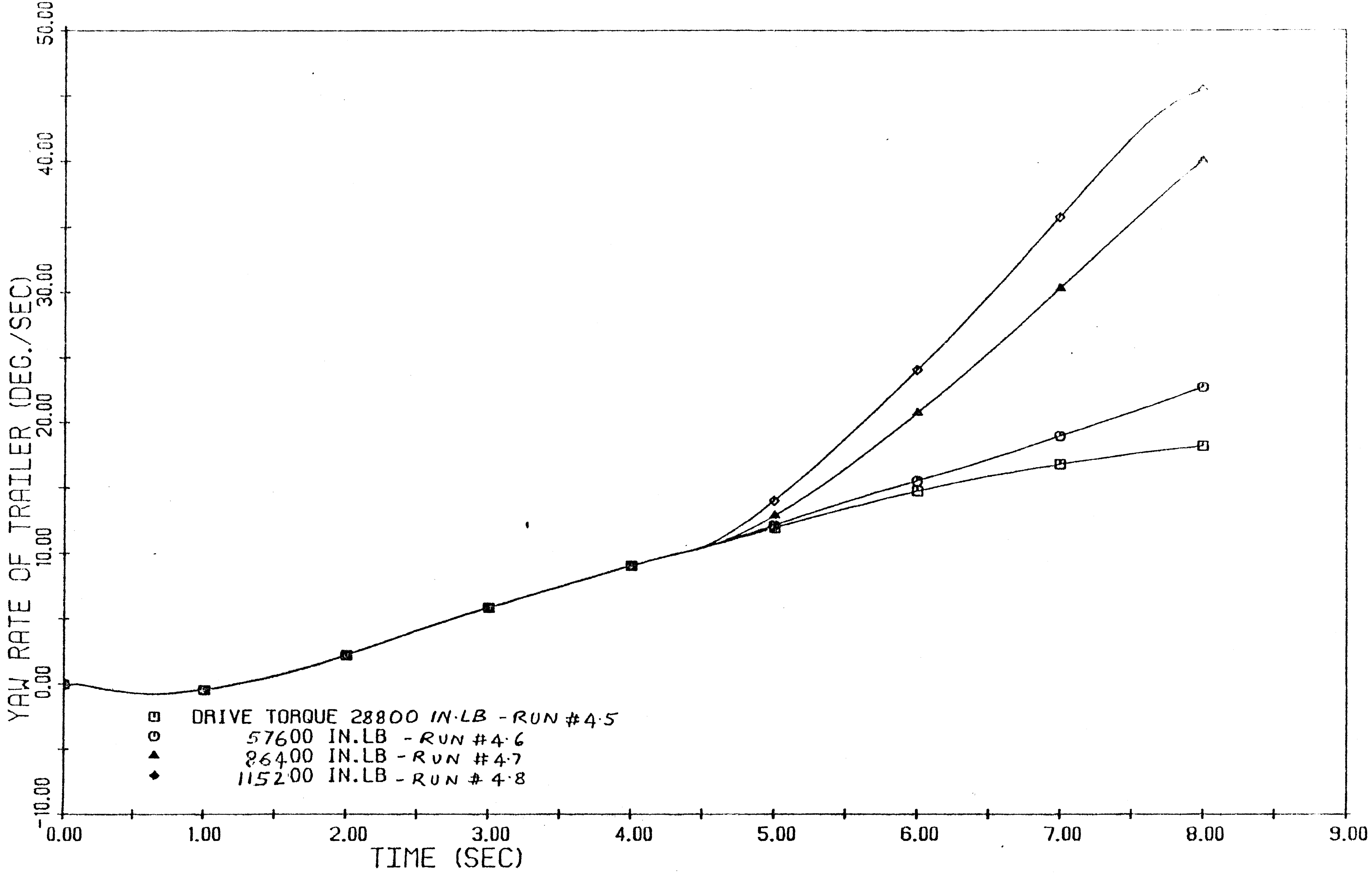
CANADIAN ARTIC BUS, EMPTY, 10 FT./SEC, ACCELERATING IN A TURN,



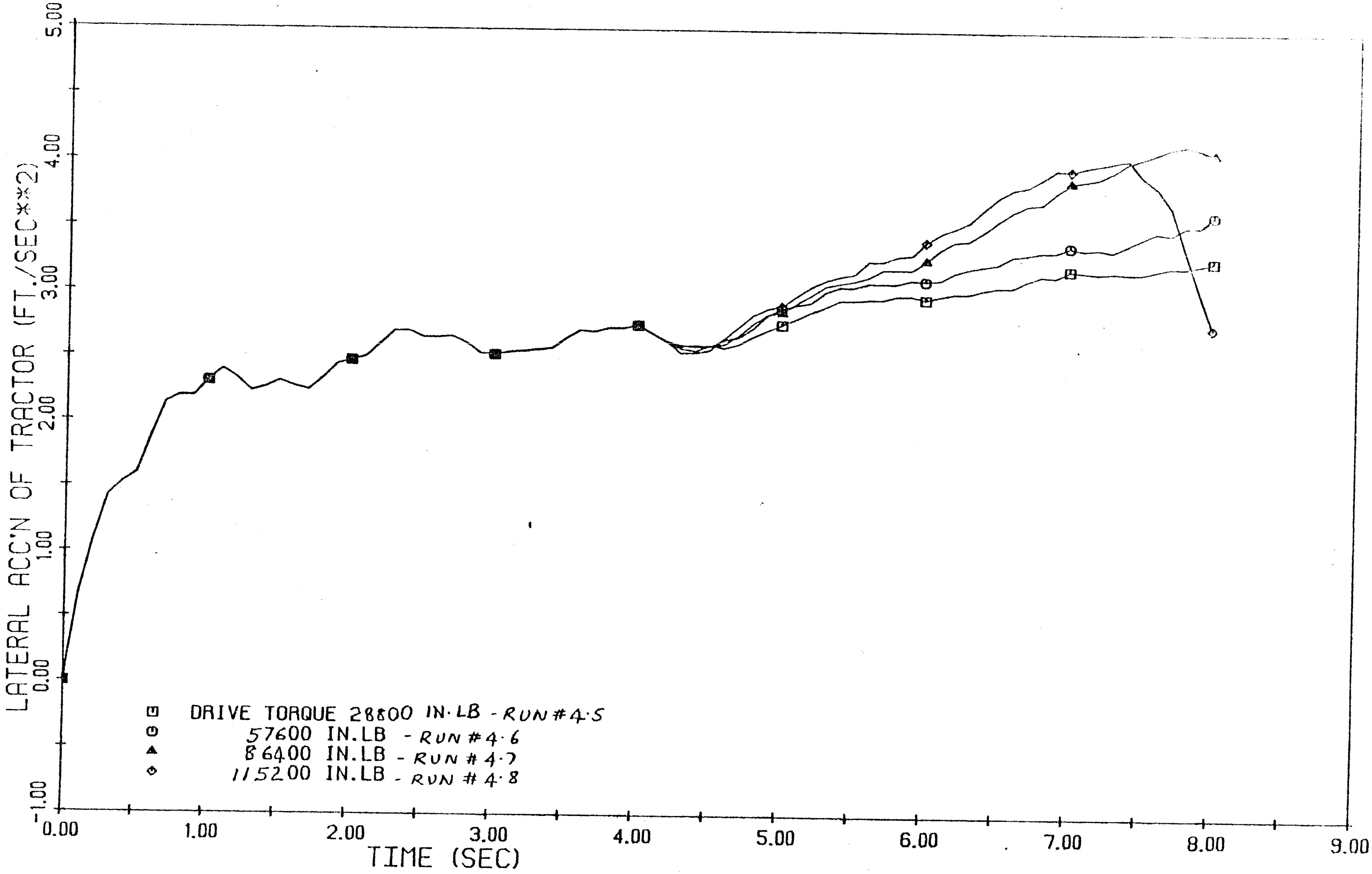
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN A TURN, 10 FT./SEC, DEC 22



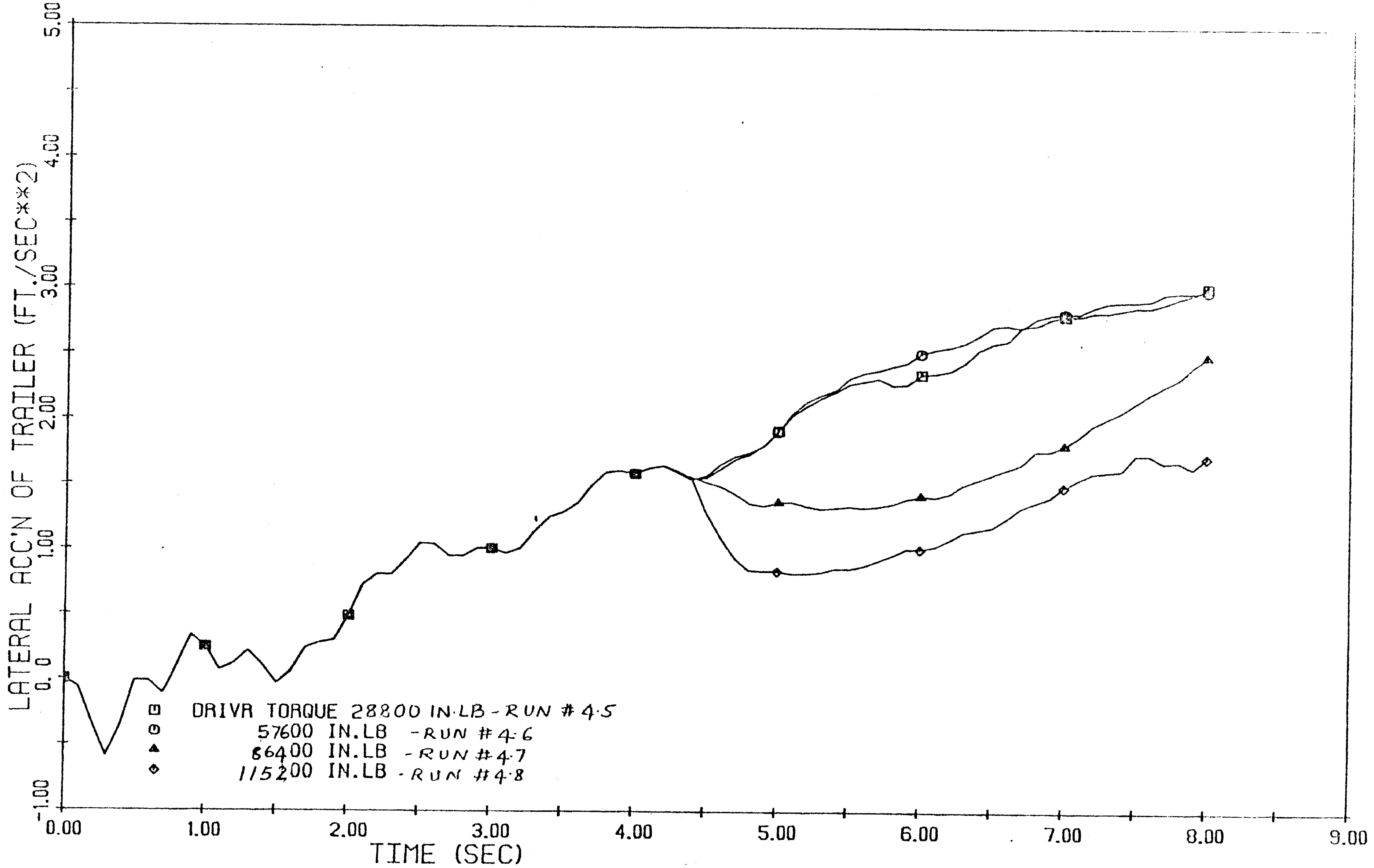
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN A TURN, 10 FT./SEC, DEC 22



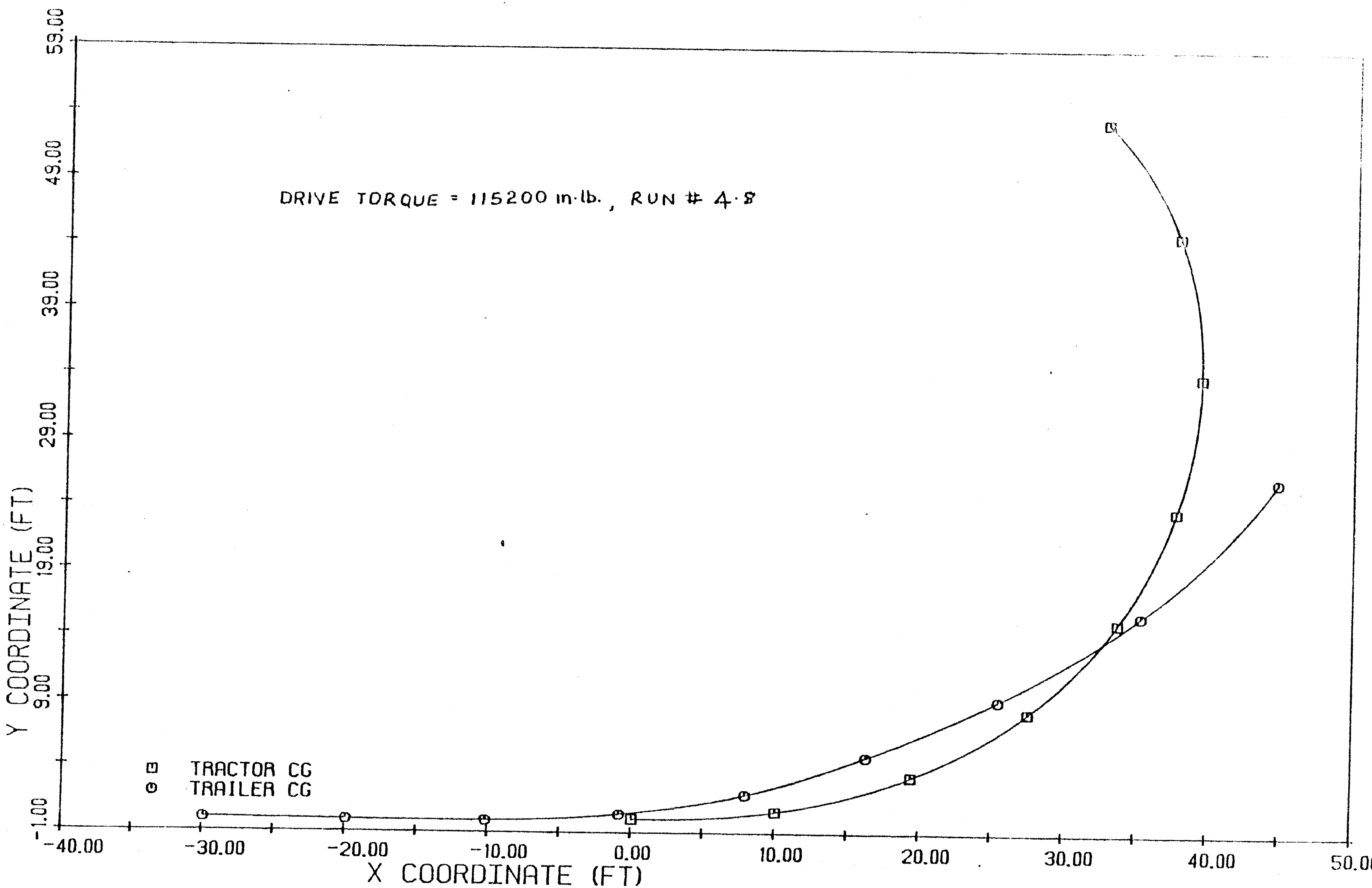
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN ATURN, 10 FT./SEC, DEC 22



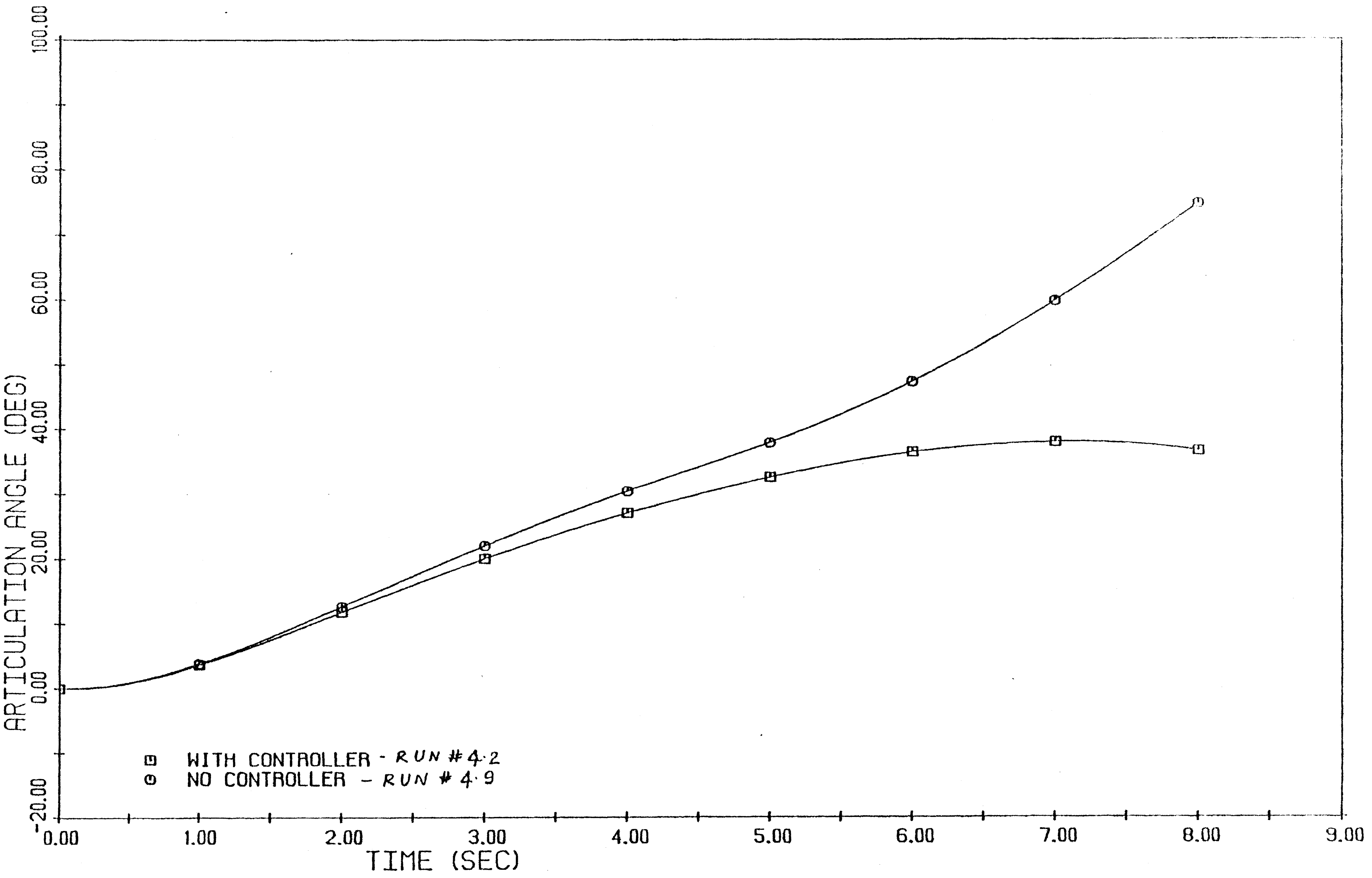
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN A TURN, 10 FT./SEC, DEC 22



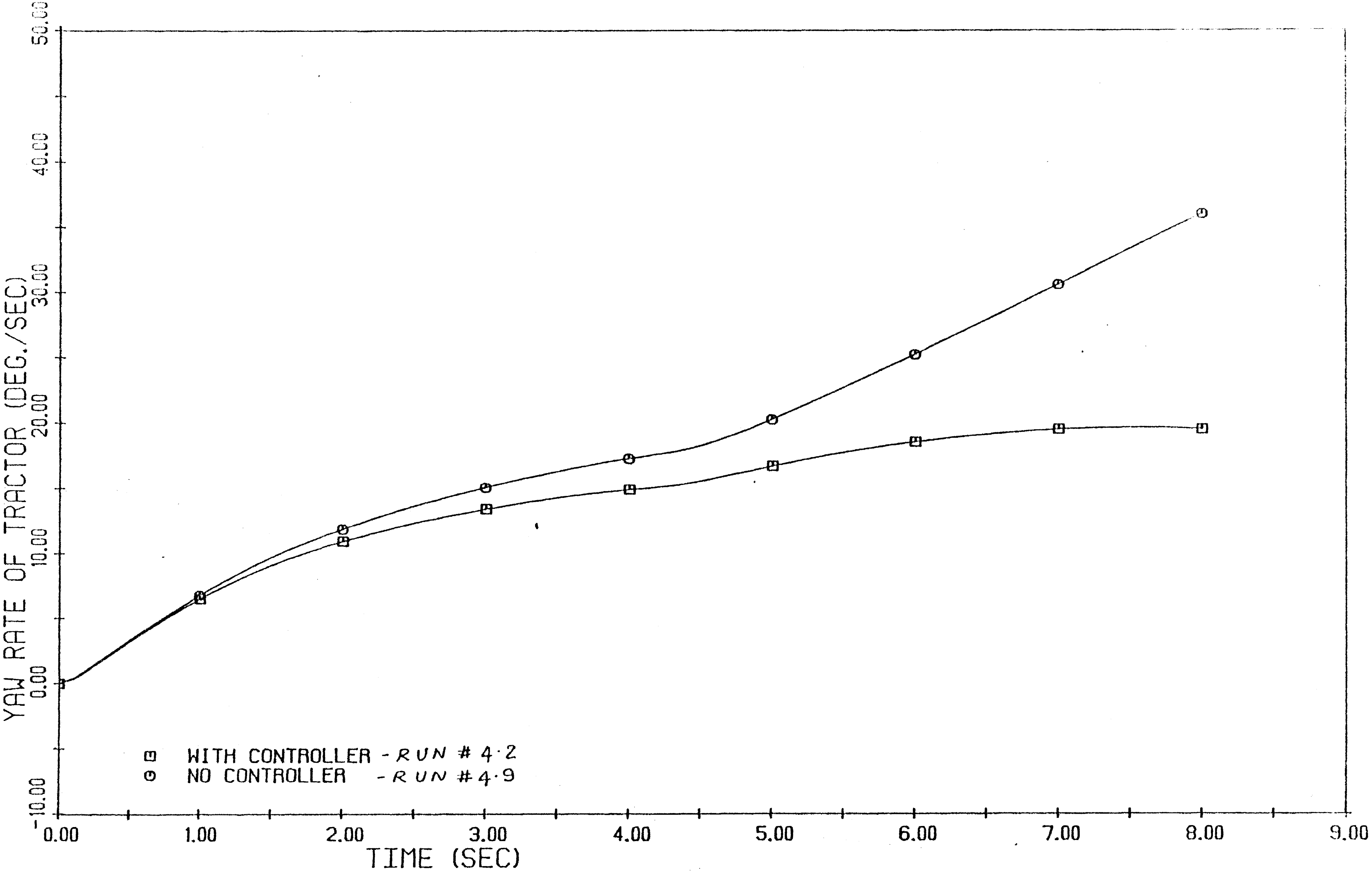
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN A TURN, 10 FT./SEC, DEC 22



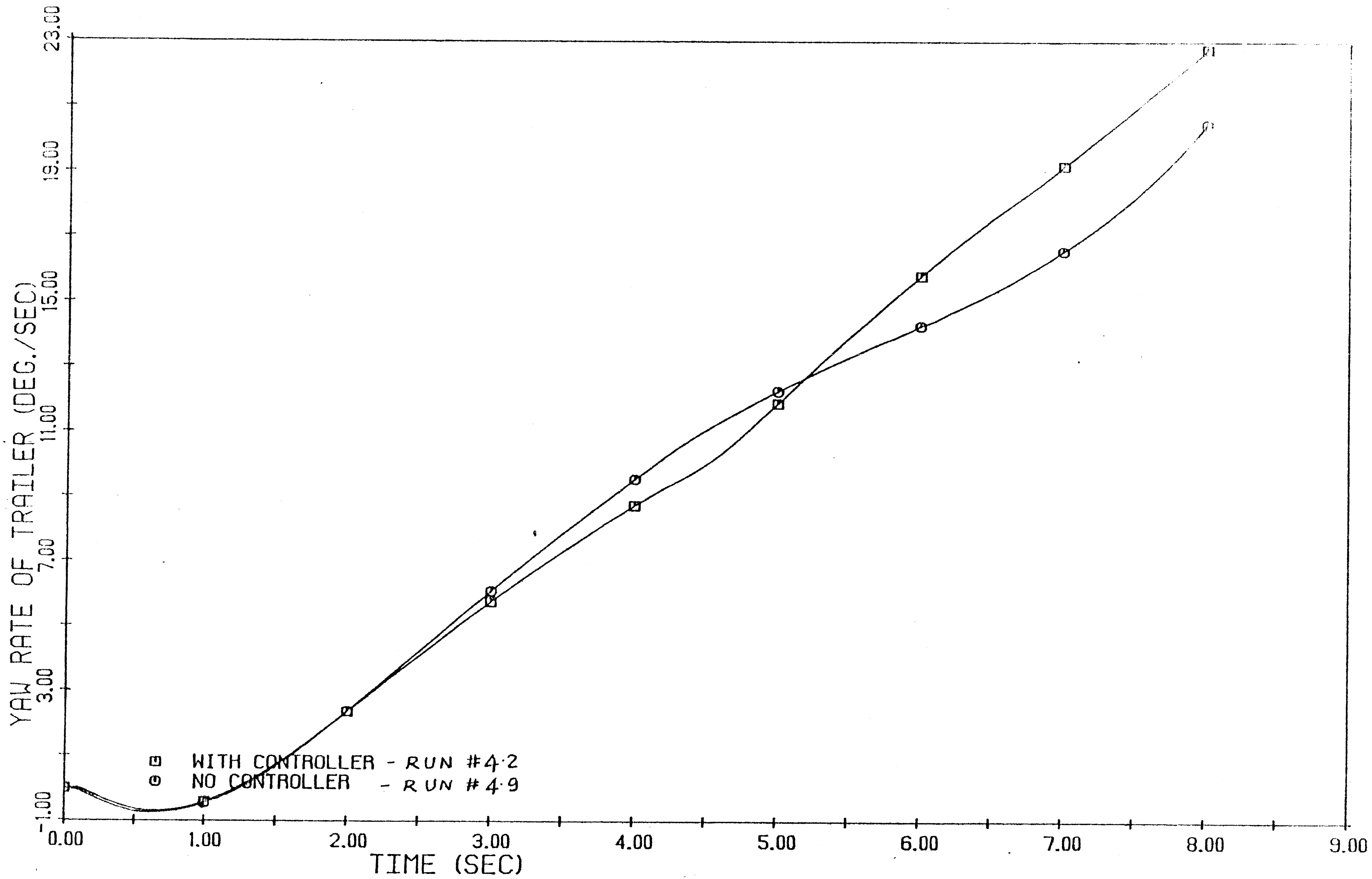
CANADIAN ARTIC BUS, LOADED, ACCELERATING IN A TURMN, 10 FT./SEC, DEC 22



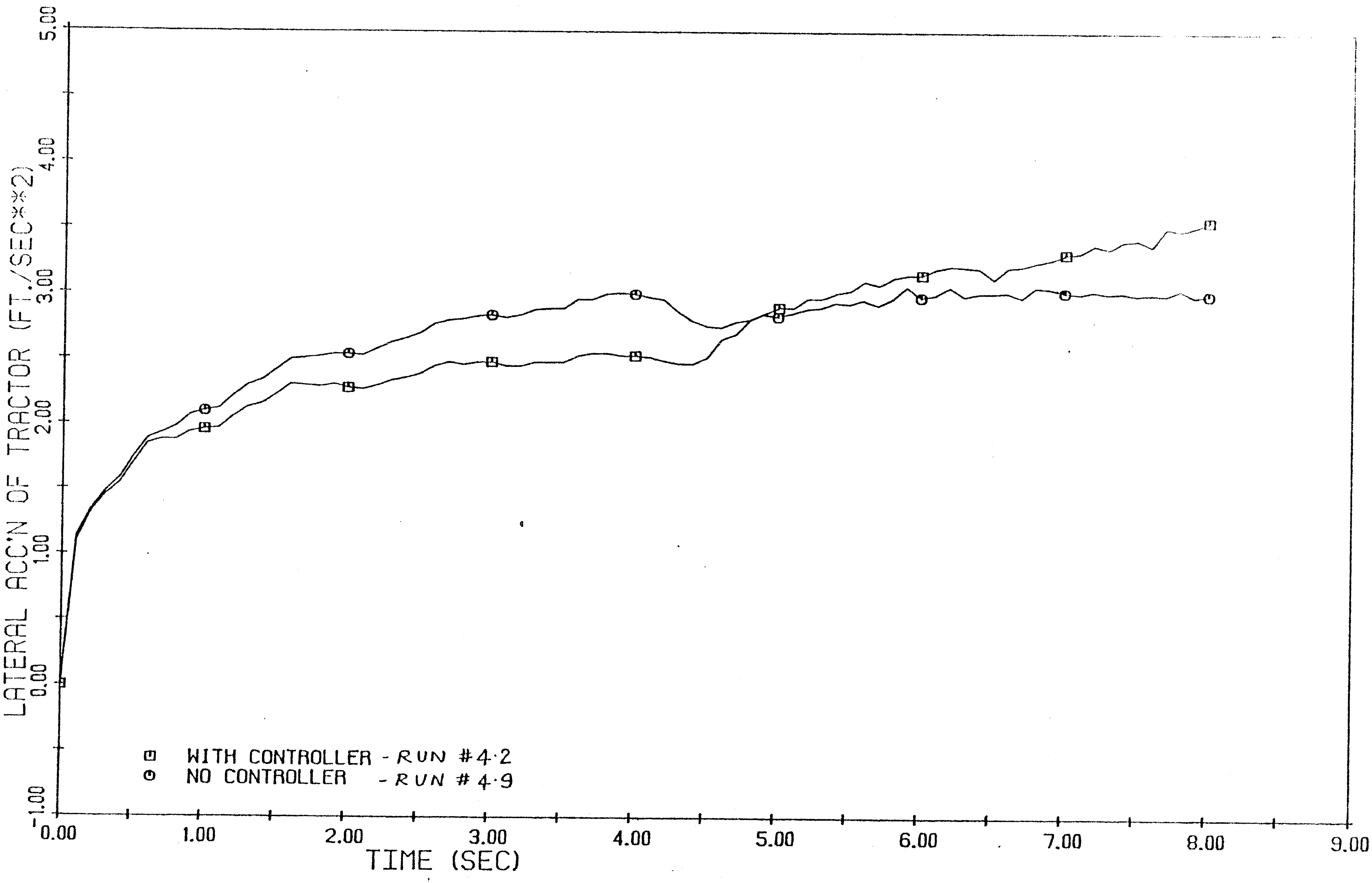
CANADIAN ARTIC BUS, ACCELERATING IN A TURN, 40000 IN.LB, INFLUENCE OF CONTROLLER



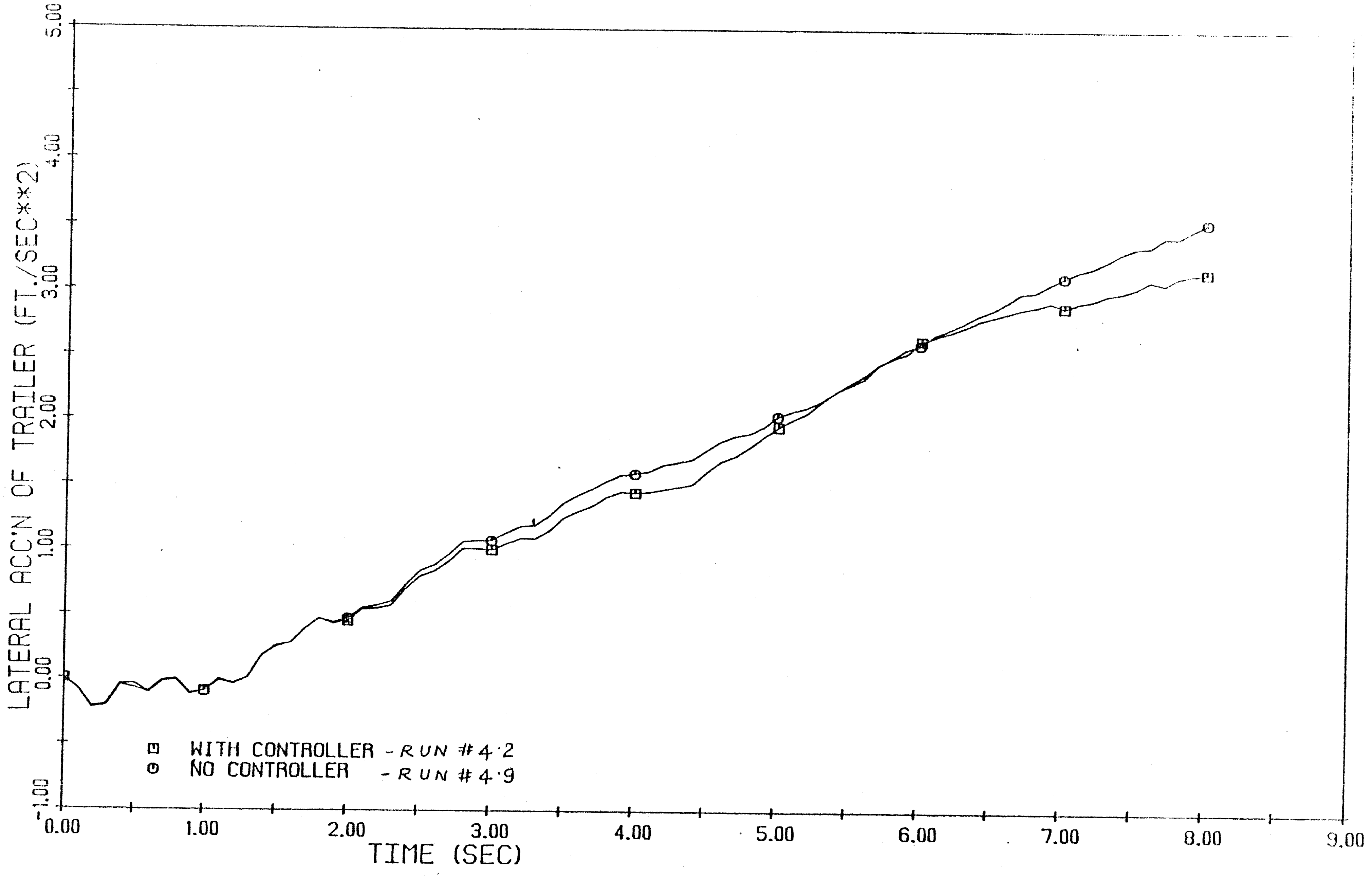
CANADIAN ARTIC BUS, EMPTY, ACC IN A TIURN, 40000 IN.LB, INFLUENCE OF CONTROLLER



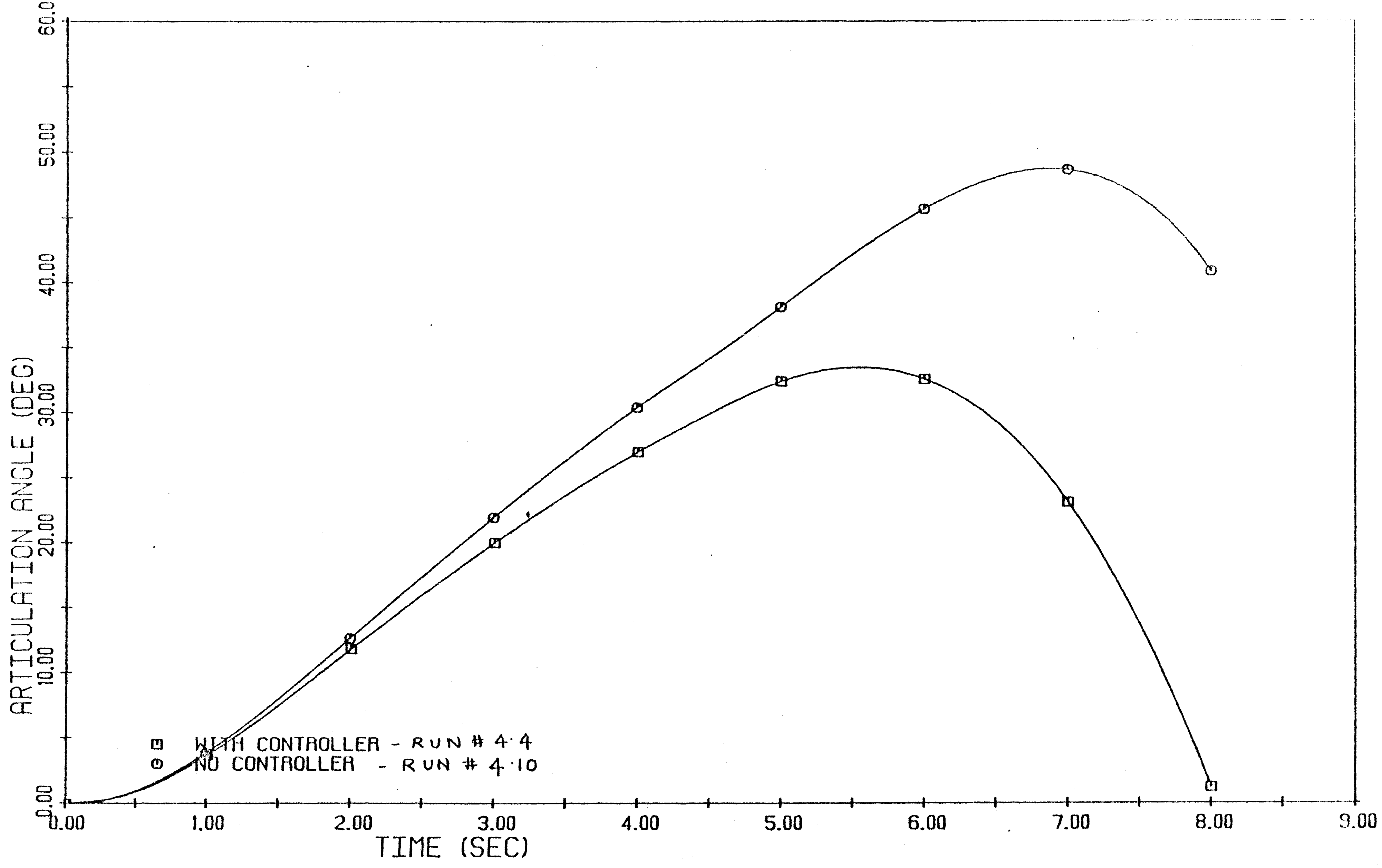
CANADIAN ARTIC BUS, ACCELERATING IN A TURN,40000 IN.LB, INFLUENCE OF CONTROLLER



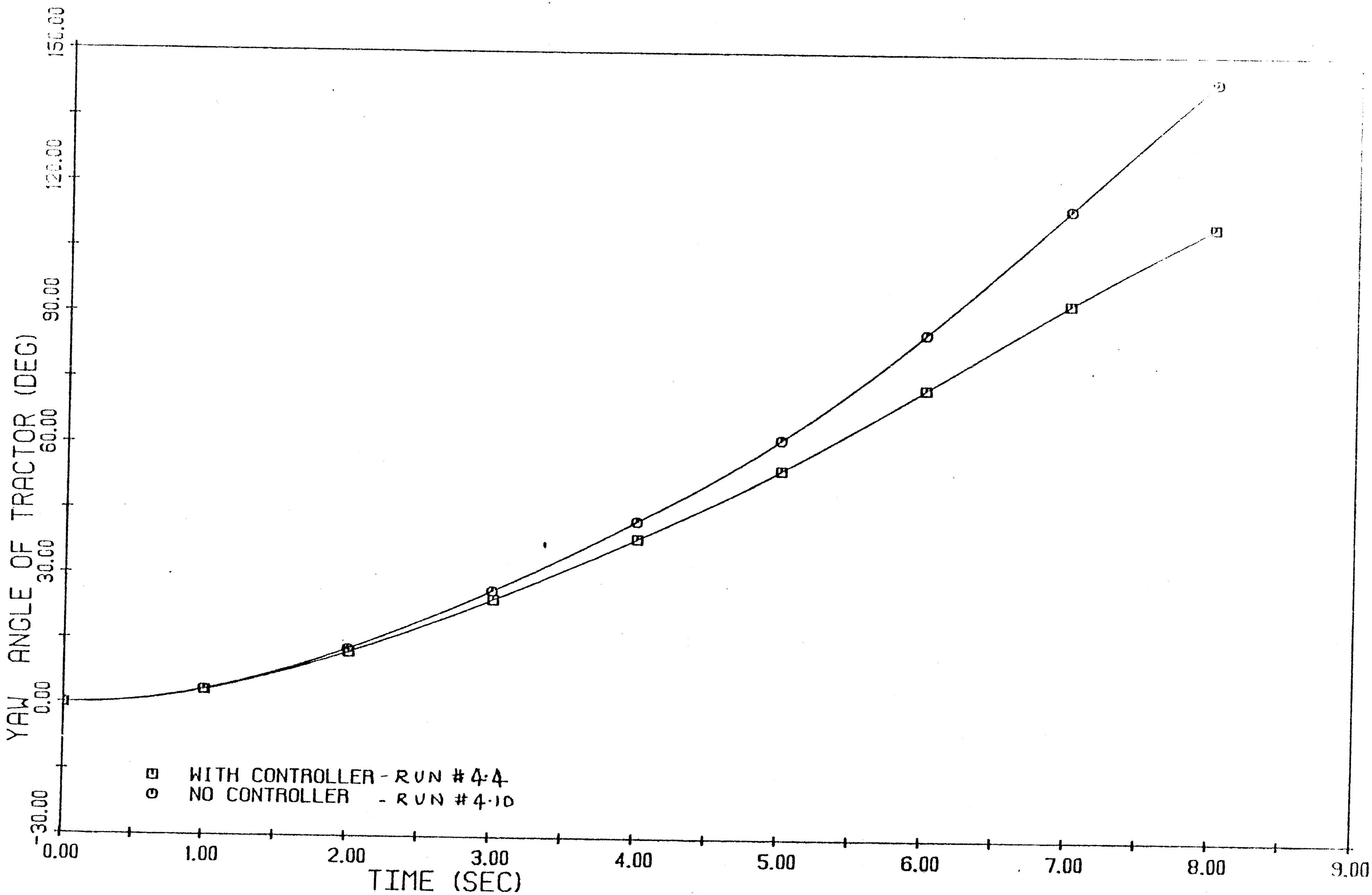
CANADIAN ARTIC BUS, ACCELERATING IN A TURN, 40000 IN.LB, INFLUENCE OF CONTROLLER



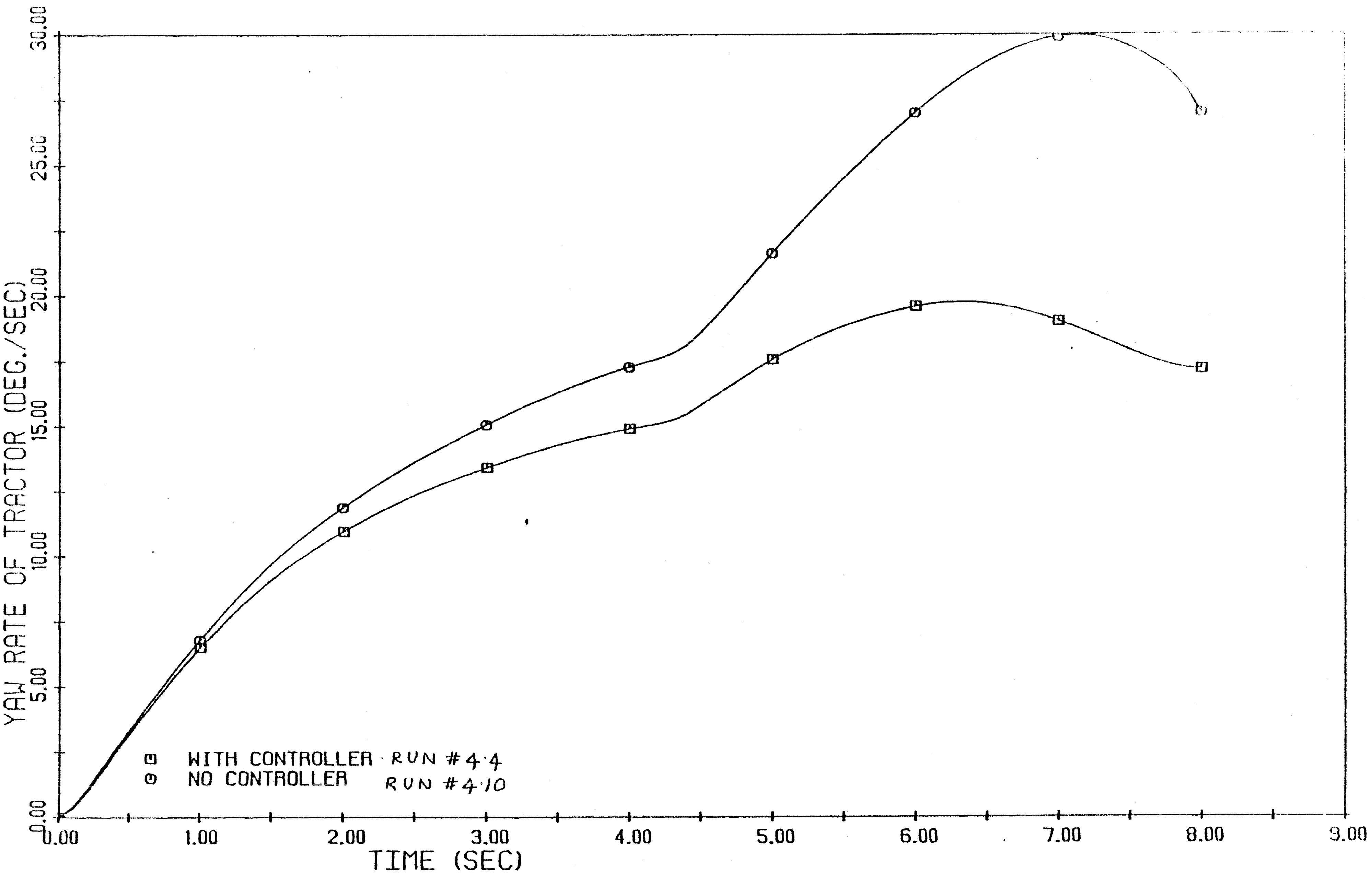
CANADIAN ARTIC BUS, ACCELERATING IN A TURN,40000 IN.LB,INFLUENCE OF CONTROLLER



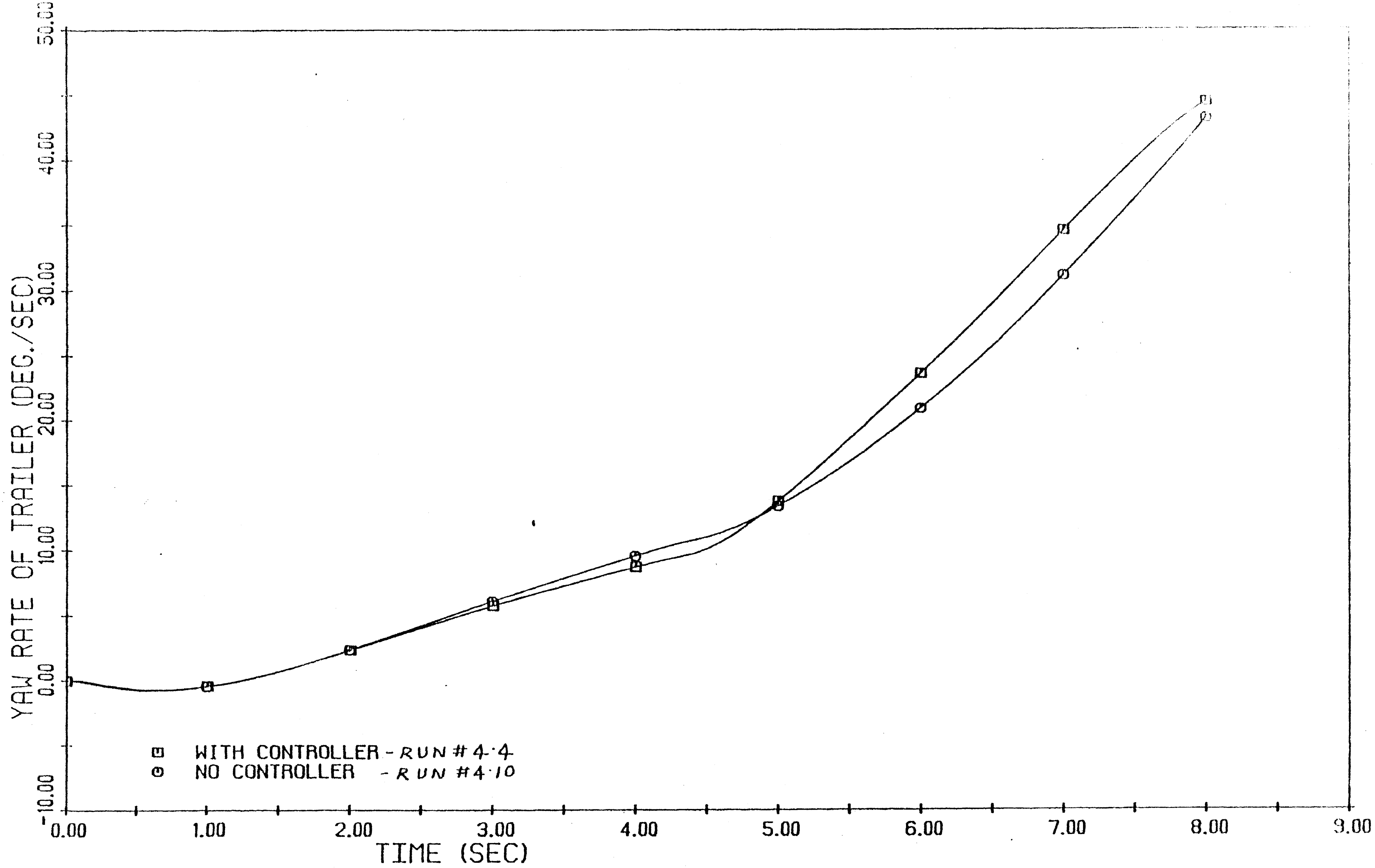
CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB



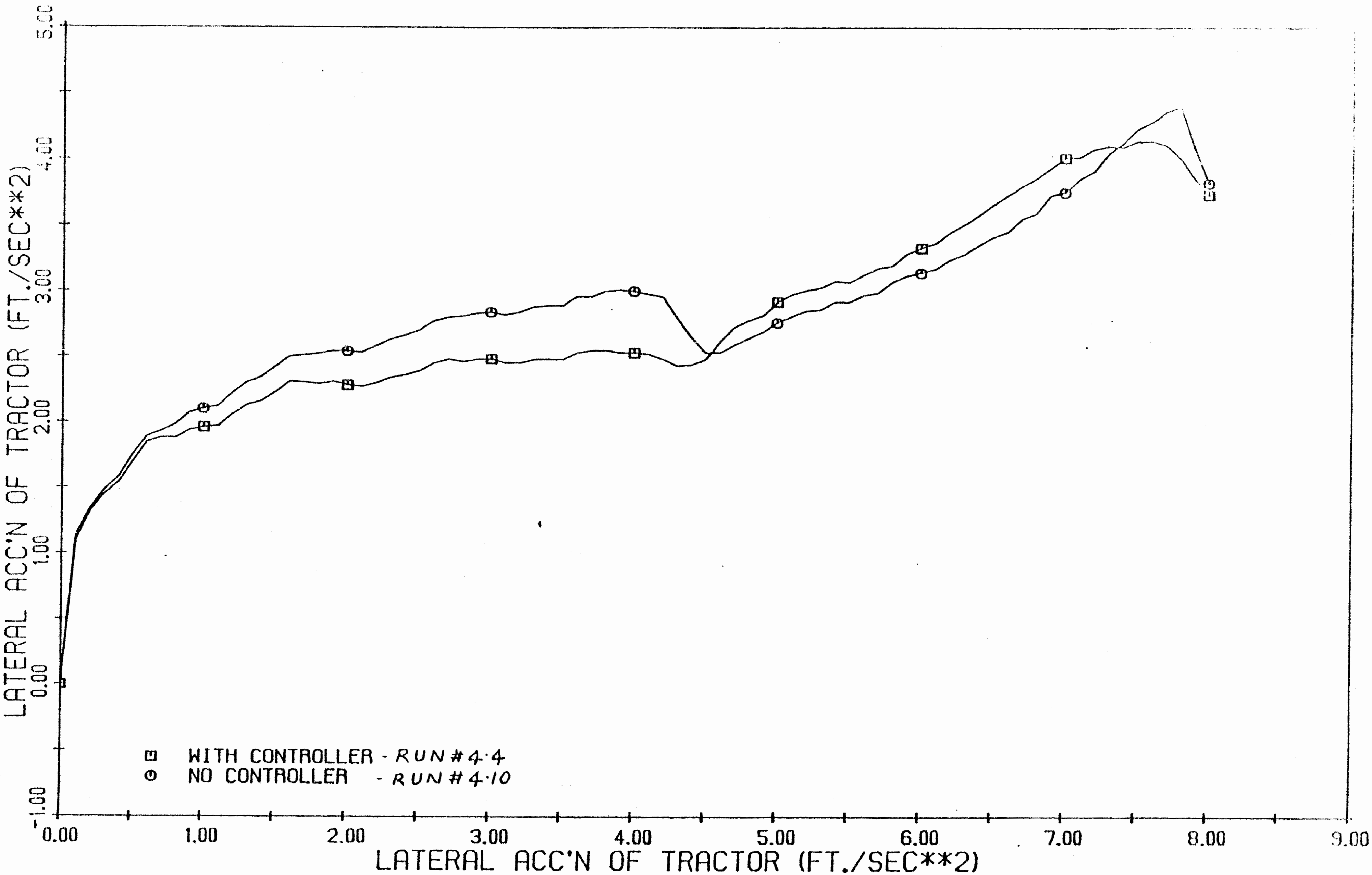
CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB



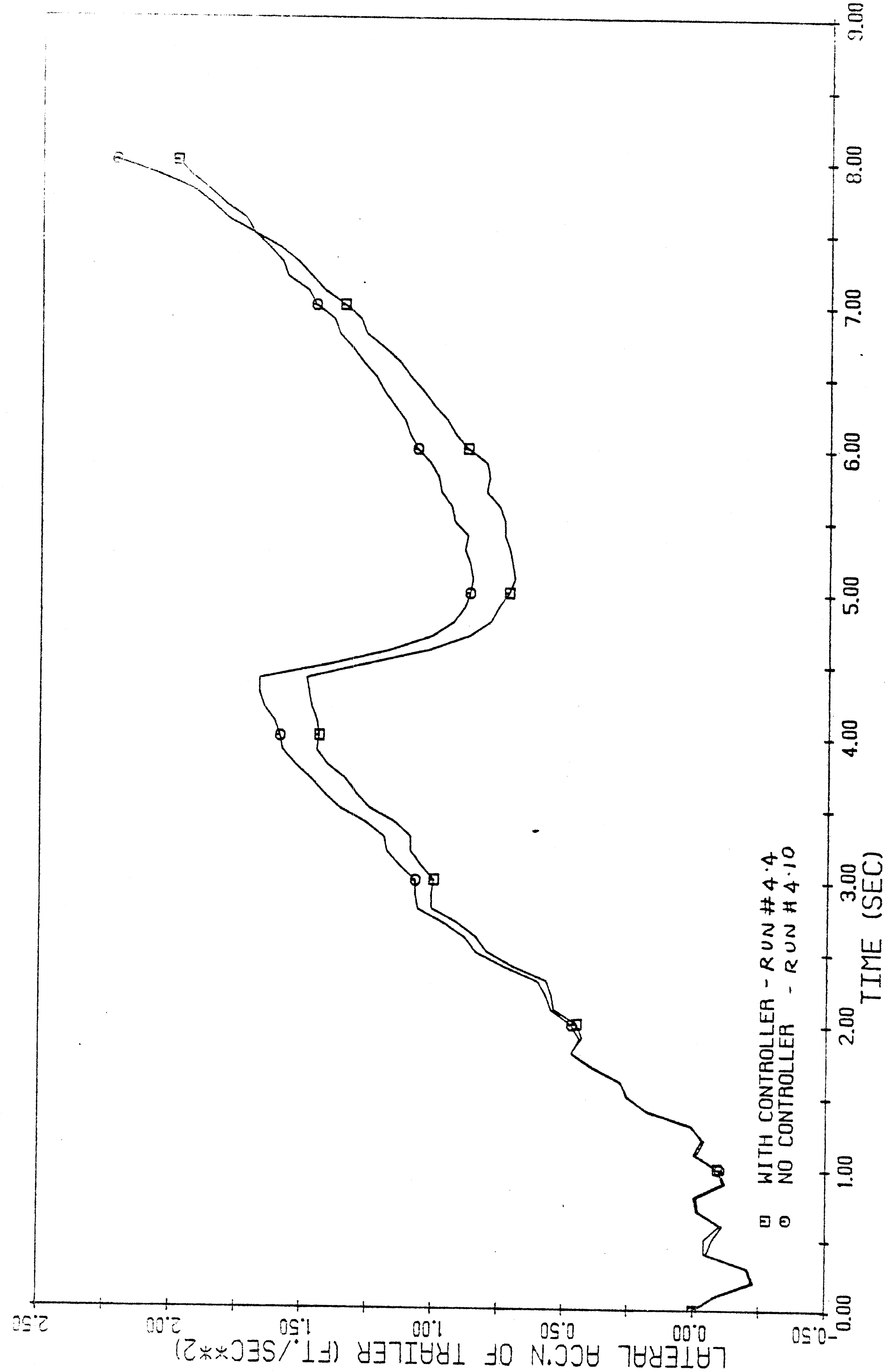
CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB



CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB



CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB



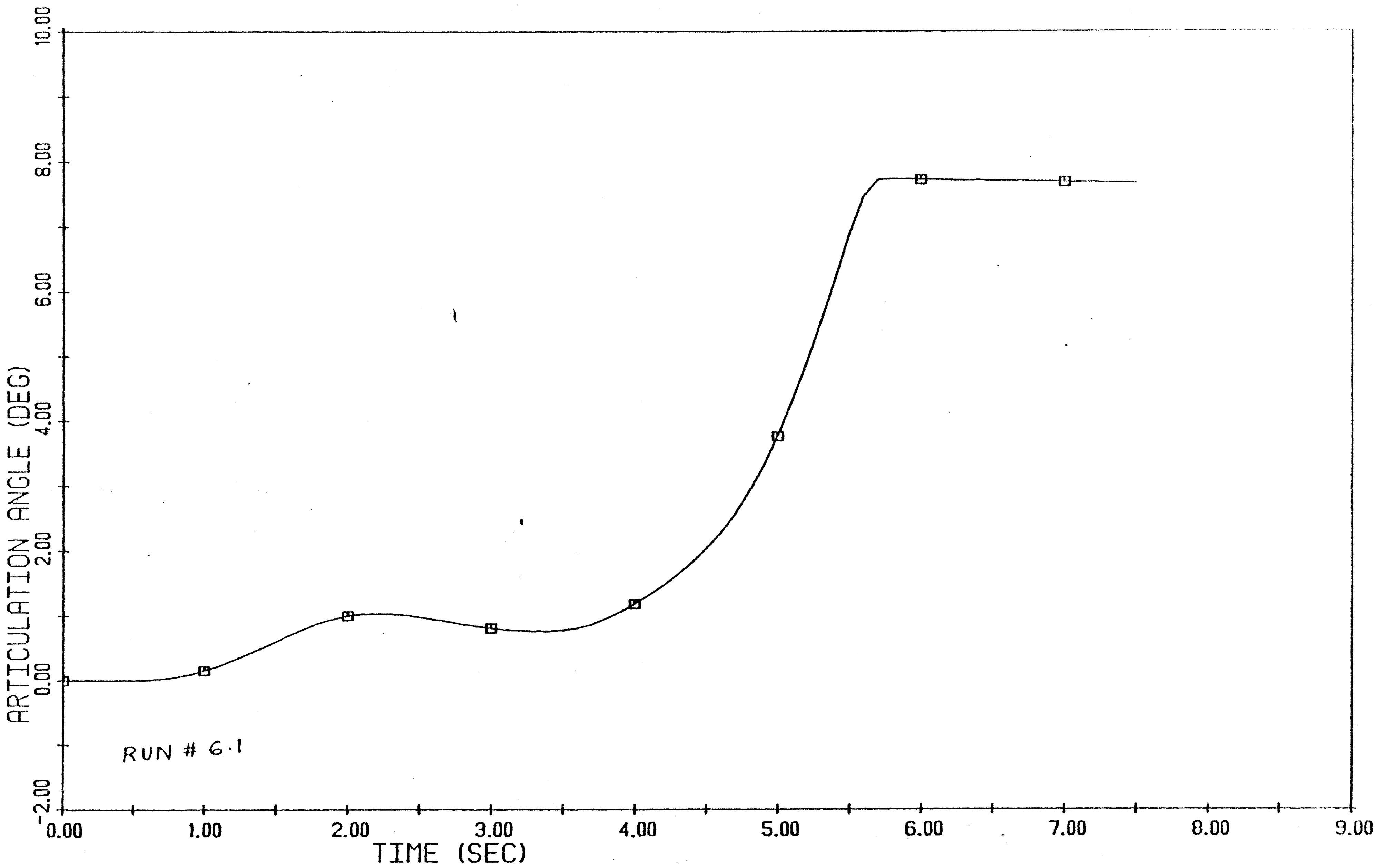
CANADIAN ARTIC BUS, ACC IN A TURN, INFLUENCE OF CONTROLLER, 80000 IN.LB

Table 5. Straight-Line Braking

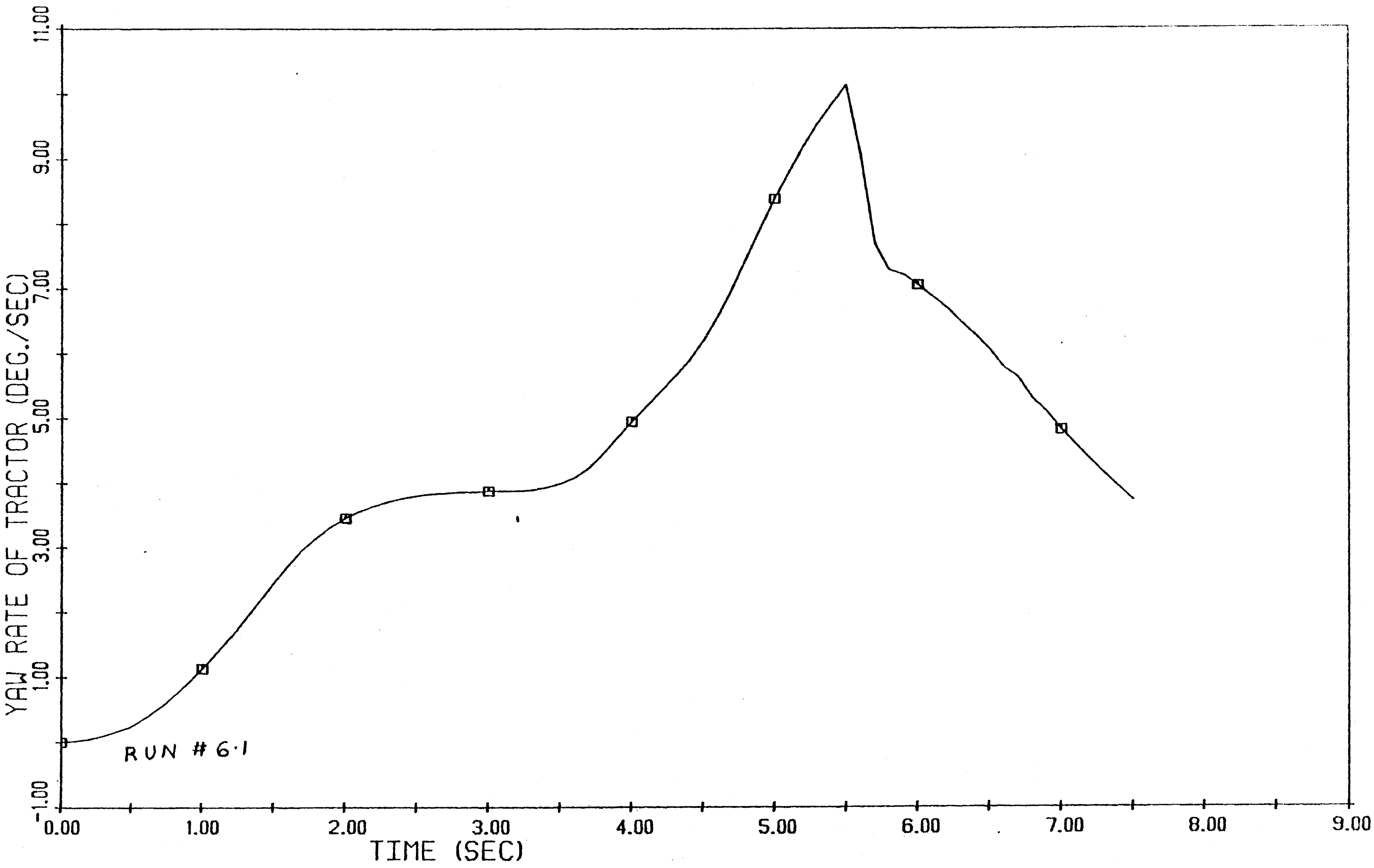
Run #	Calculation #	Loading Condition	Speed (KPH)	Brake Pressure (psi)	Retarder	Comments
5.1	46	E	100	20	Yes	μ_p=0.3
5.2	47	E	100	40	Yes	μ_p=0.6
5.3	48	E	100	20	No	μ_p=0.3
5.4	51	E	50	7	Yes	μ_p=0.1 μ_s=0.08, s_p=0.1
5.5	49	L	100	30	Yes	μ_p=0.3
5.6	50	L	100	60	Yes	μ_p=0.6

Table 6. Braking in a Turn

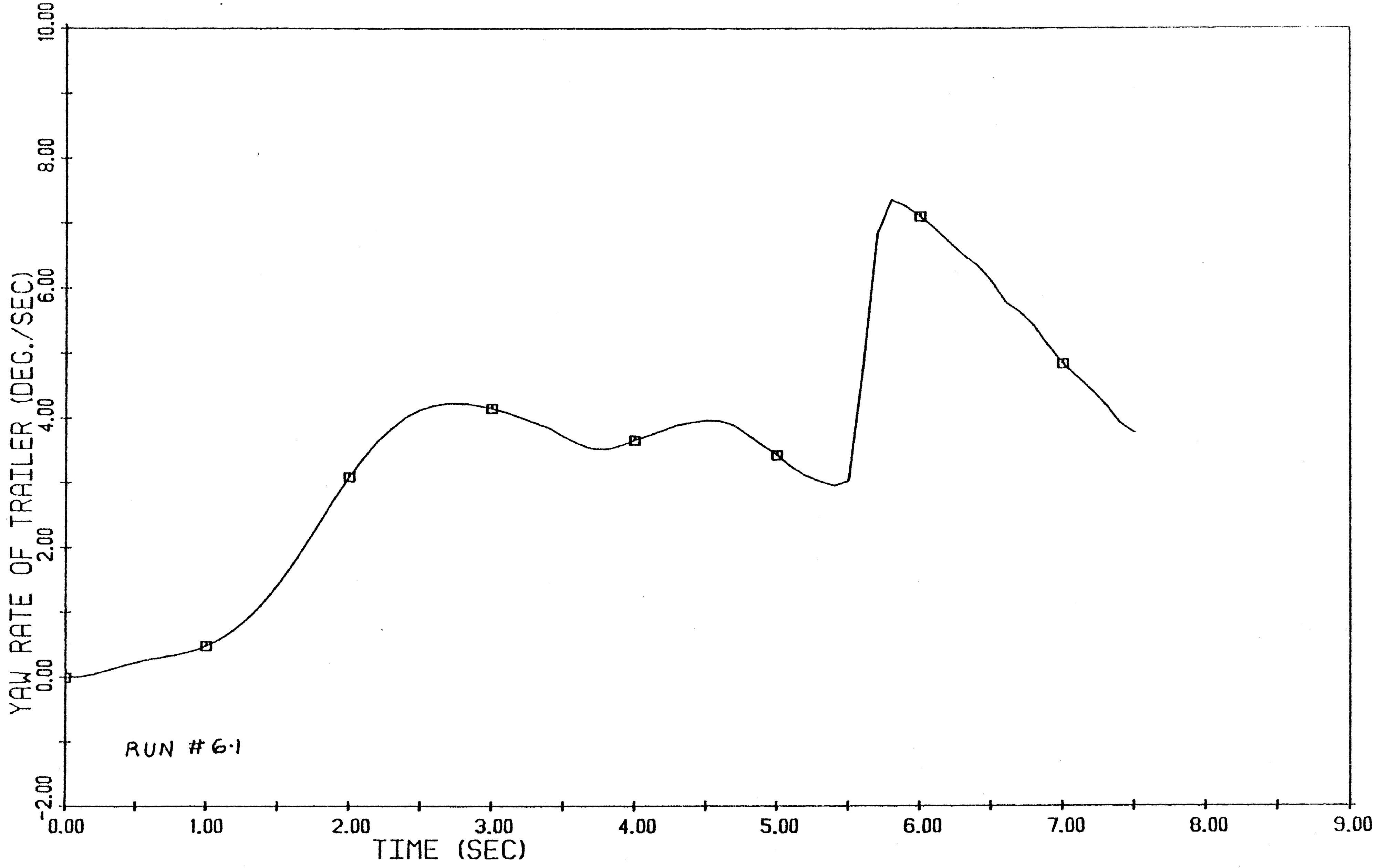
Run #	Calculation #	Loading Condition	Speed (KPH)	Maneuver	Artic. Controller	Retarder	Open- or Closed-Loop	Brake Pressure (psi)	Comments
6.1	55	E	100	50° Steer Inp.	Yes	Yes	O	44	μ_p=0.6
6.2	52	E	50	120° " "	Yes	Yes	O	22	μ_p=0.3
6.3	54	E	50	120° " "	Yes	No	O	25	μ_p=0.3
6.4	56	L	100	85° " "	Yes	Yes	O	63	μ_p=0.6
6.5	53	L	50	160° " "	Yes	Yes	O	33	μ_p=0.3
6.6	63	E	100		Yes	Yes	C	44	μ_p=0.6
6.7	60	E	50		Yes	Yes	C	22	μ_p=0.3
6.8	61	E	50		Yes	No	C	25	μ_p=0.3
6.9	64	L	100		Yes	Yes	C	63	μ_p=0.6
6.10	62	L	50		Yes	Yes	C	33	μ_p=0.3
6.11	113	E	50	120° " "	No	Yes	O	22	Same as #6.2 with New Load Data
6.12	107	L	100	85° " "	No	Yes	O	63	Same as #6.4 without Cont.
6.13	108	L	100	-85° " "	Yes	Yes	O	63	Same as #6.4 Left turn



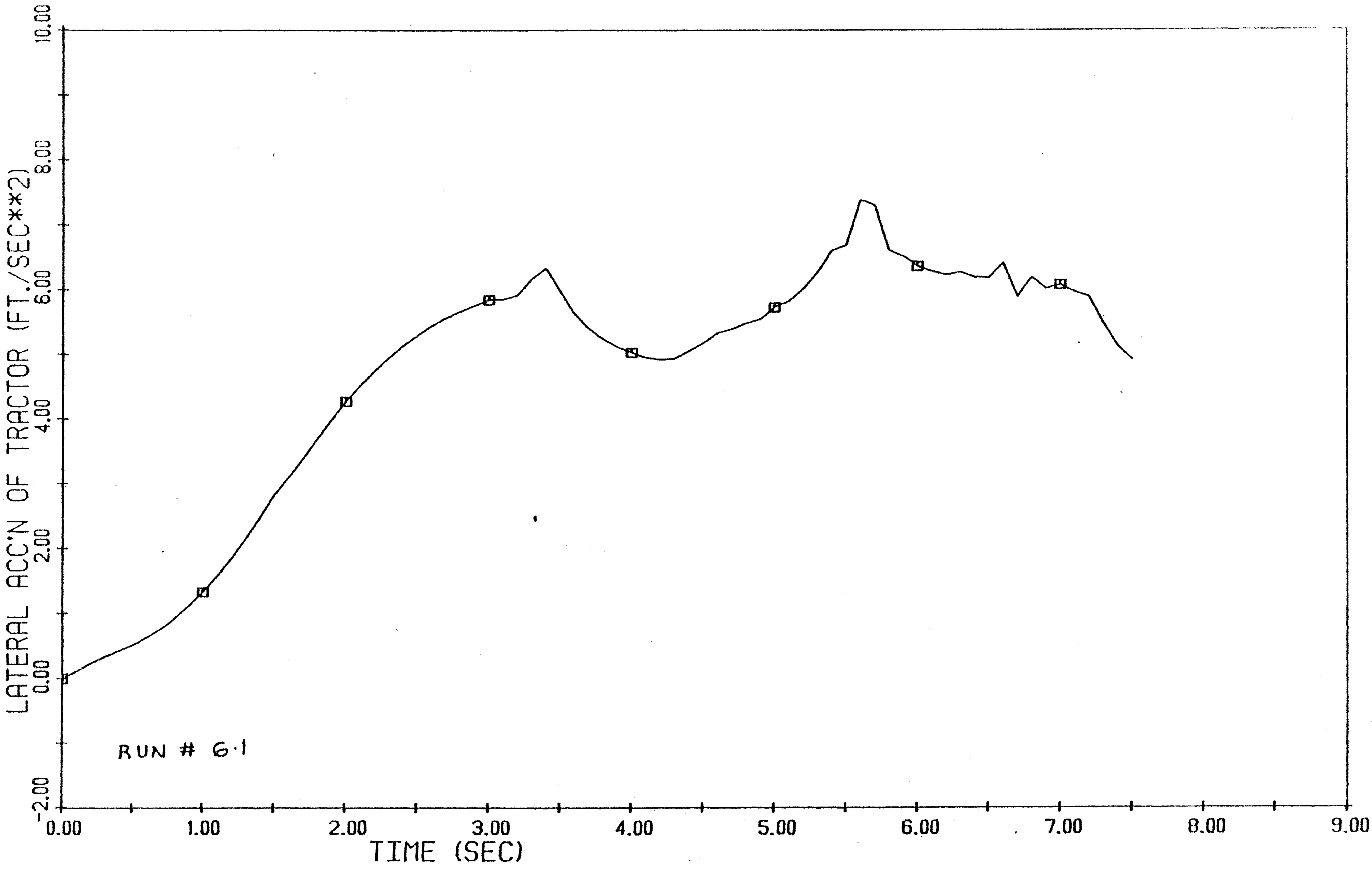
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



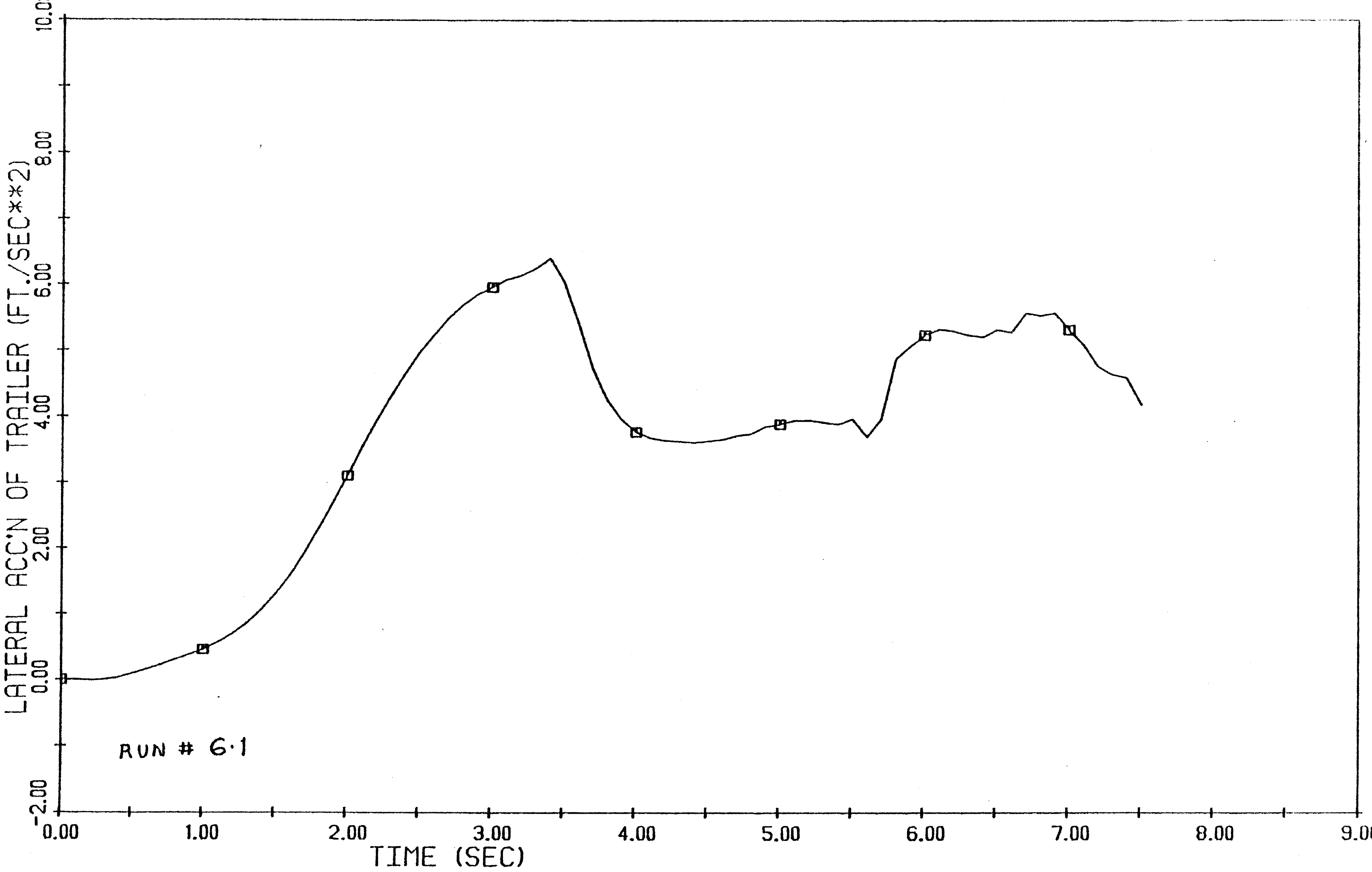
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



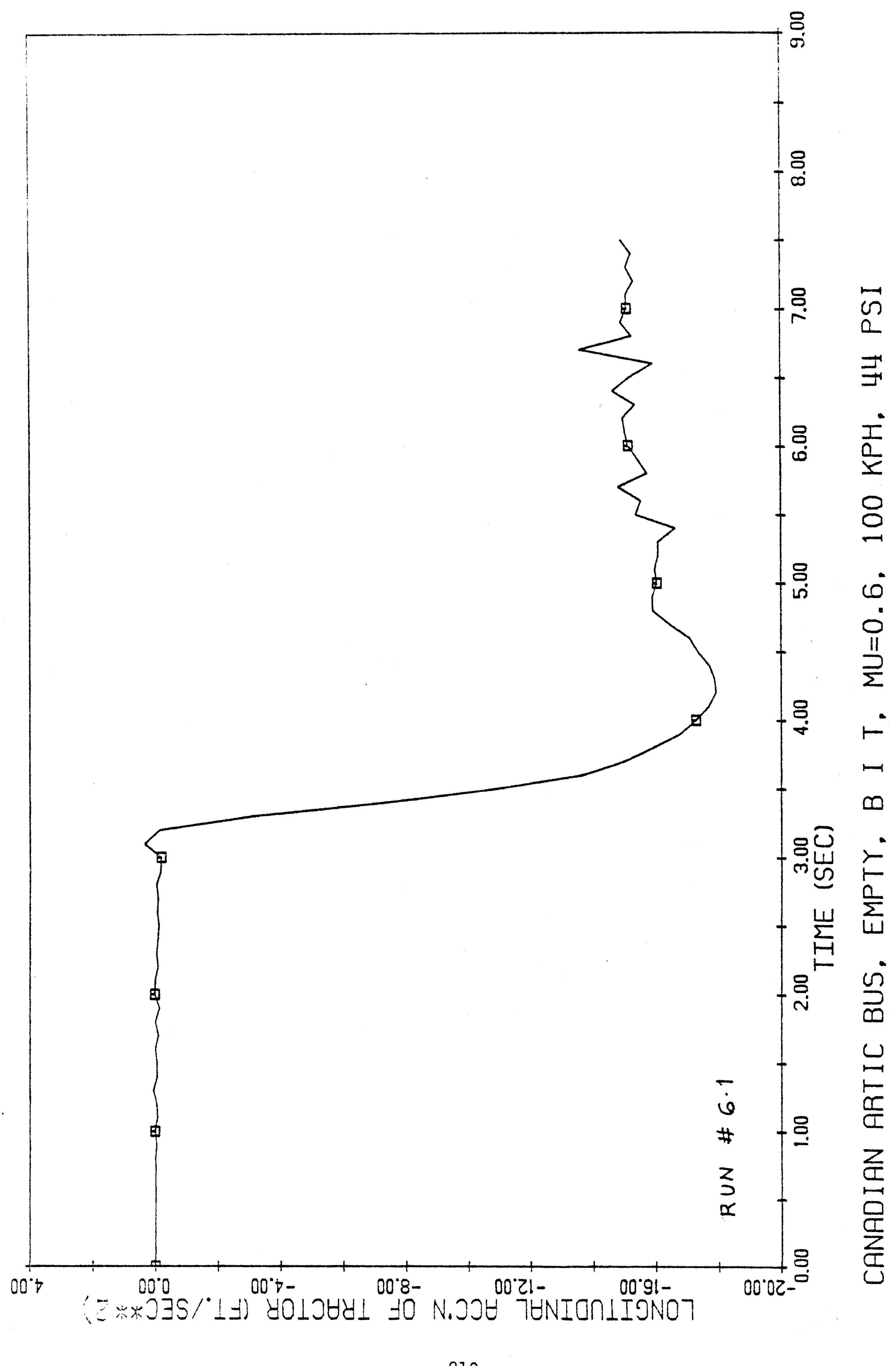
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



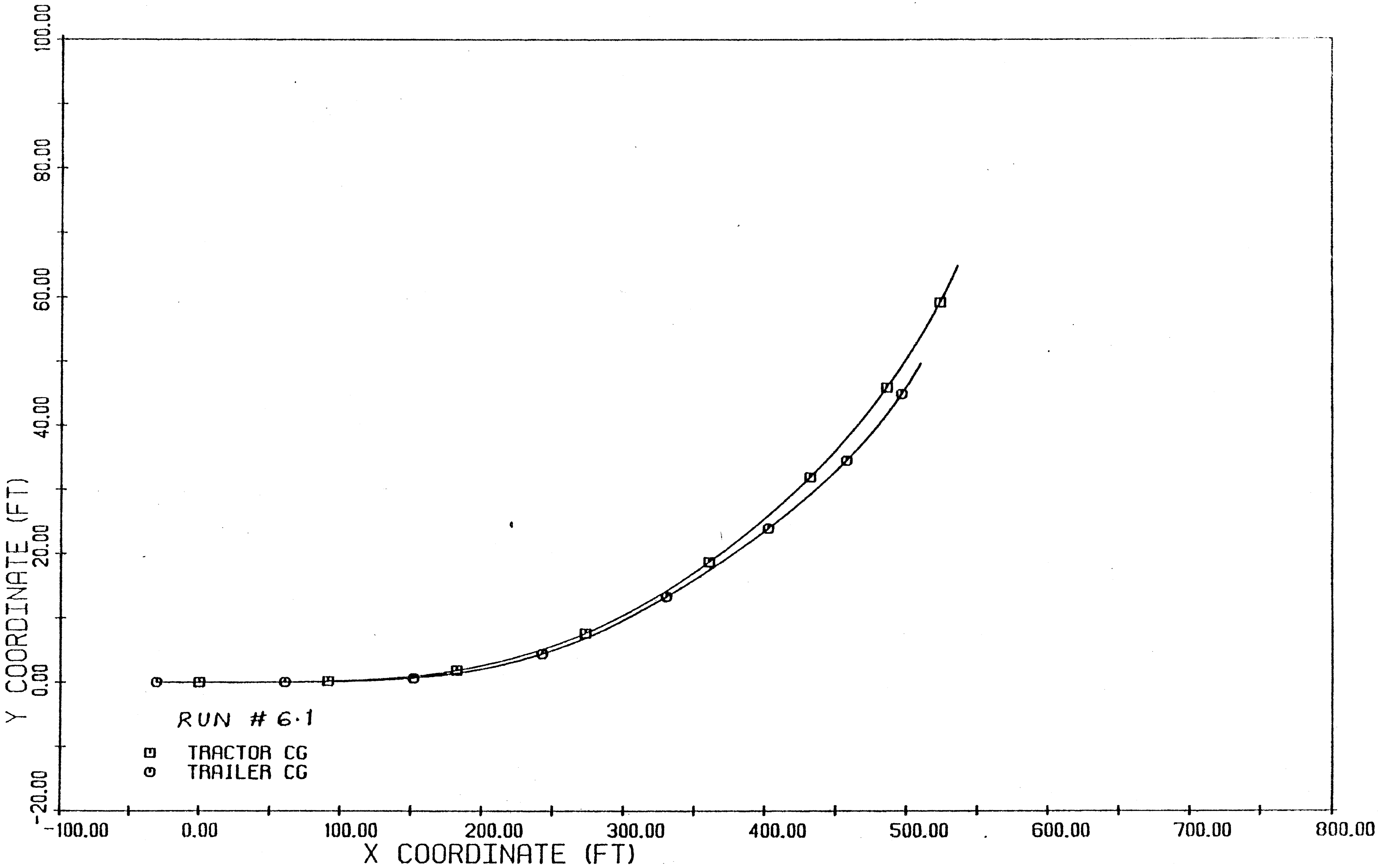
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



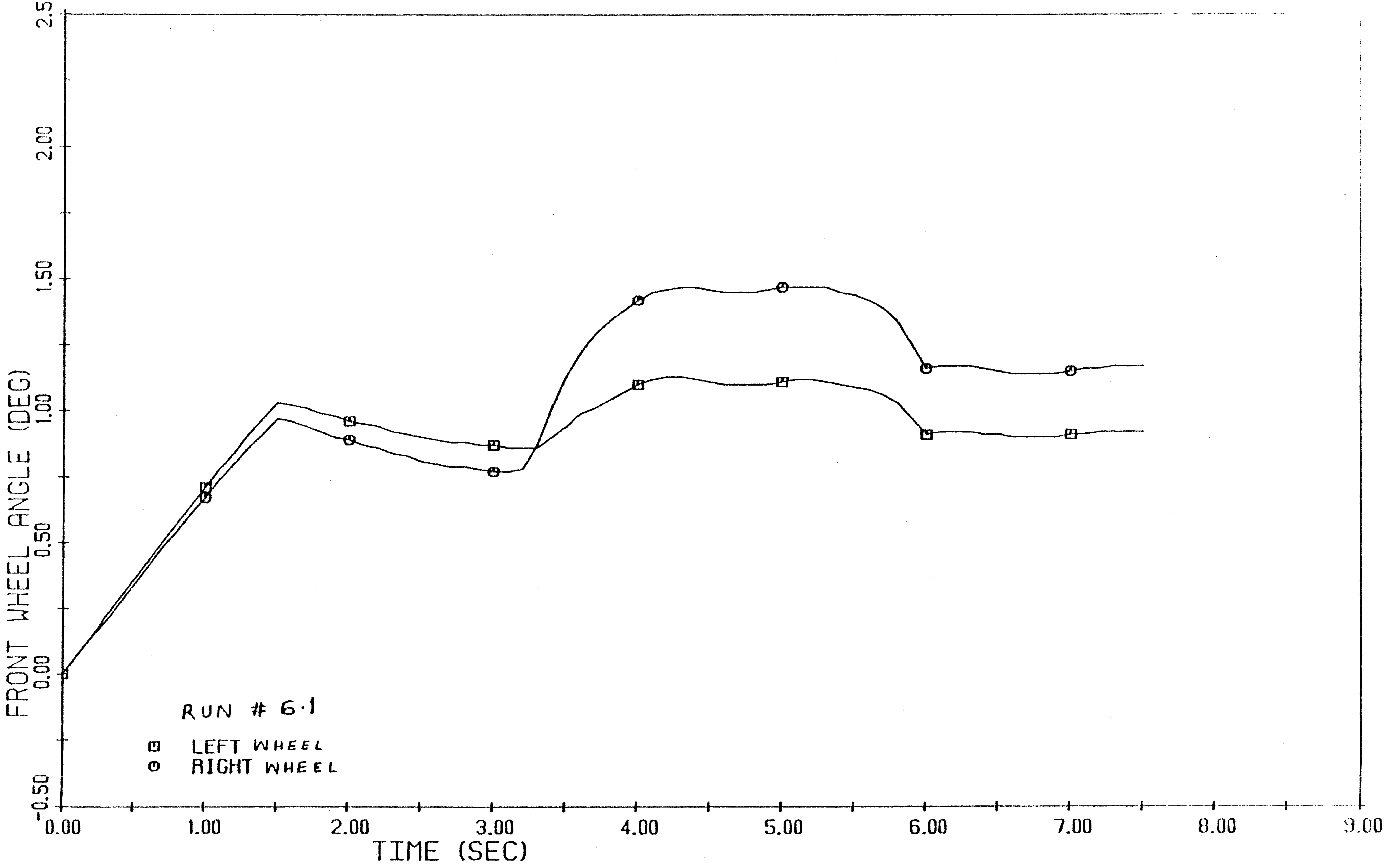
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



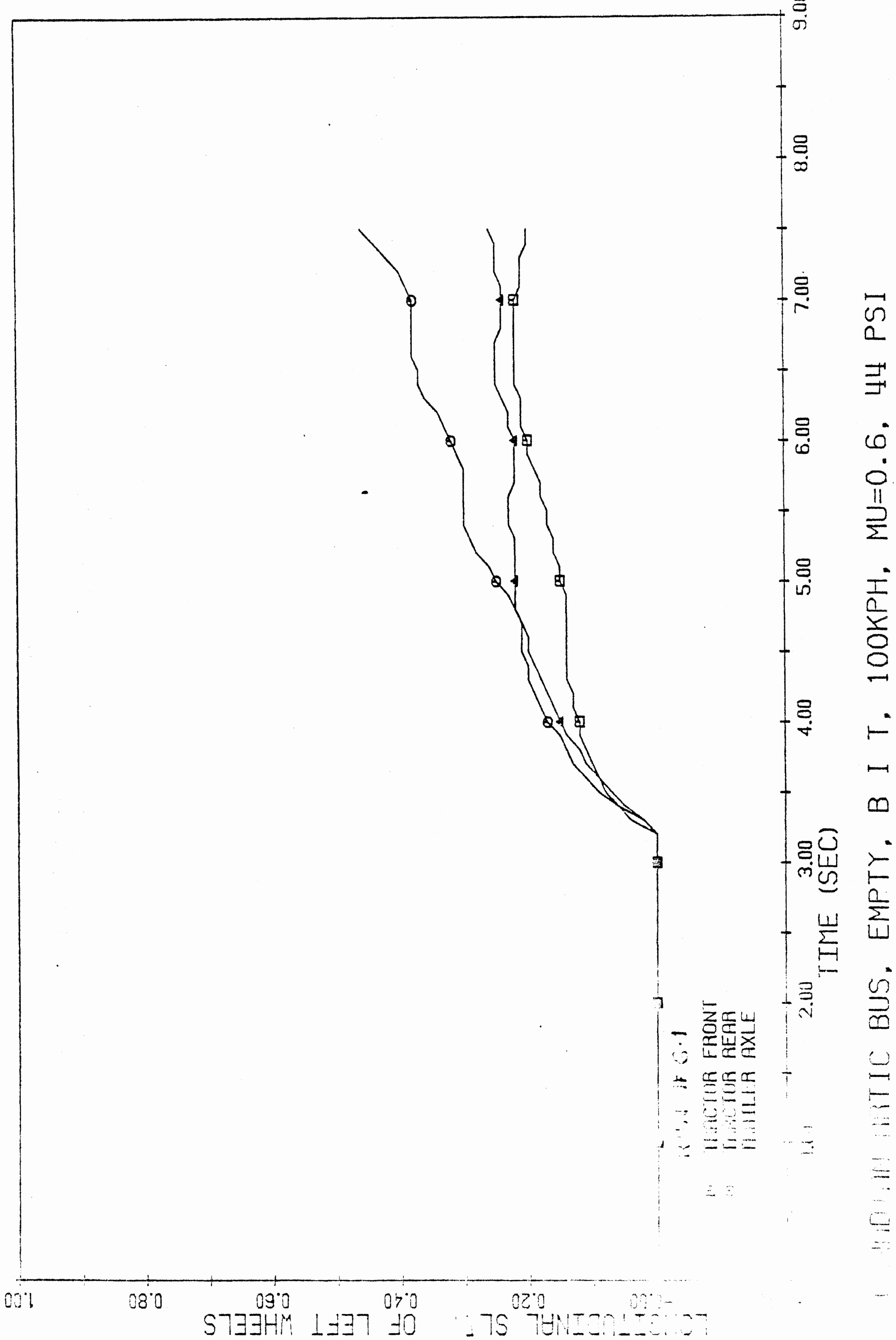
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI
TIME (SEC)
LONGITUDINAL ACC'N OF TRACTOR (FT./SEC**2)
RUN # 6·1
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
-20.00
-16.00
-12.00
-8.00
-4.00
0.00
4.00



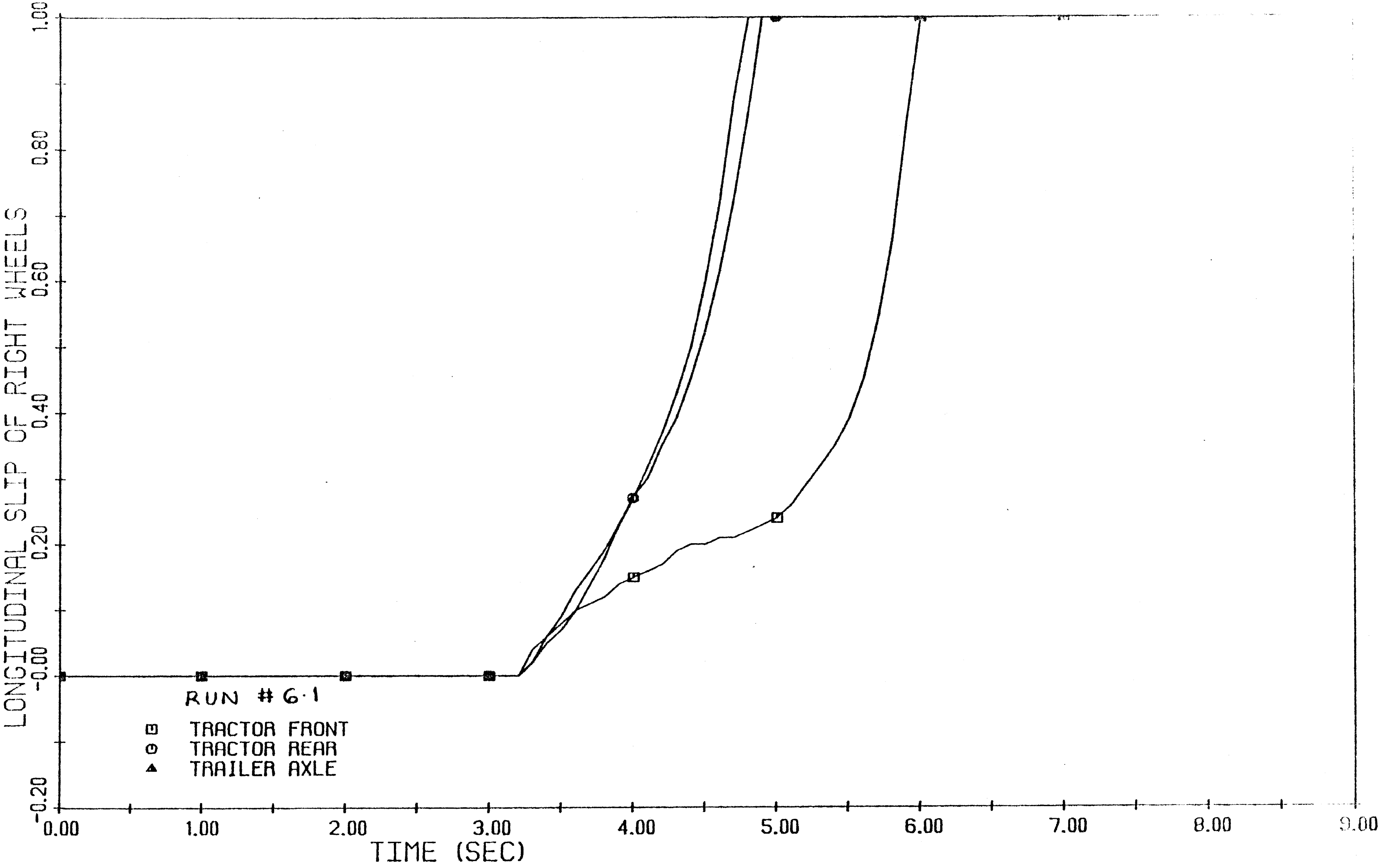
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



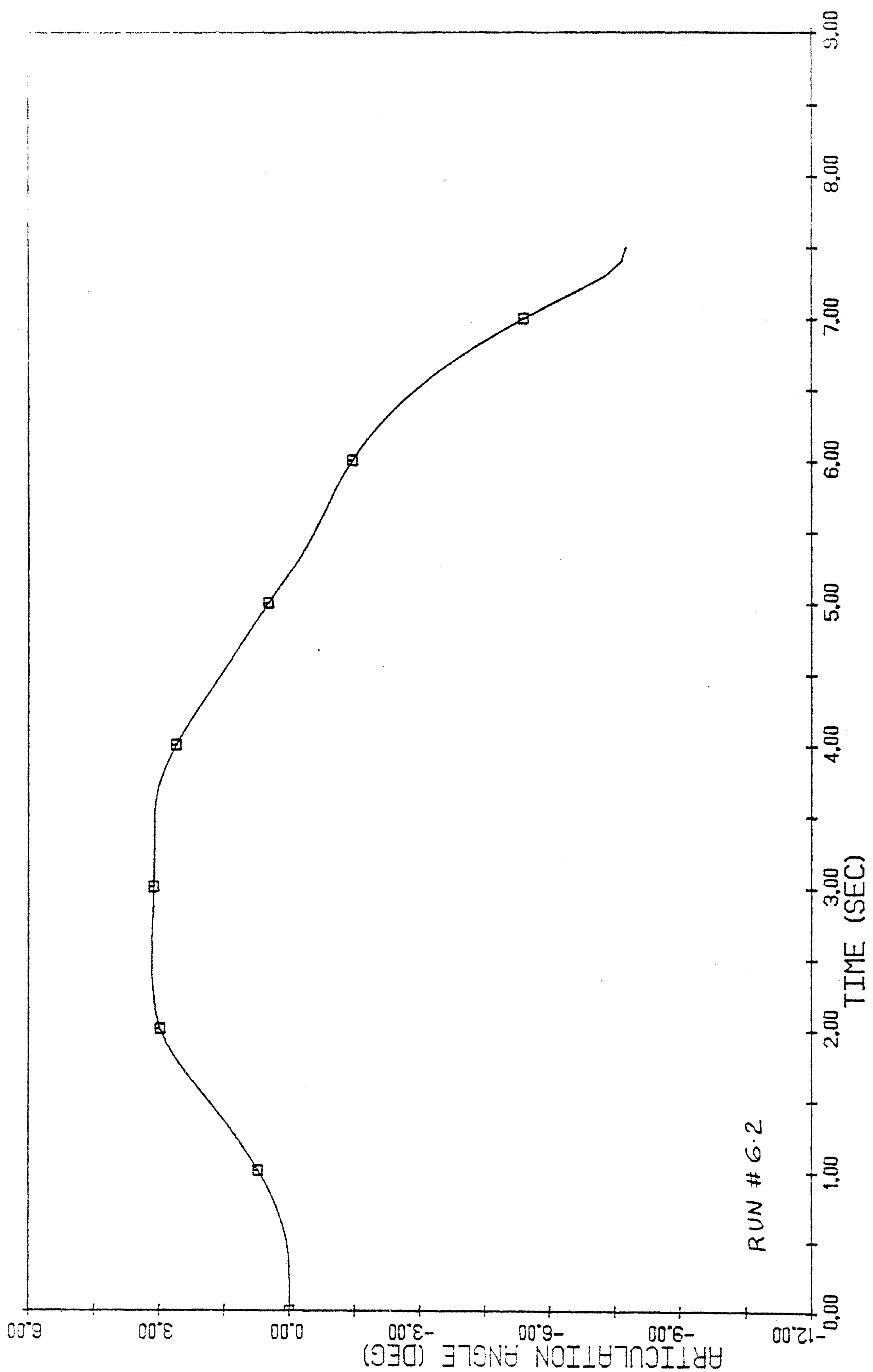
CANADIAN ARTIC BUS, EMPTY, B I T, MU=0.6, 100 KPH, 44 PSI



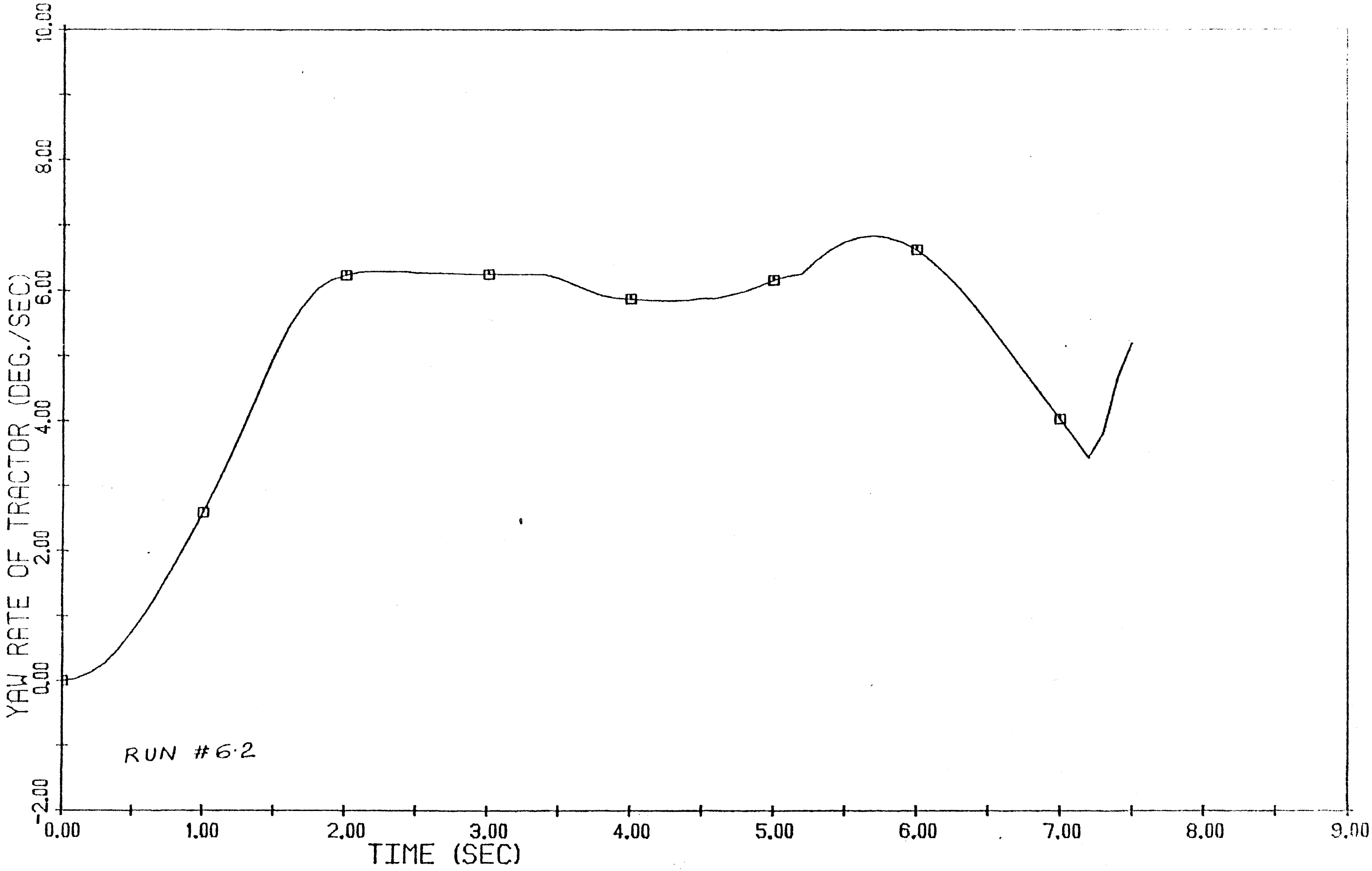
ARTIC BUS, EMPTY, B I T, 100KPH, MU=0.6, 44 PSI
TIME (SEC)
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
OF LEFT WHEELS
0.20
0.40
0.60
0.80
1.00
FRONT
REAR
AXLE



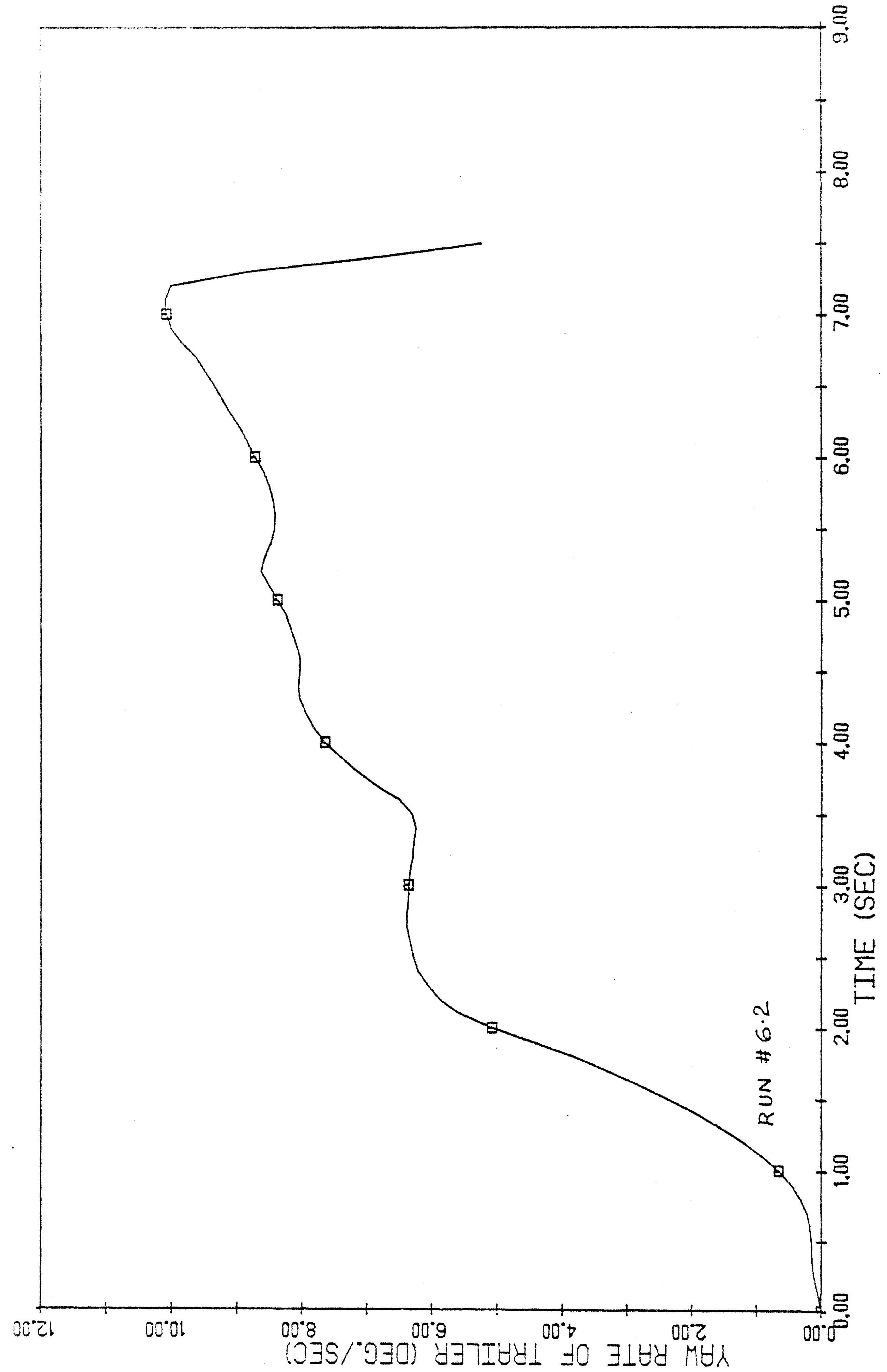
CANADIAN ARTIC BUS, EMPTY, B I T, 100KPH, MU=0.6, 44 PSI



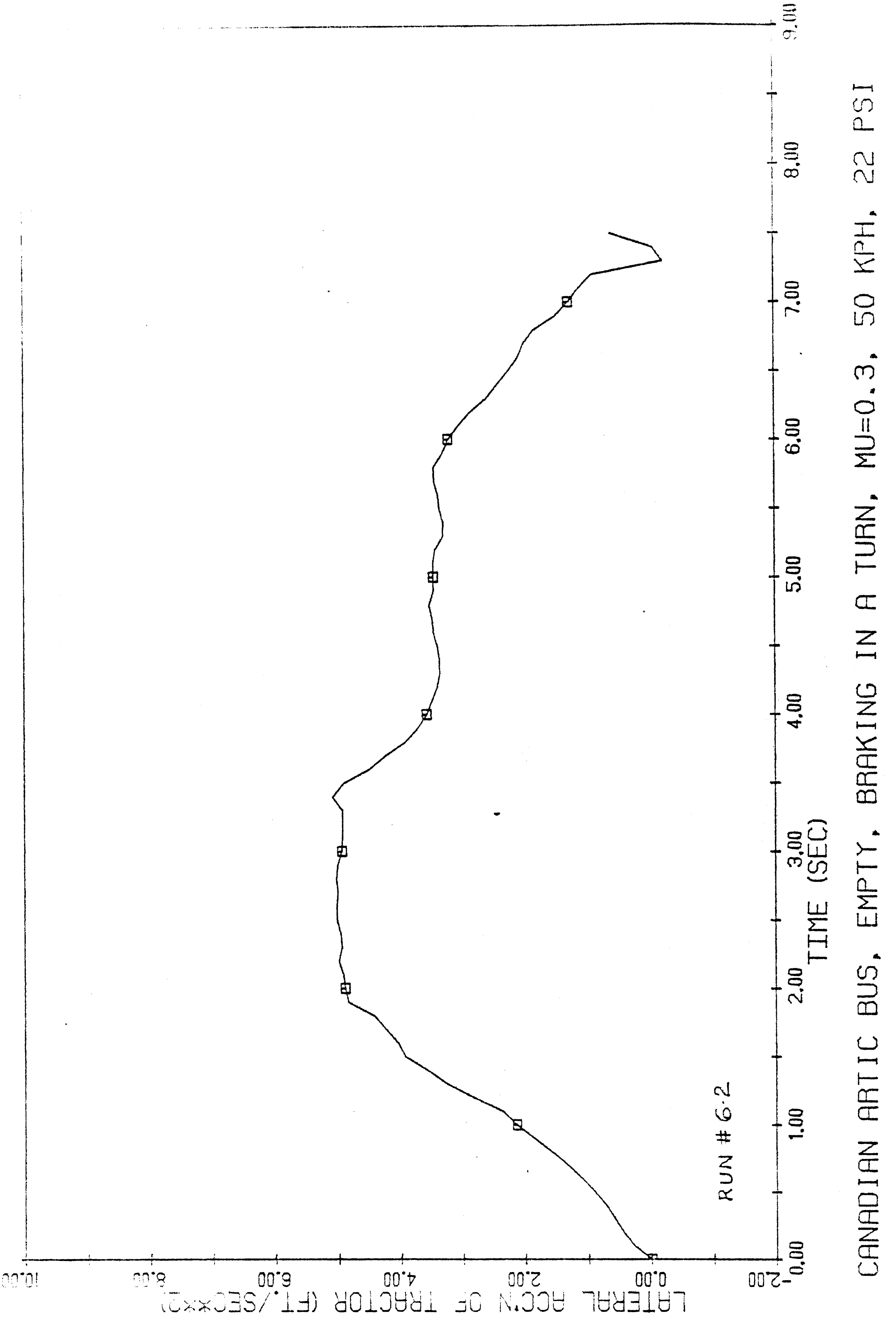
CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI

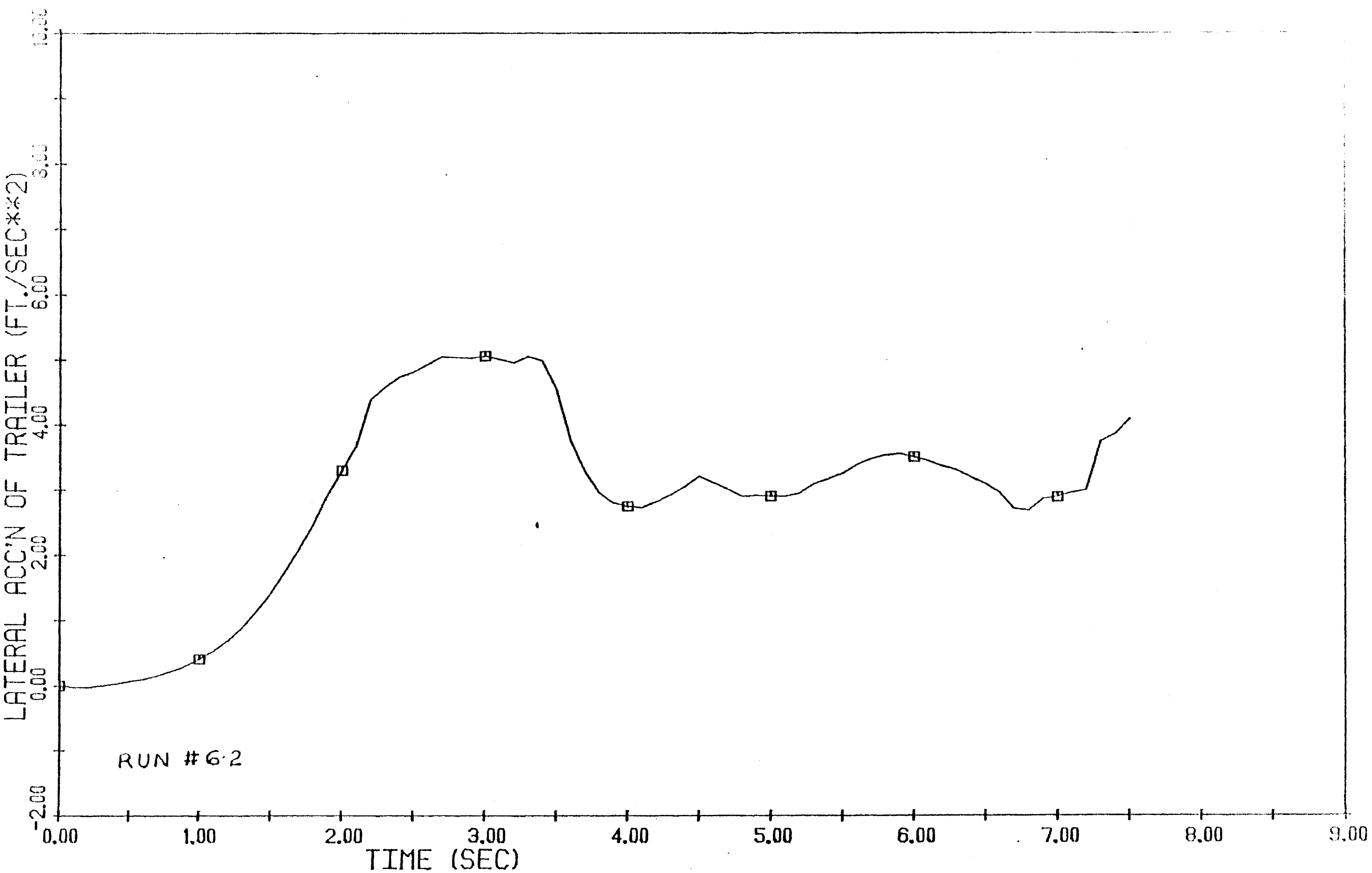


CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI

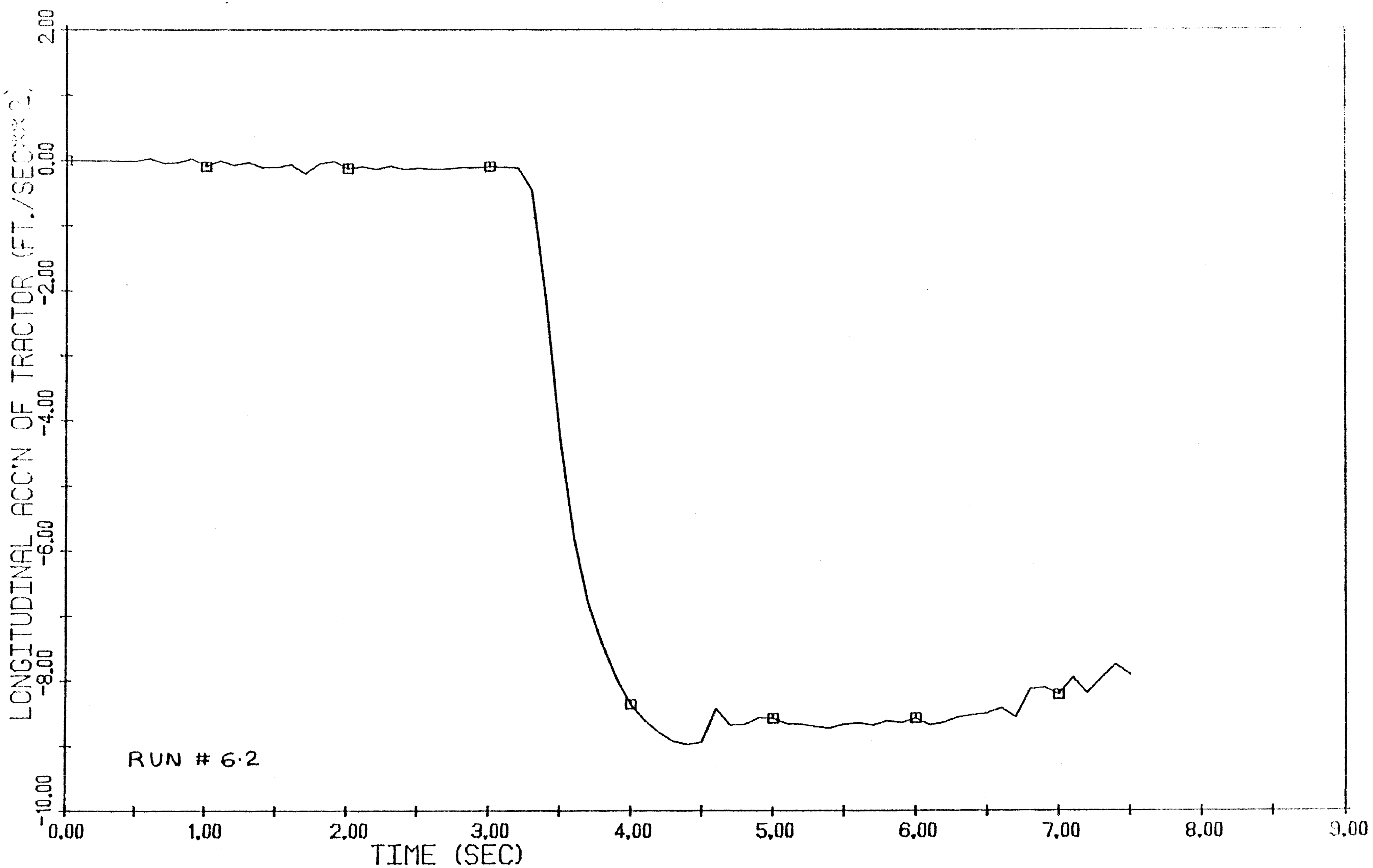


CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI

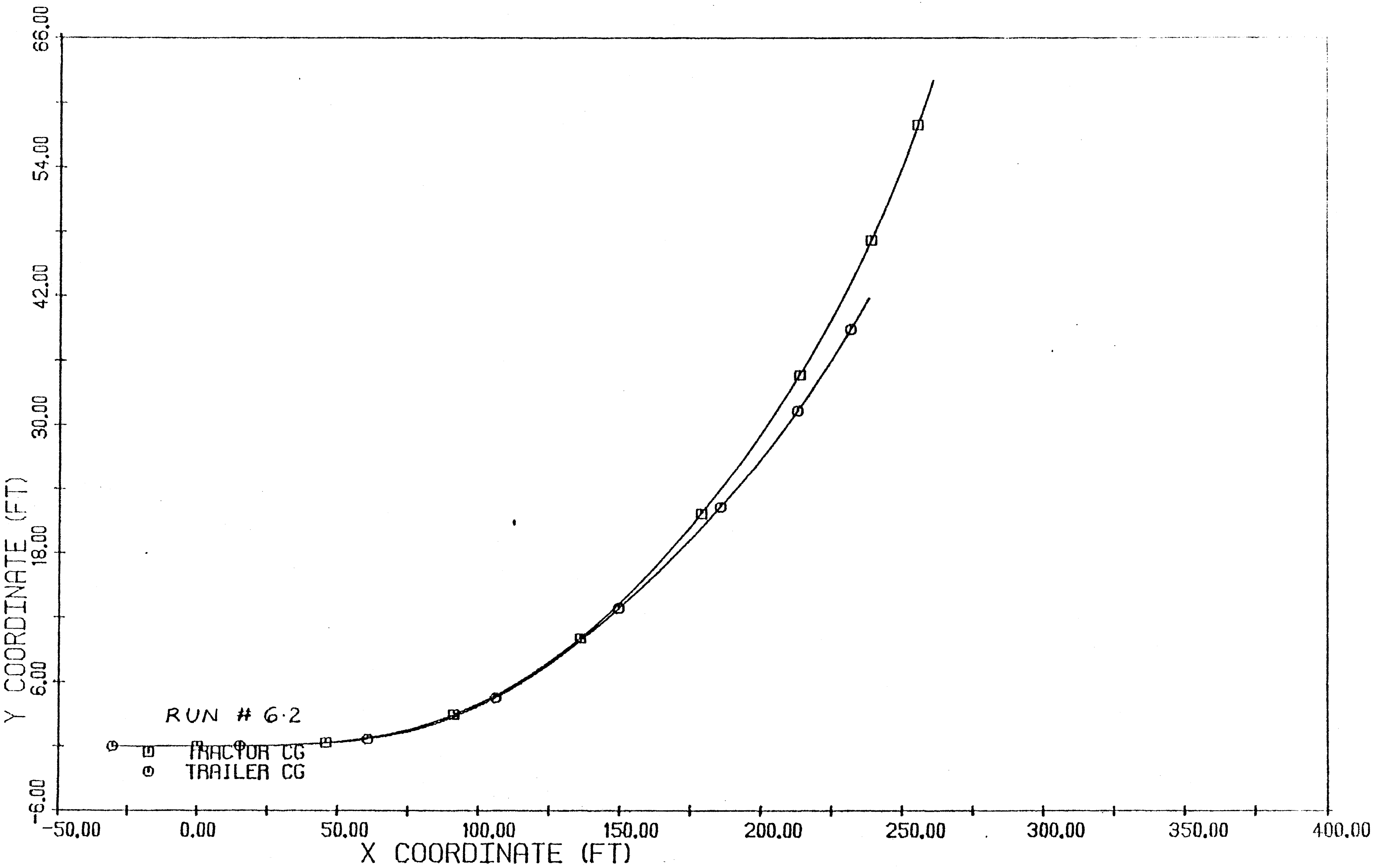

RUN # 6·2
TIME (SEC)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
LATERAL ACC'N OF TRACTOR (FT./SEC**2)
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI



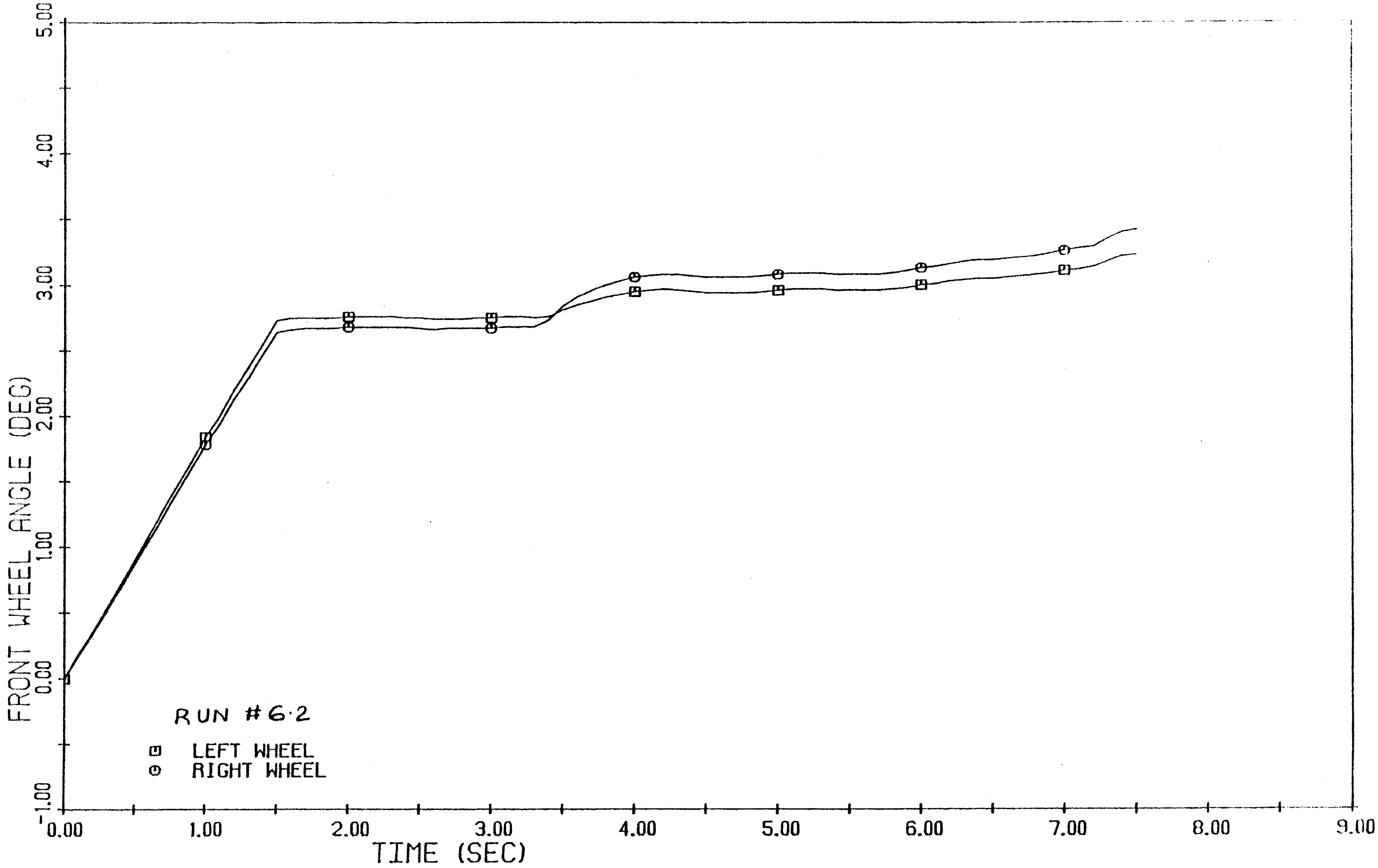
CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI



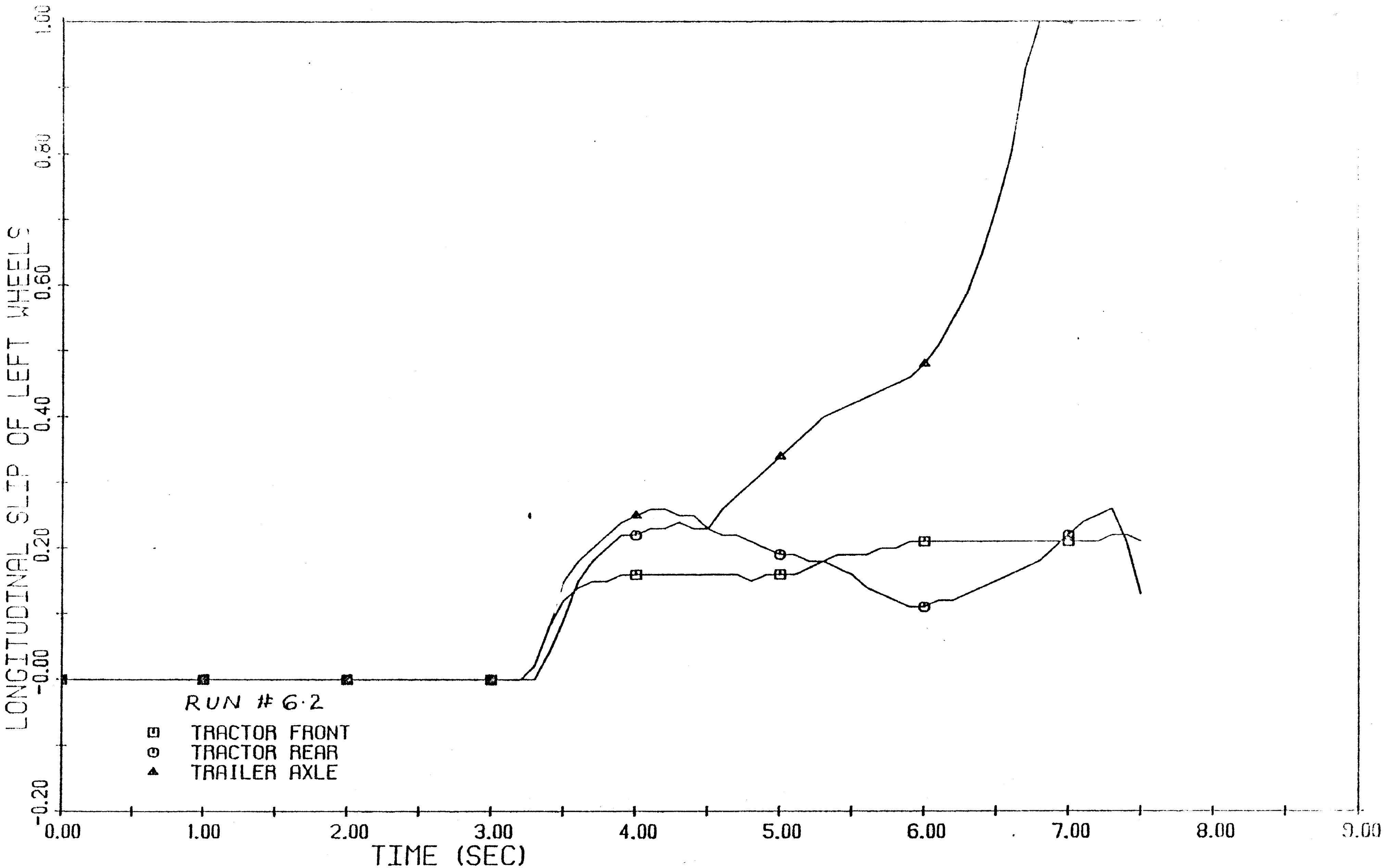
CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI



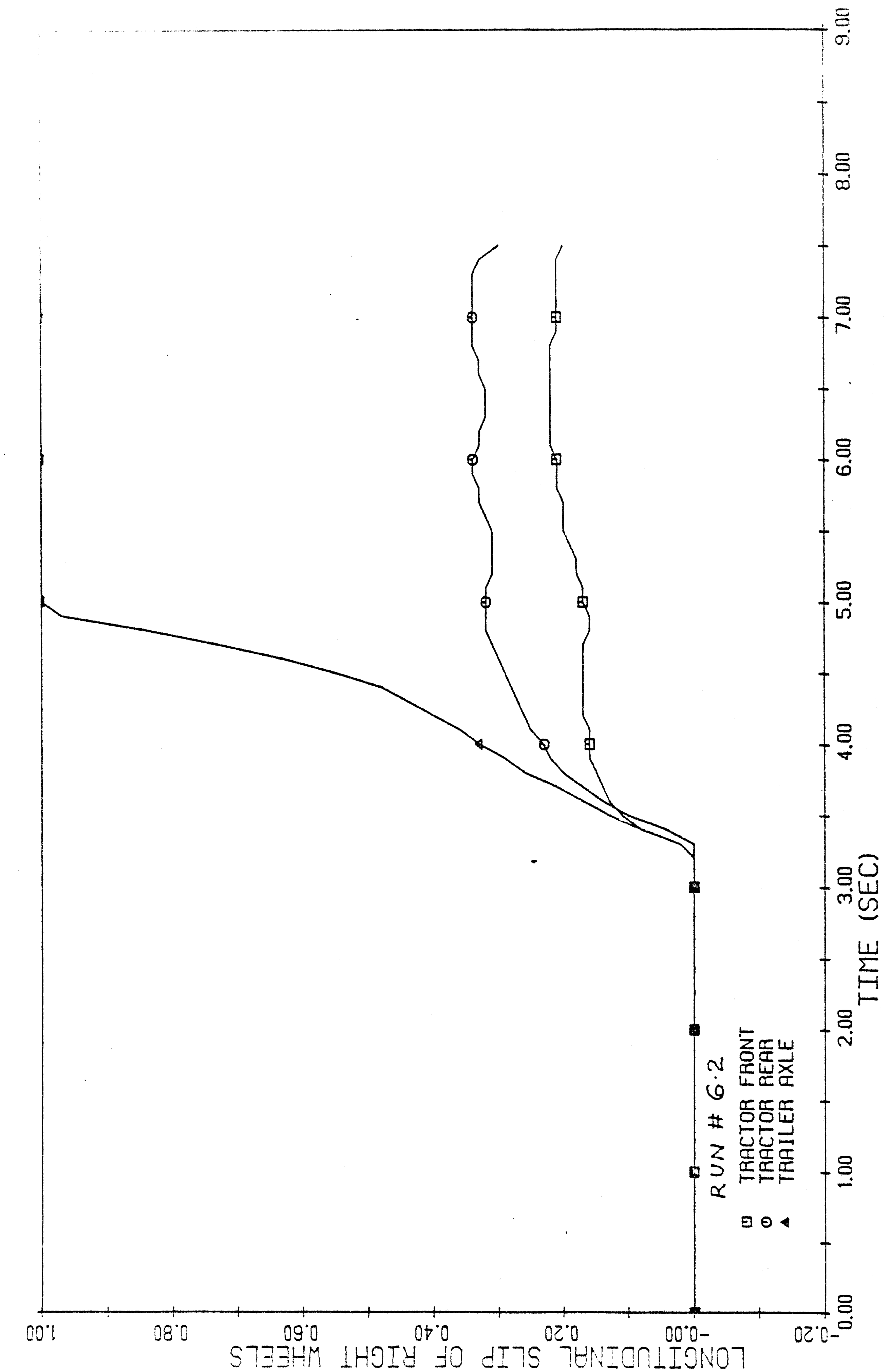
CANADIAN ARTIC BUS, EMPTY, BRAKING IN A TURN, MU=0.3, 50 KPH, 22 PSI



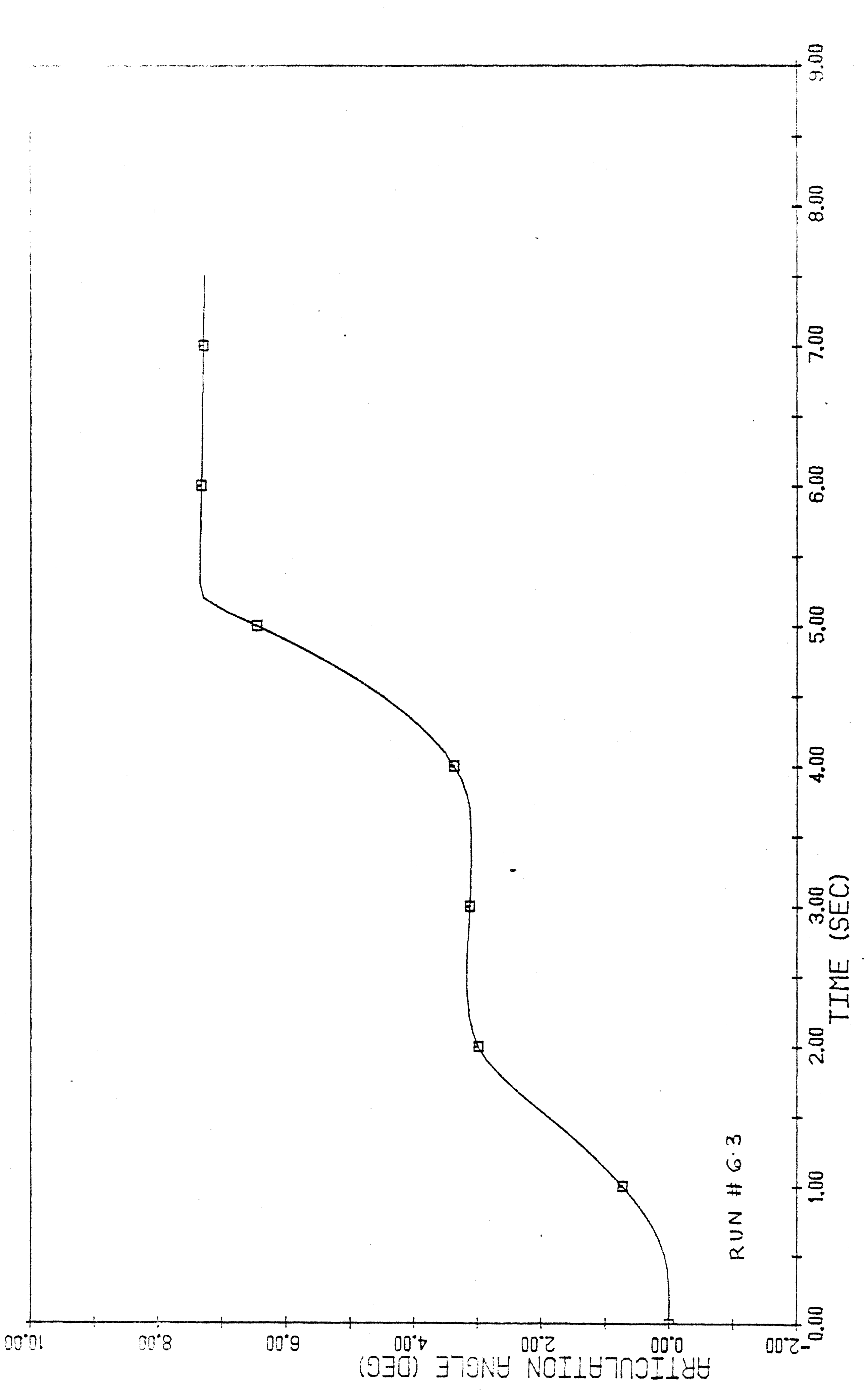
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, MU=0.3, 22 PSI



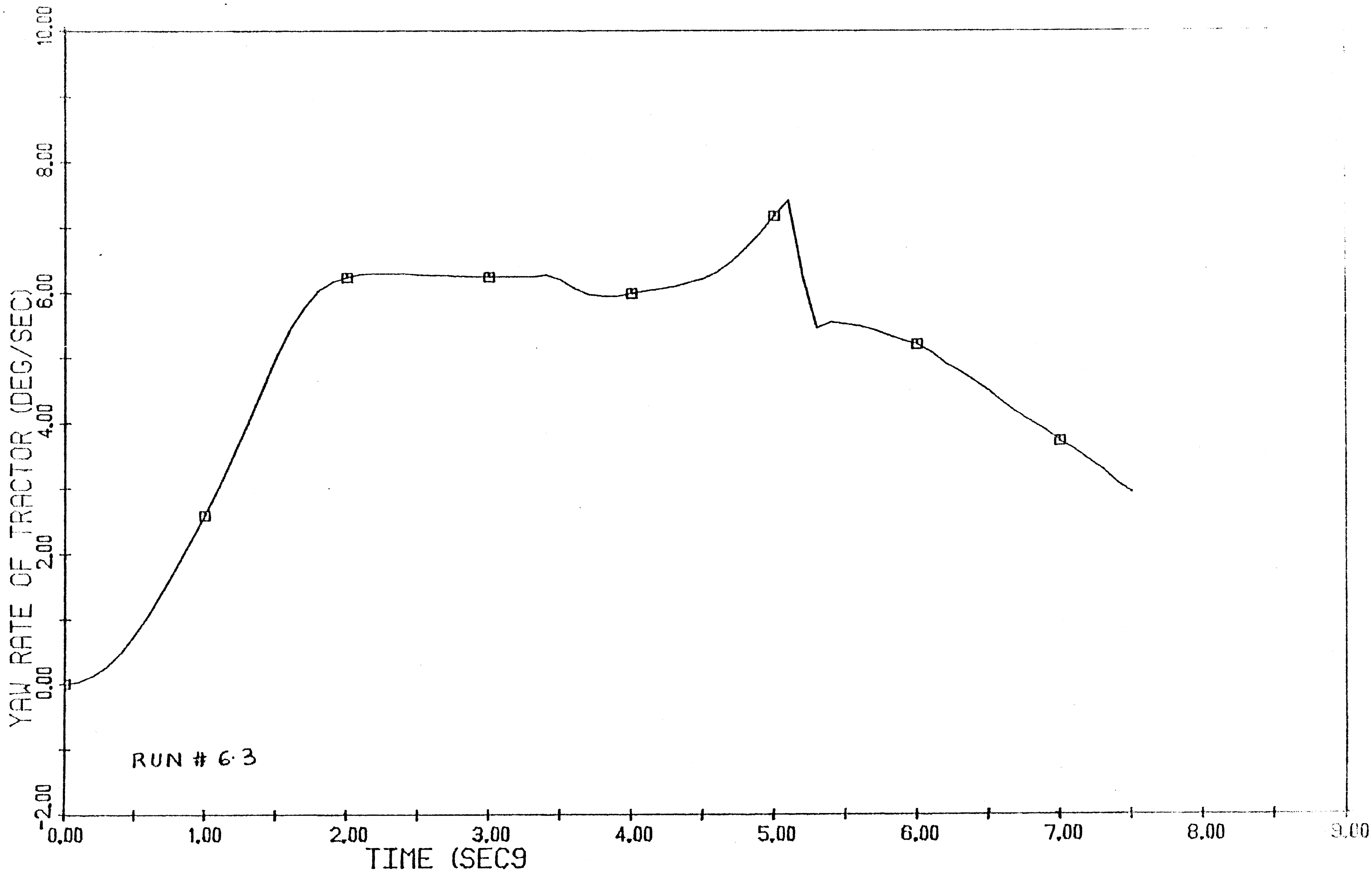
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, MU=0.3, 22 PSI



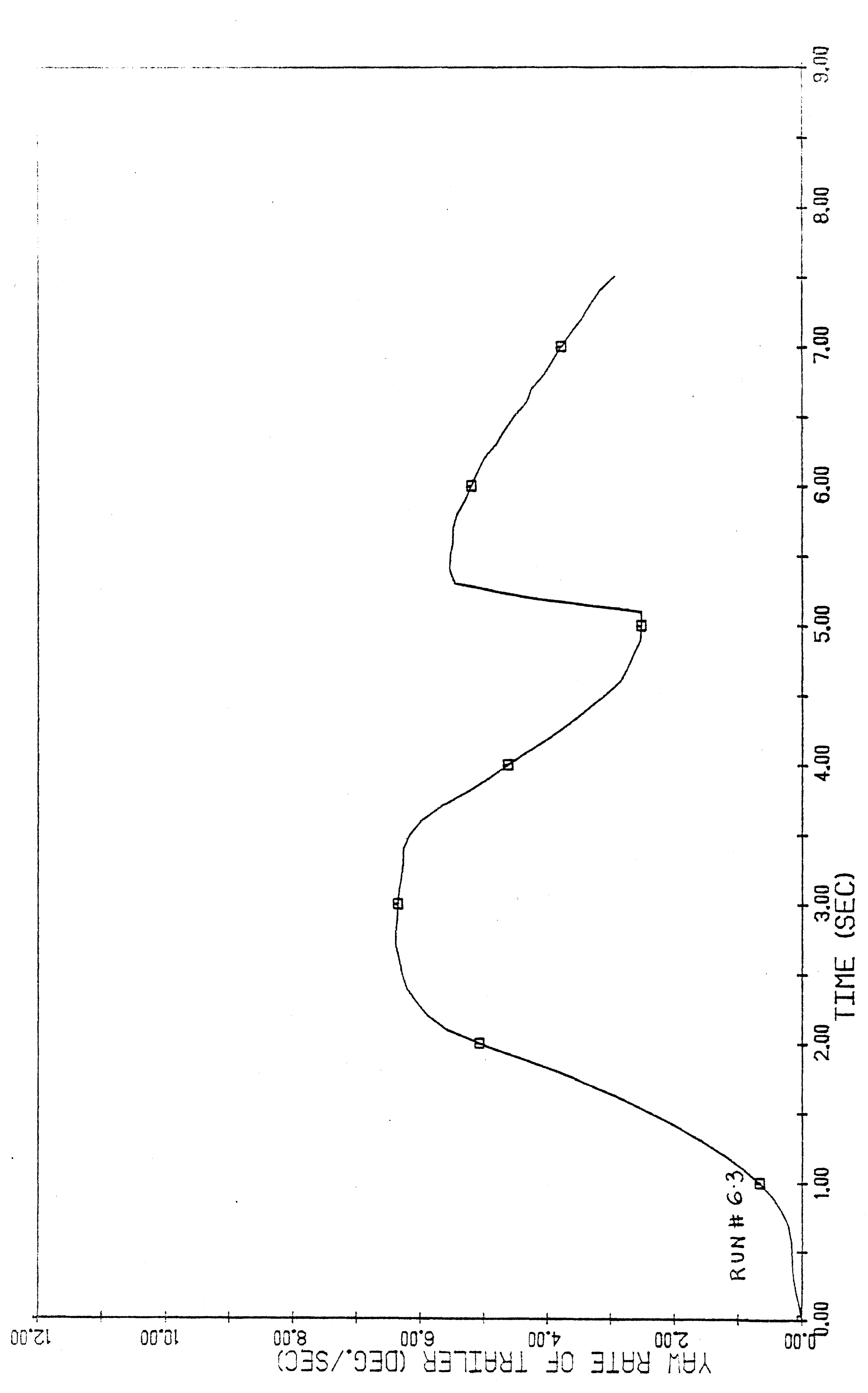
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, MU=0.3, 22 PSI



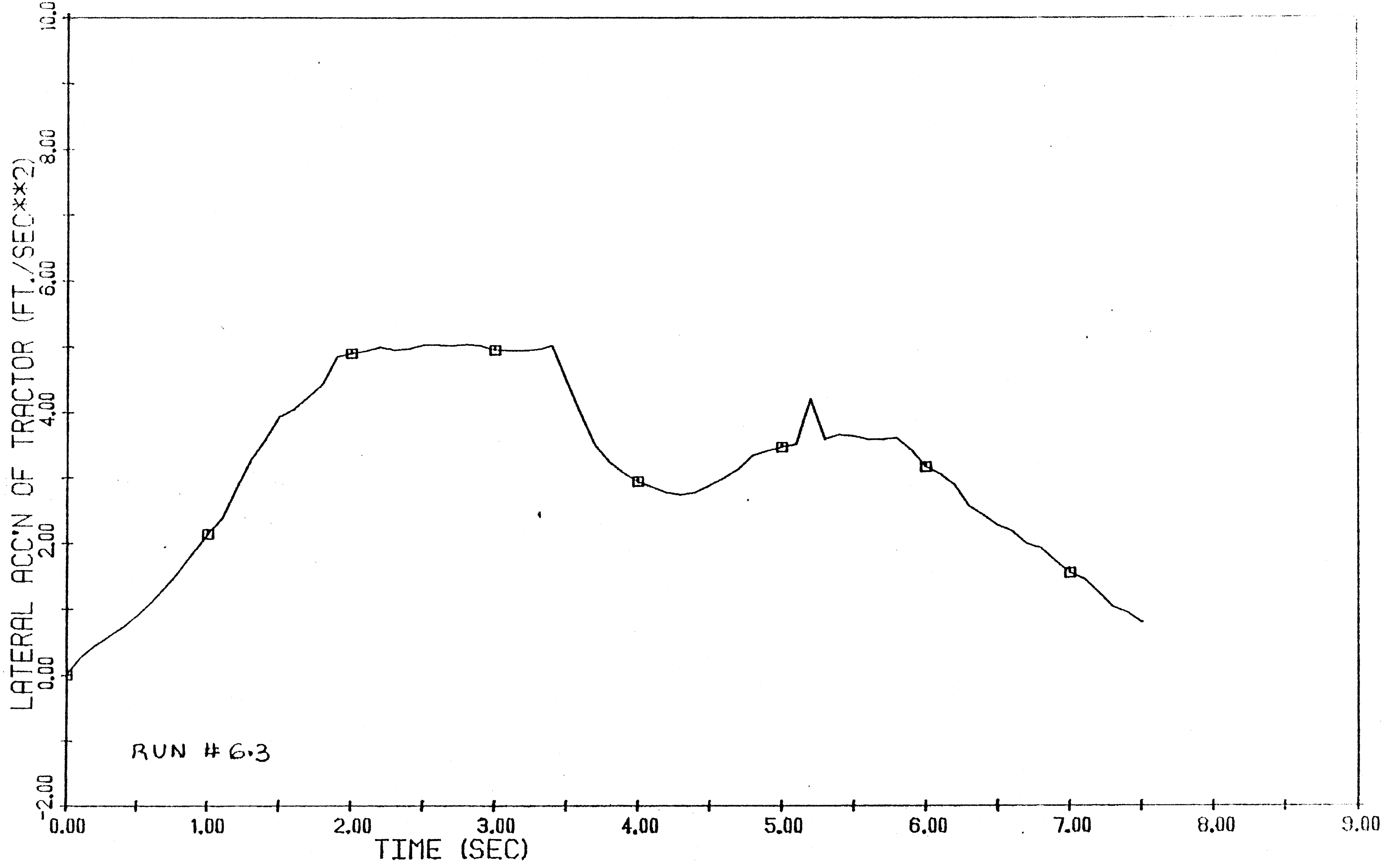
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



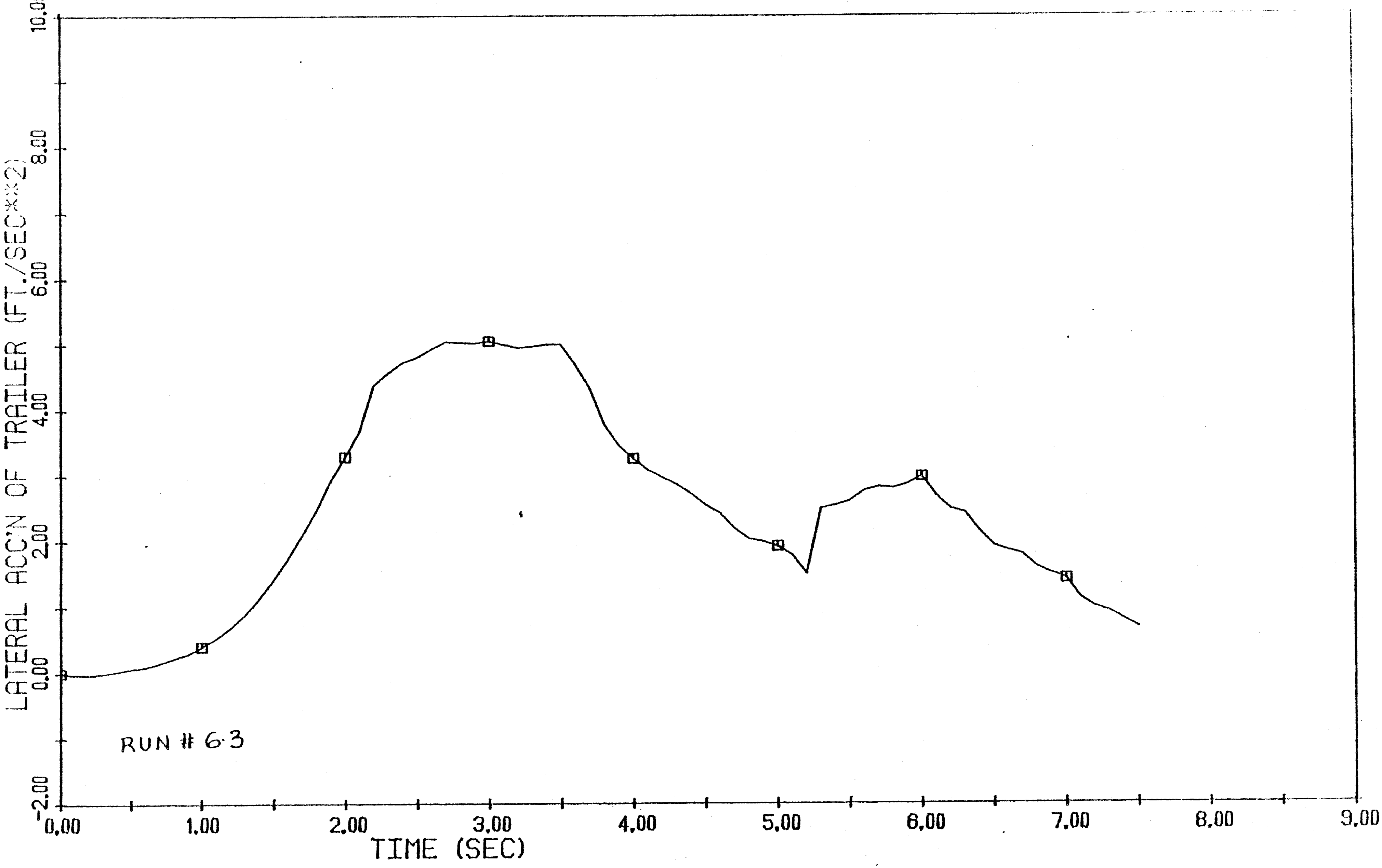
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 P S I



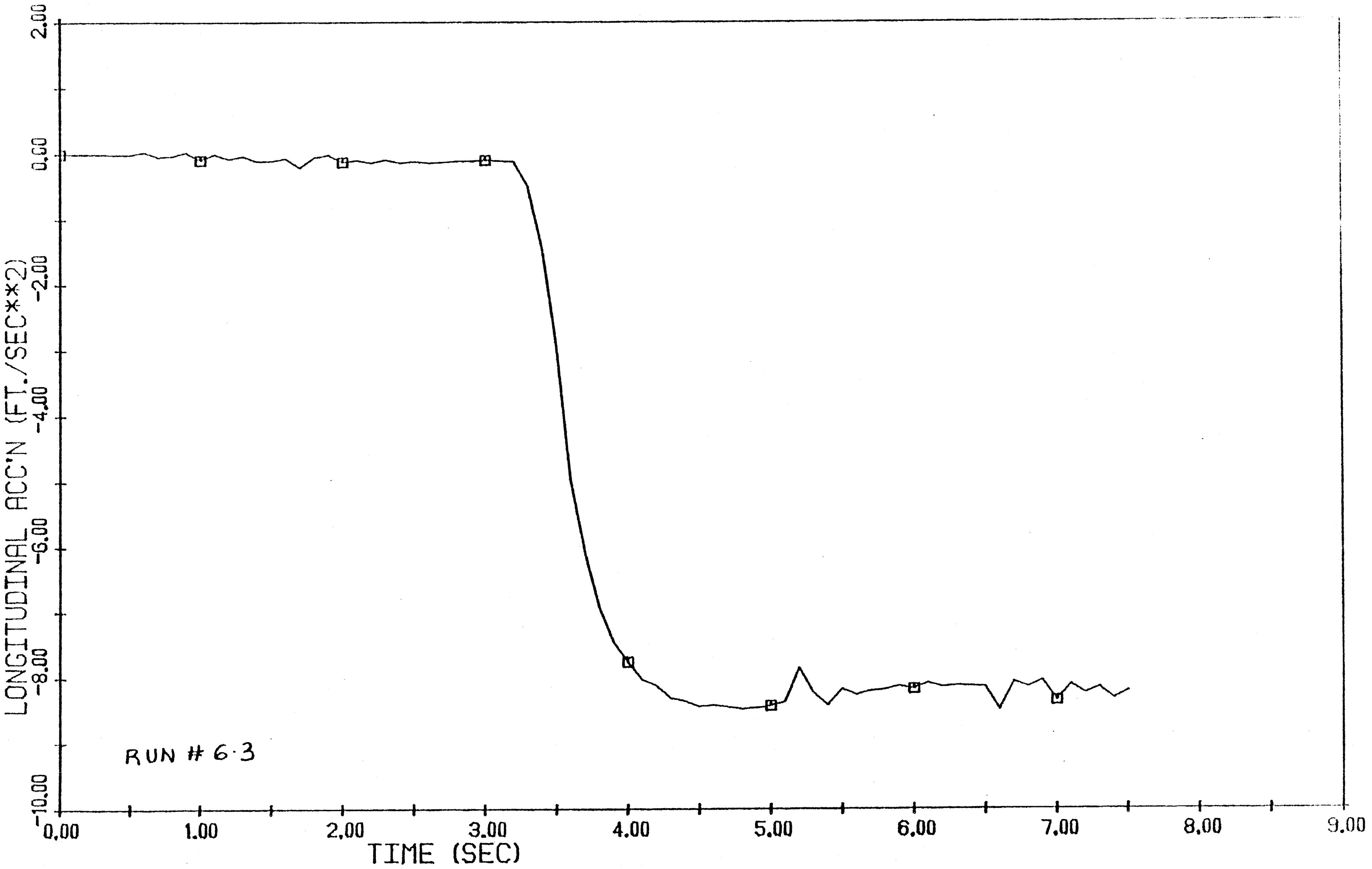
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



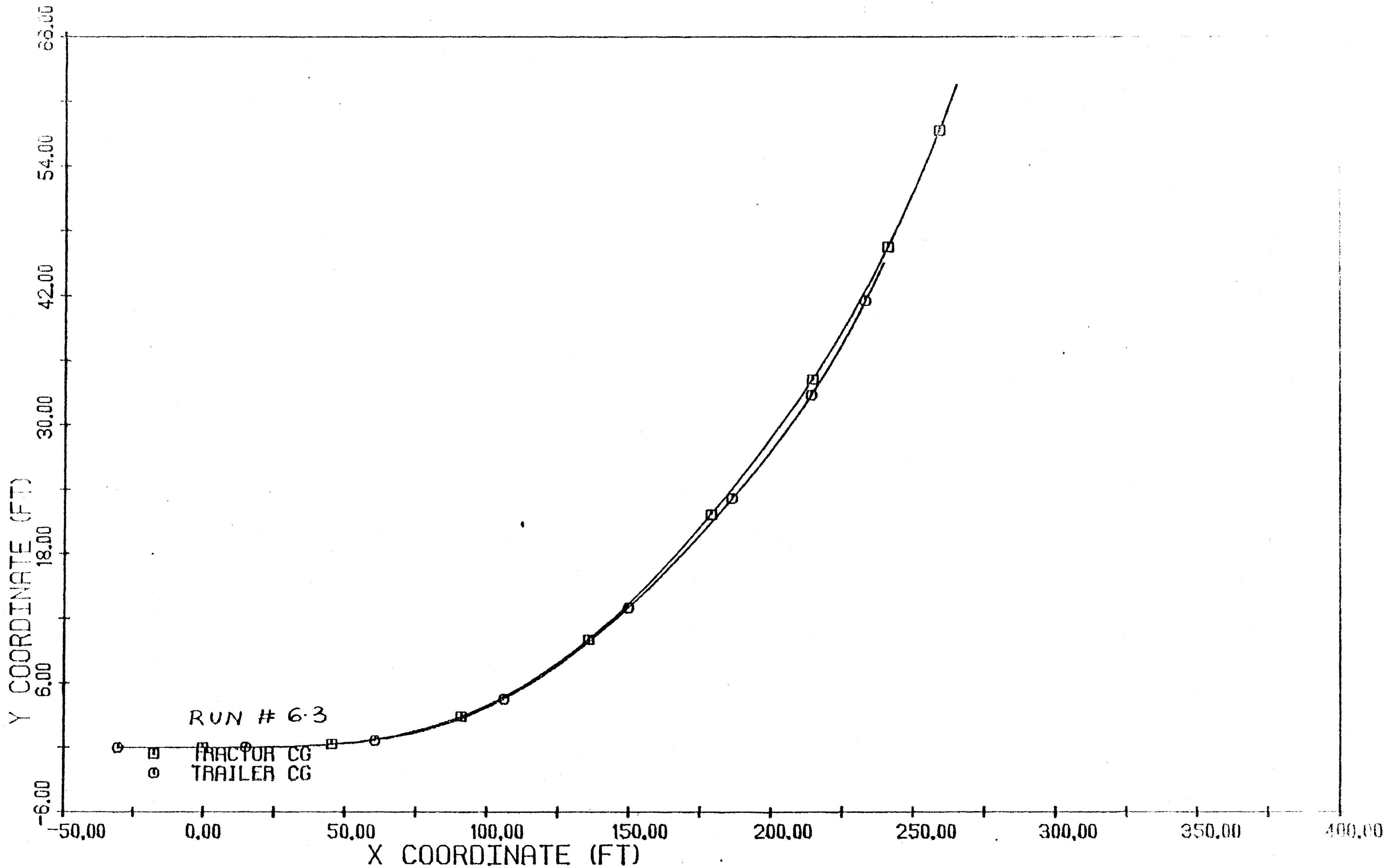
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



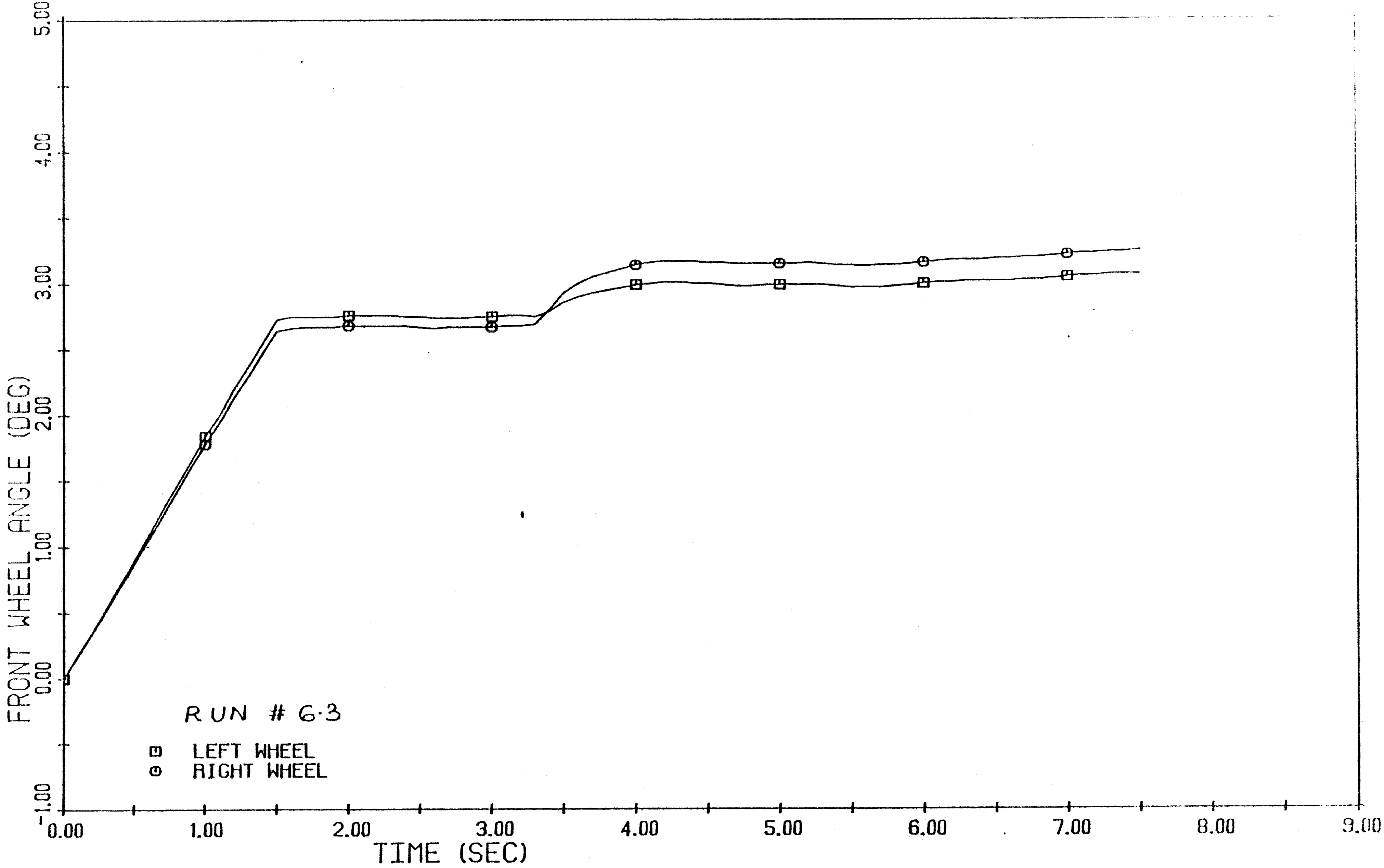
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



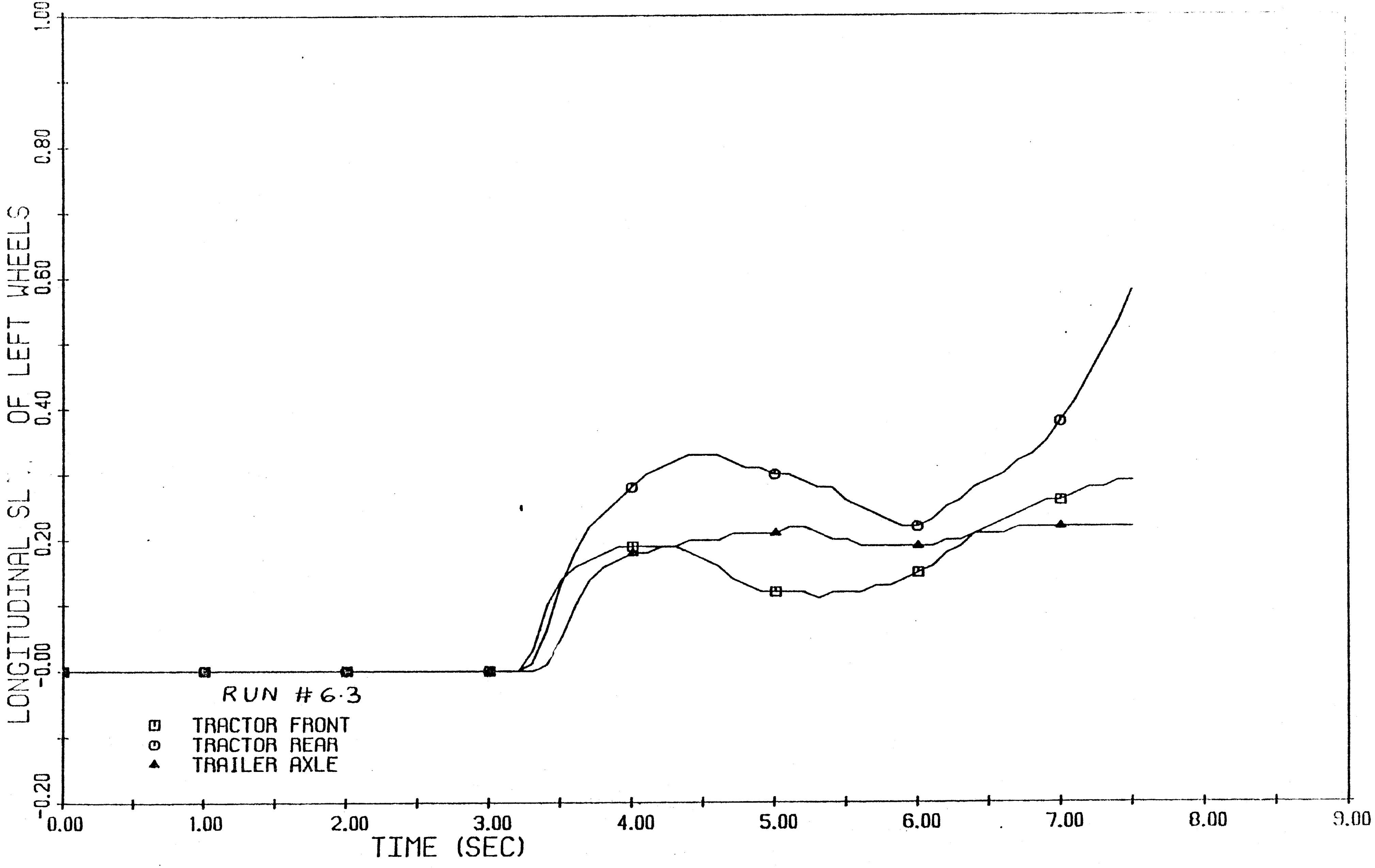
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



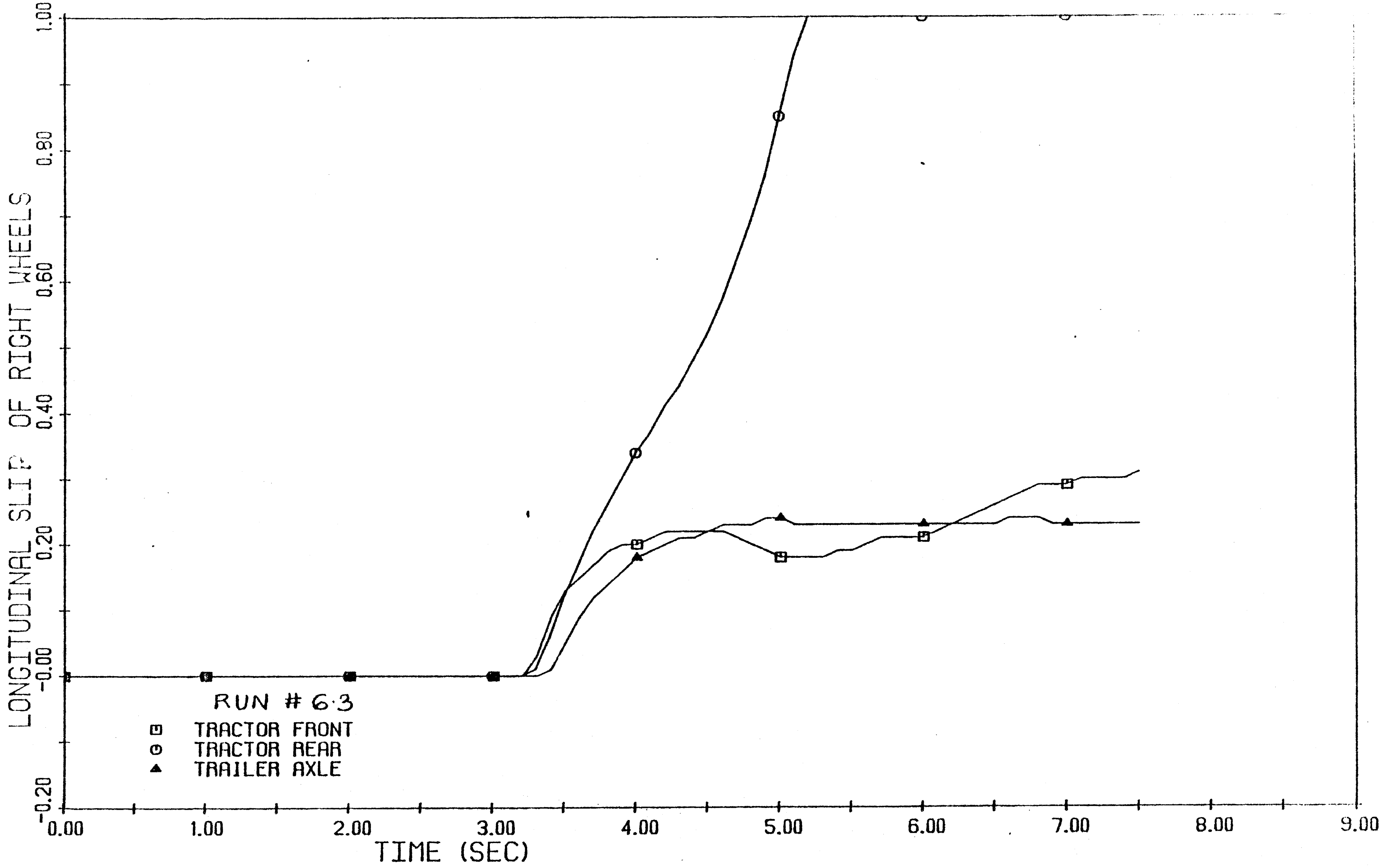
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, MU=0.3, 50 KPH, 25 PSI



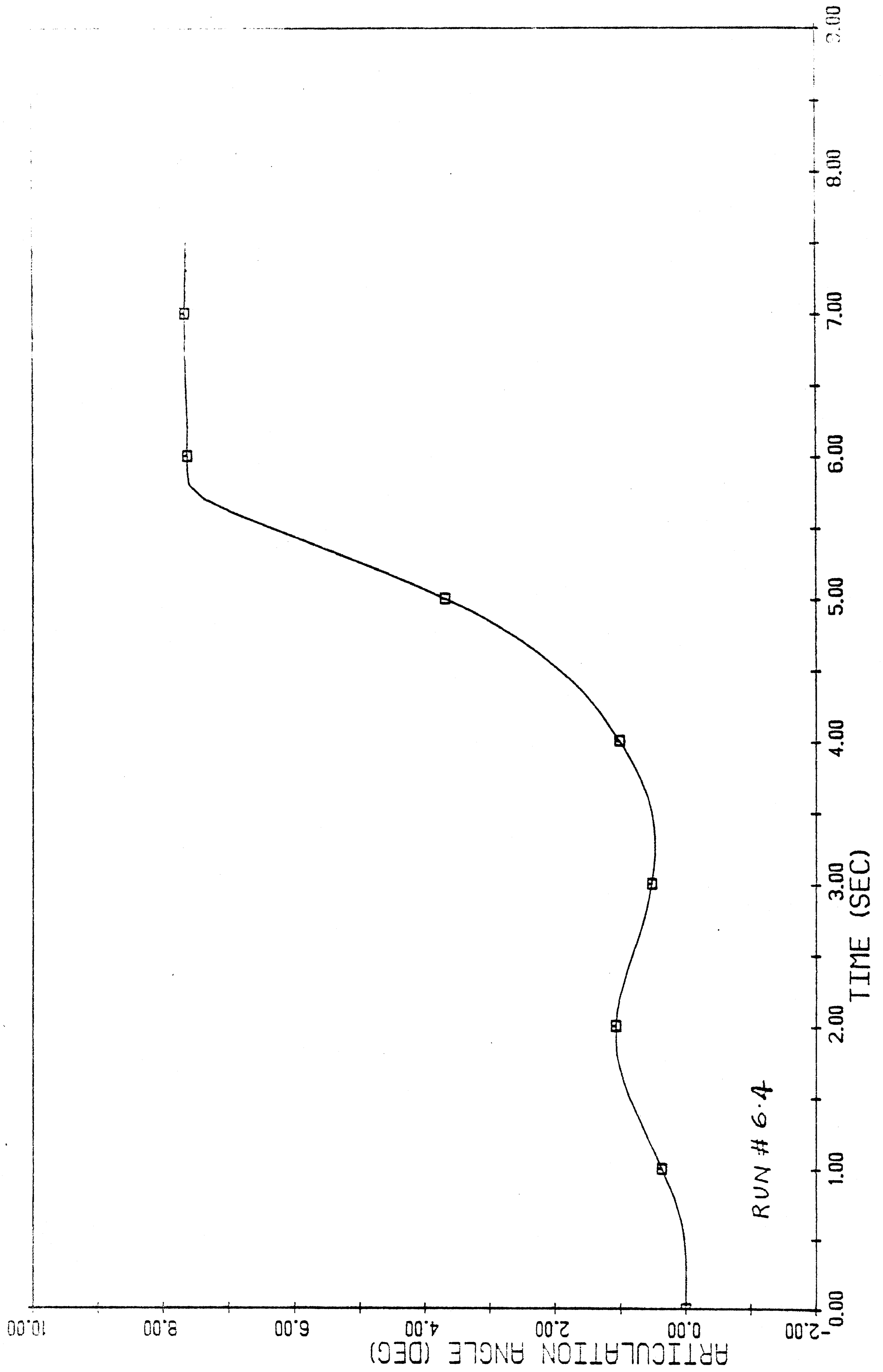
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, 50 KPH, MU=0.3, 25 PSI



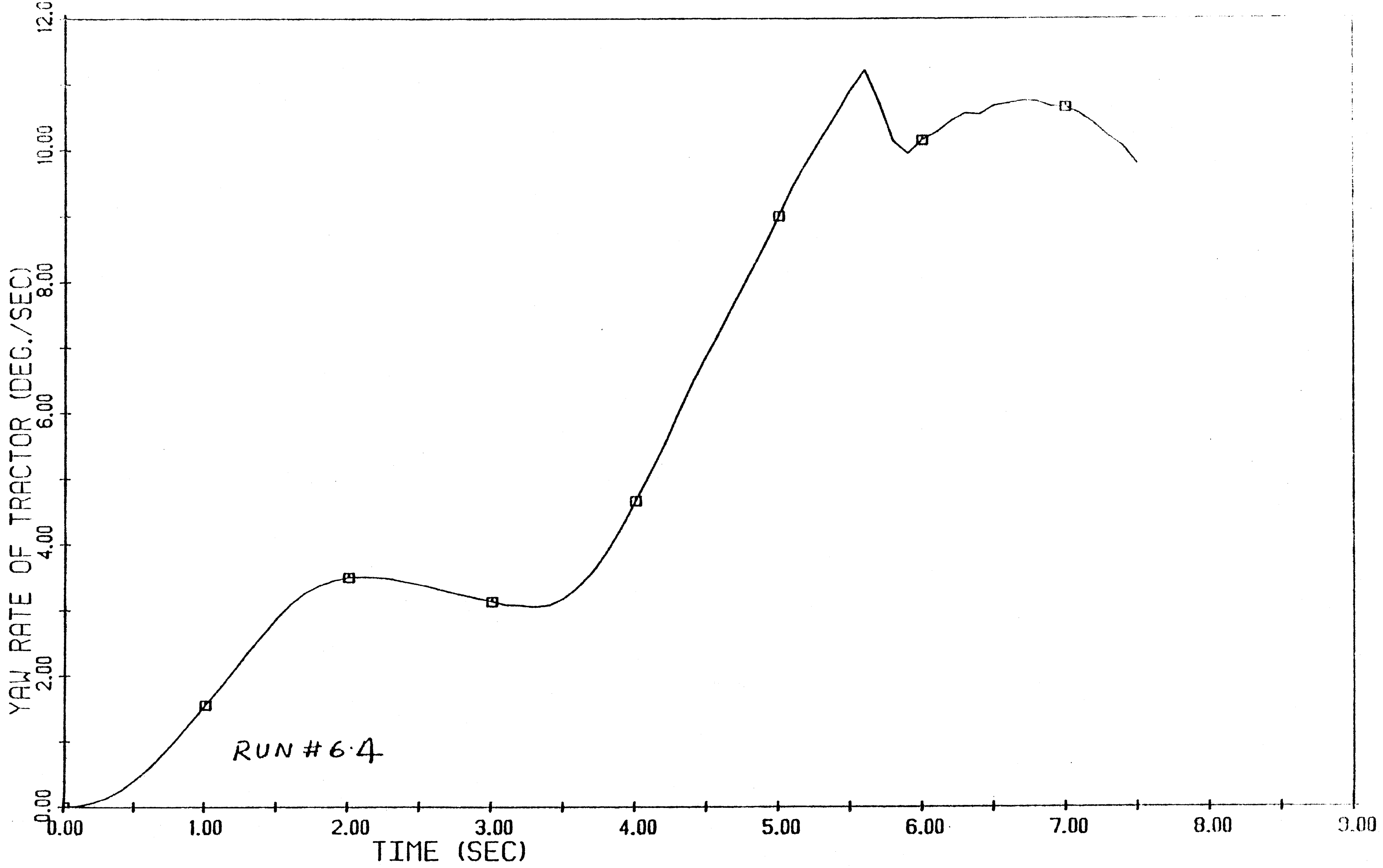
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, 50 KPH, 25 PSI, MU=0.3



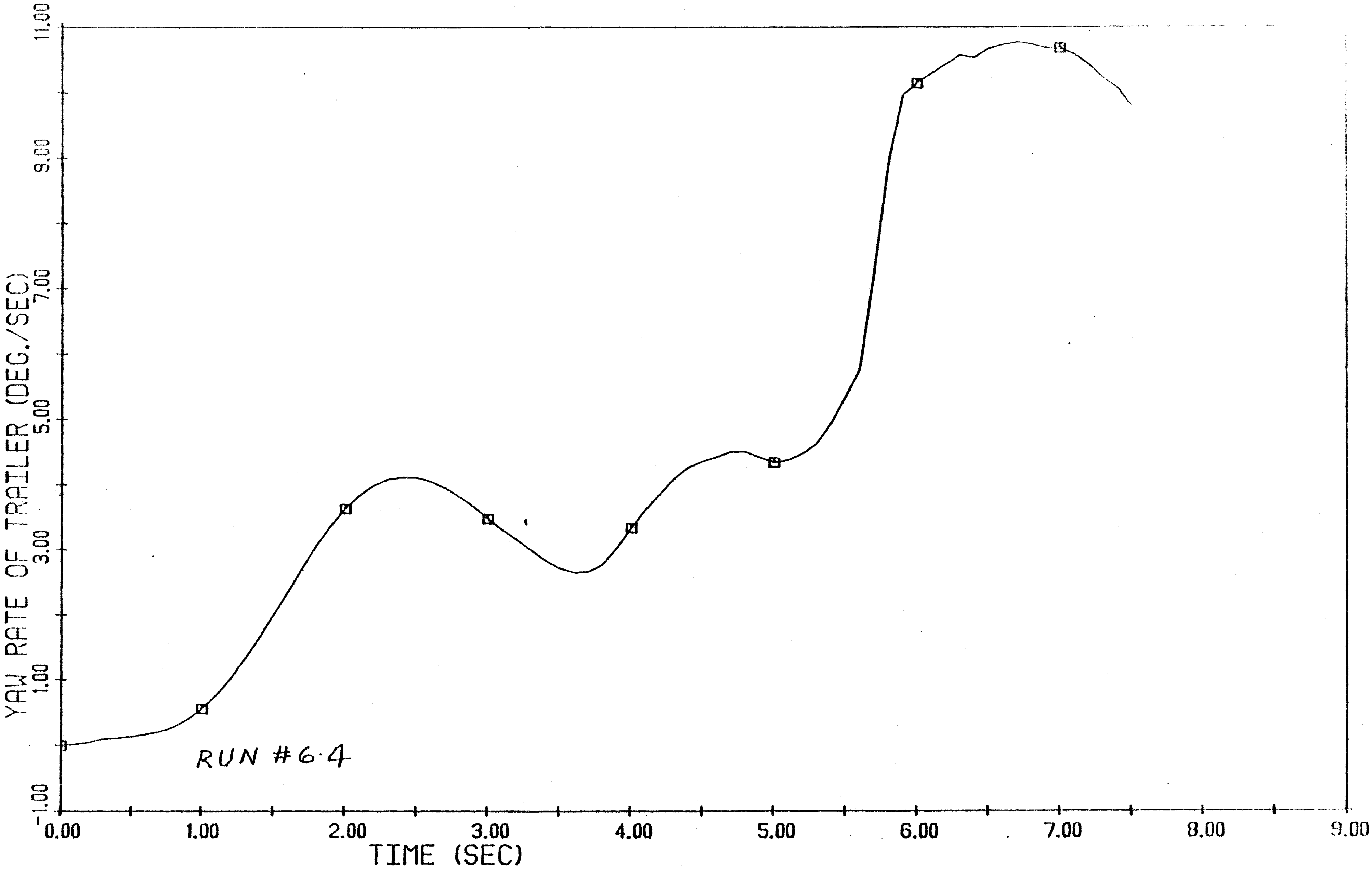
CANADIAN ARTIC BUS, EMPTY, B I T, WITHOUT RETARDER, 50 KPH, 25 PSI, MU=0.3



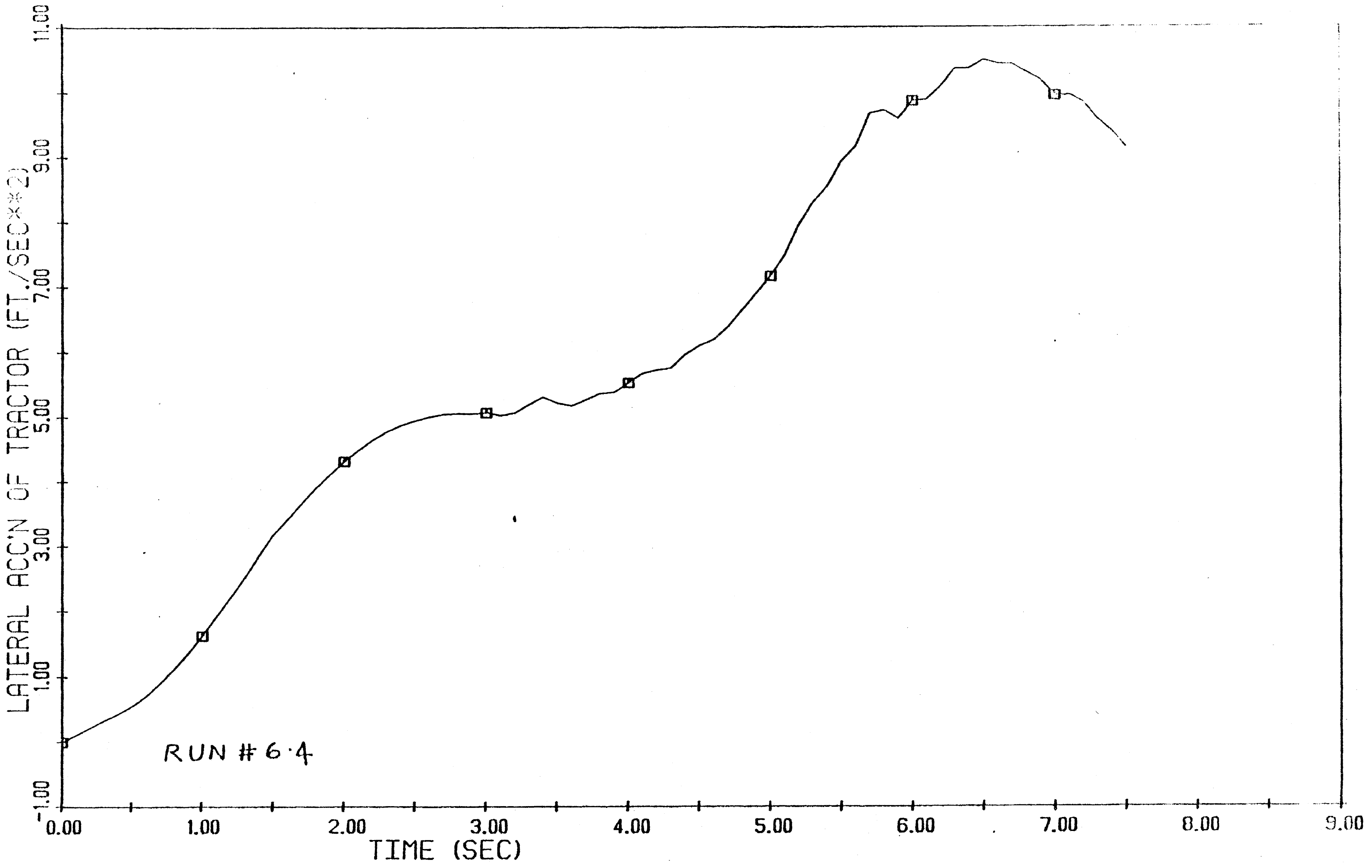
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



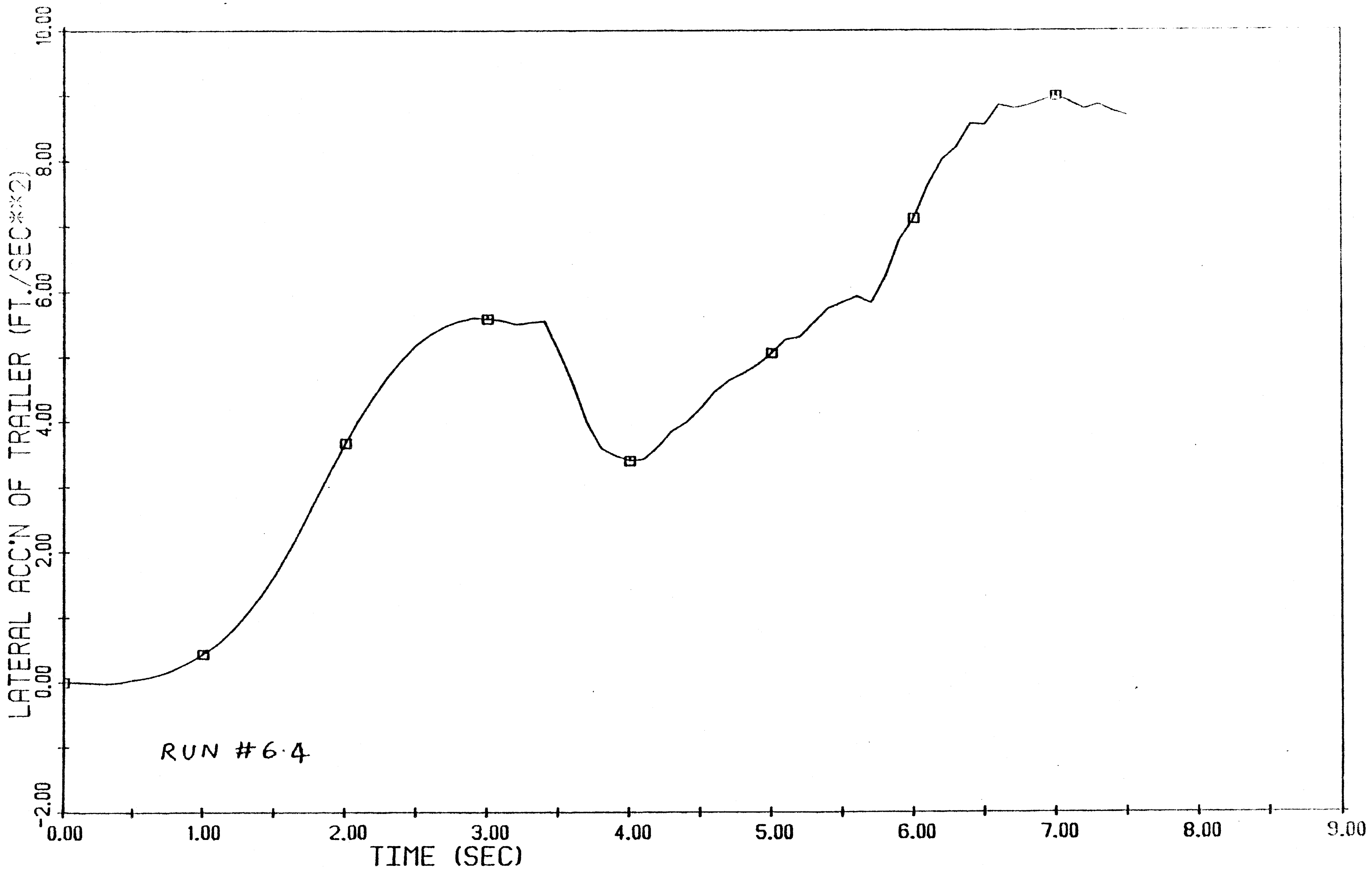
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



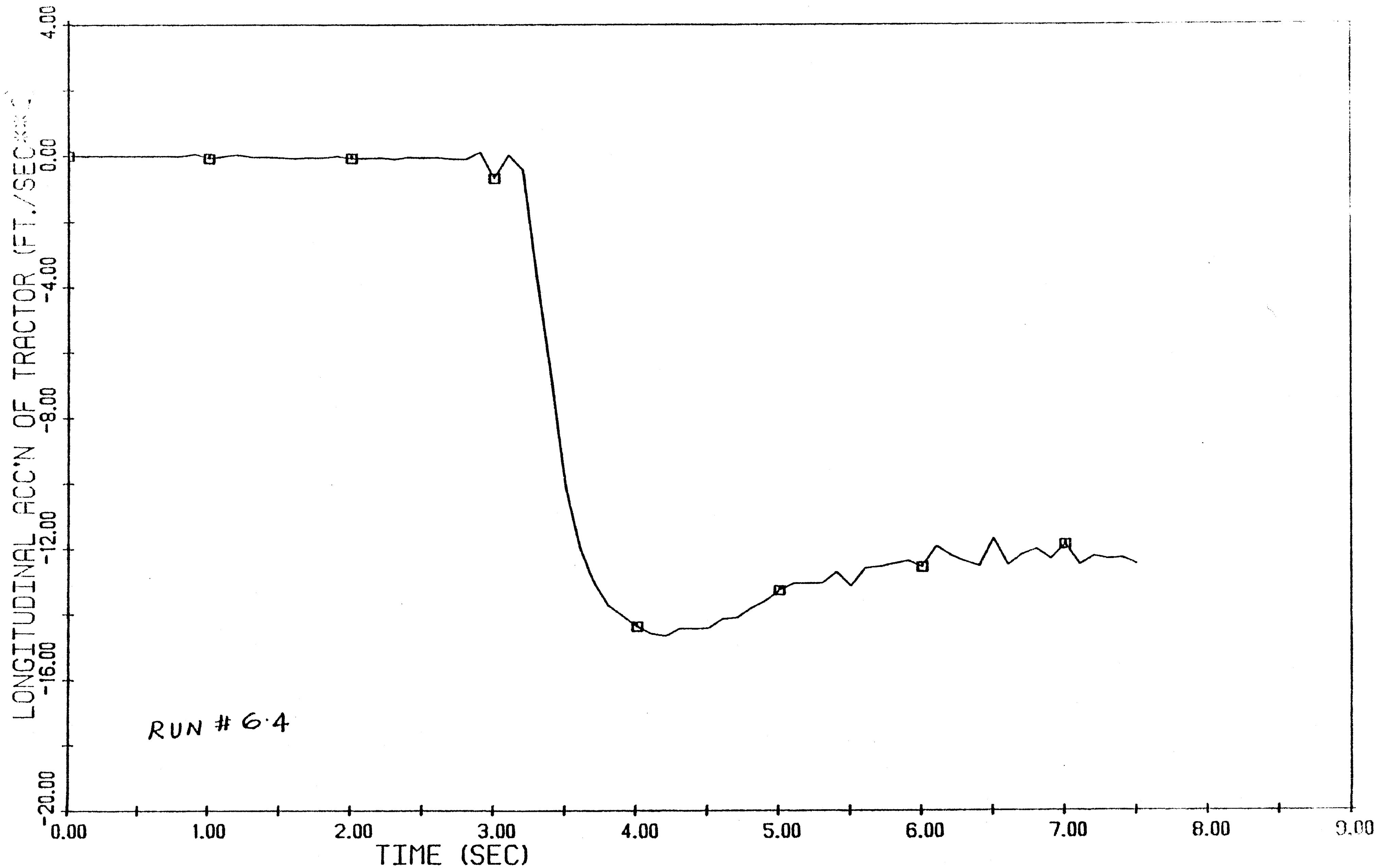
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



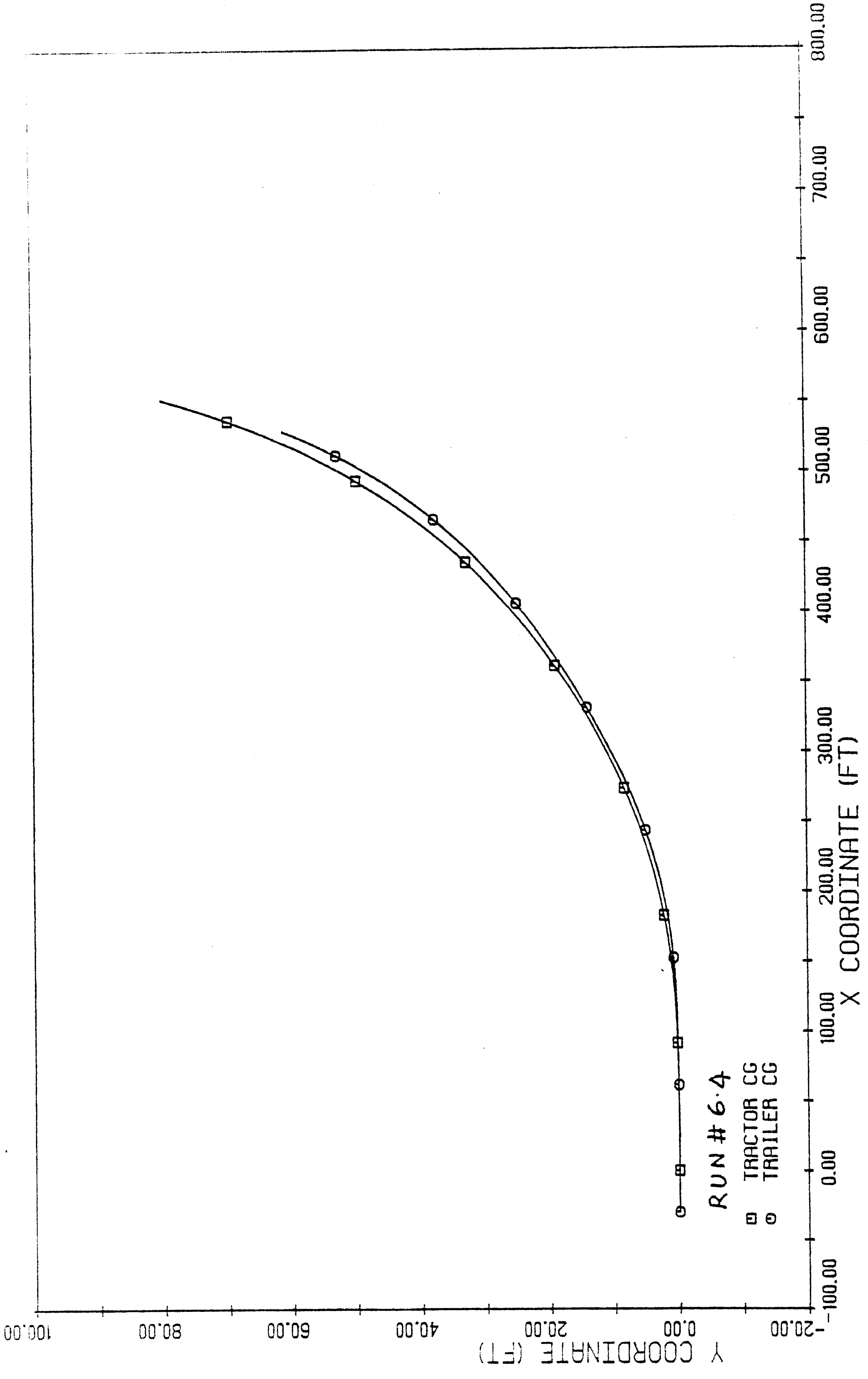
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



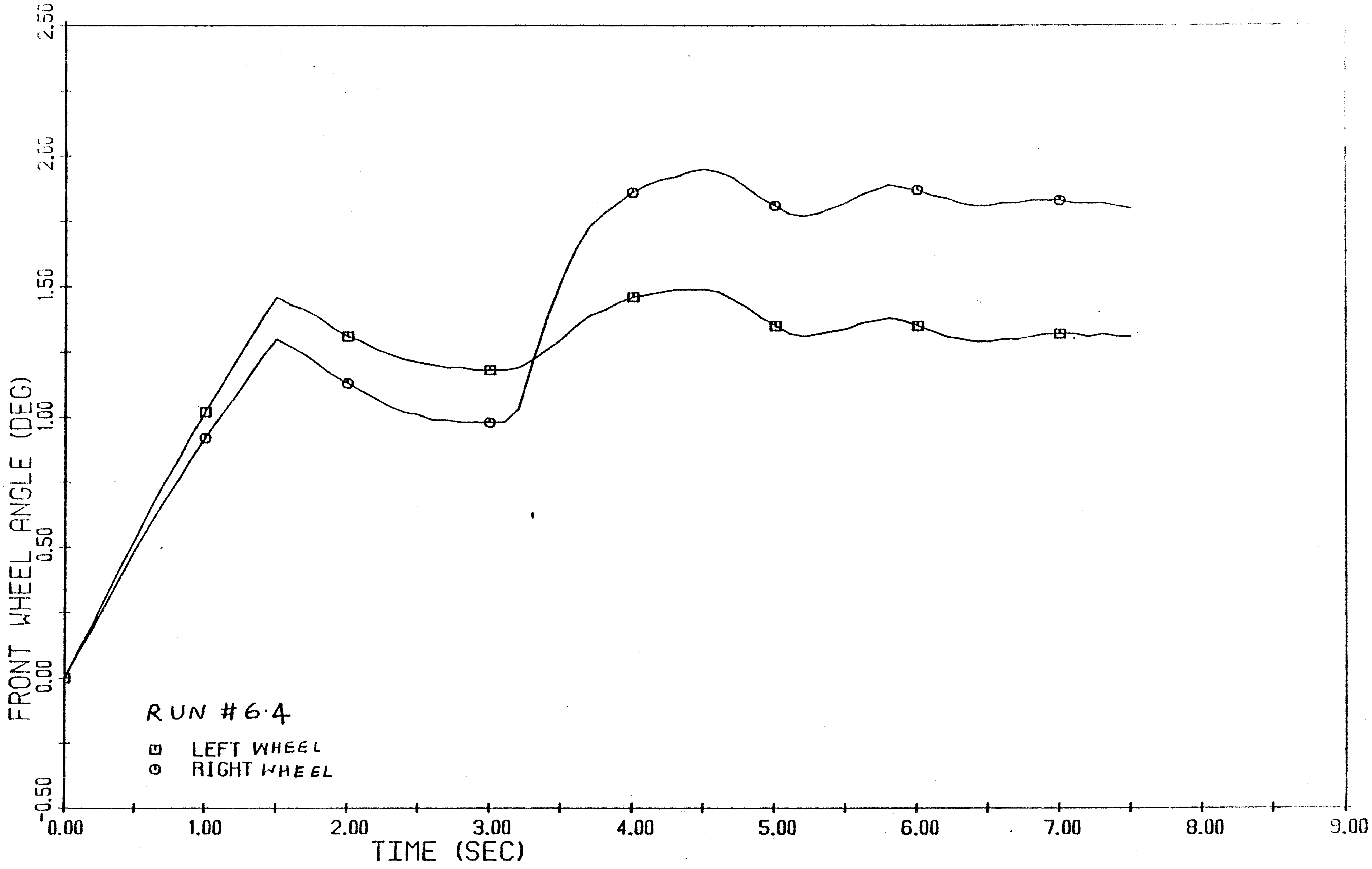
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



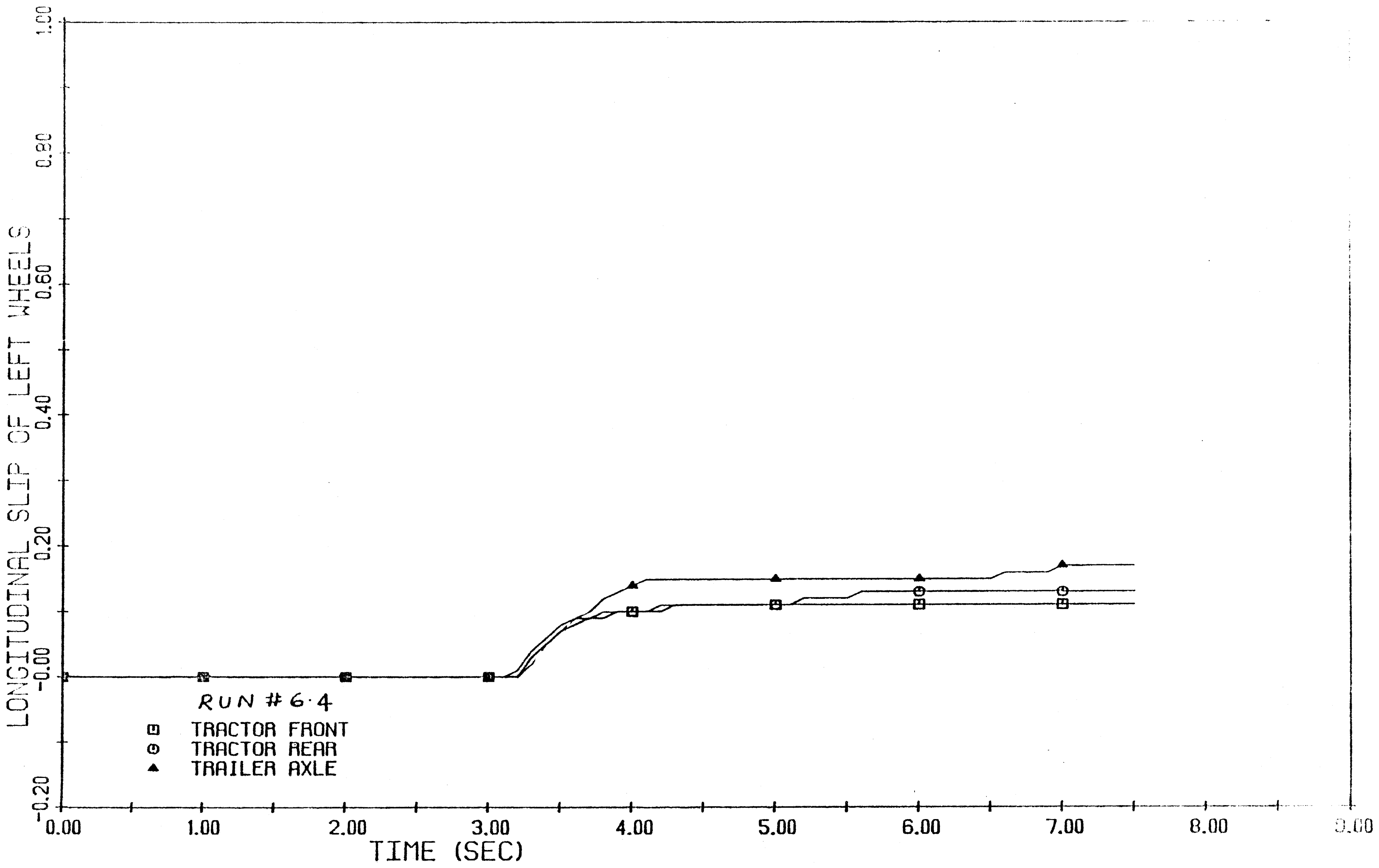
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



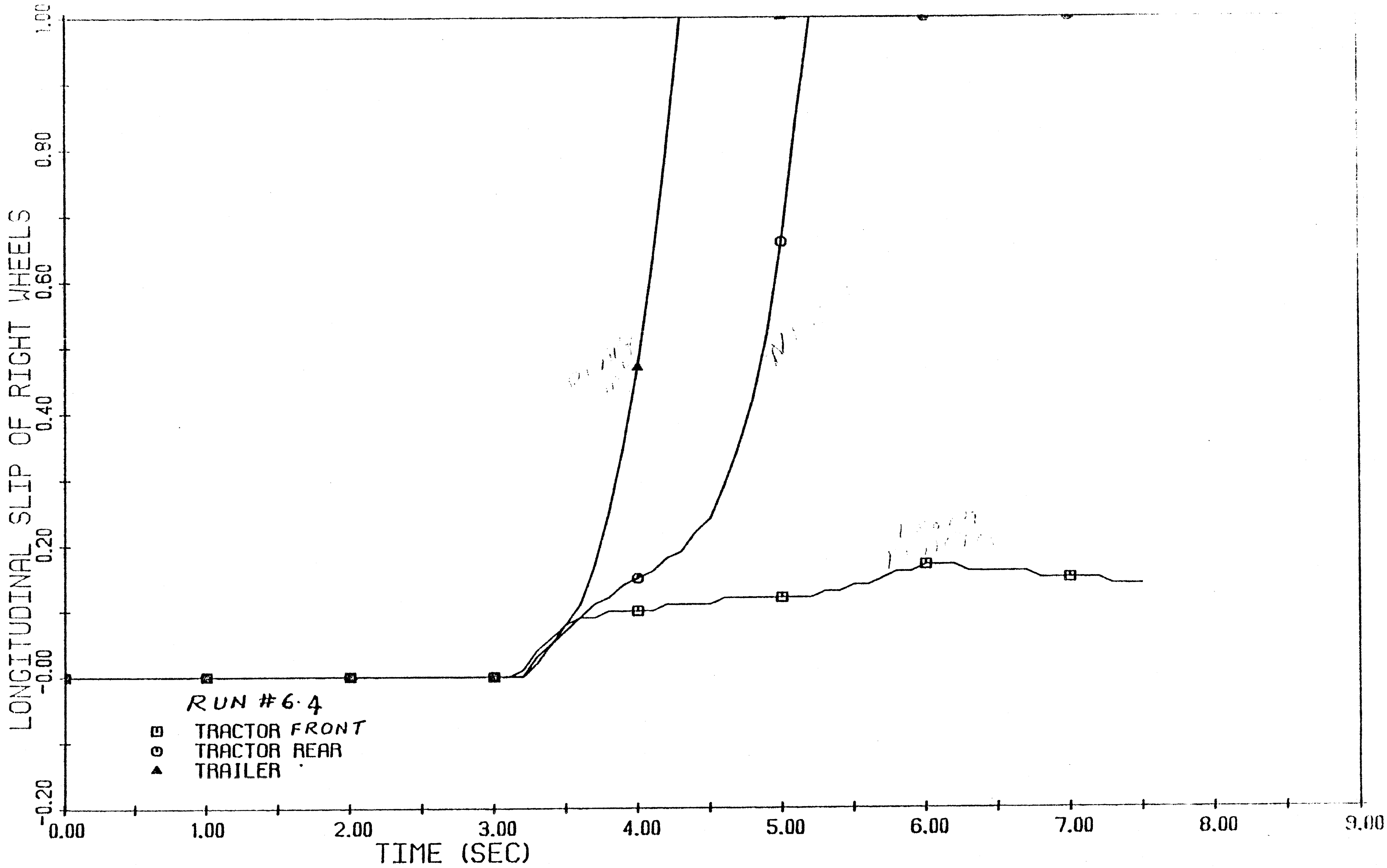
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



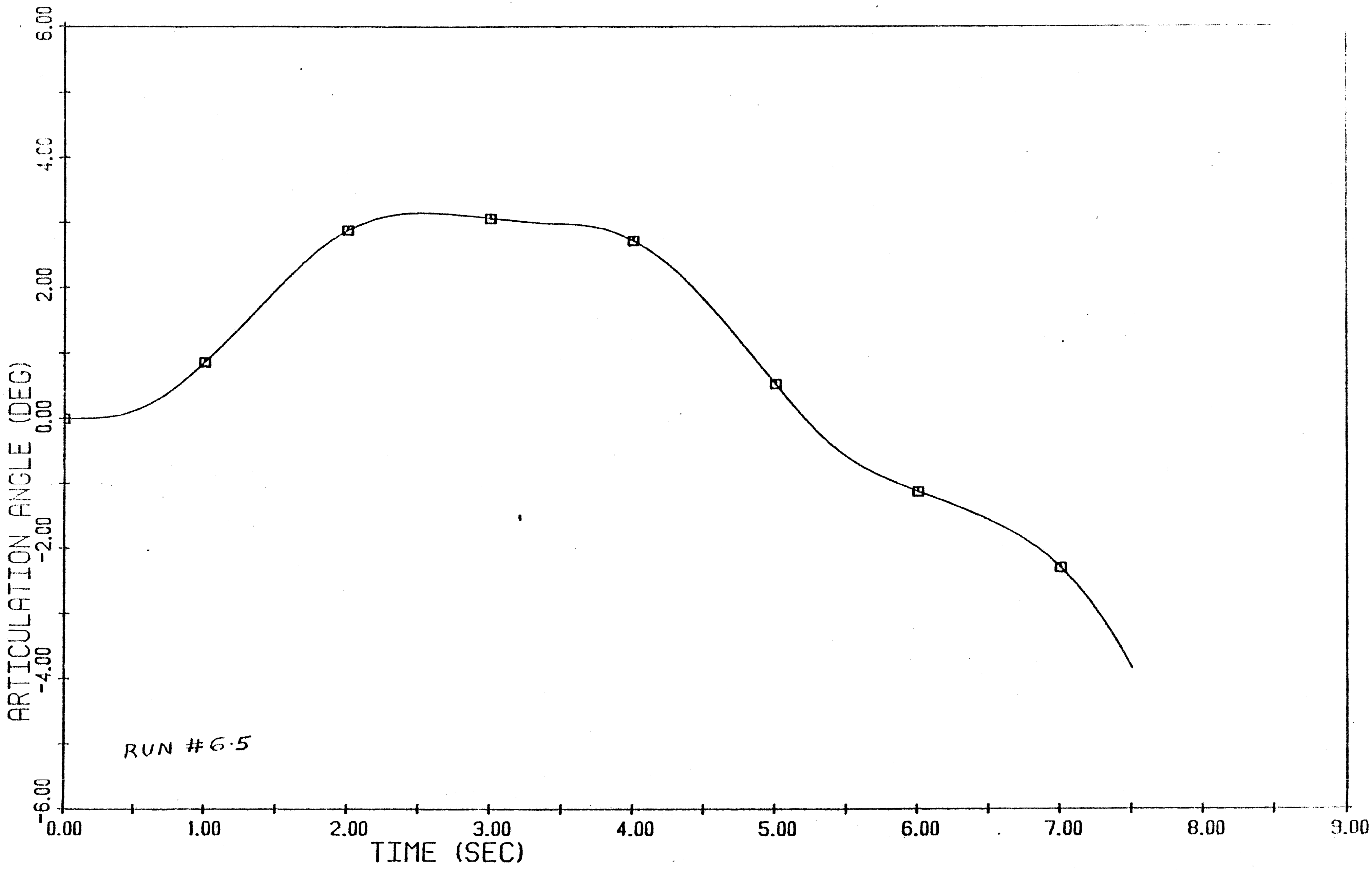
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.6, 100 KPH, 63 PSI



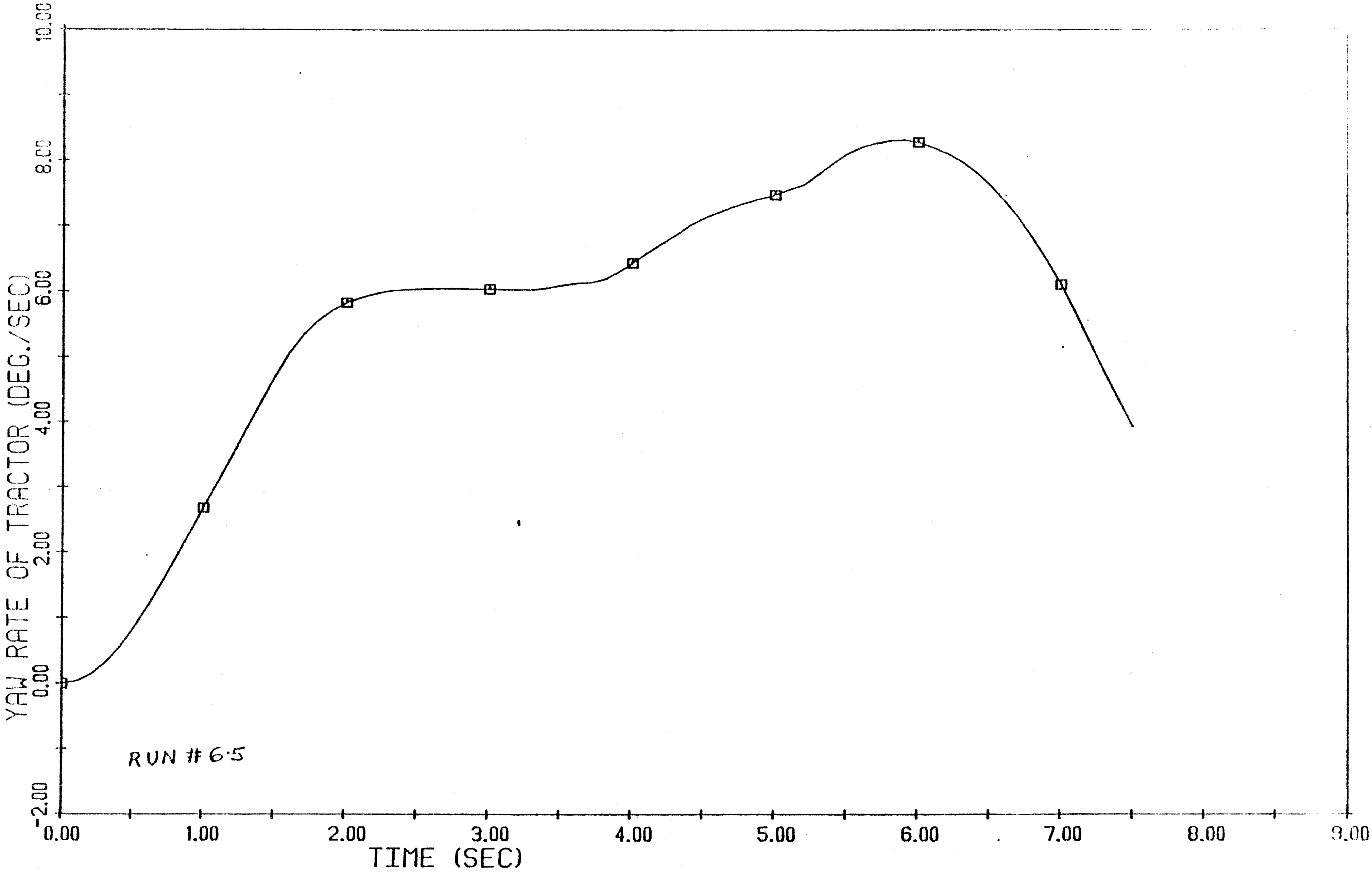
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, MU=0.6, 63 PSI



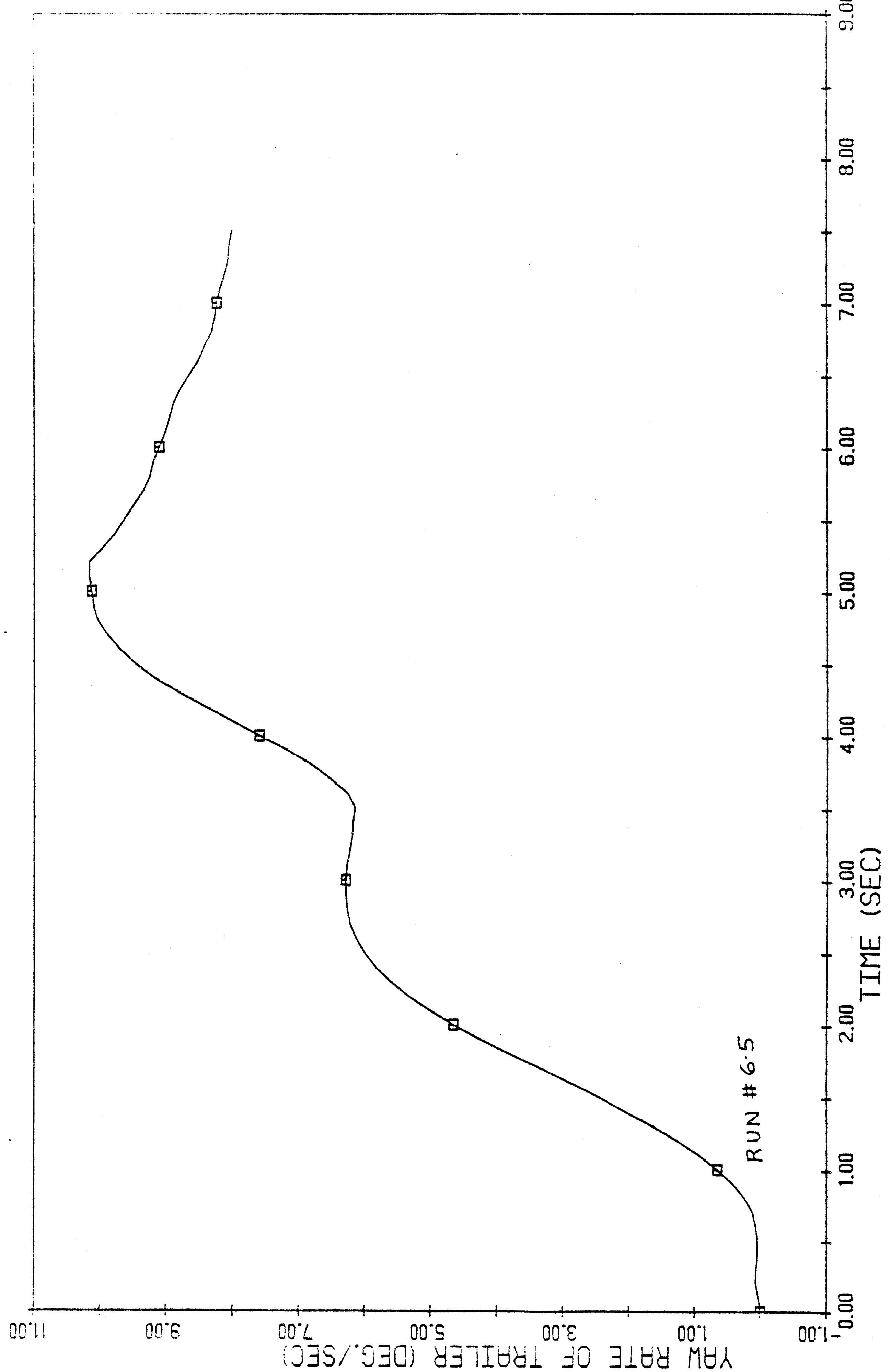
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, MU=0.6, 63 PSI



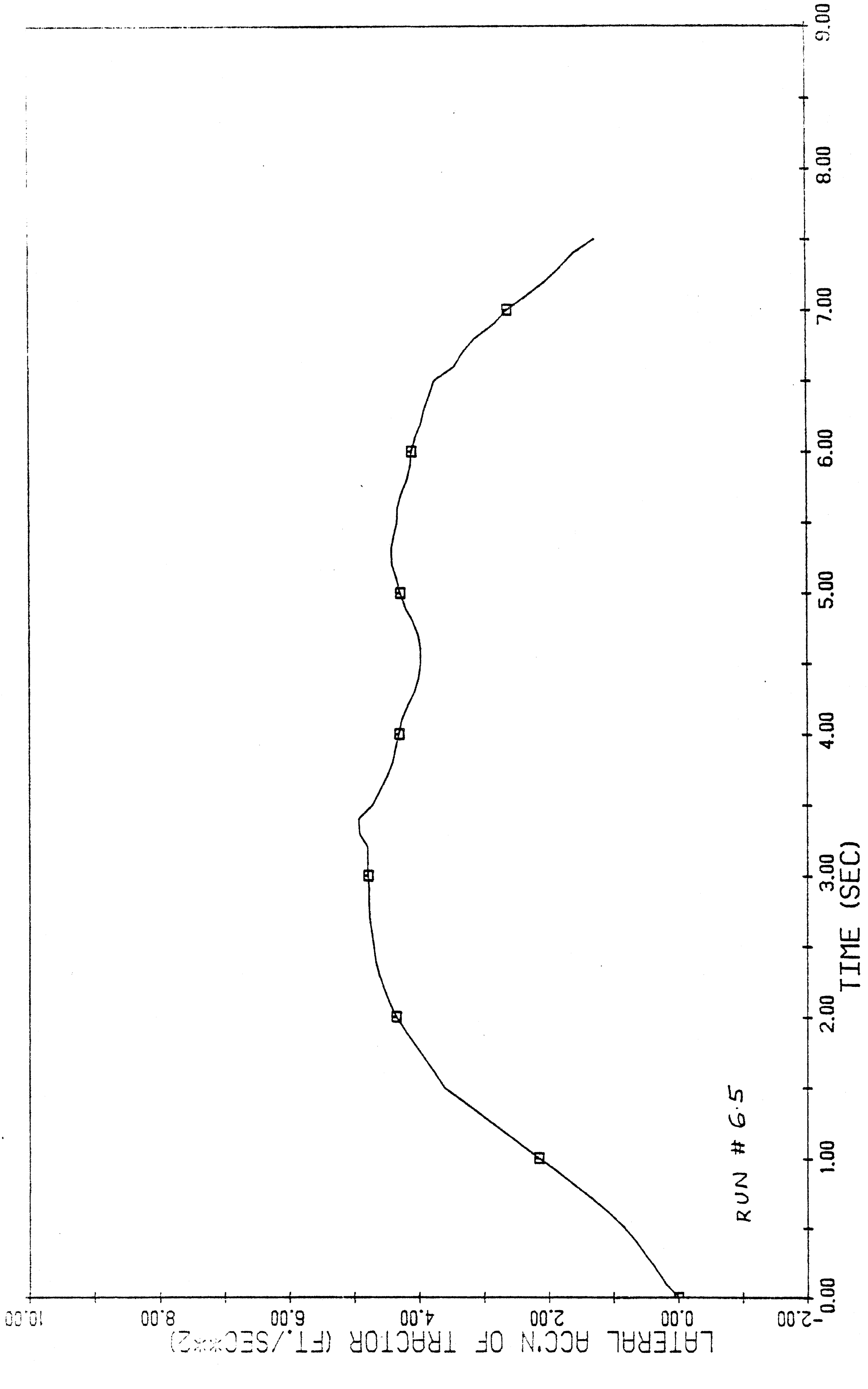
CANADIAN ARTIC BUS, LOADED, B I T,MU=0.3, 50 KPH, 33 PSI



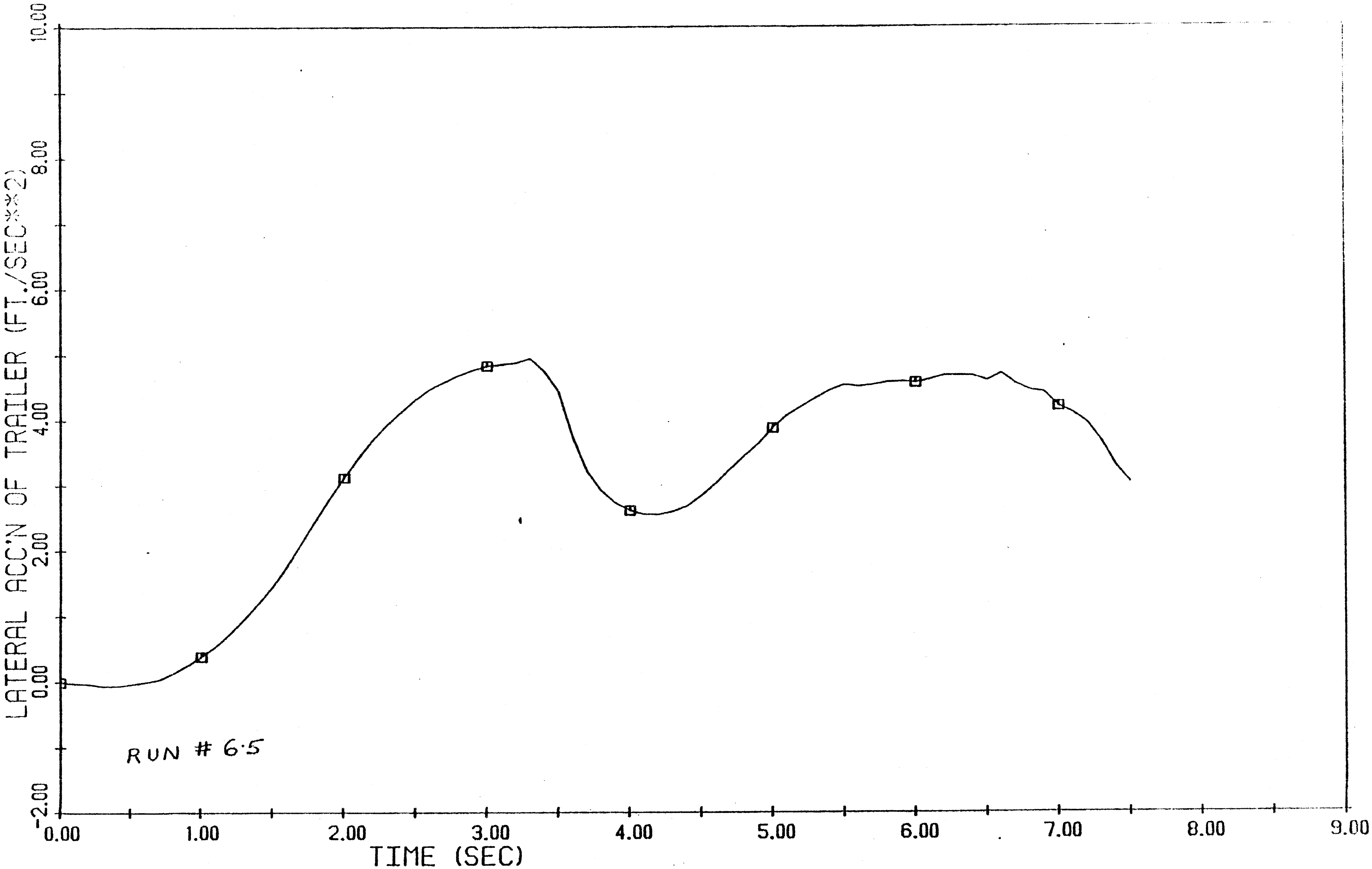
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.3, 50 KPH, 33 PSI



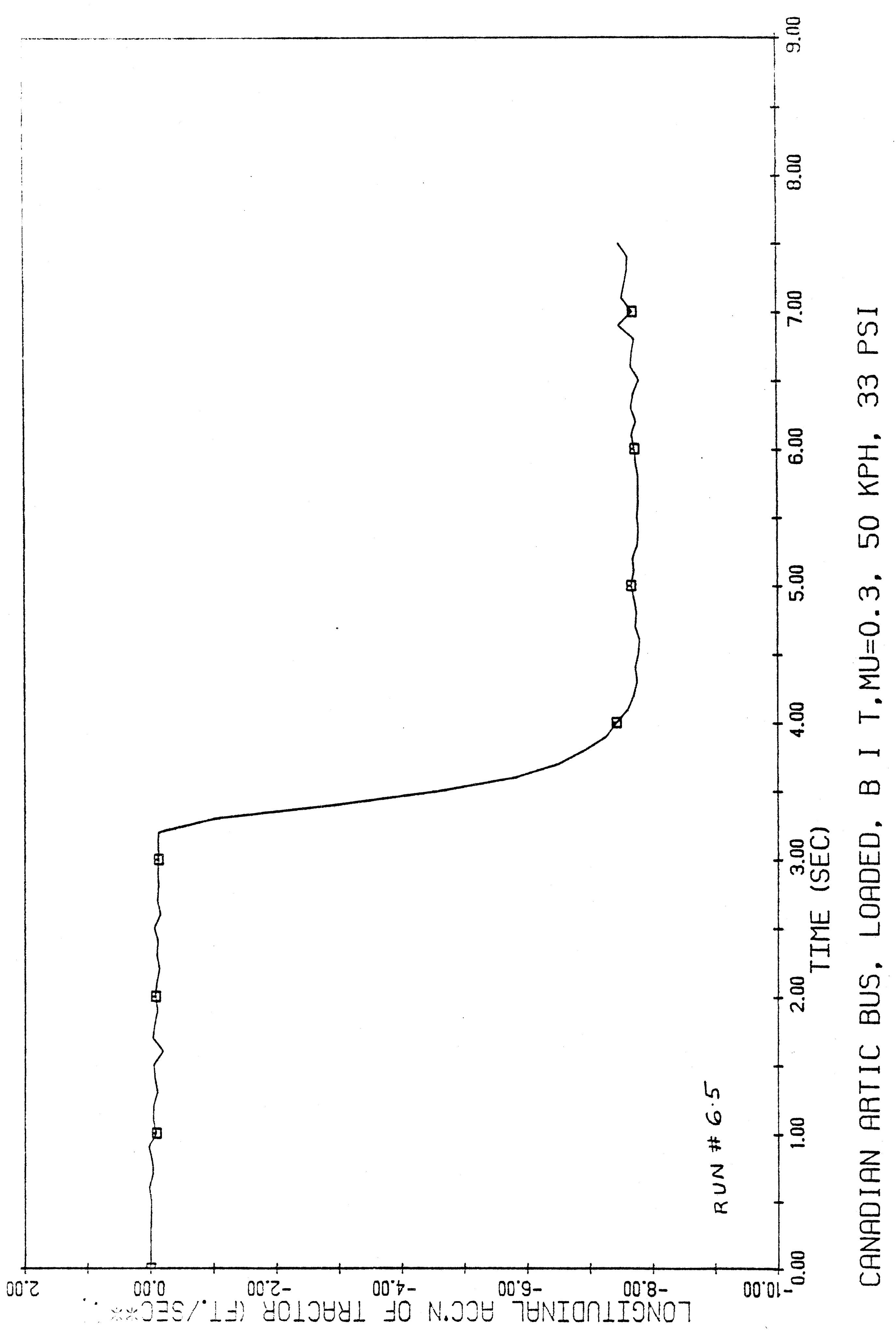
CANADIAN ARTIC BUS, LOADED, B I T.MU=0.3, 50 KPH, 33 PSI



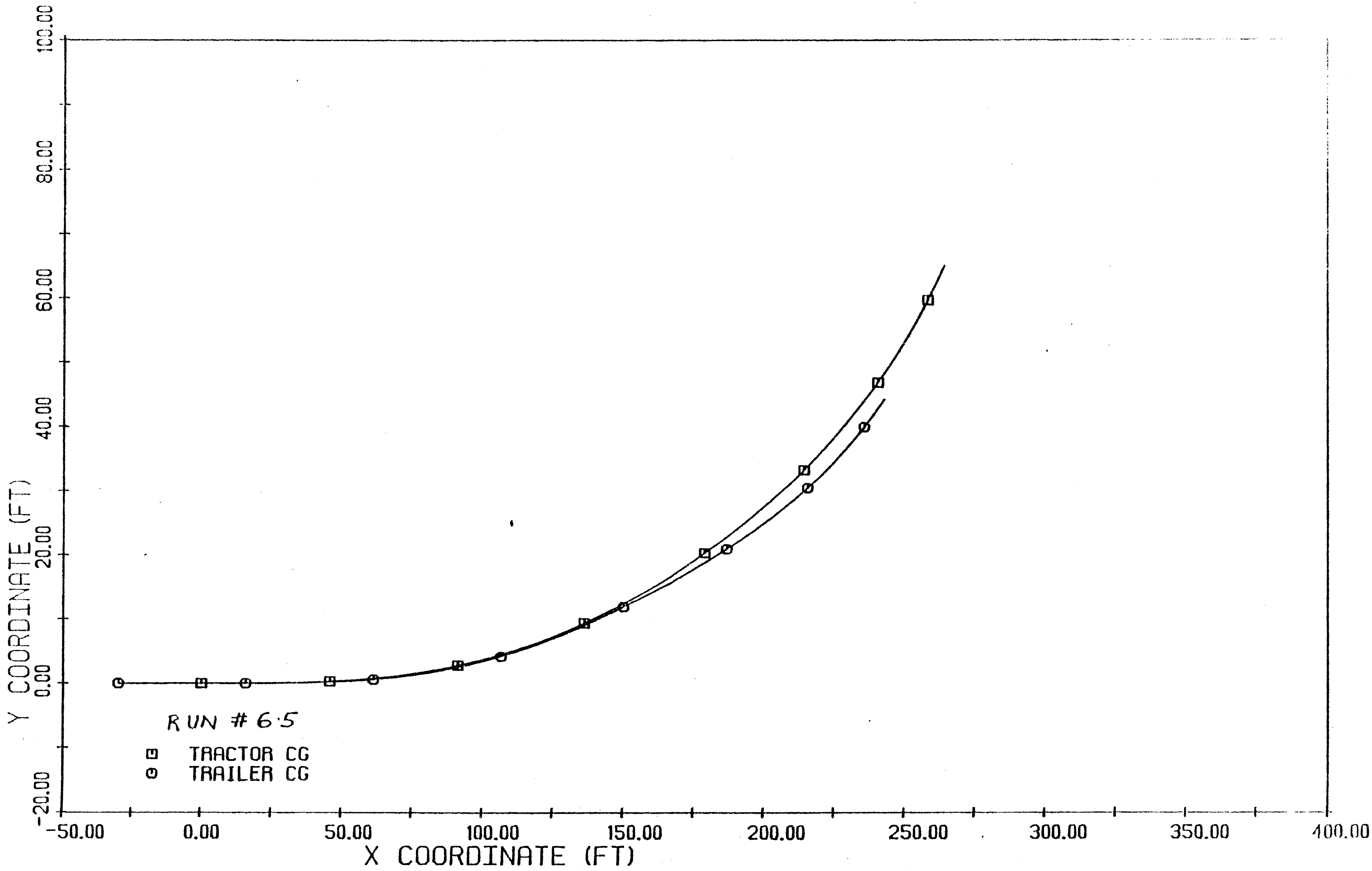
CANADIAN ARTIC BUS, LOADED, B I T,MU=0.3, 50 KPH, 33 PSI



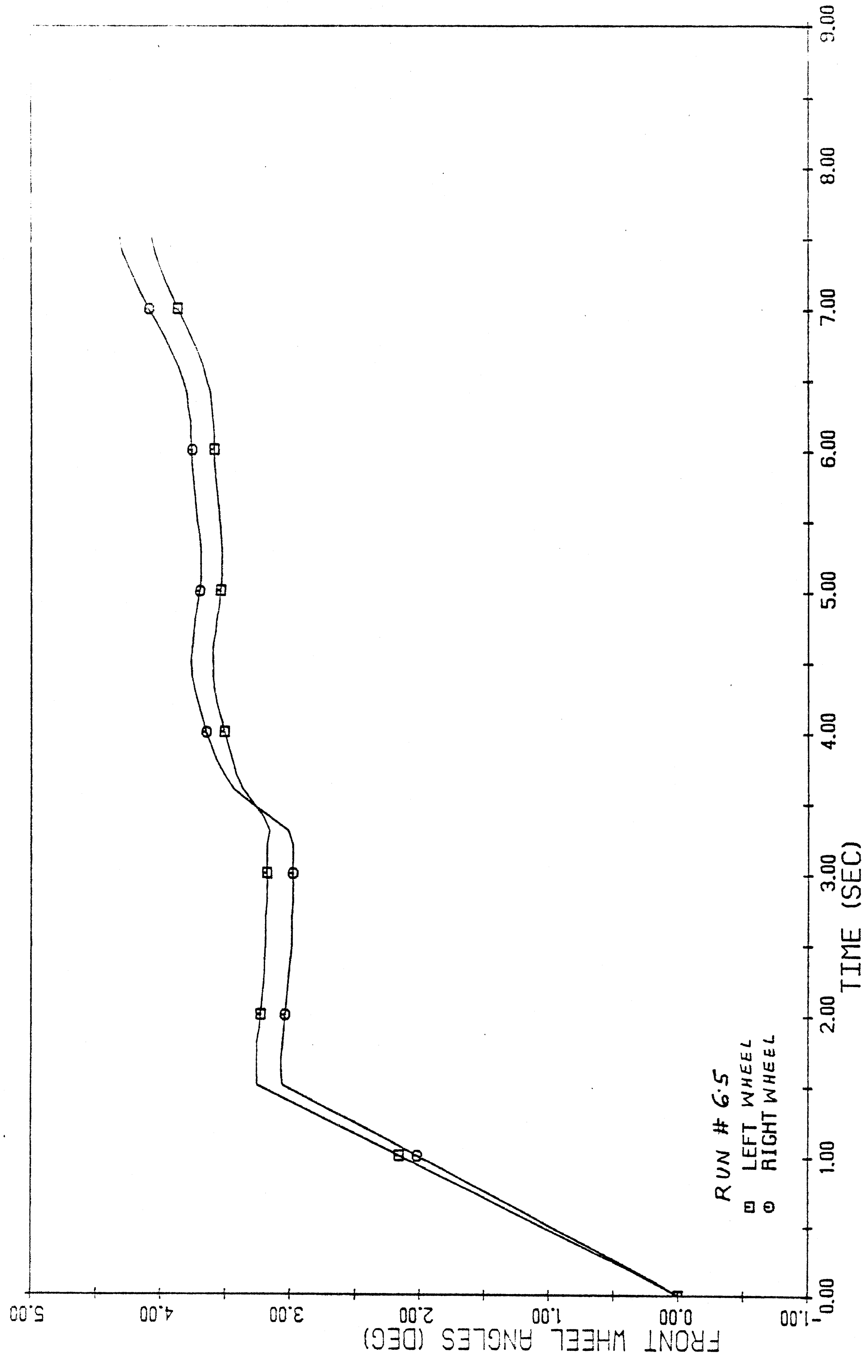
CANADIAN ARTIC BUS, LOADED, B I T, MU=0.3, 50 KPH, 33 PSI



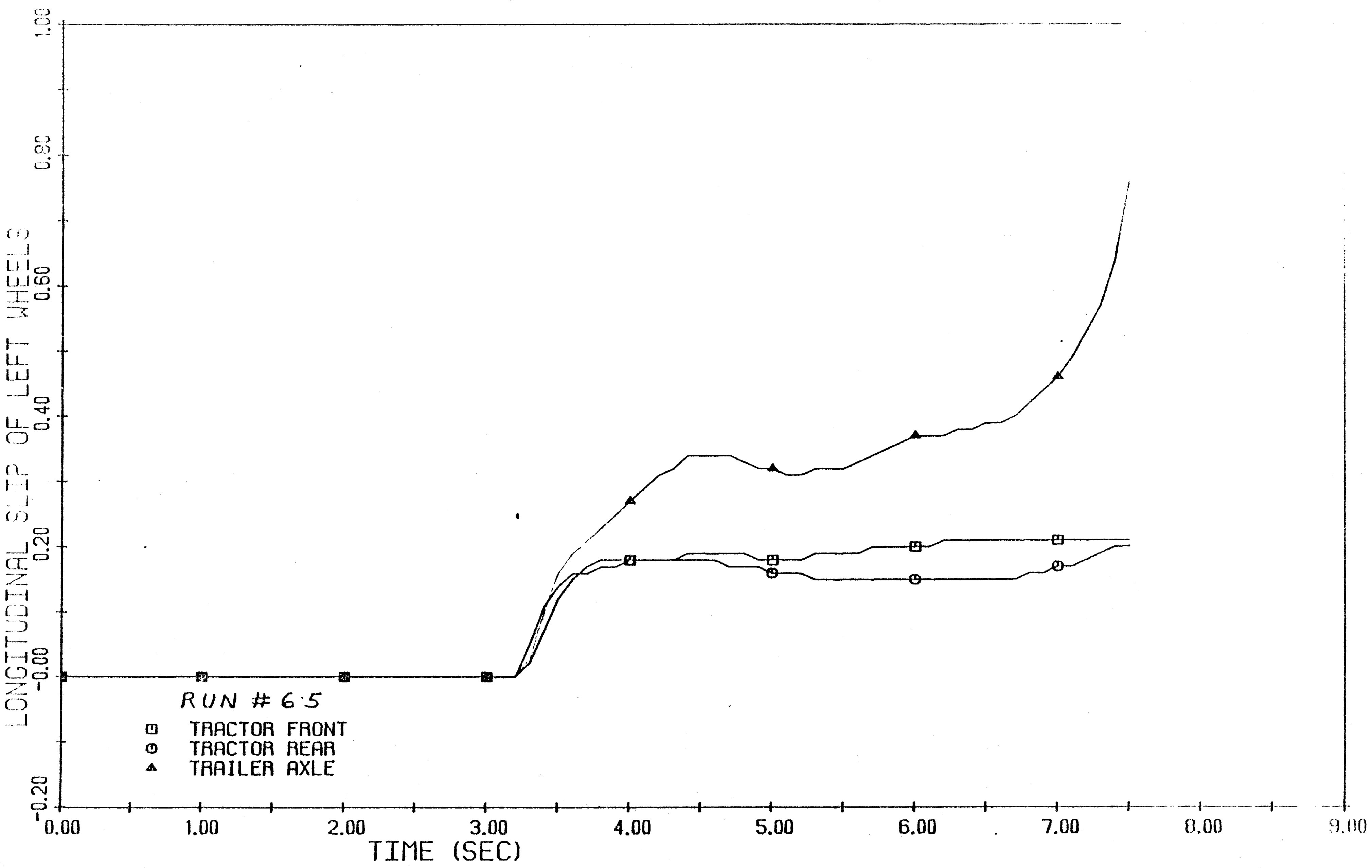
CANADIAN ARTIC BUS, LOADED, B I T,MU=0.3, 50 KPH, 33 PSI
TIME (SEC)
LONGITUDINAL ACC'N OF TRACTOR (FT./SEC**2)
RUN # 6.5
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00



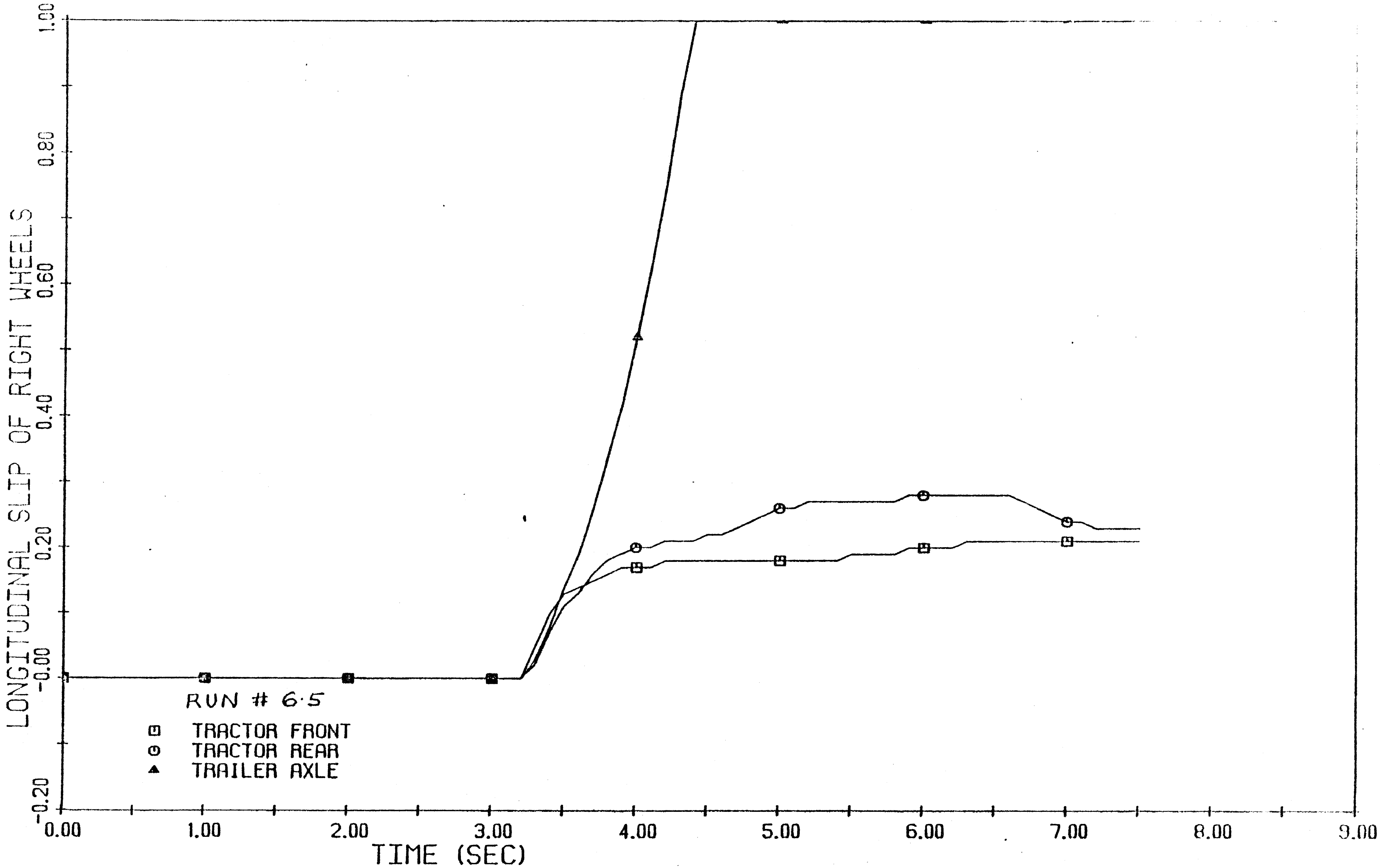
CANADIAN ARTIC BUS, LOADED, B I T,MU=0.3, 50 KPH, 33 PSI



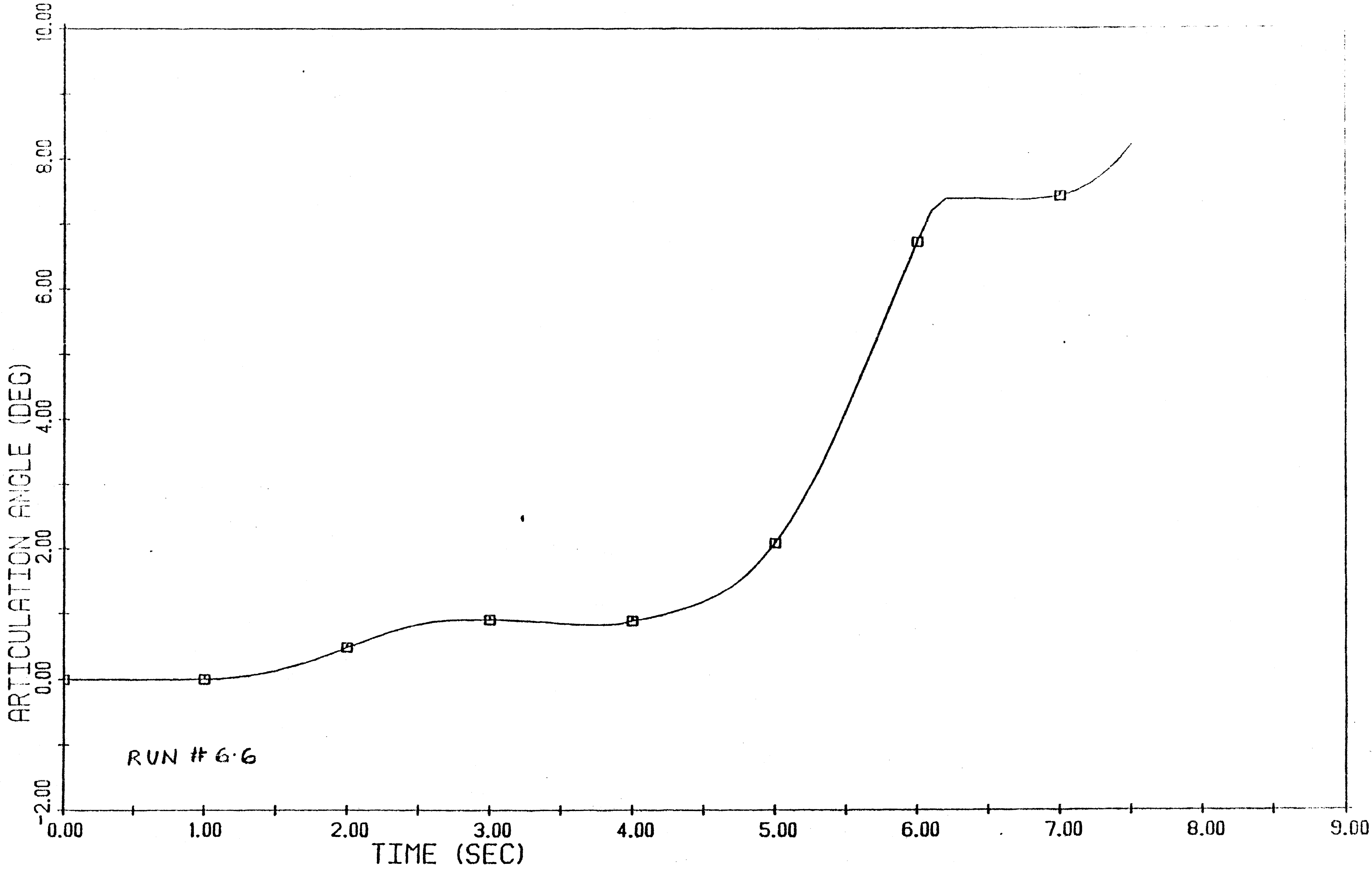
CANADIAN ARTIC BUS, LOADED, B I T,MU=0.3, 50 KPH, 33 PSI



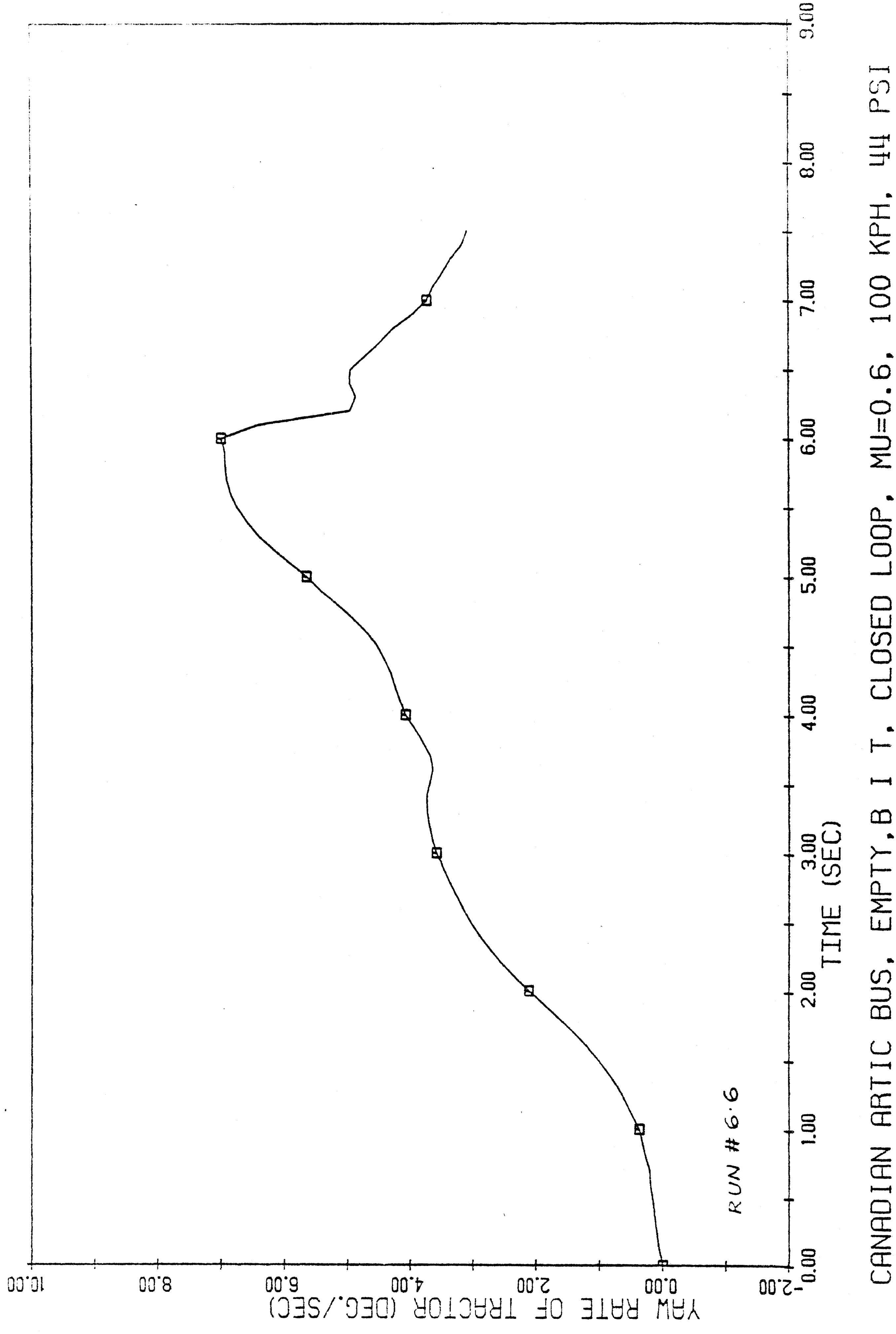
CANADIAN ARTIC BUS, LOADED, B I T,50 KPH, 33 PSI, MU=0.3

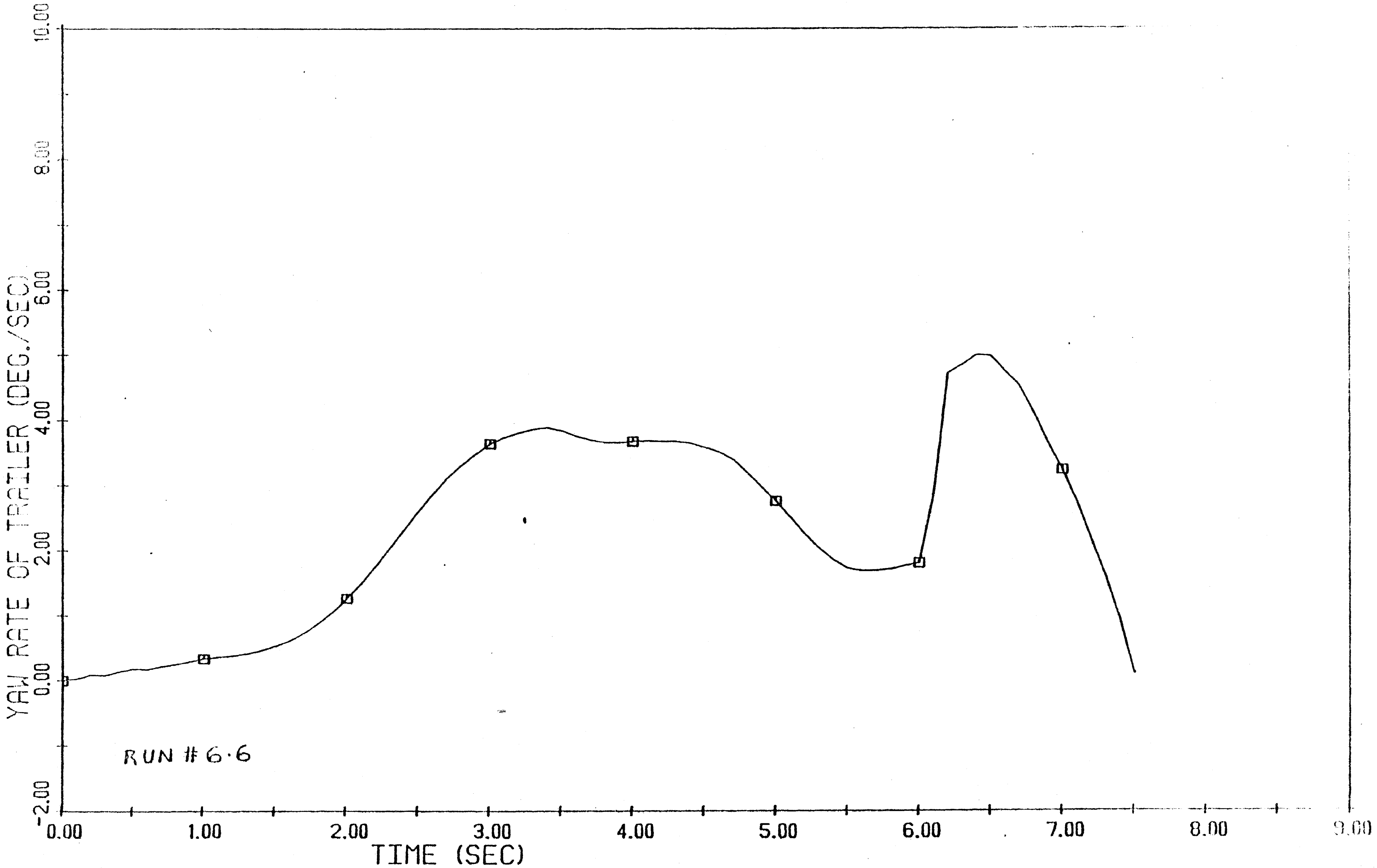


CANADIAN ARTIC BUS, LOADED, B I T,50 KPH, 33 PSI, MU=0.3

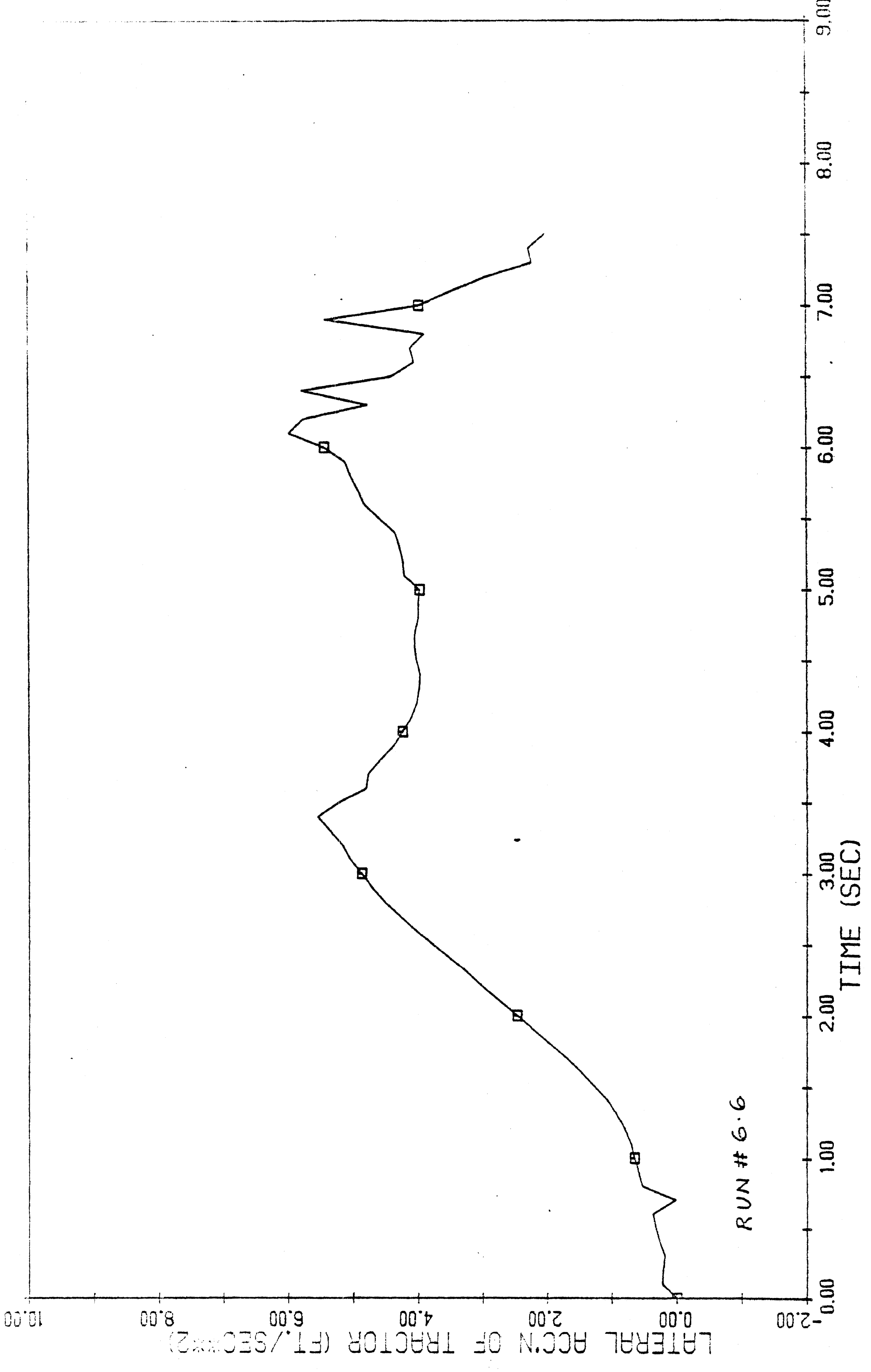


CANADIAN ARTIC BUS, EMPTY,B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI

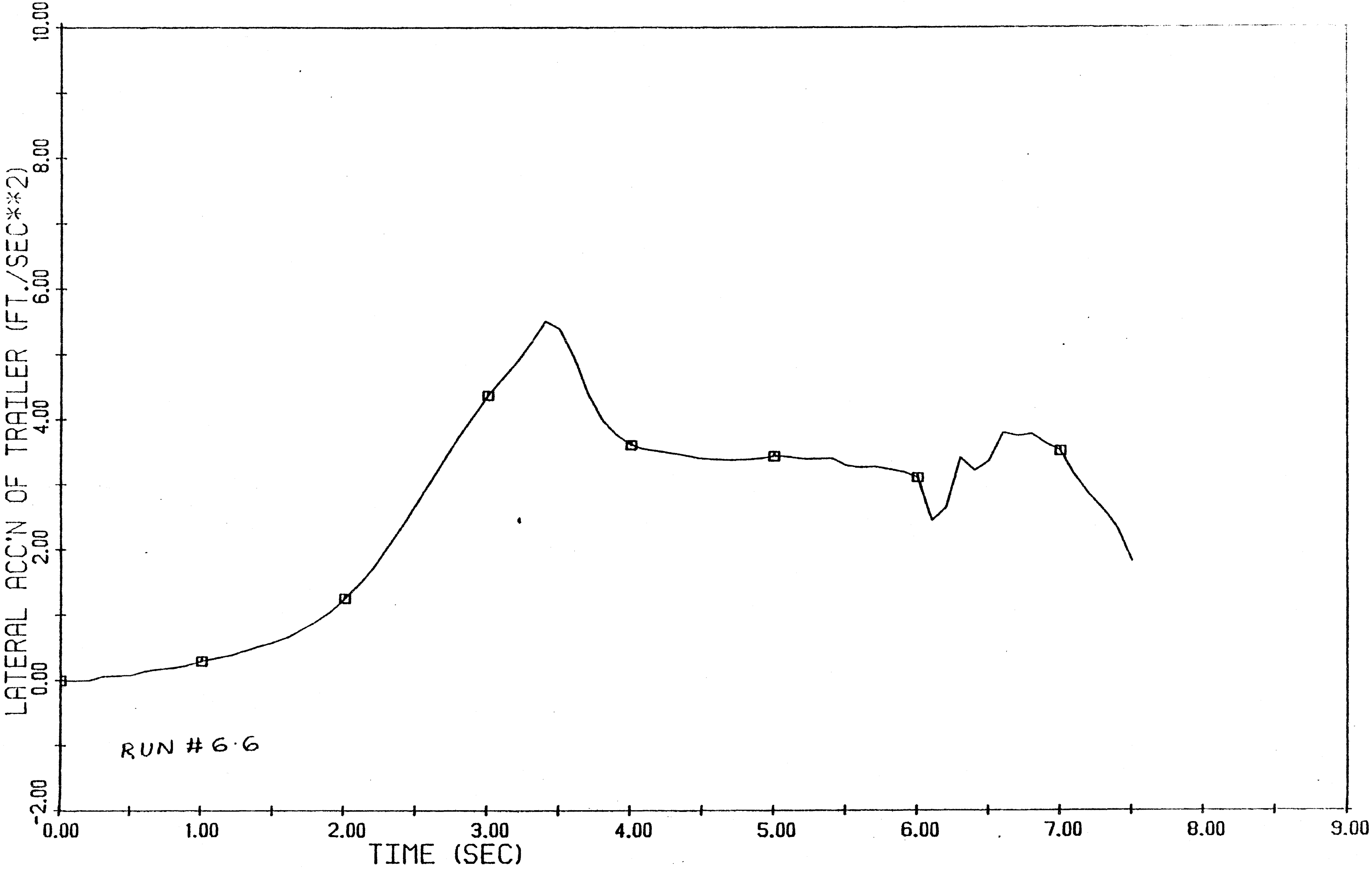

CANADIAN ARTIC BUS, EMPTY,B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI
TIME (SEC)
YAW RATE OF TRACTOR (DEG./SEC)
RUN # 6·6
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00



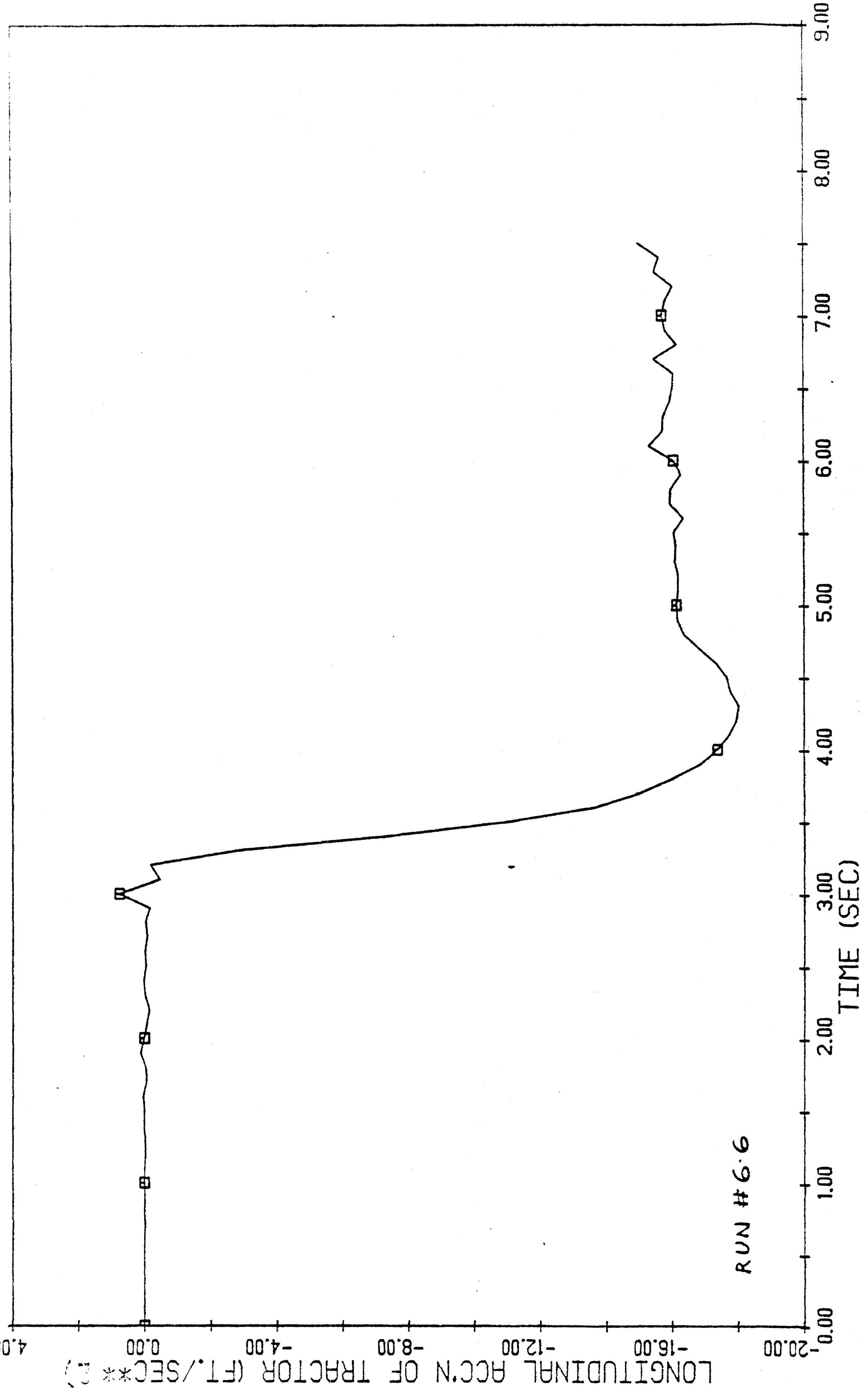
CANADIAN ARTIC BUS, EMPTY,B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI



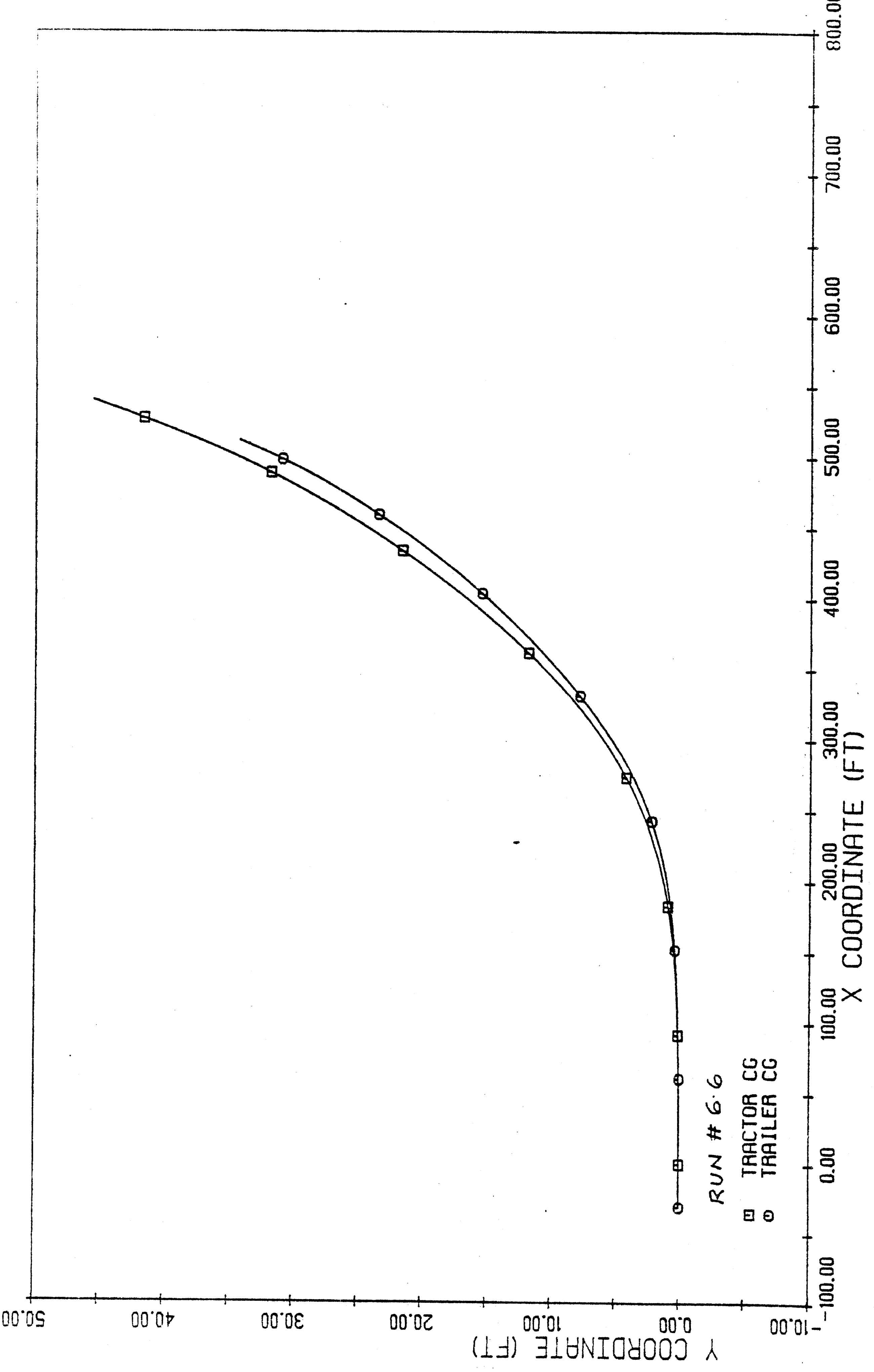
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI



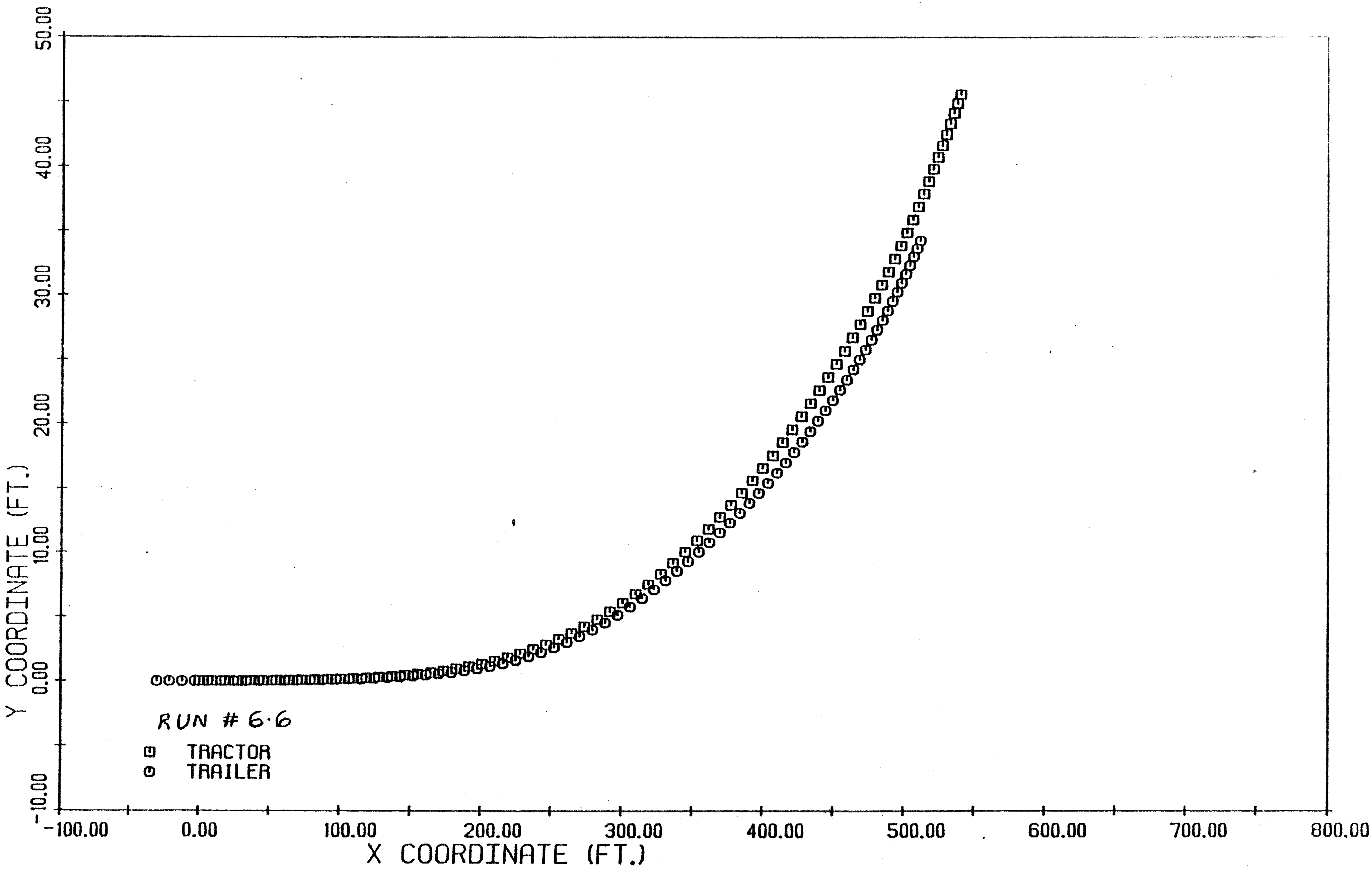
CANADIAN ARTIC BUS, EMPTY,B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI



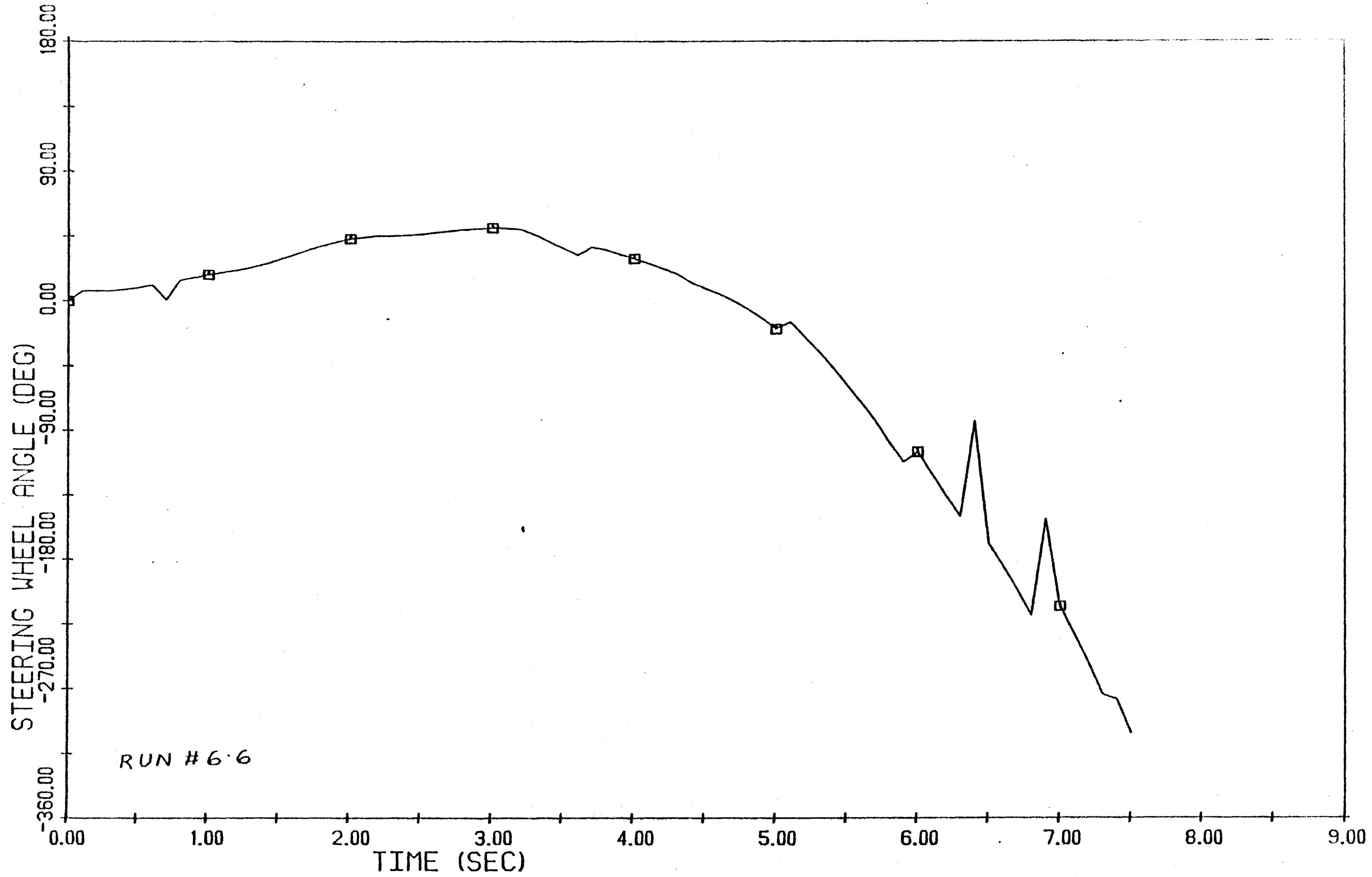
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI



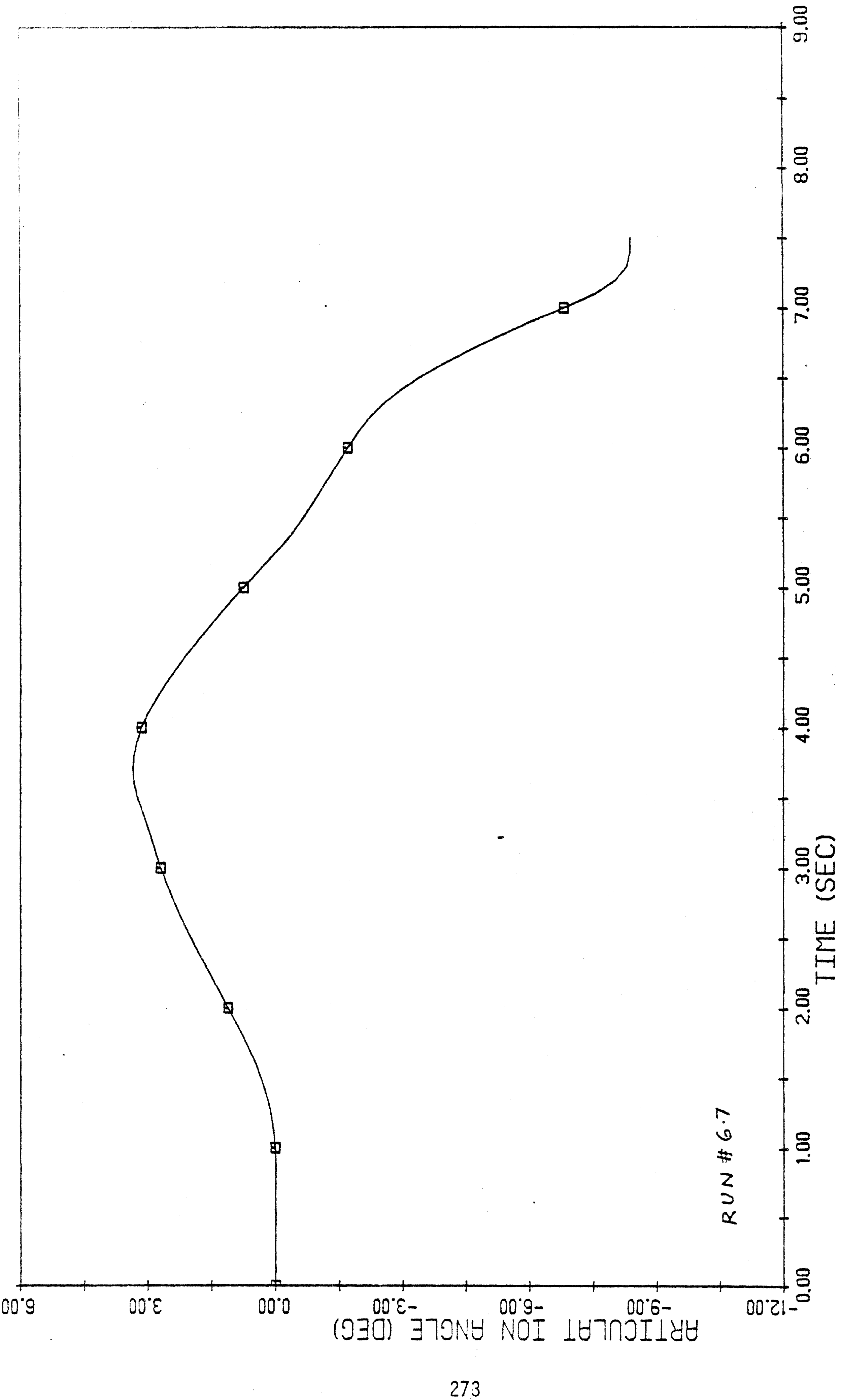
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI



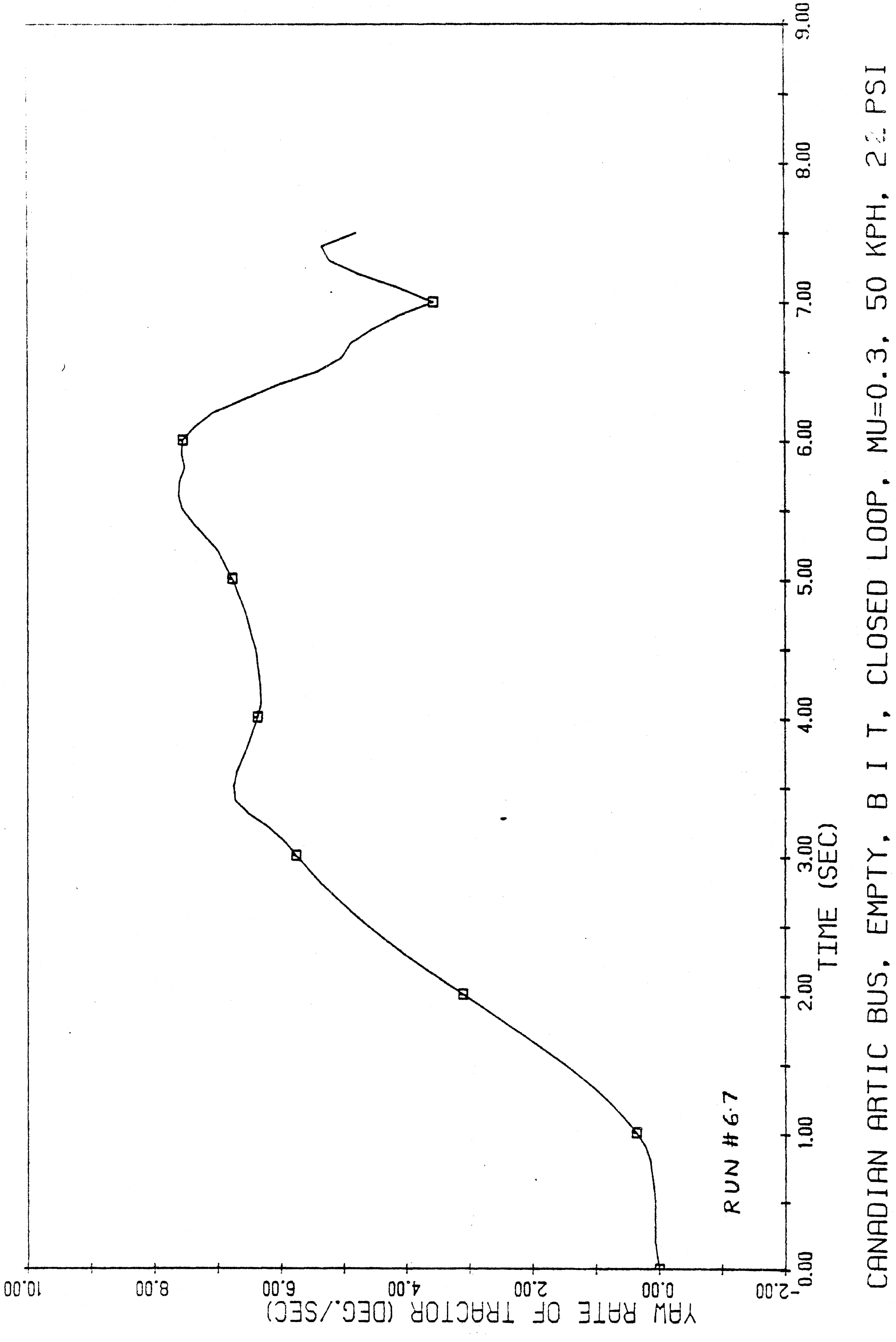
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI

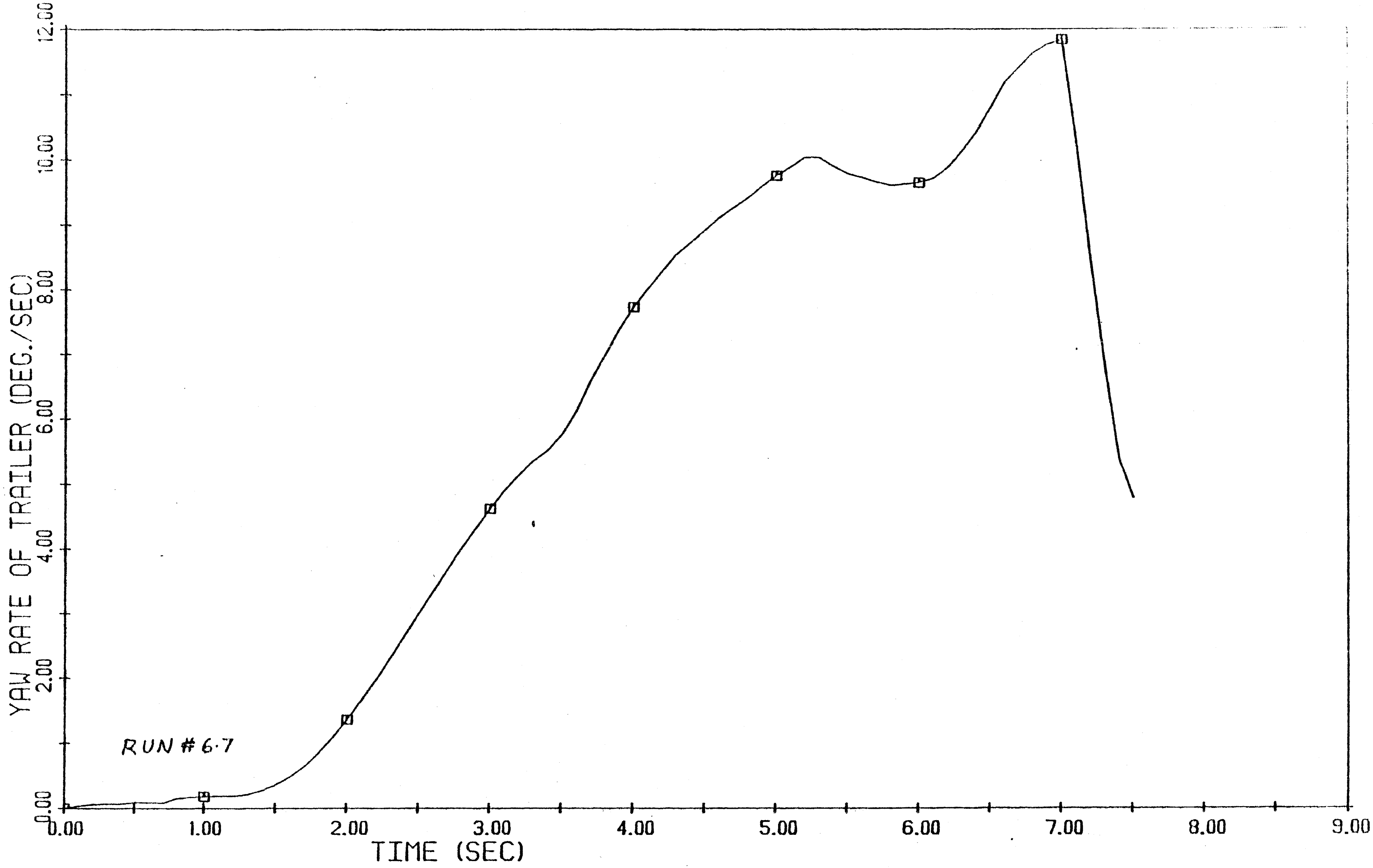


CANADIAN ARTIC BUS, EMPTY,B I T, CLOSED LOOP, MU=0.6, 100 KPH, 44 PSI

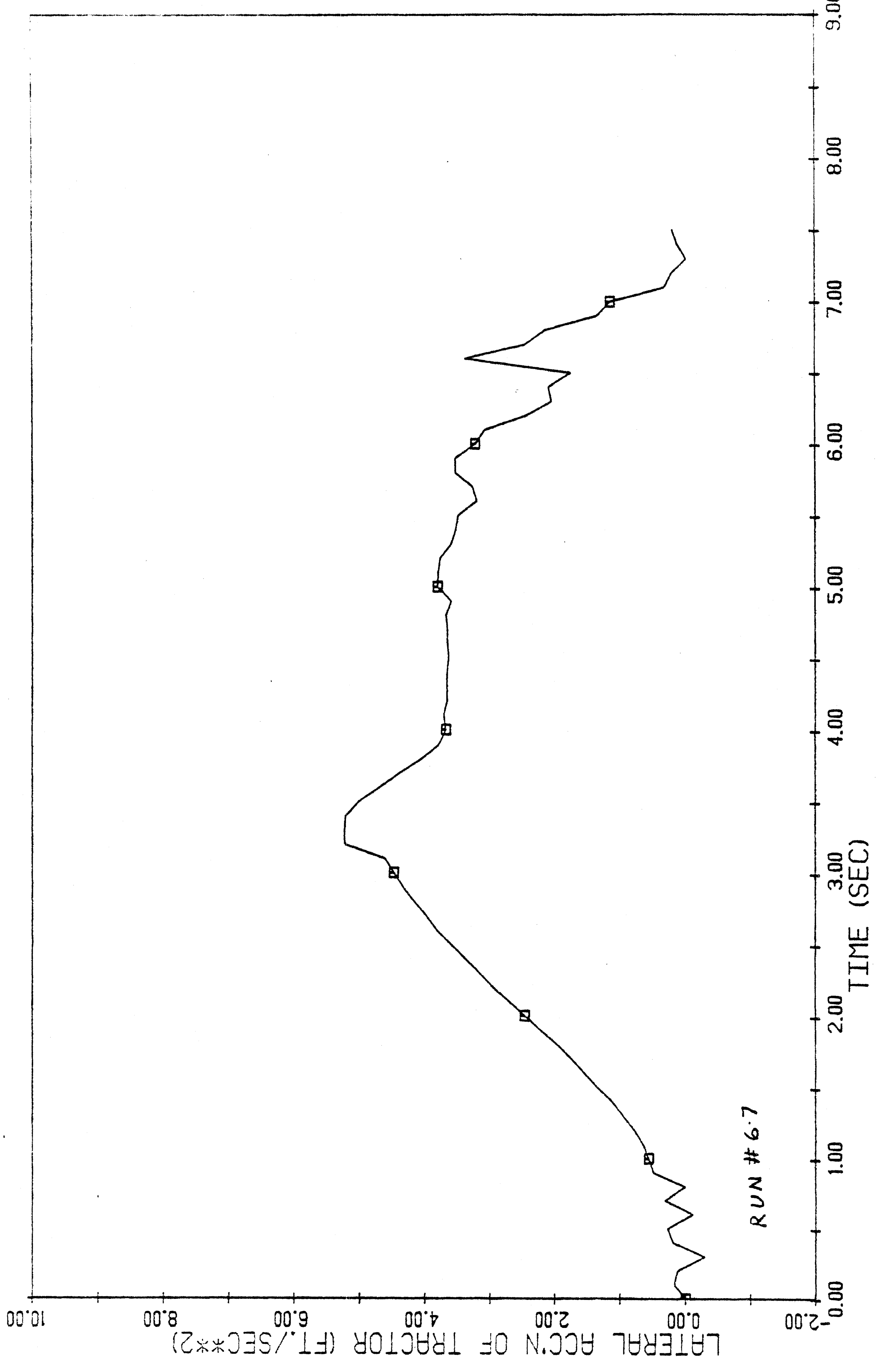


CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 2[illegible] PSI

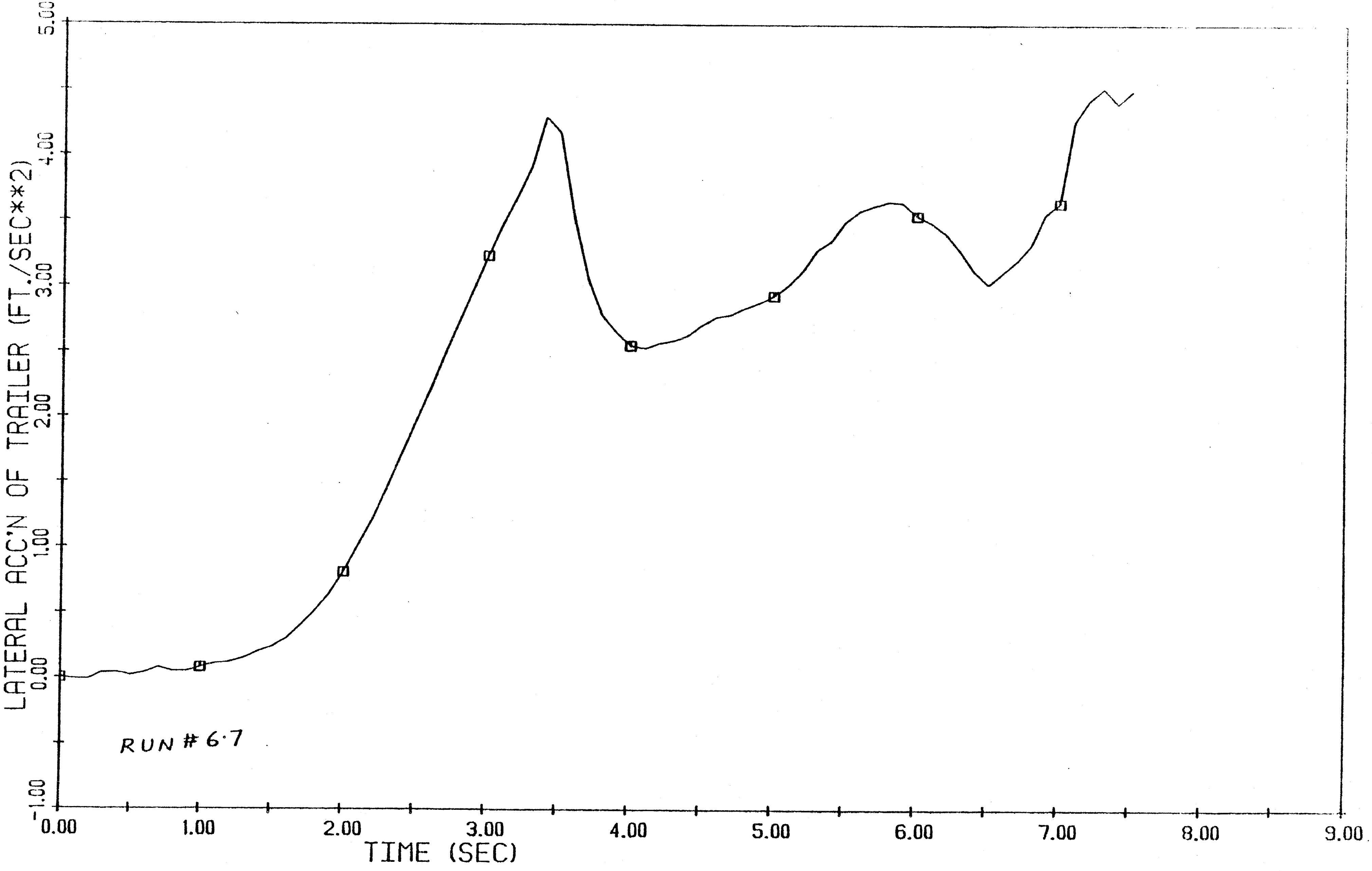

RUN #6·7
YAW RATE OF TRACTOR (DEG./SEC)
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
TIME (SEC)
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 22 PSI



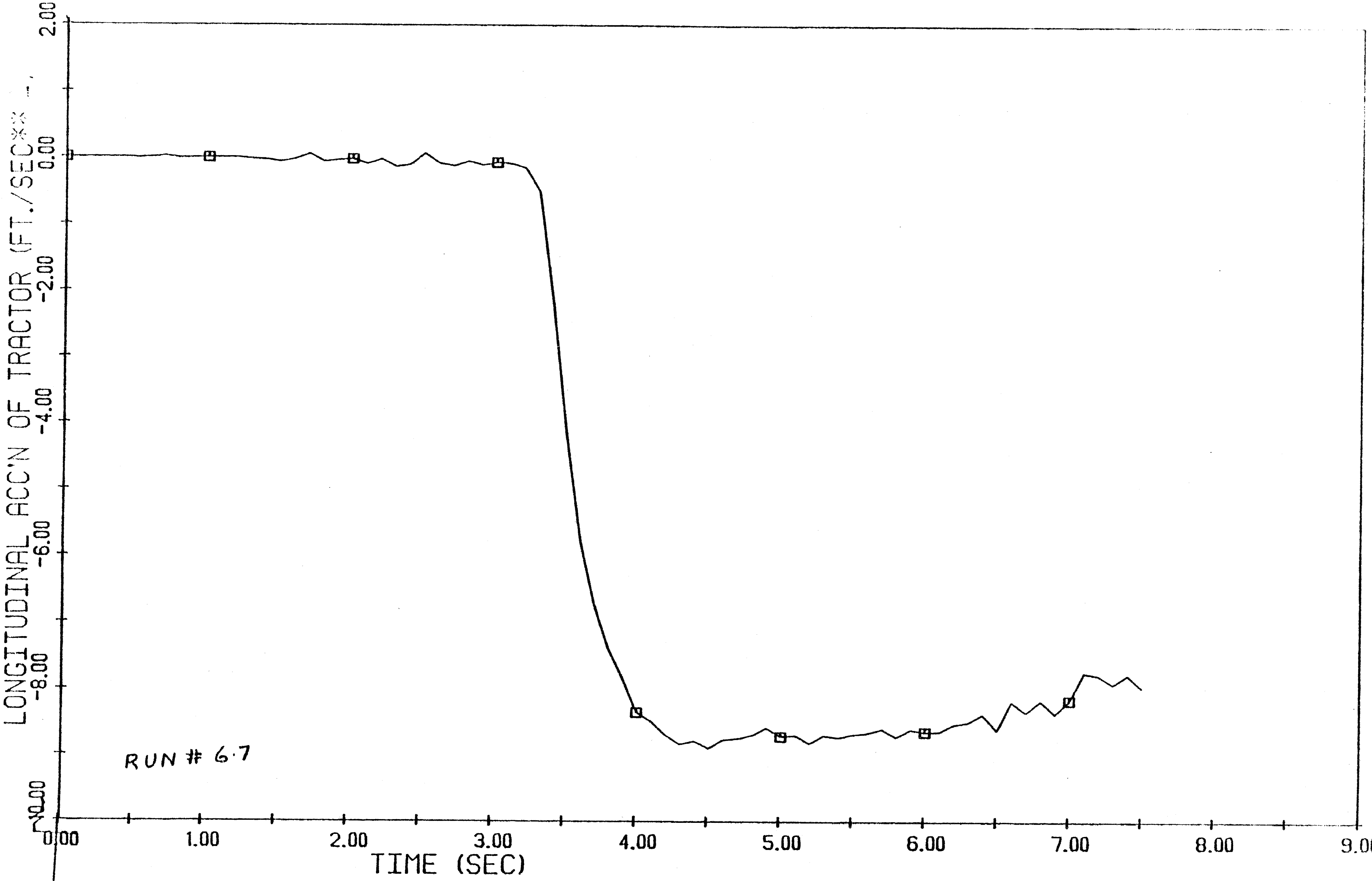
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 22 PSI



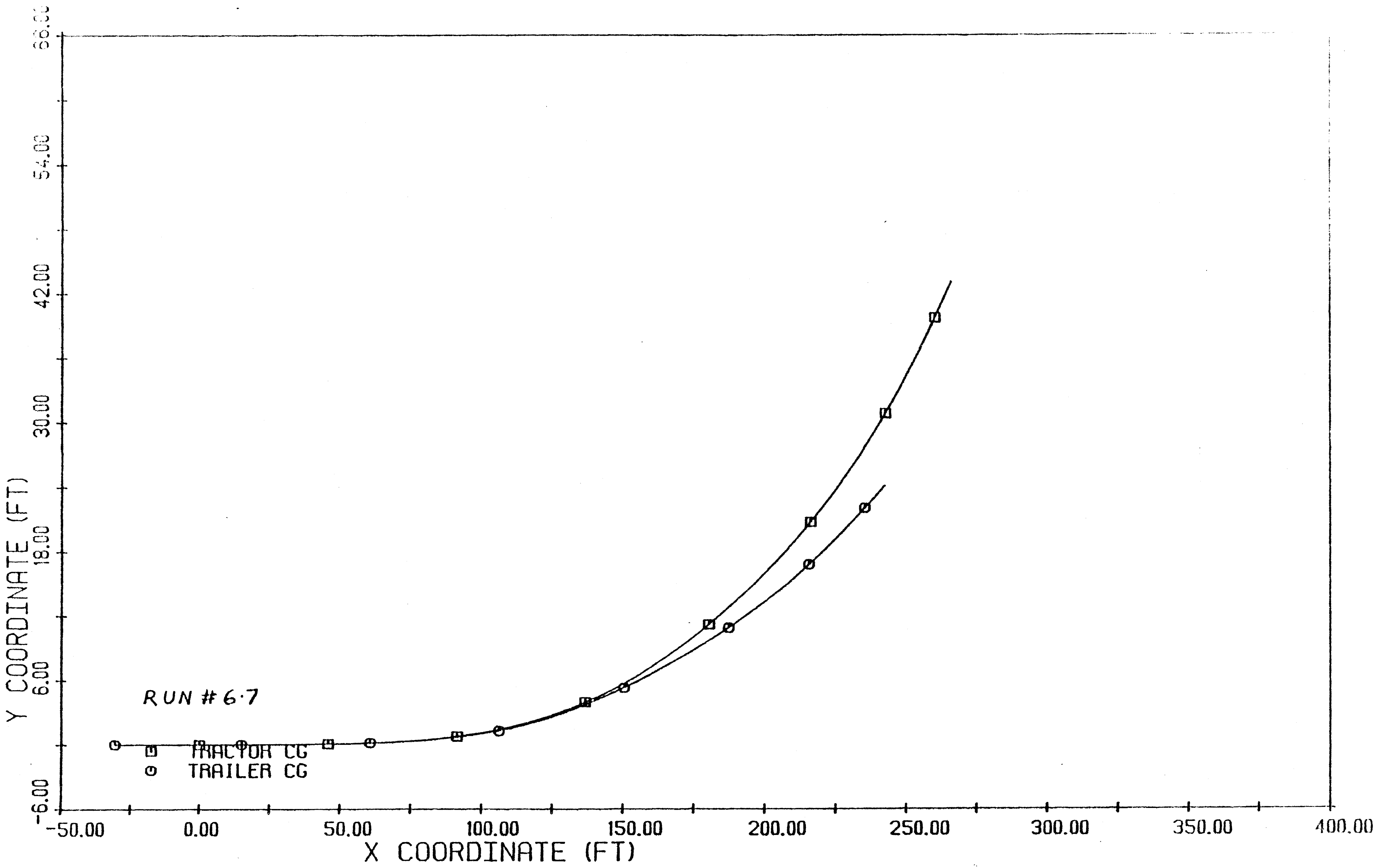
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 2[illegible] PSI



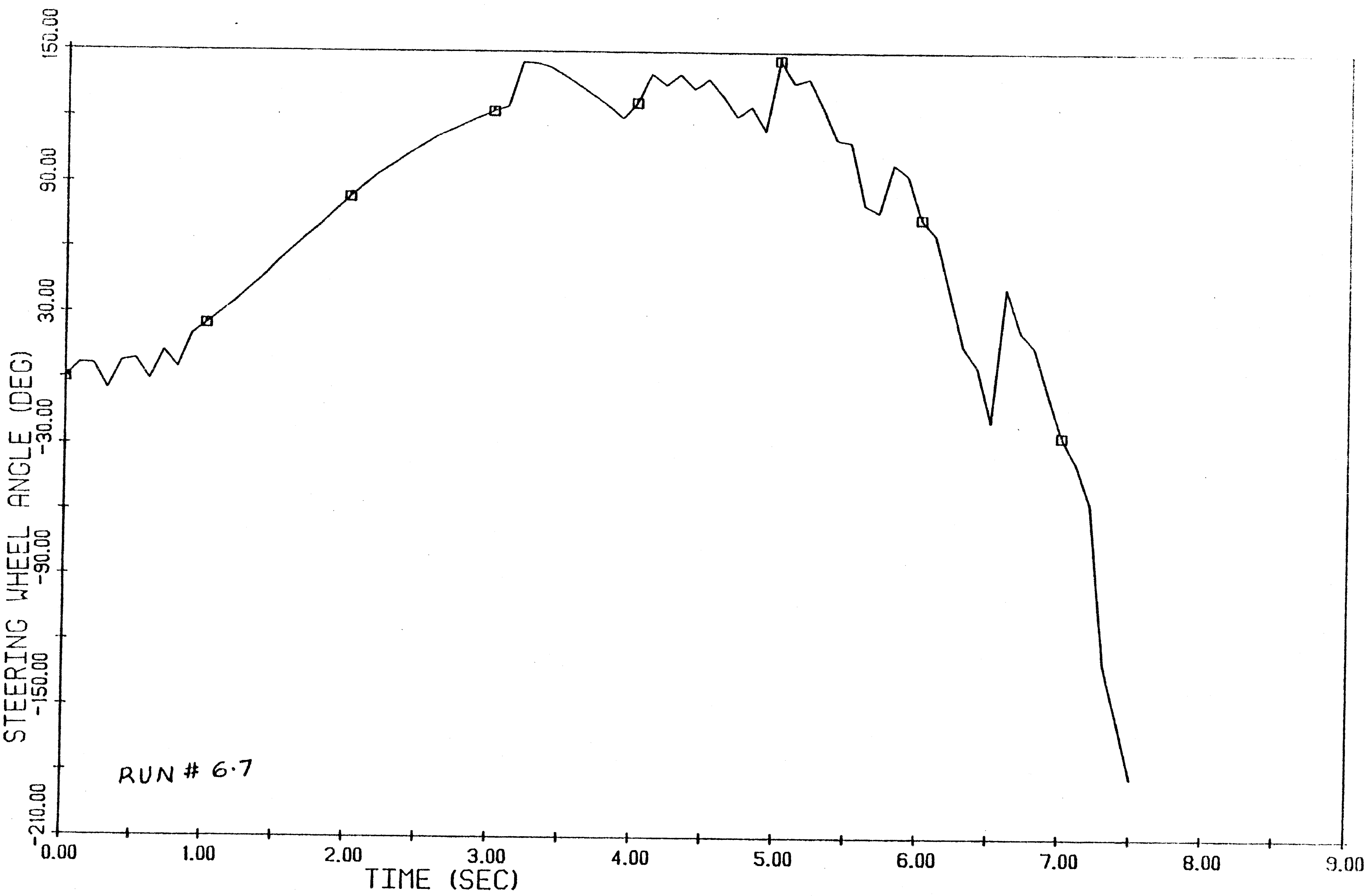
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 22 PSI



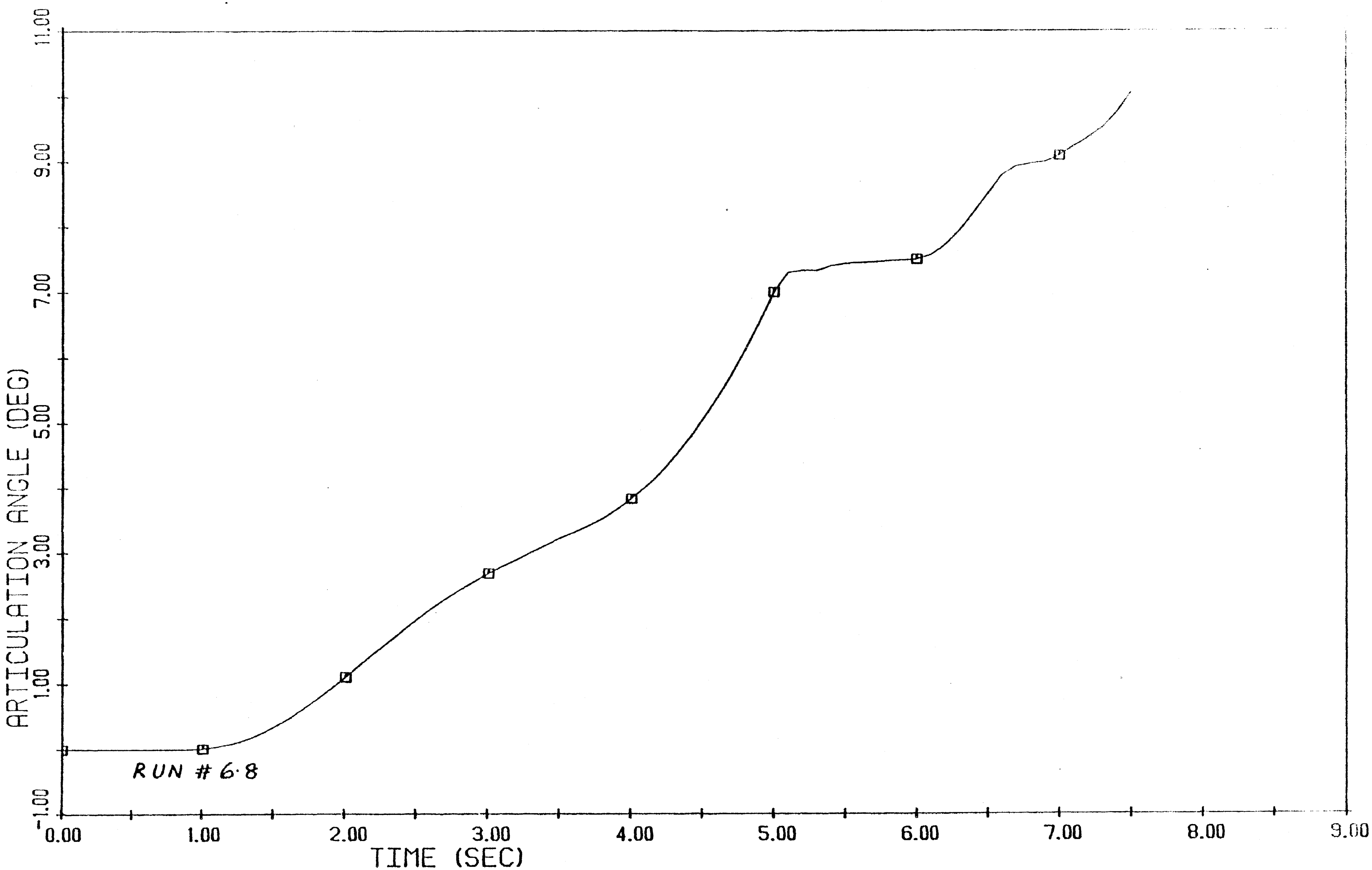
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 2 . PSI



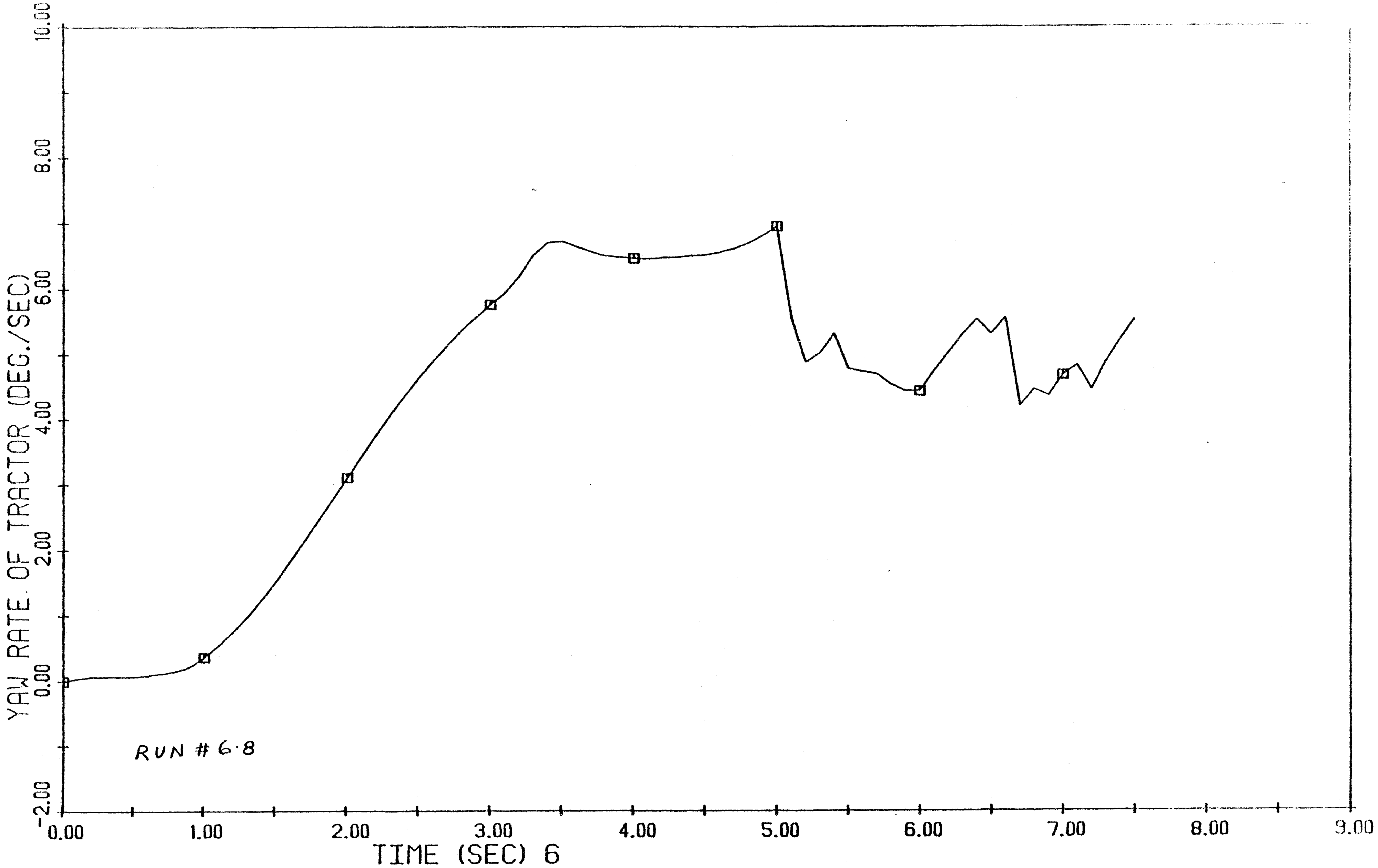
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 22 PSI



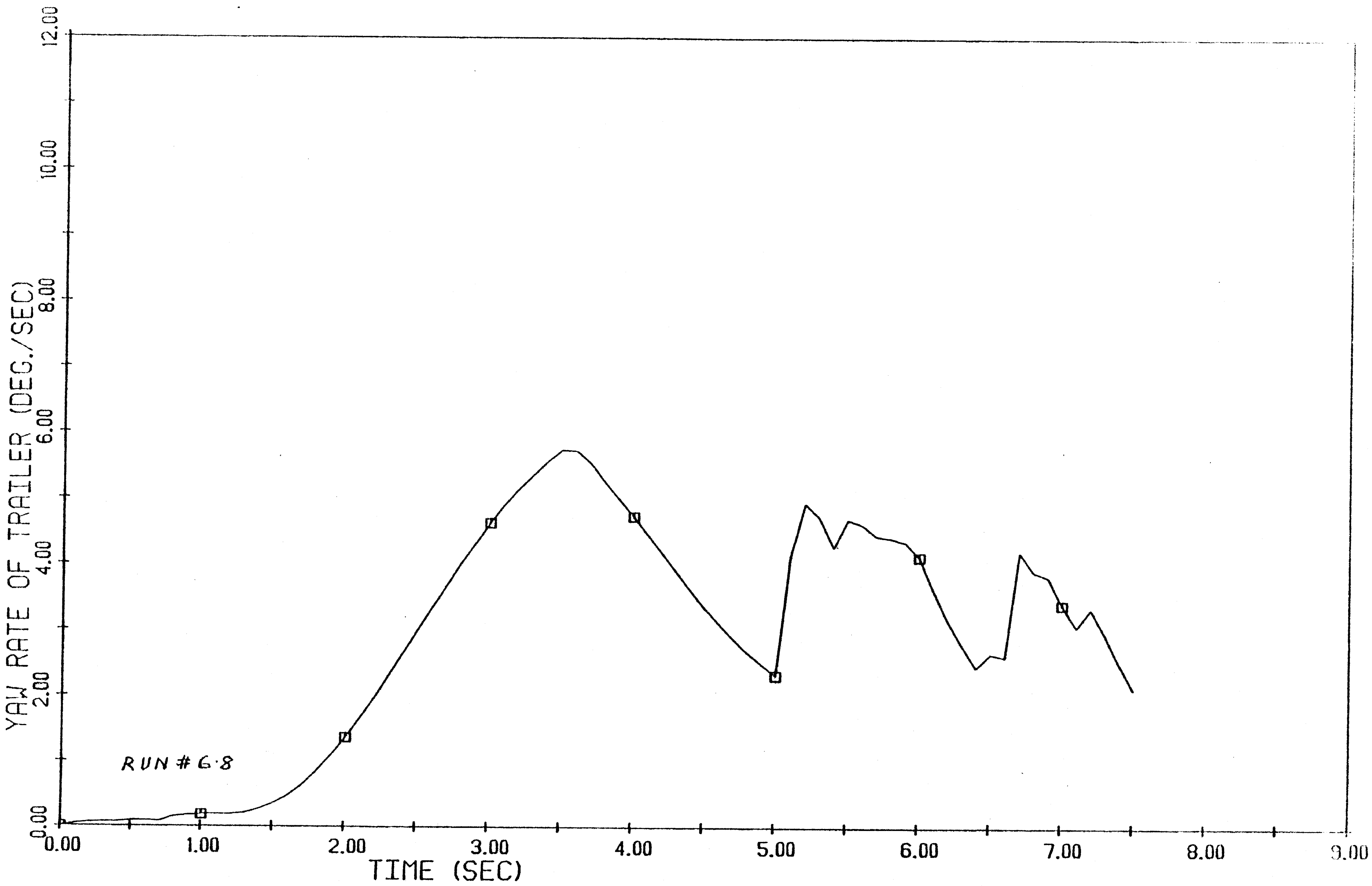
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, MU=0.3, 50 KPH, 22 PSI



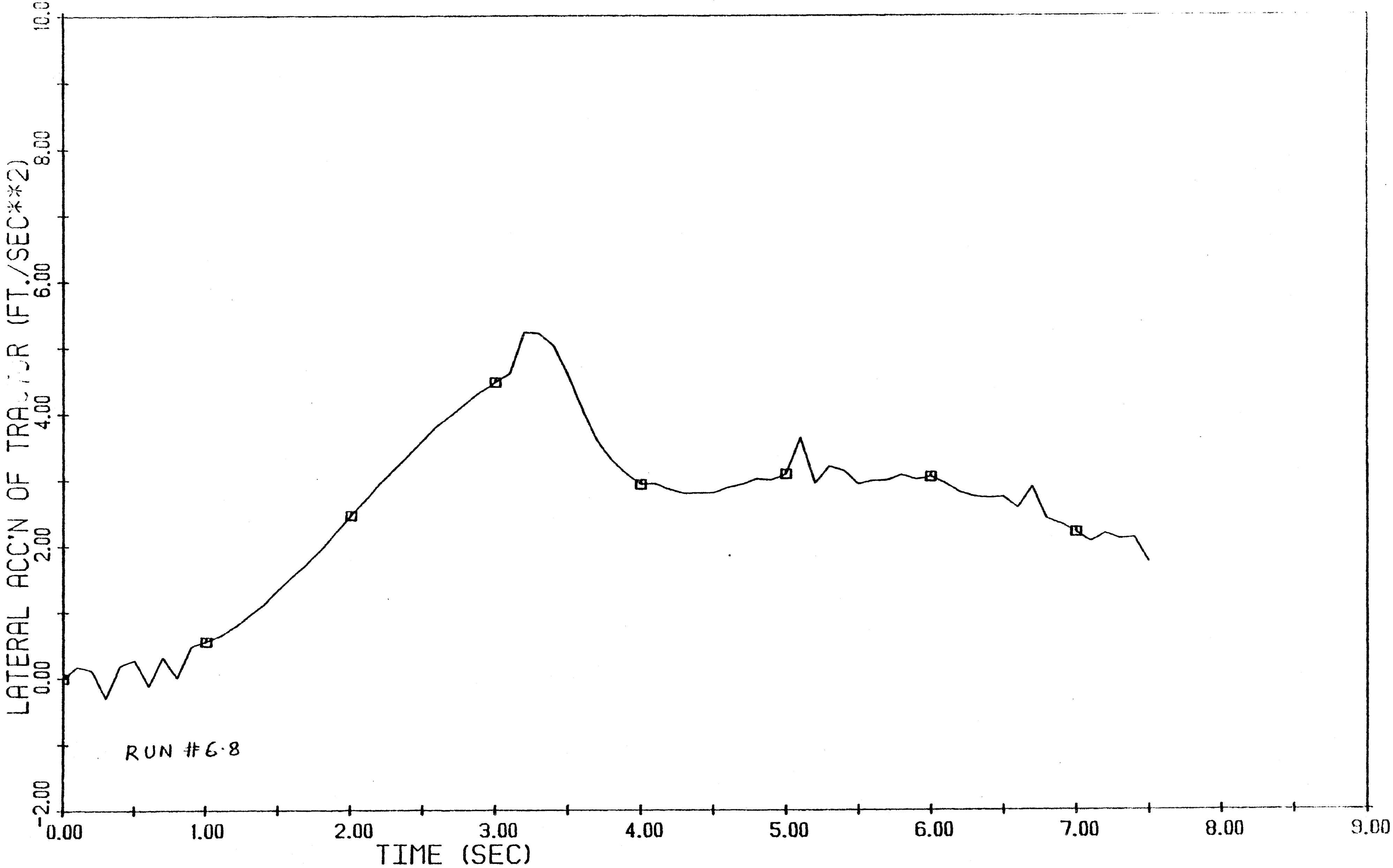
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH,



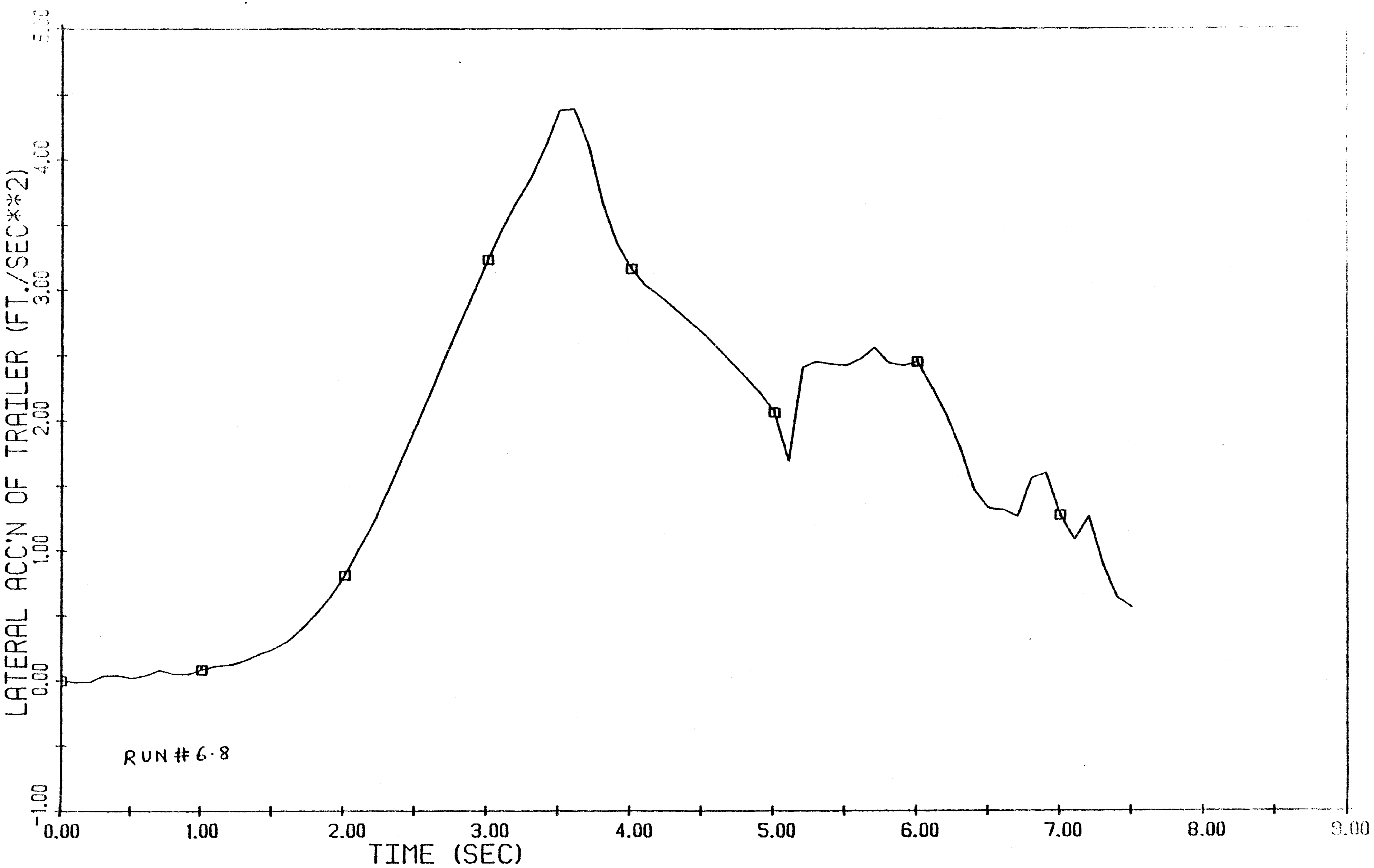
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH,



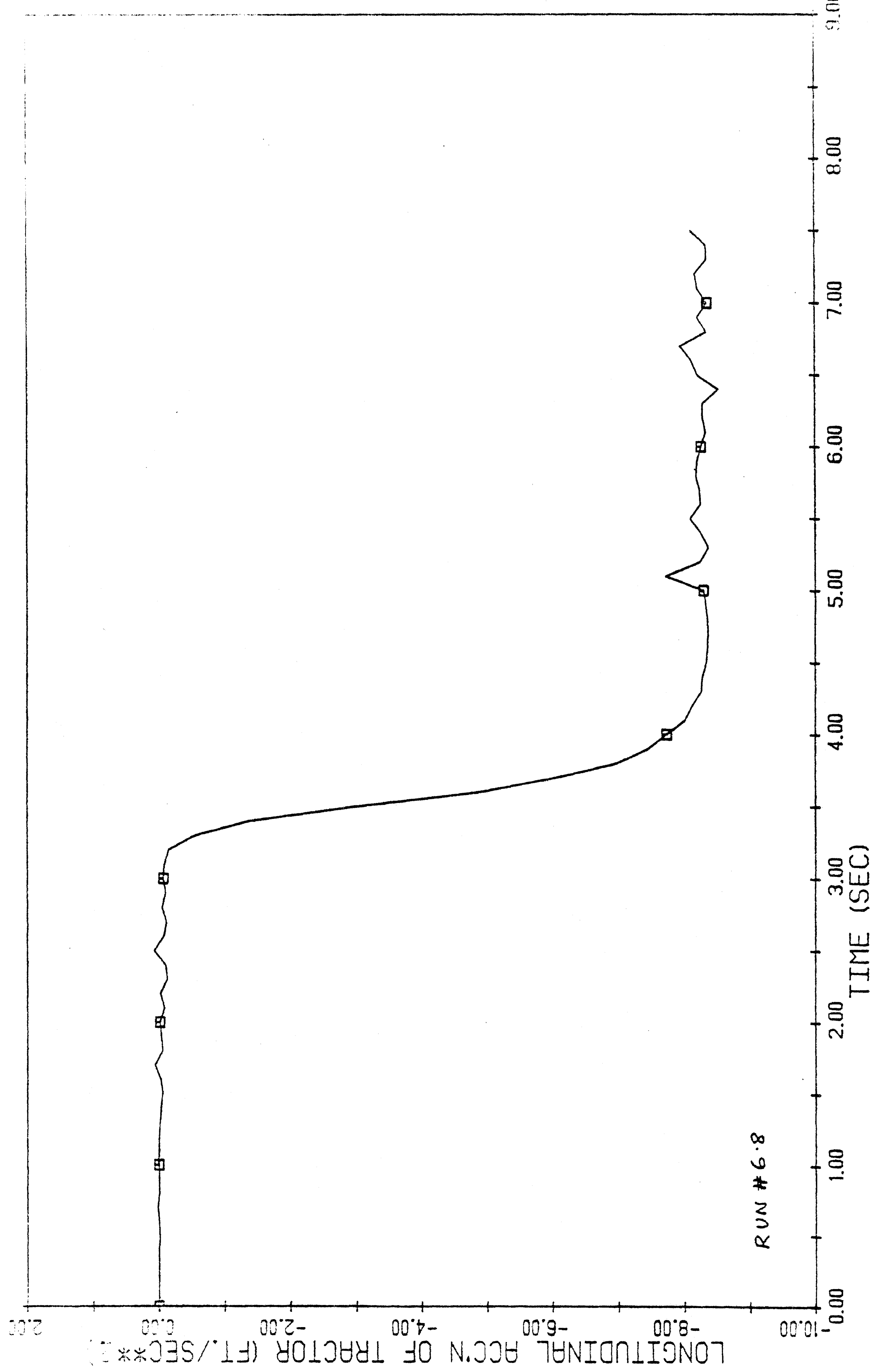
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH.



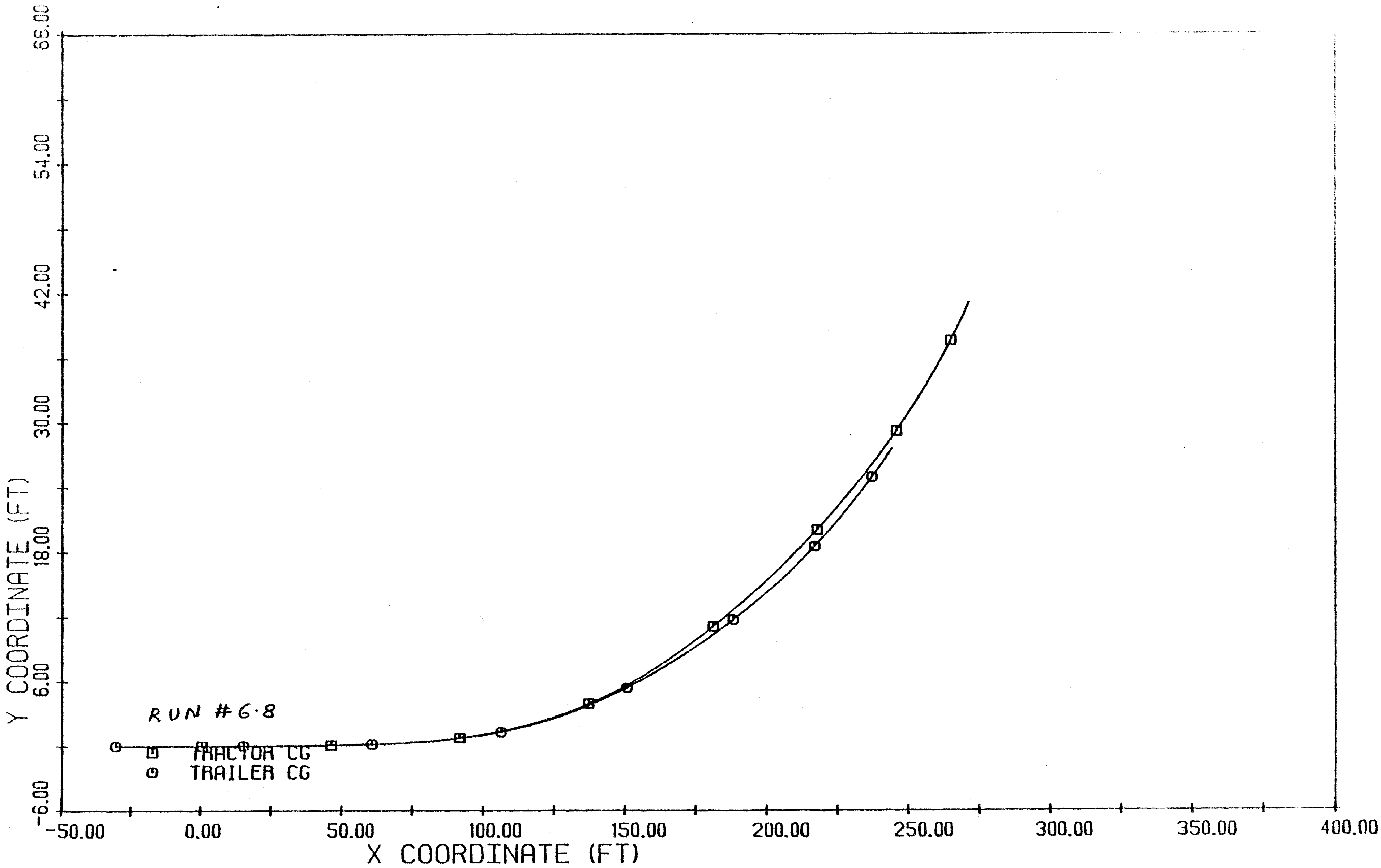
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH.



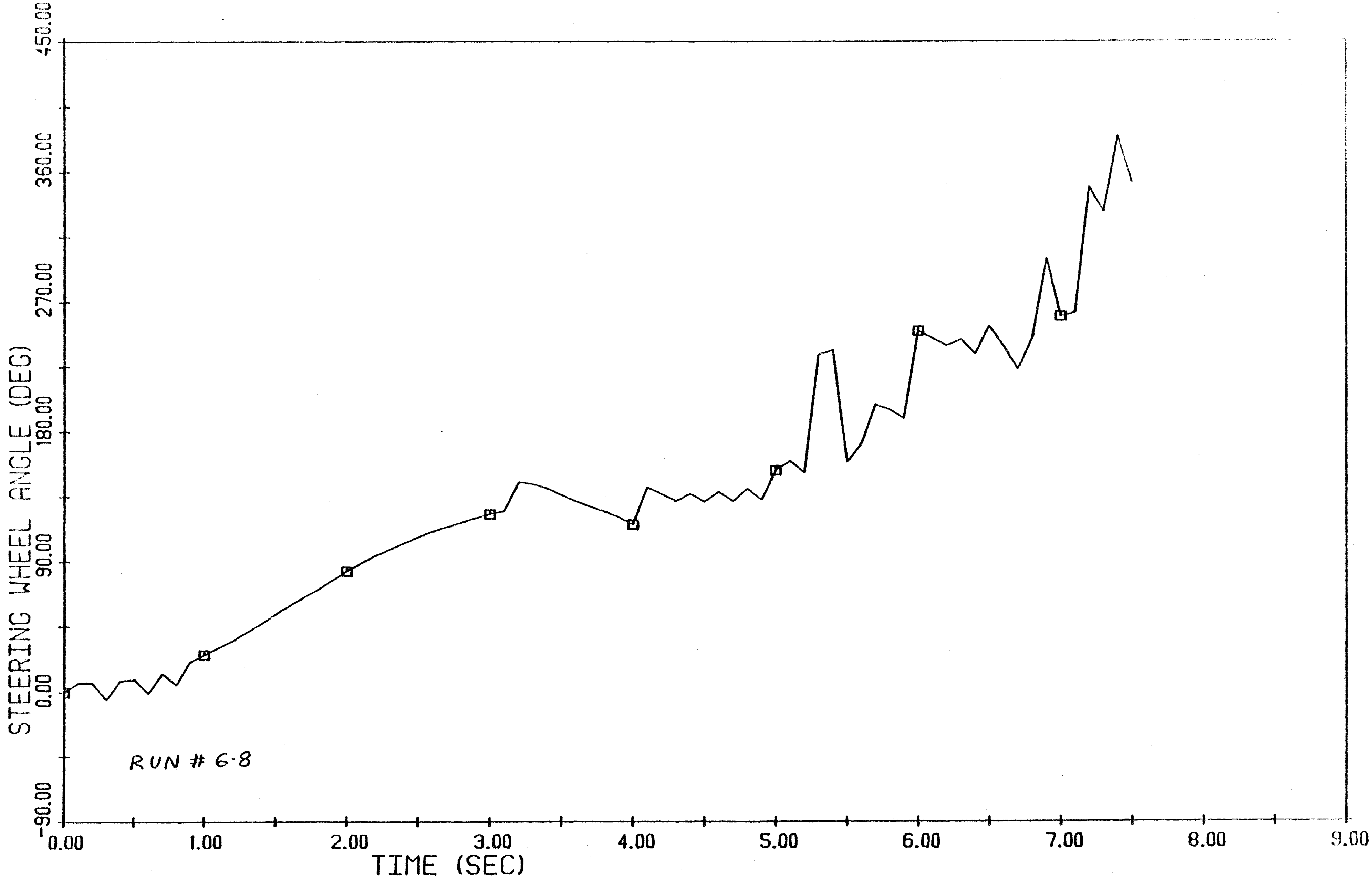
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH,



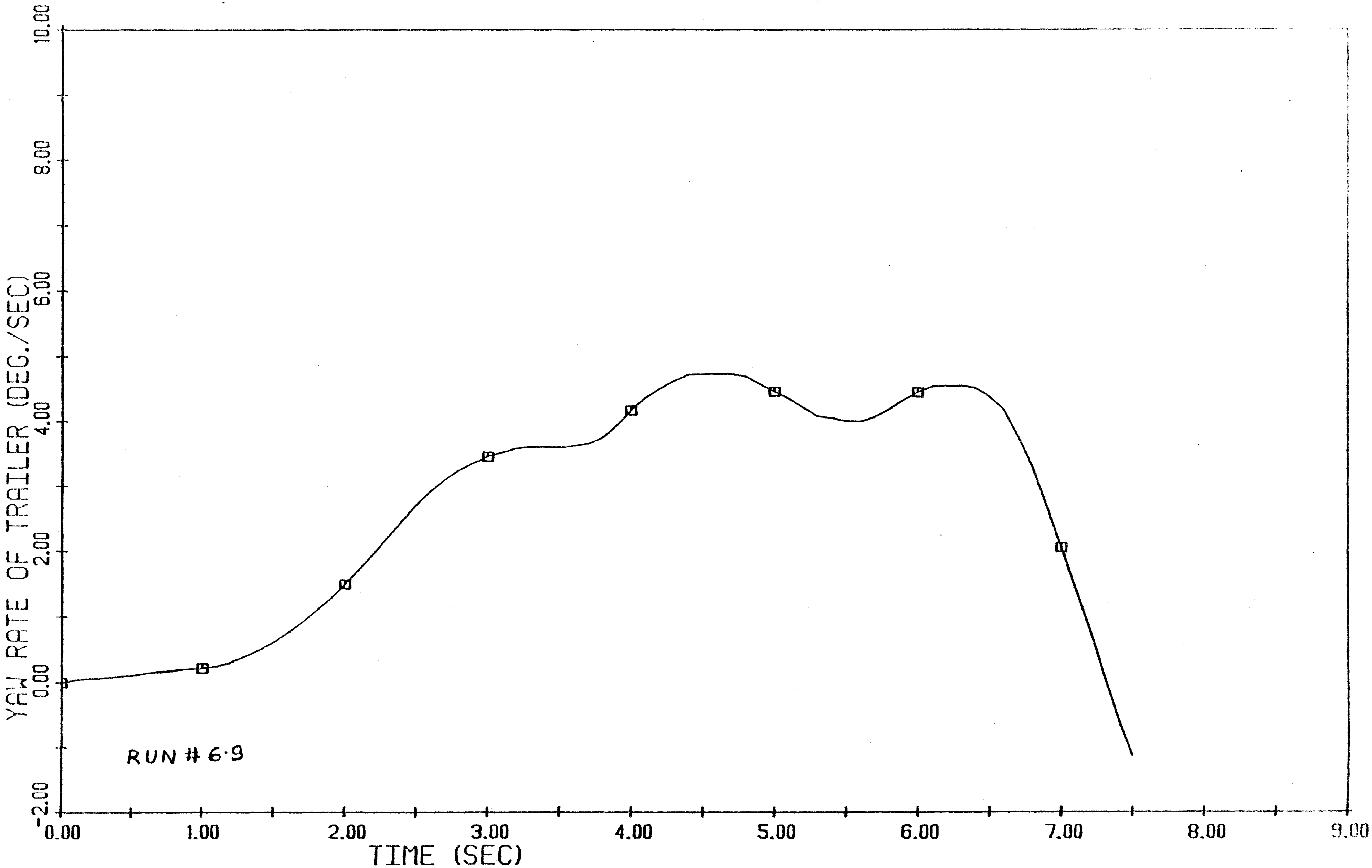
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH.



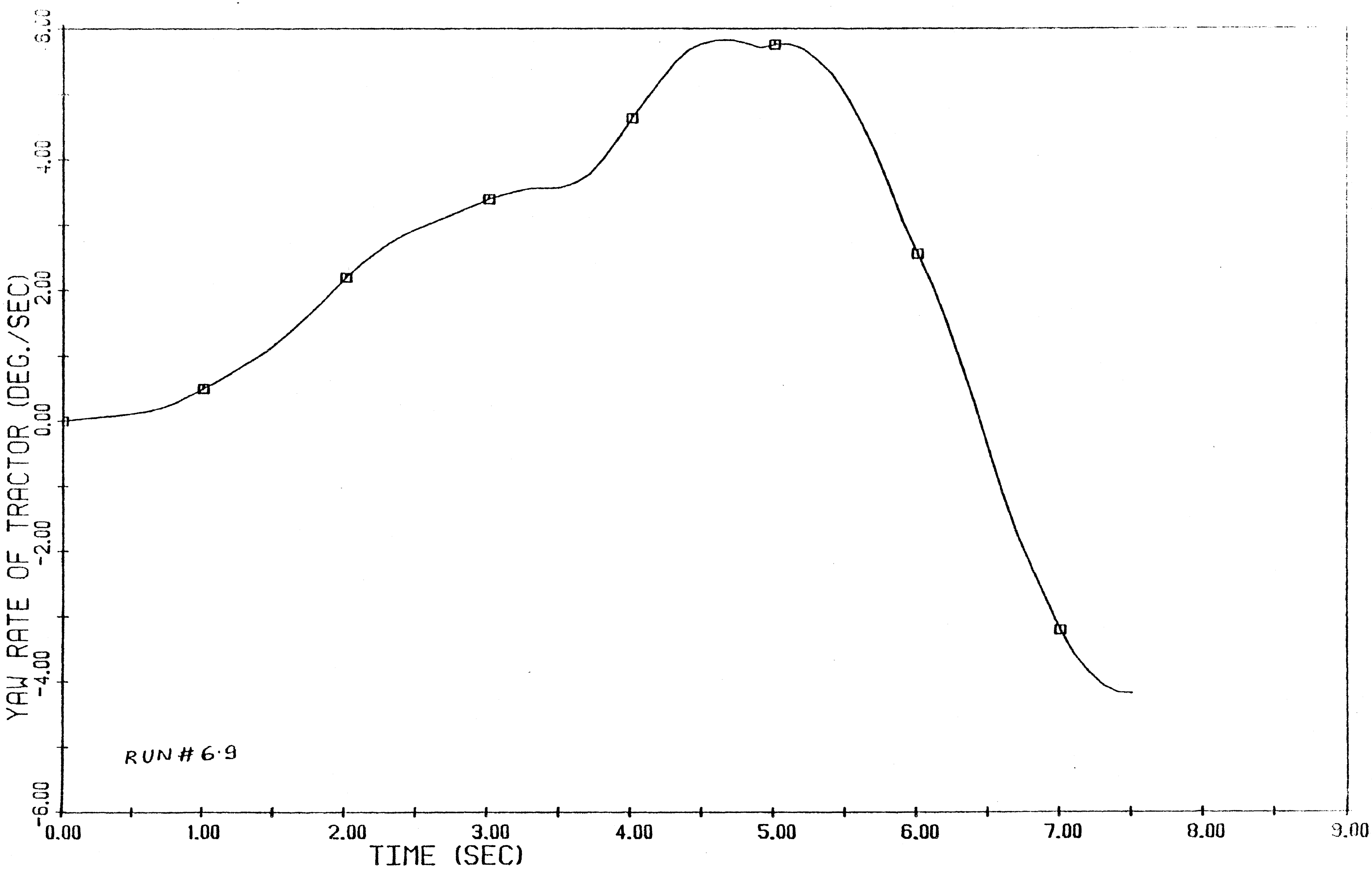
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH,



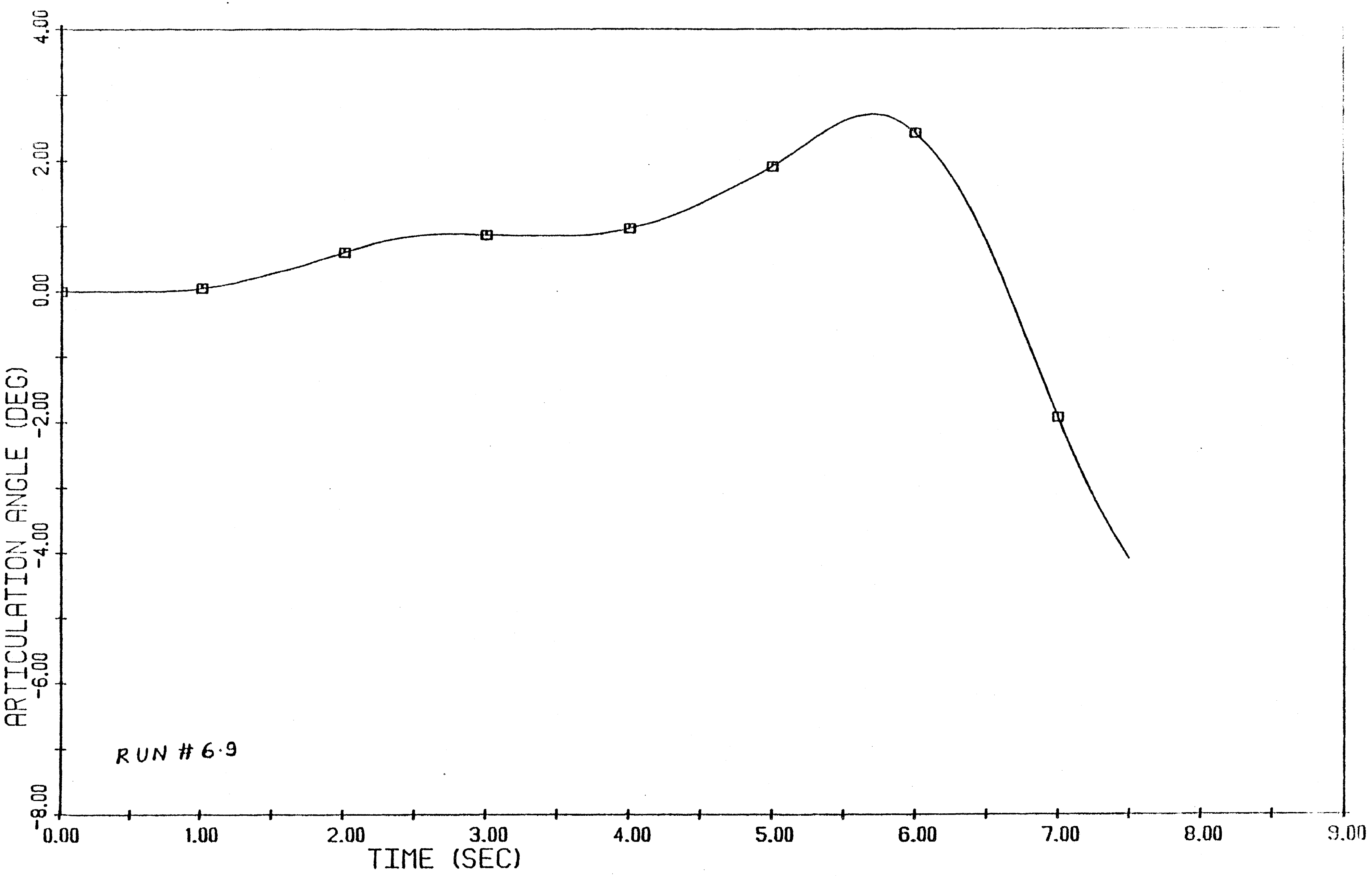
CANADIAN ARTIC BUS, EMPTY, B I T, CLOSED LOOP, WITHOUT RETARDER, 50 KPH



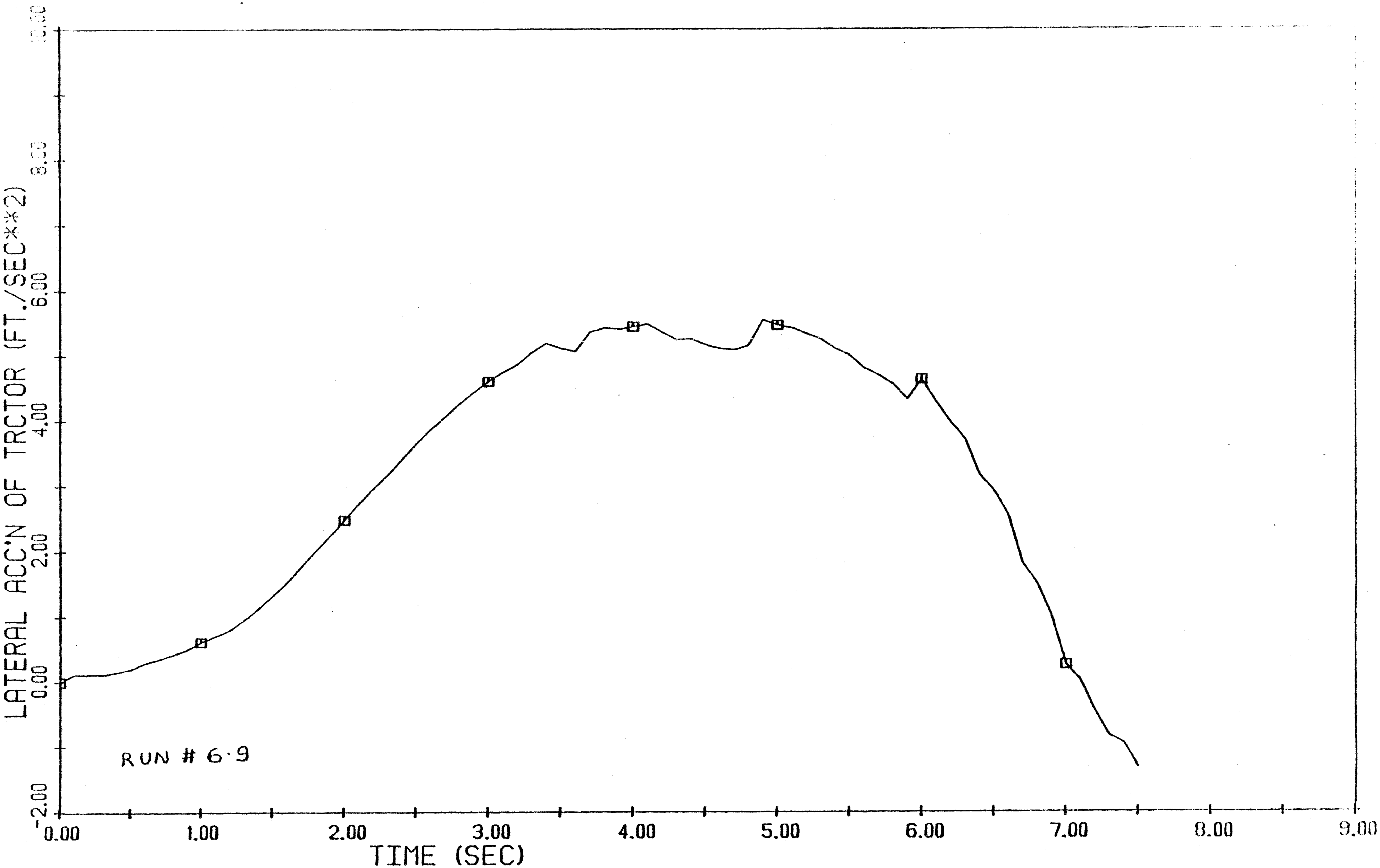
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



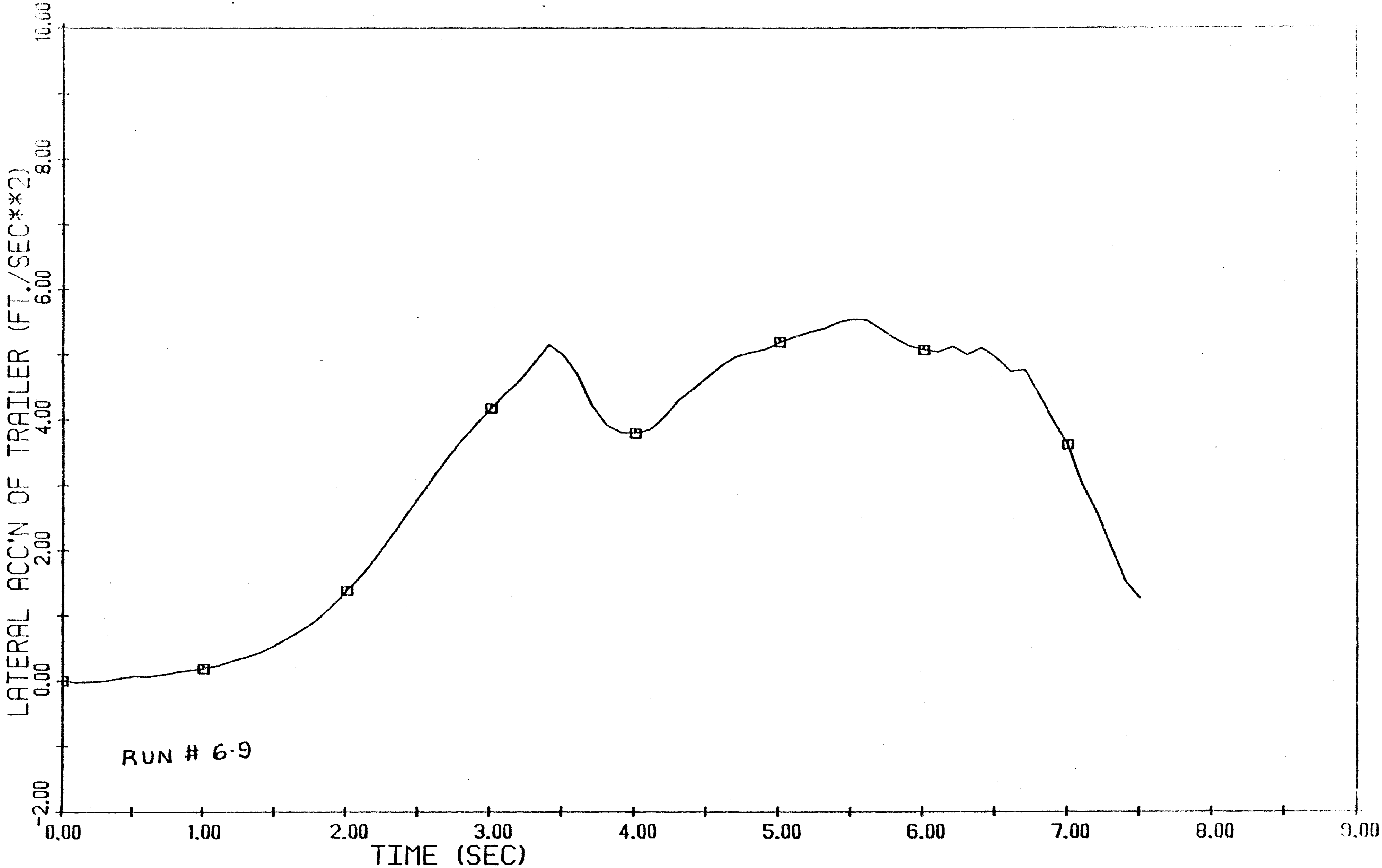
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



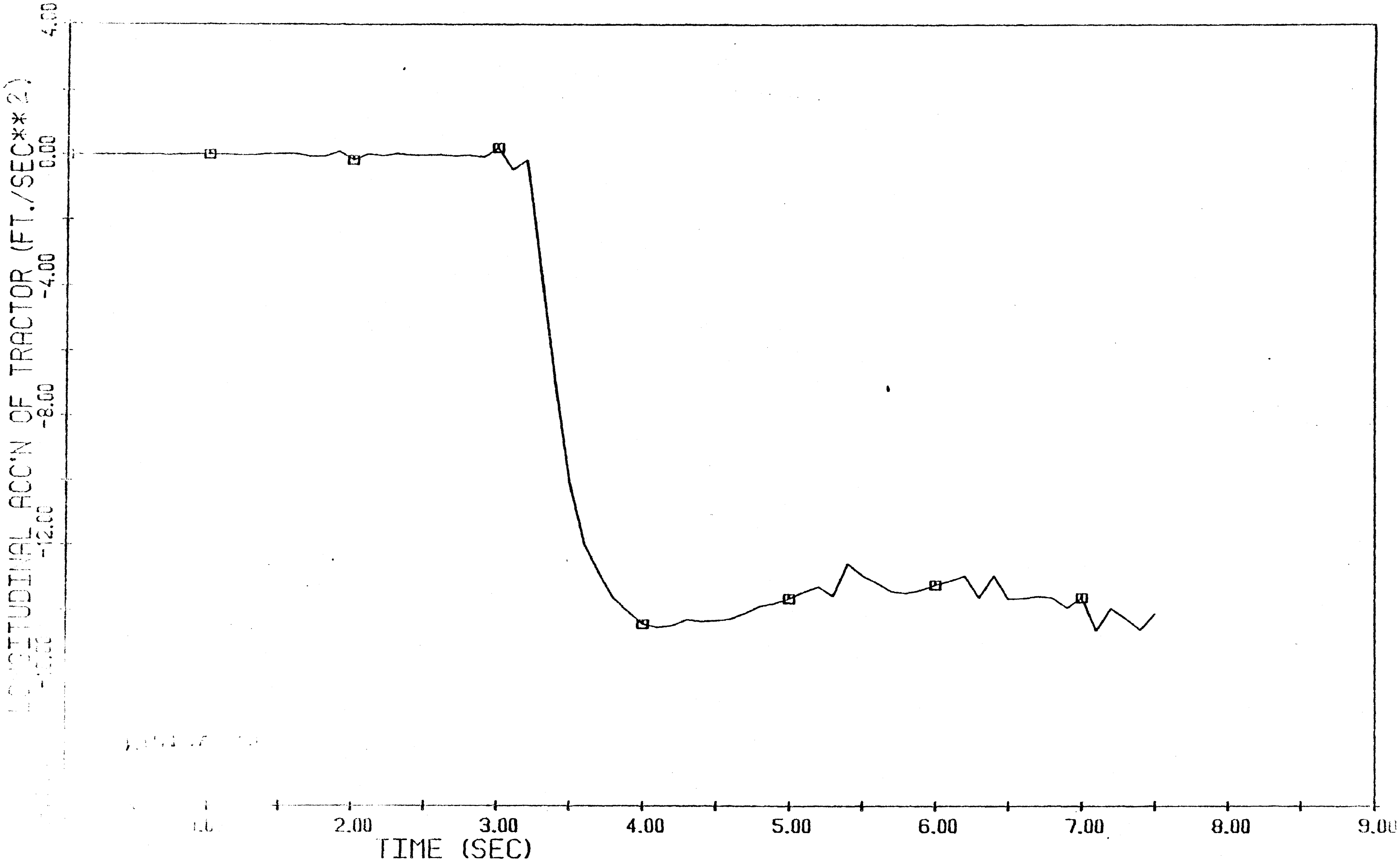
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



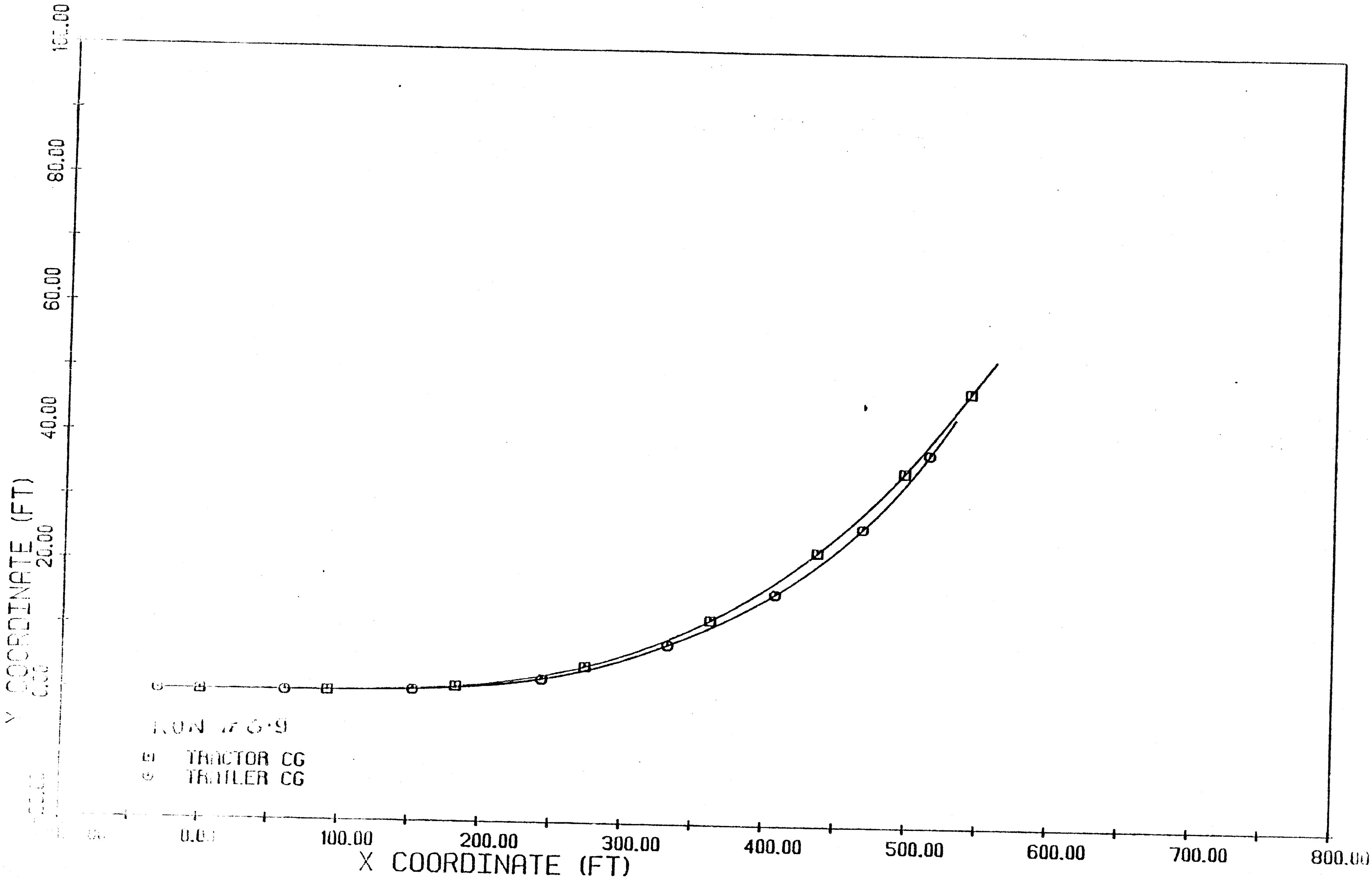
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



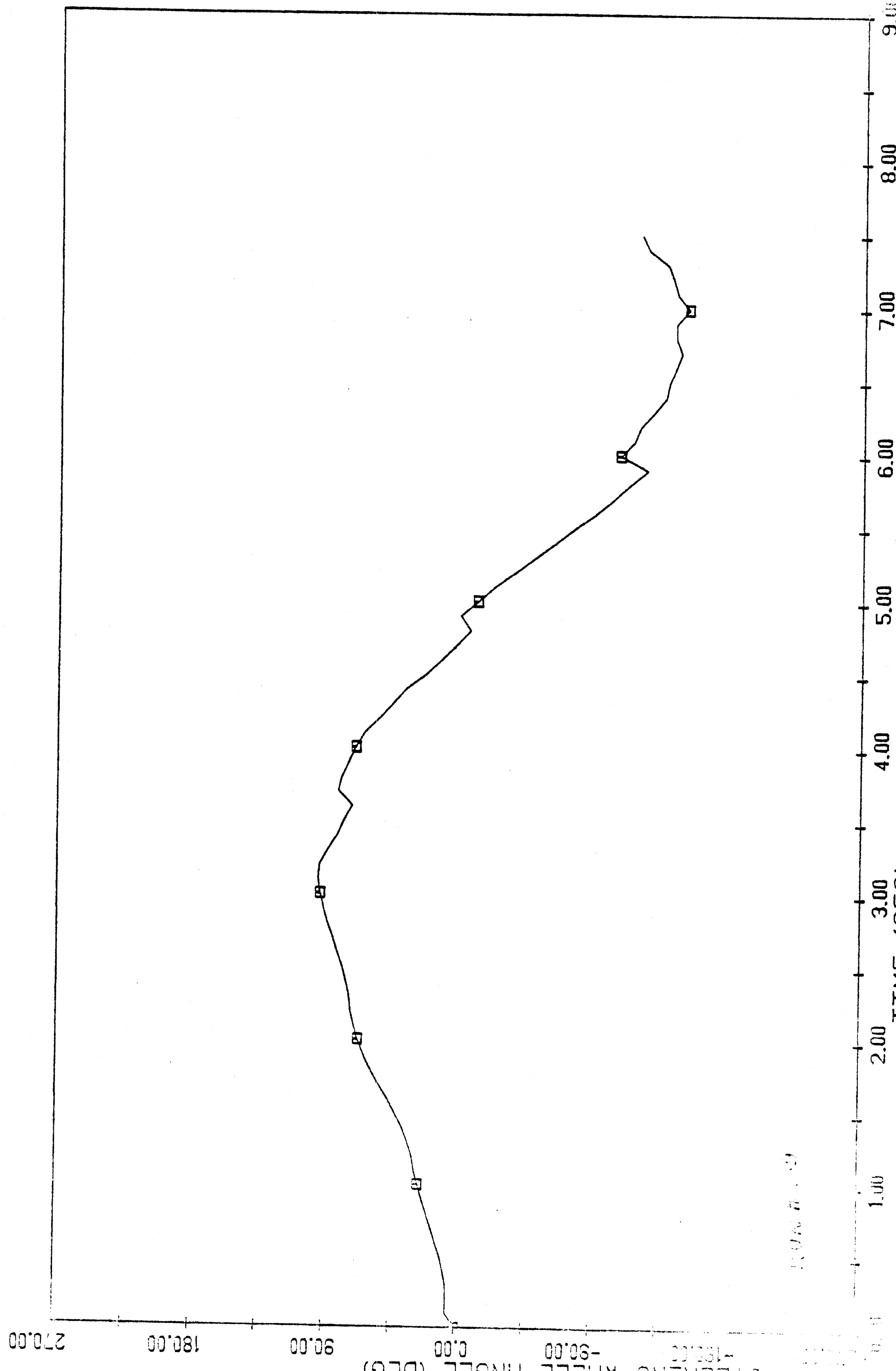
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



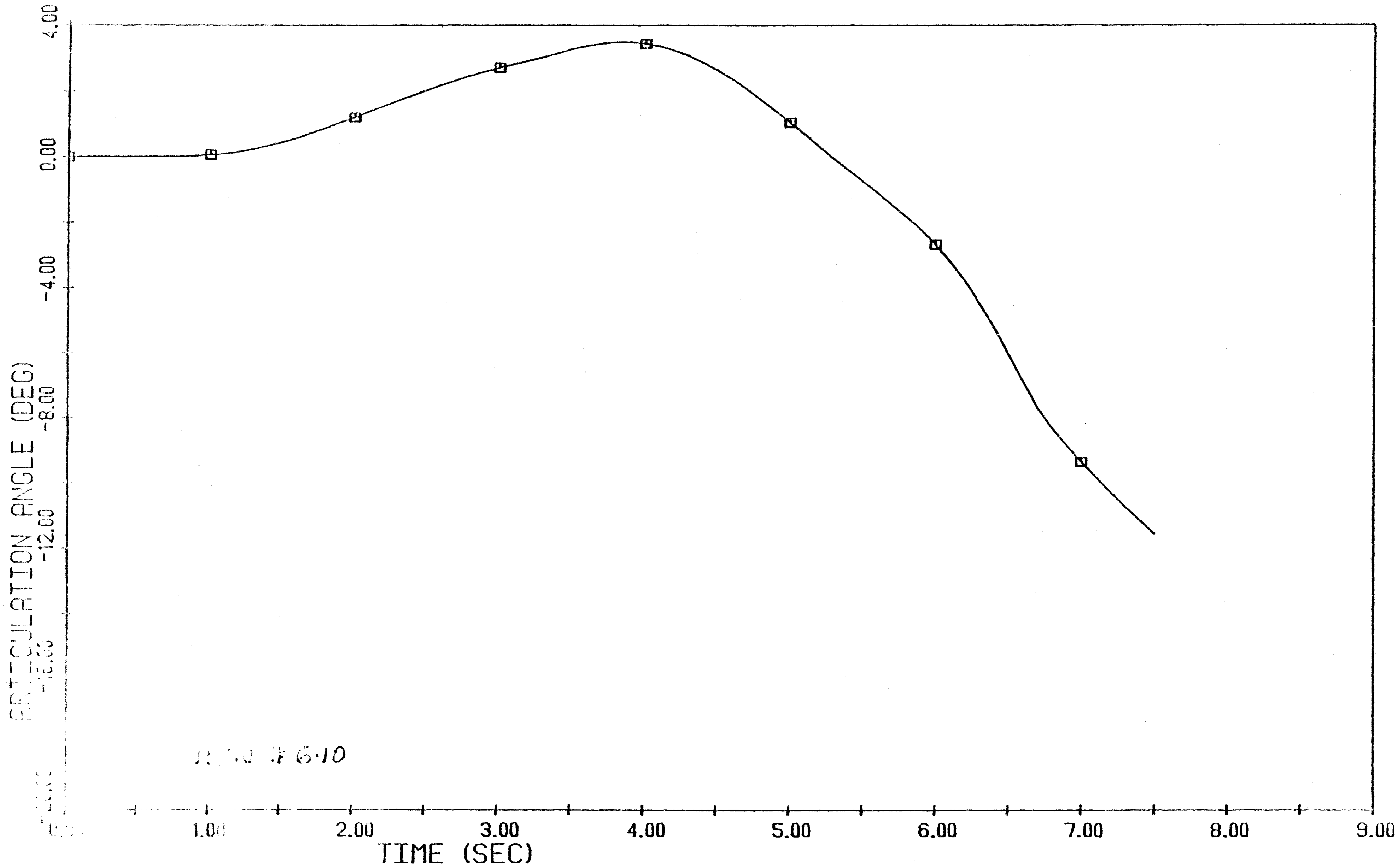
ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



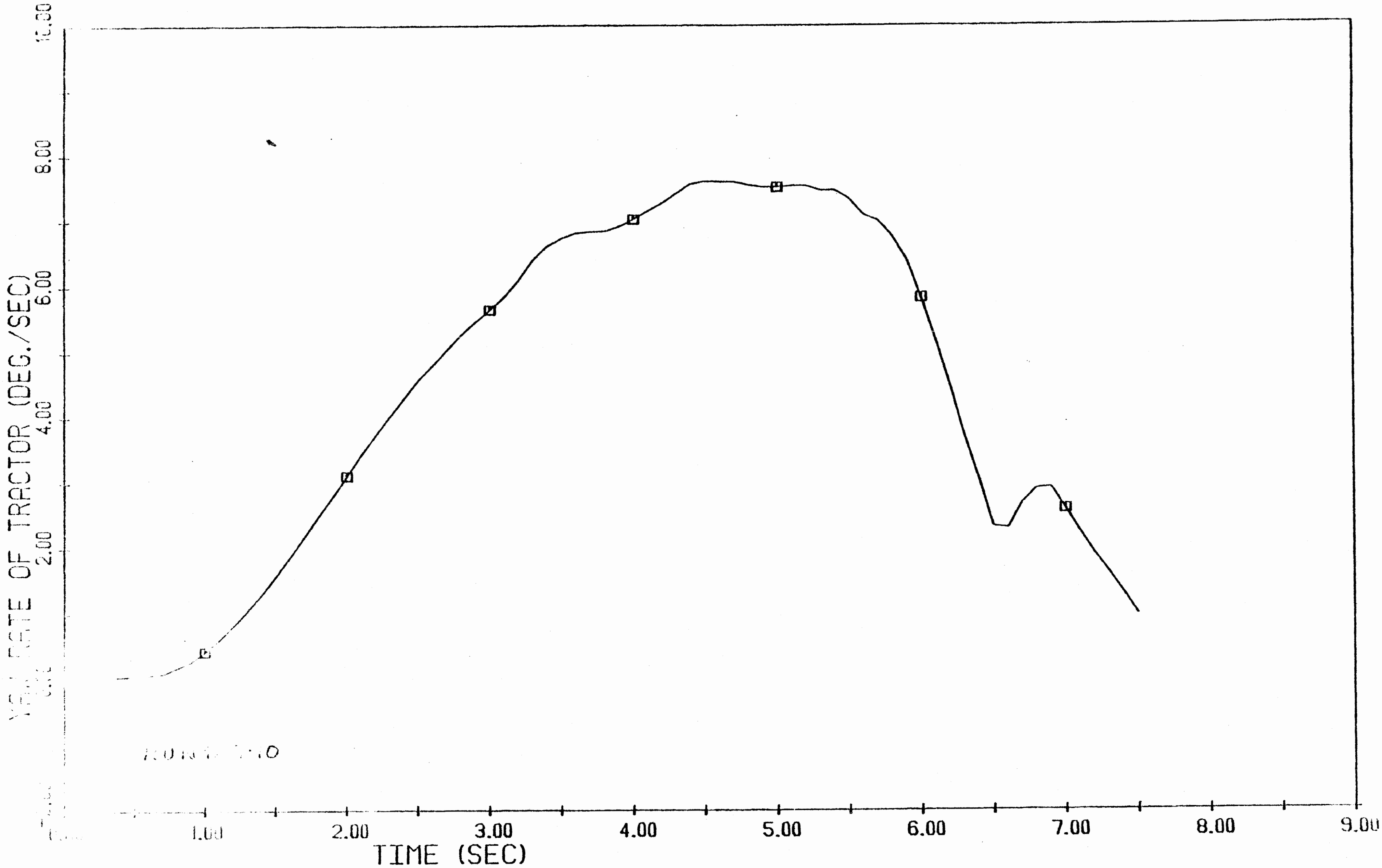
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



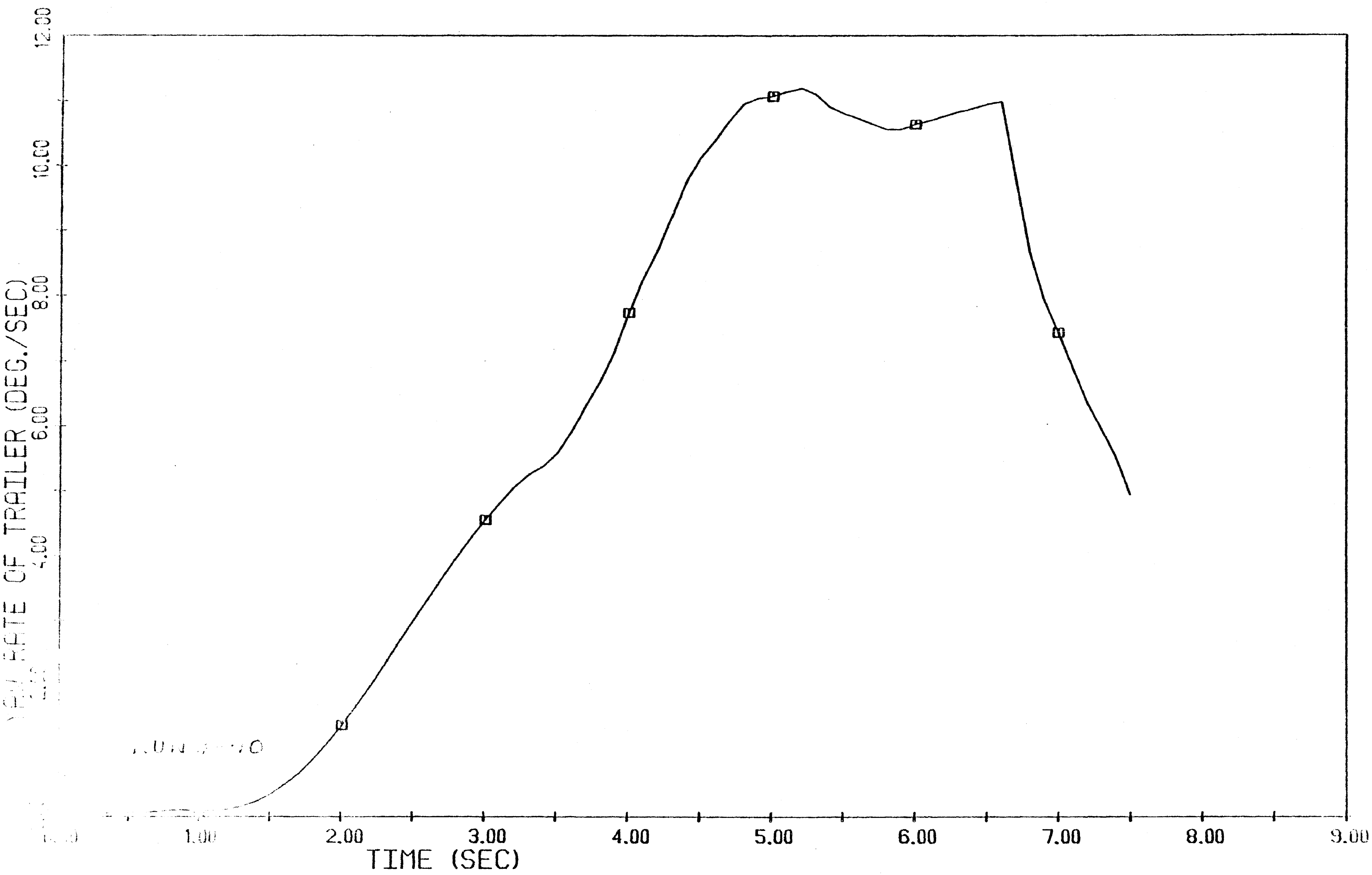
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 100 KPH, 63 PSI, MU=0.6



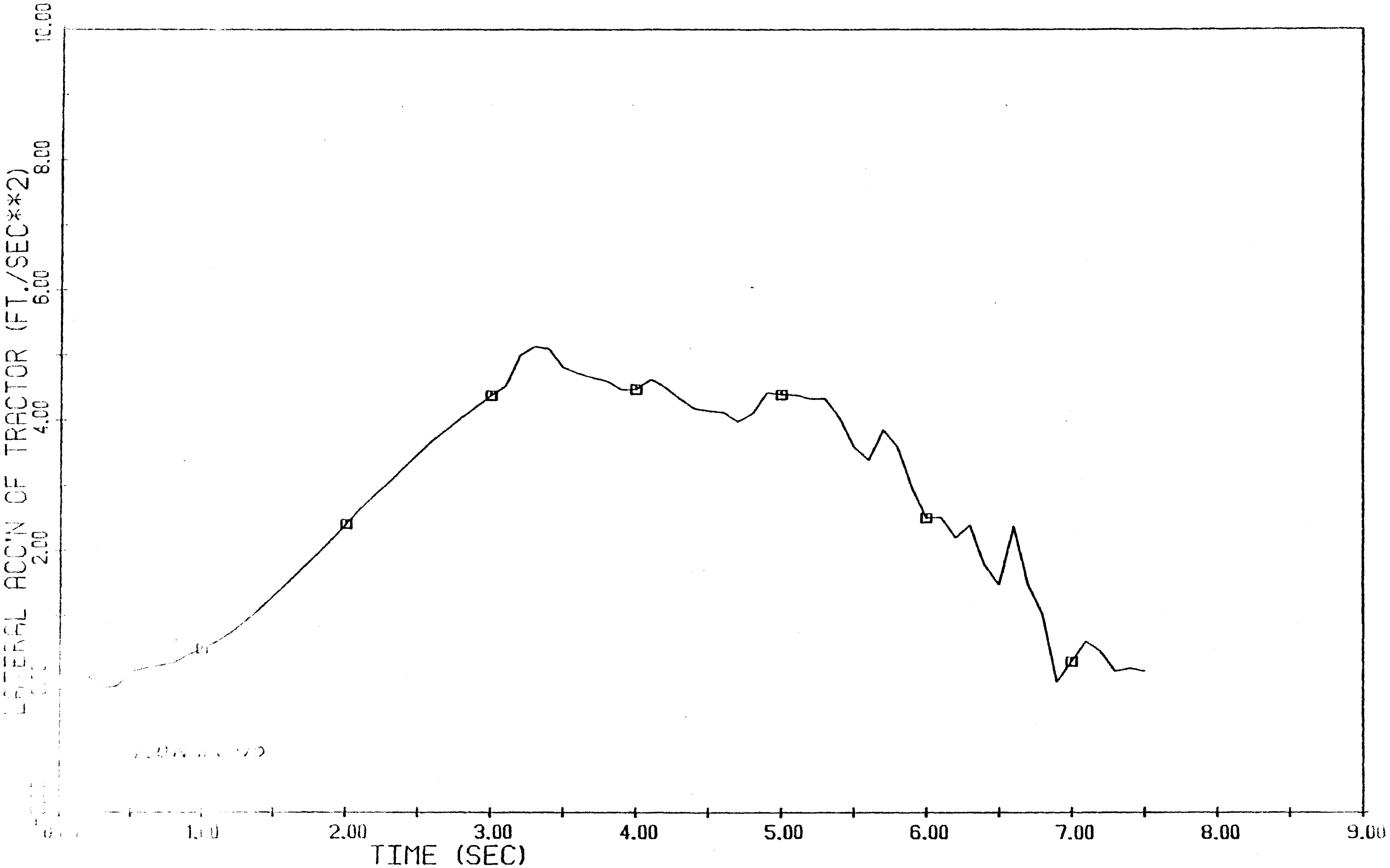
ANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



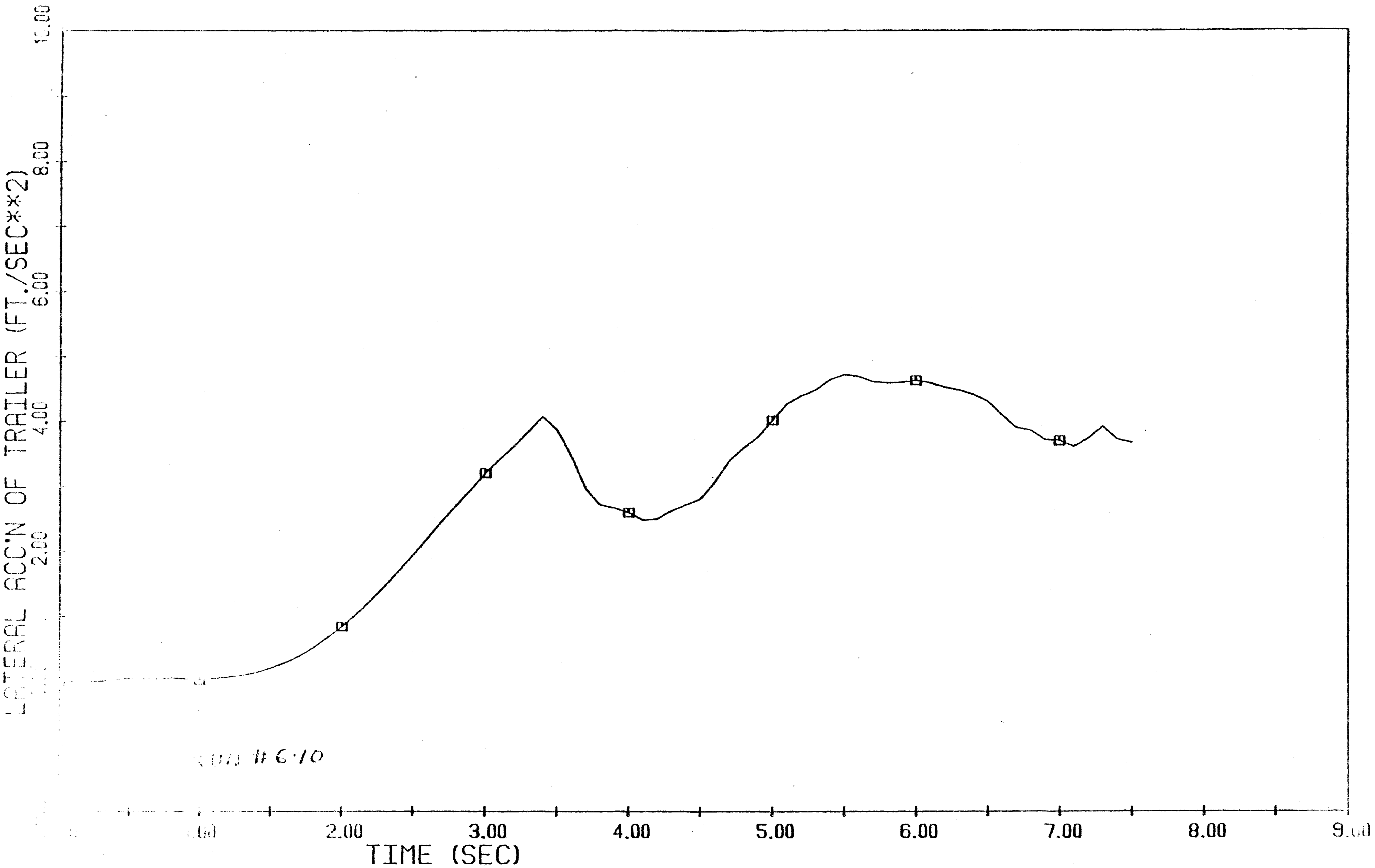
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



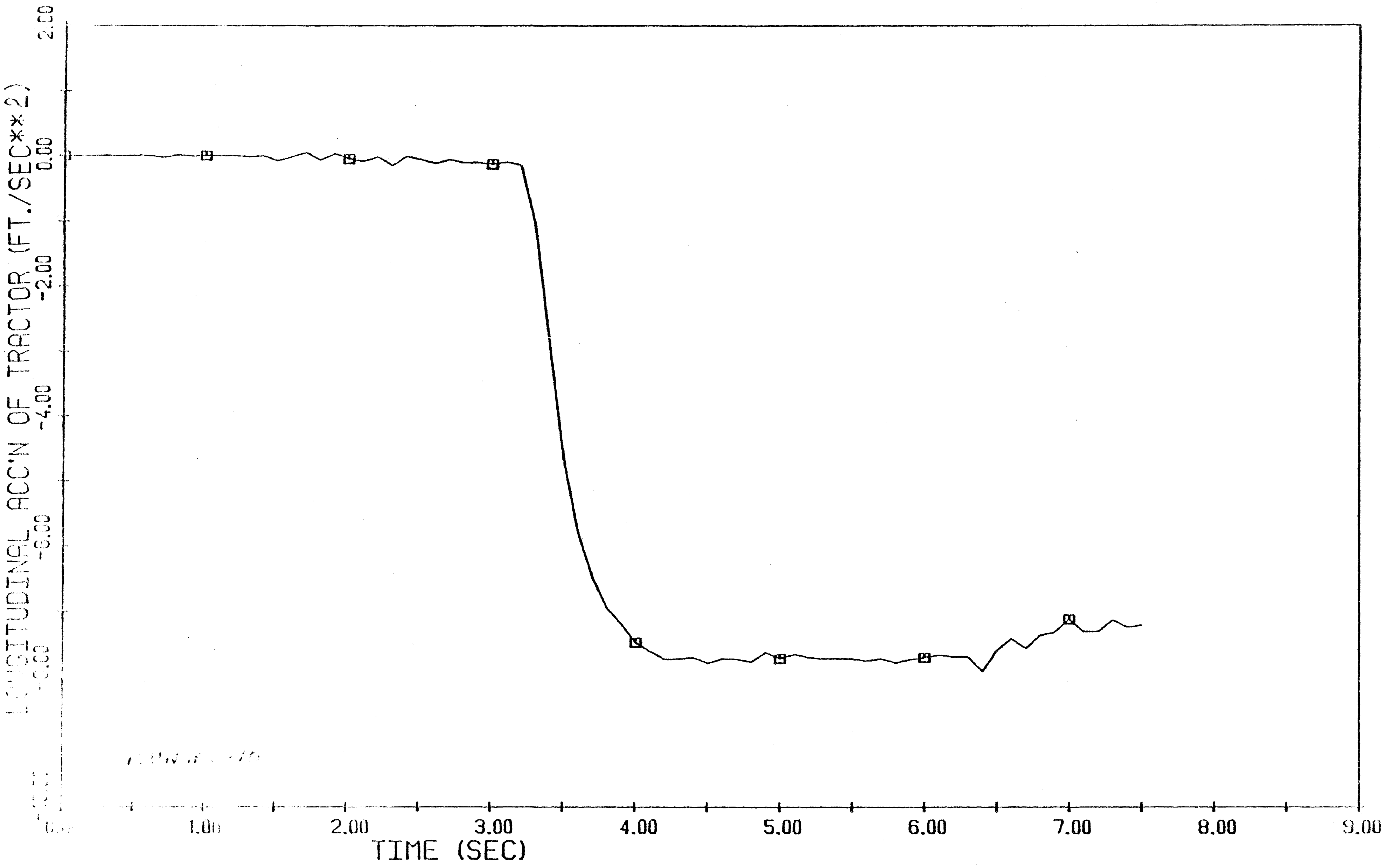
ADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



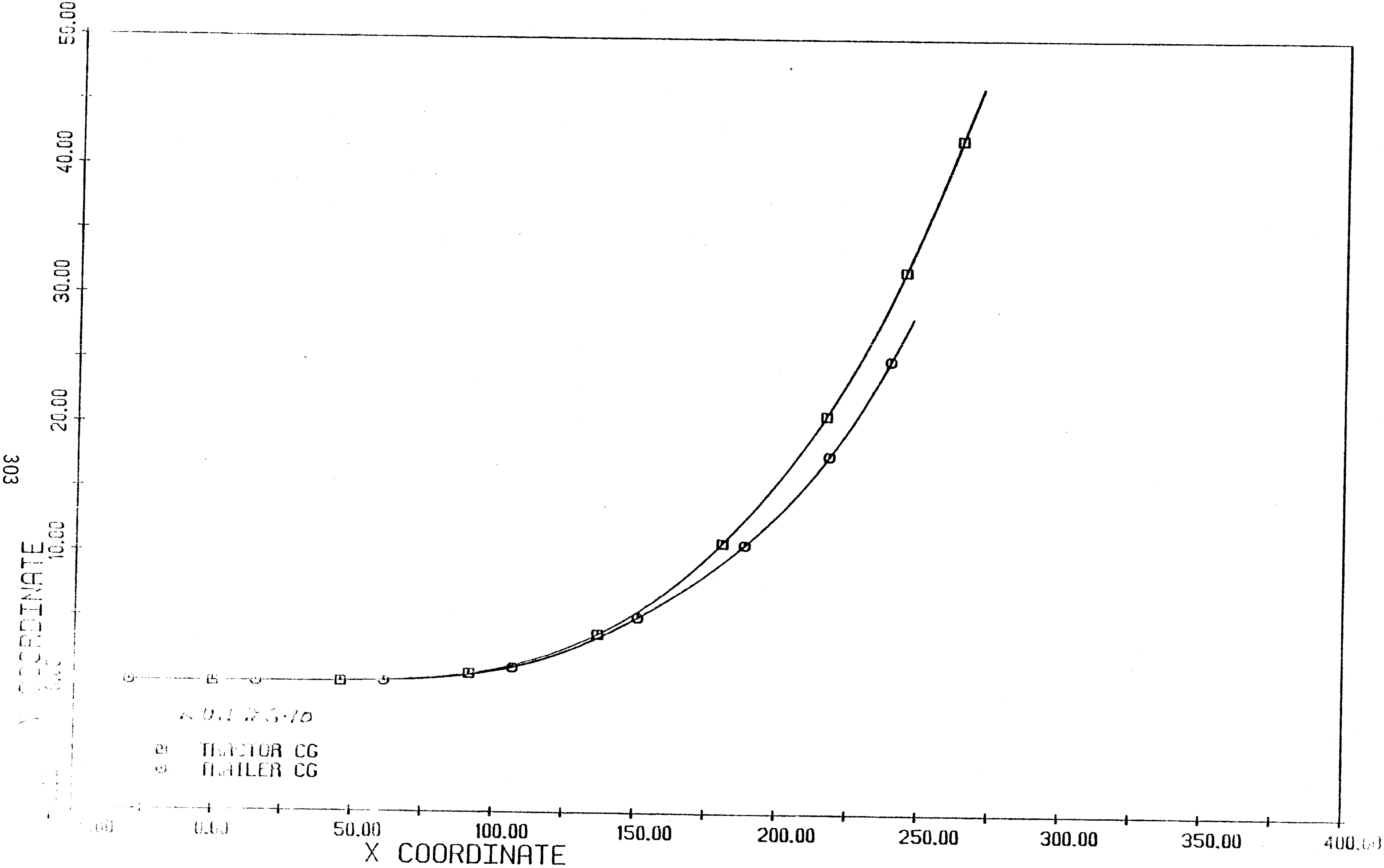
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



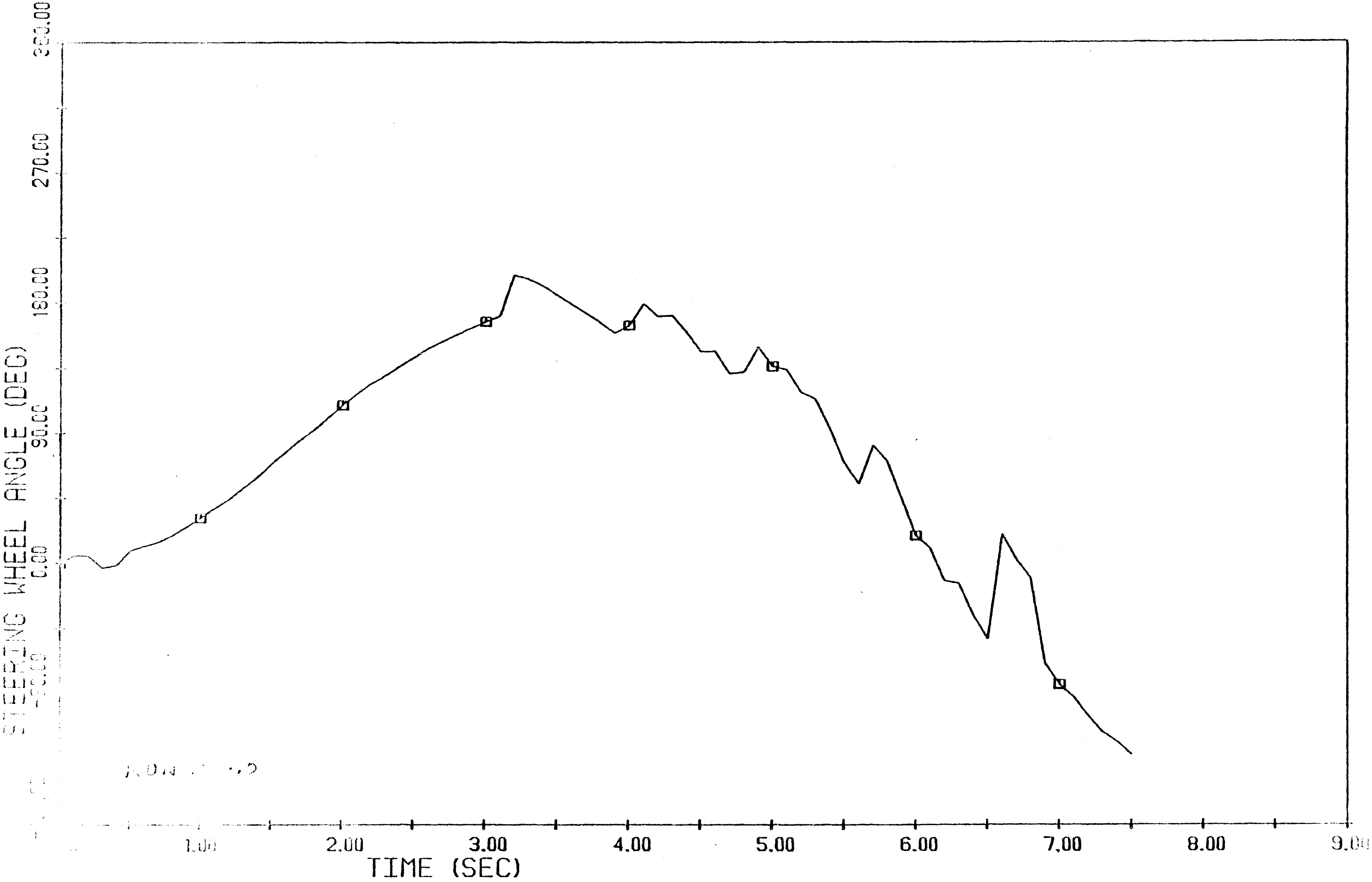
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



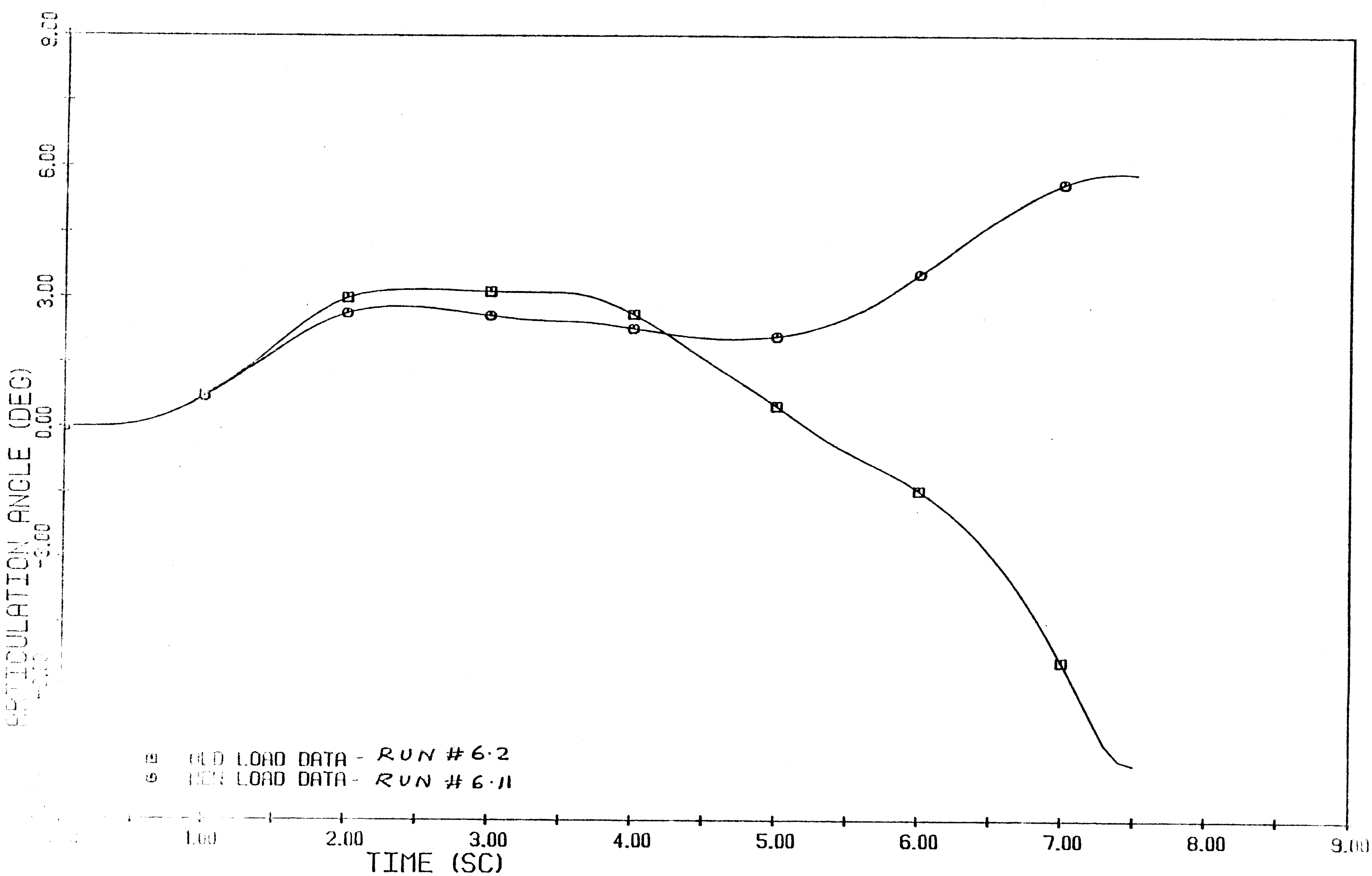
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



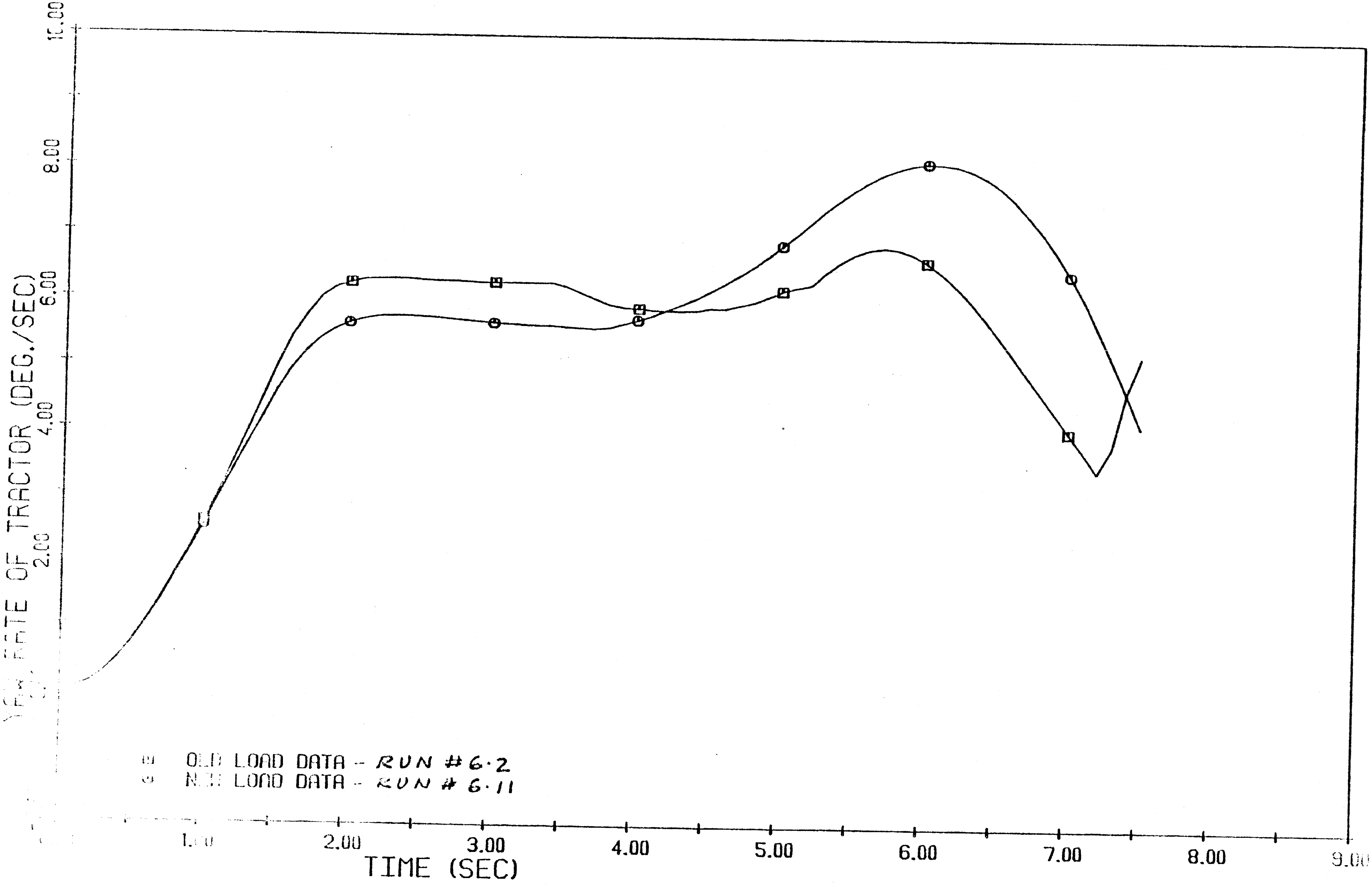
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



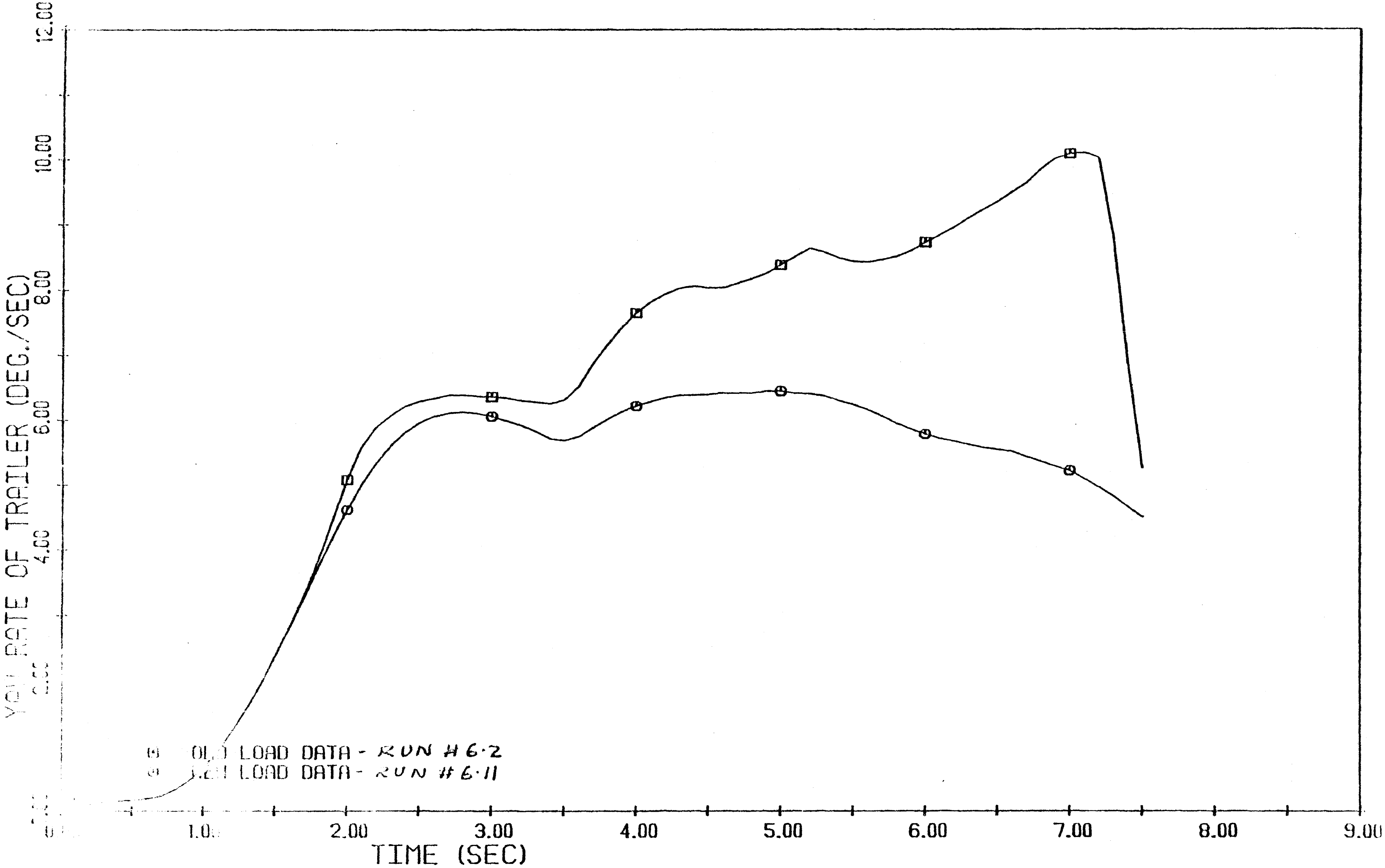
CANADIAN ARTIC BUS, LOADED, B I T, CLOSED LOOP, 50 KPH, 33 PSI, MU=0.3



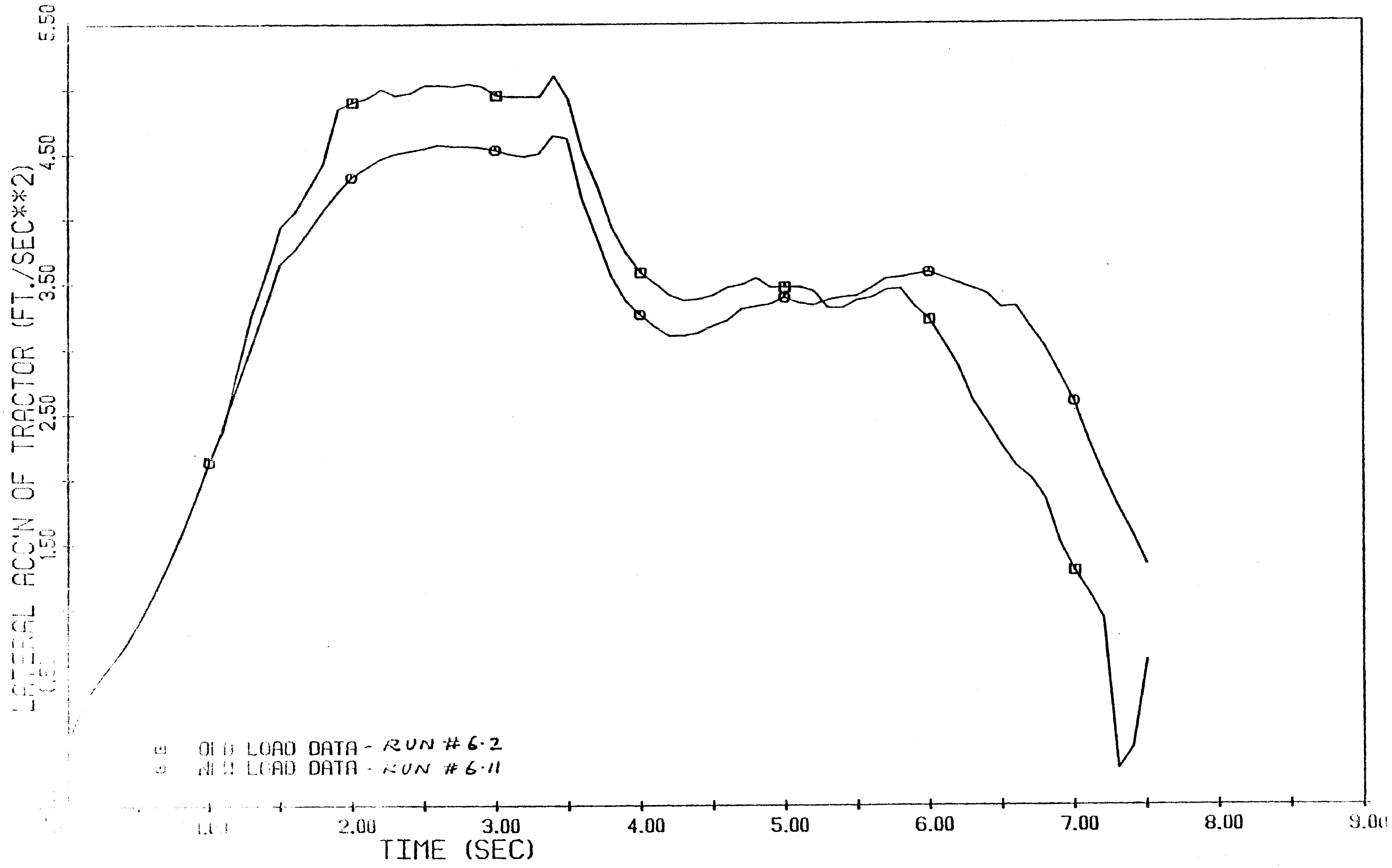
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



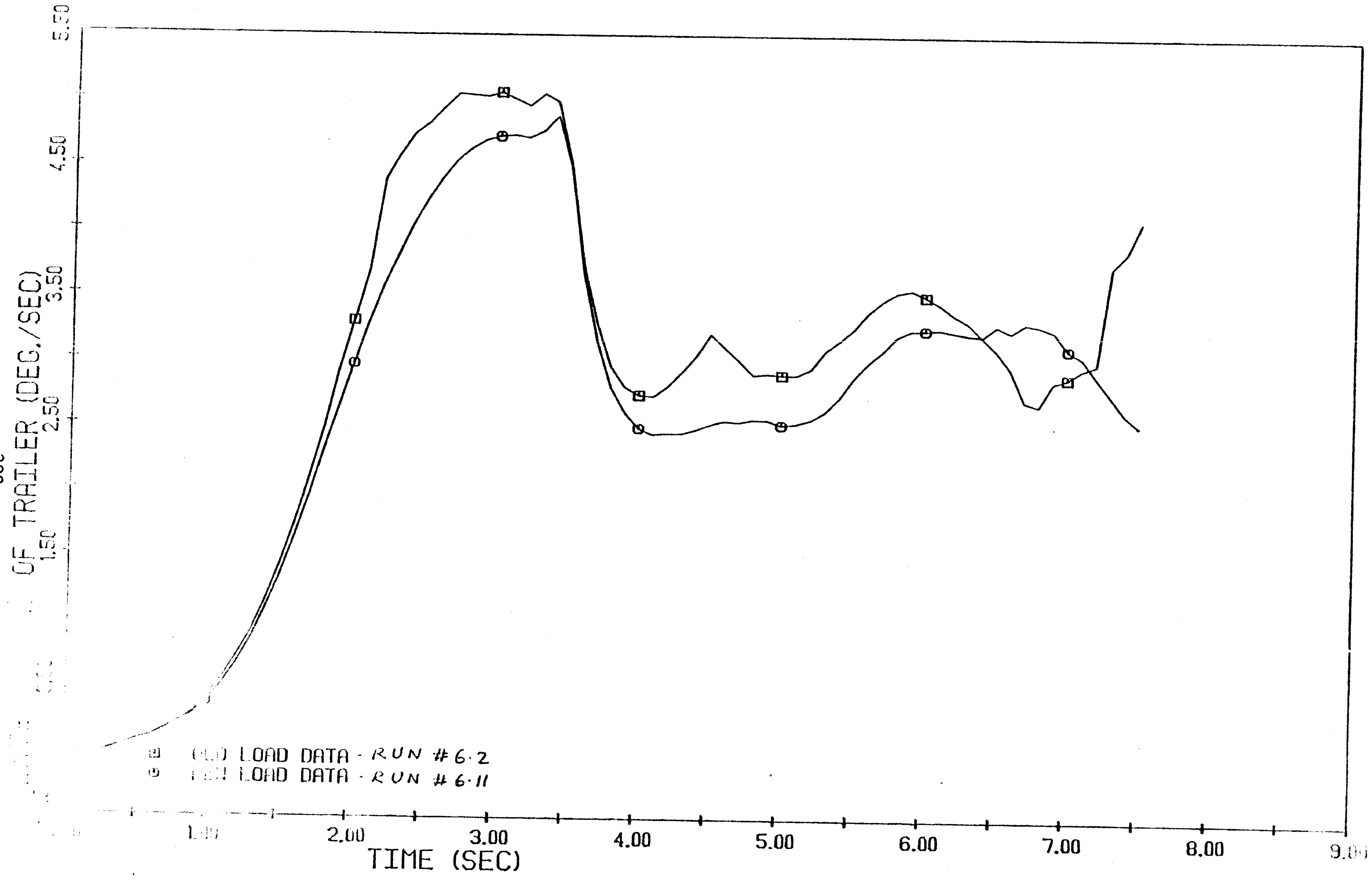
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



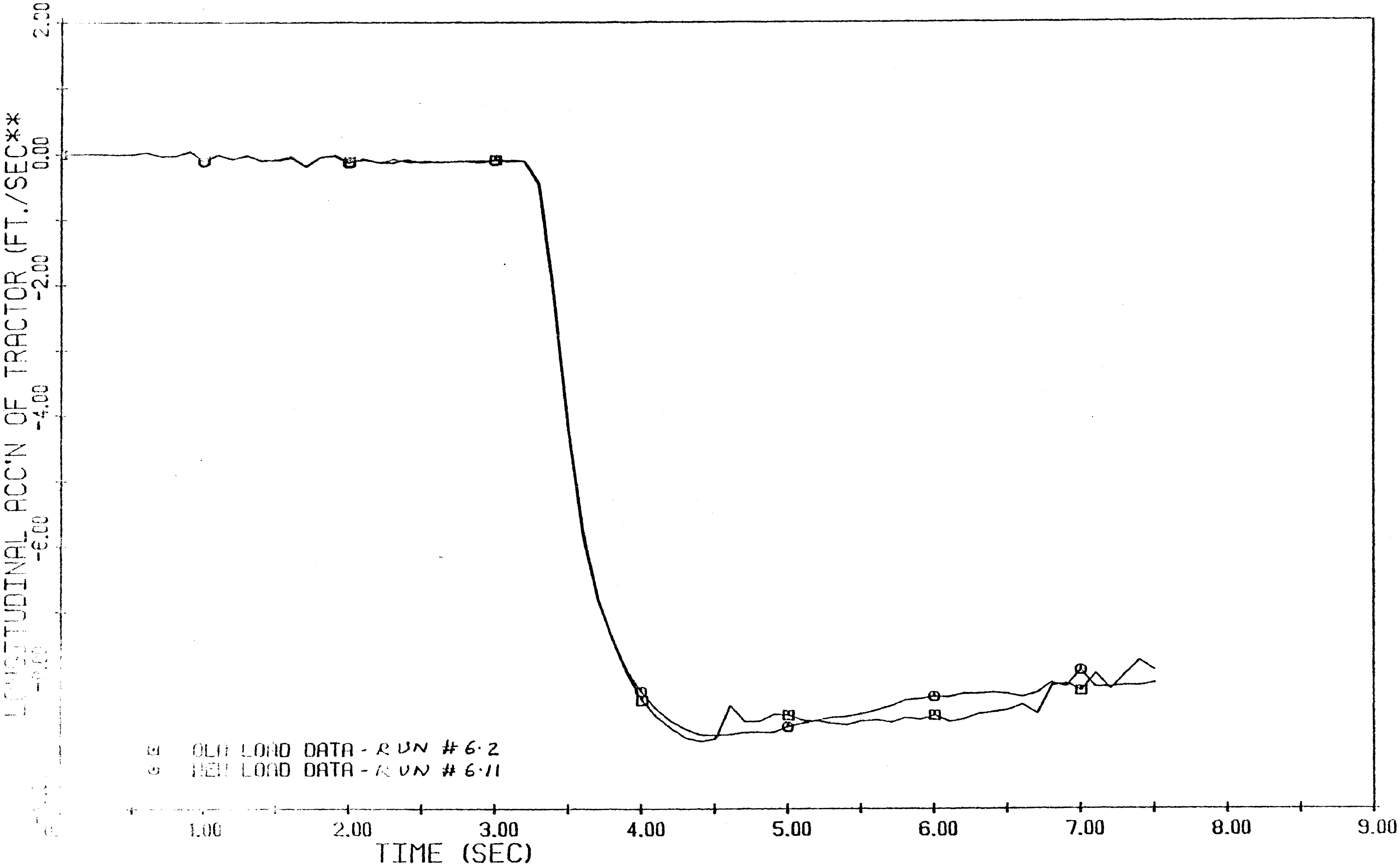
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



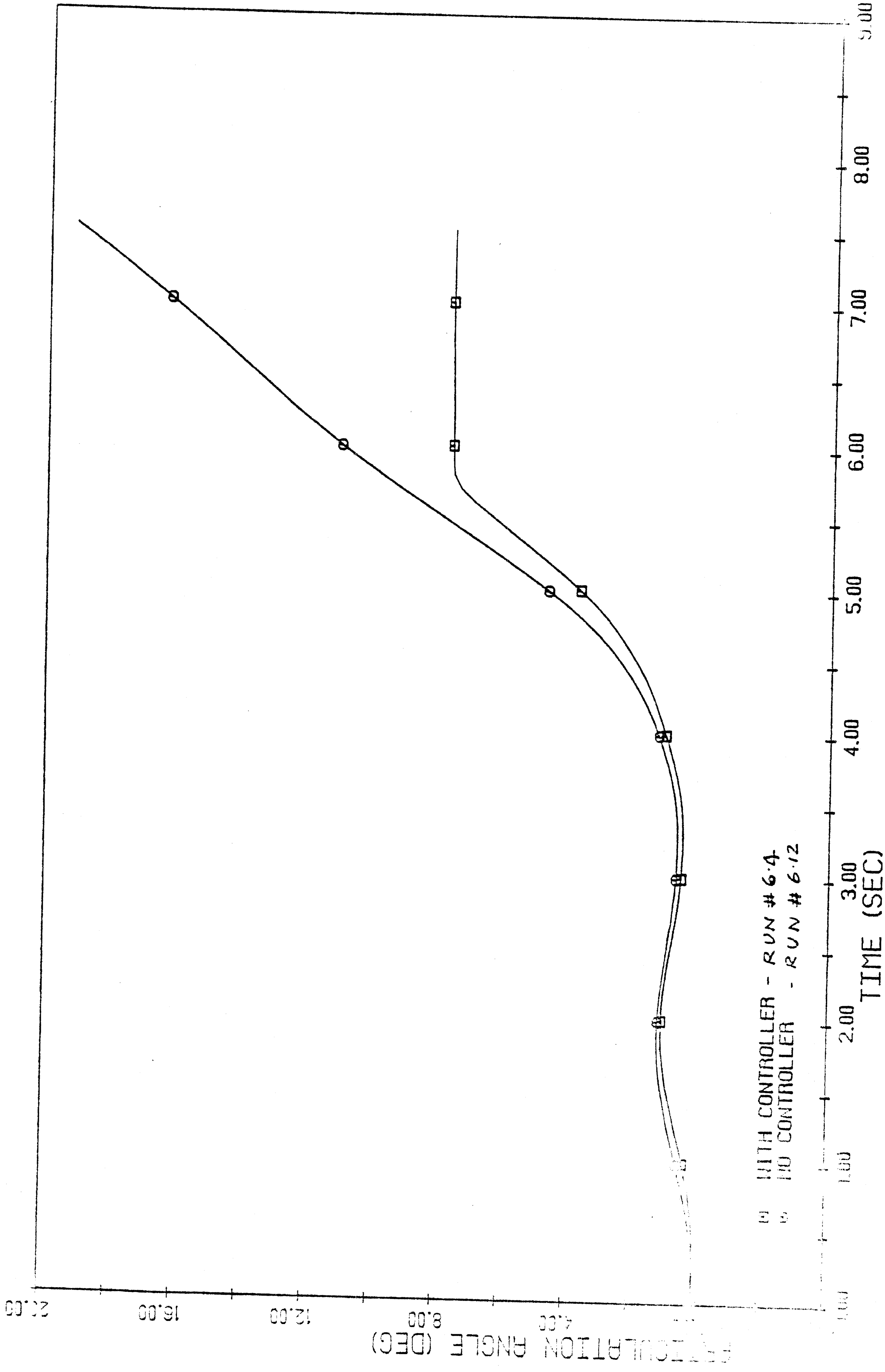
CANADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



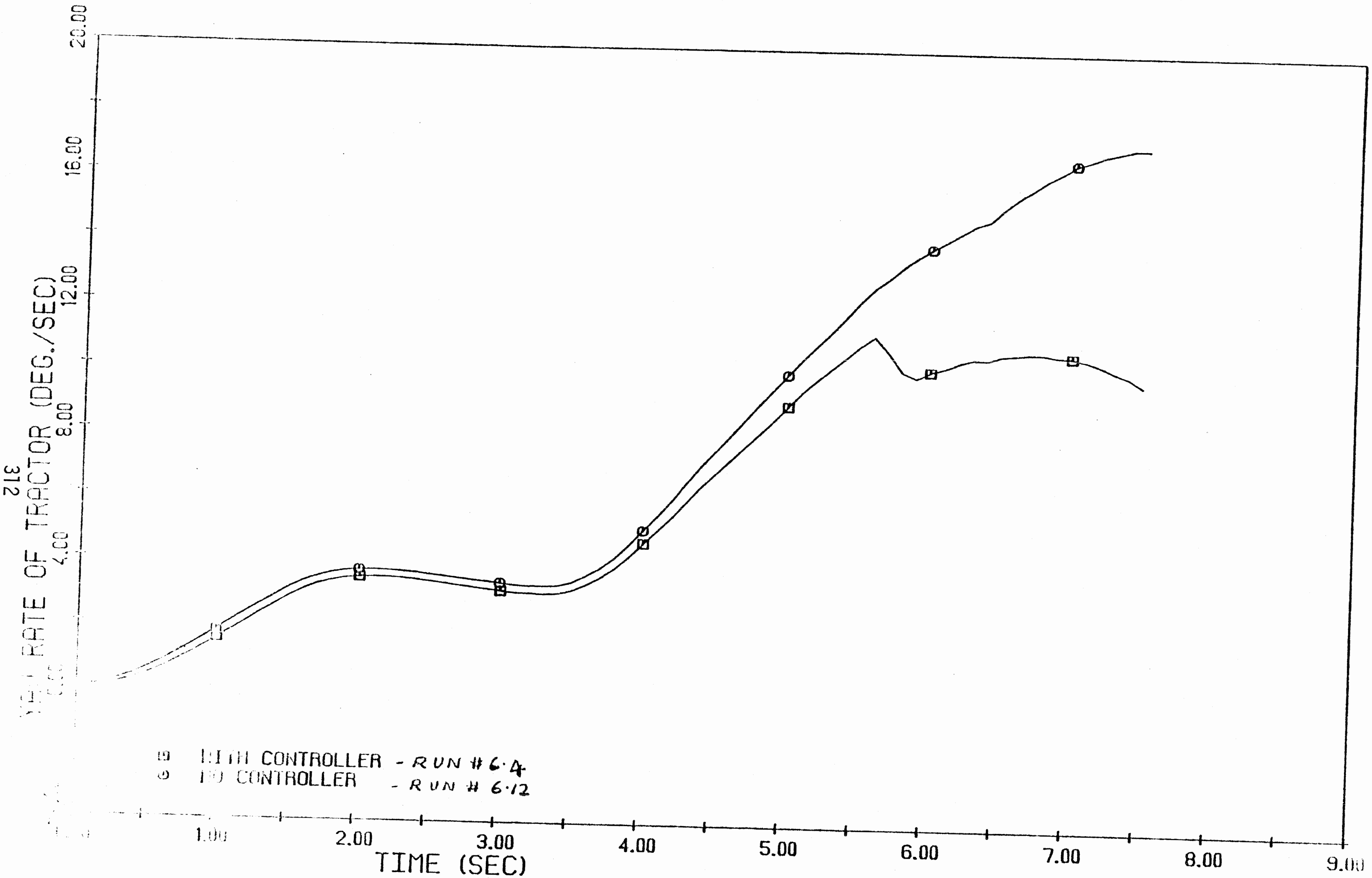
ADIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



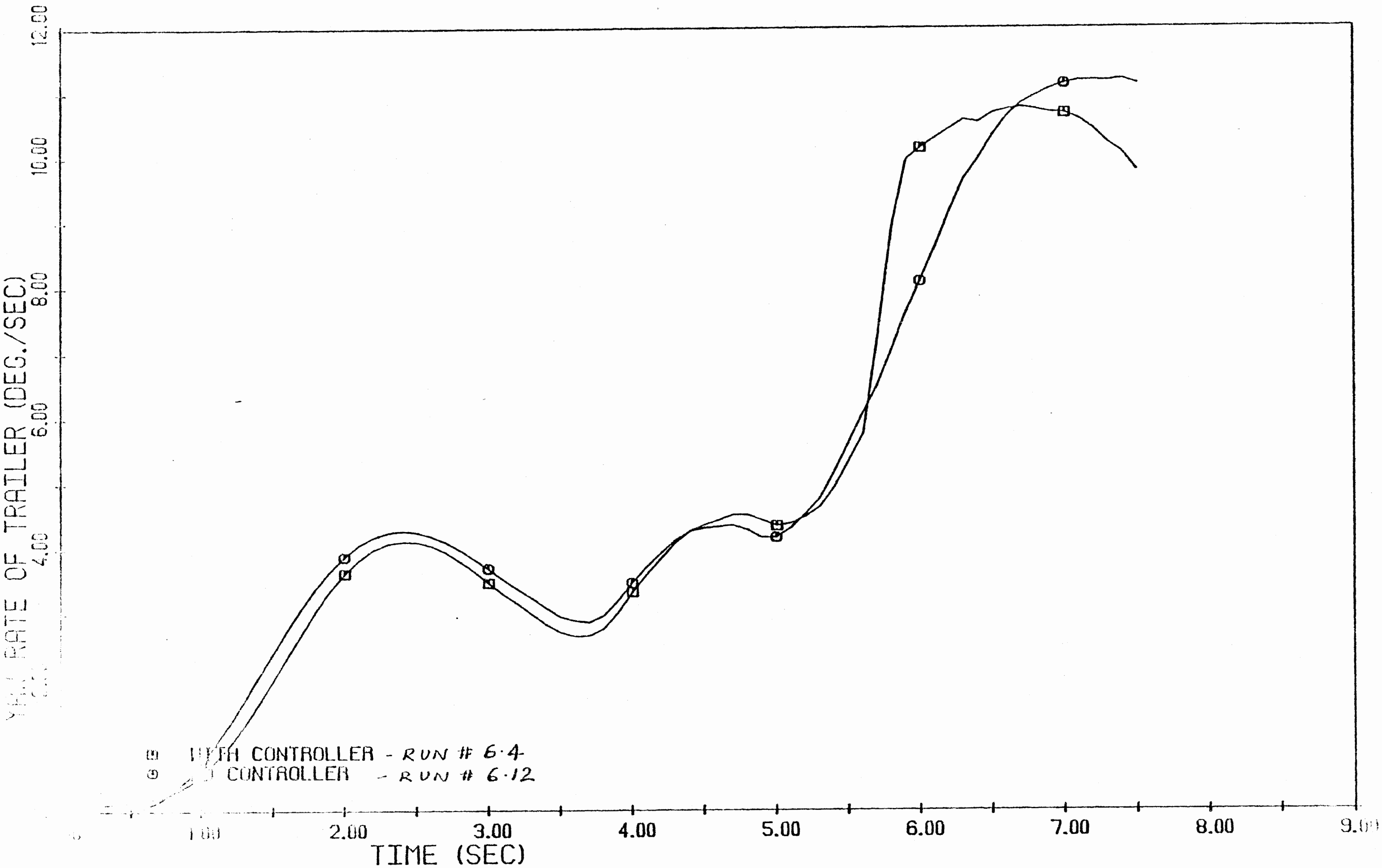
DIAN ARTIC BUS, EMPTY, B I T, 50 KPH, INFLUENCE OF LOAD DISTRIBUTION



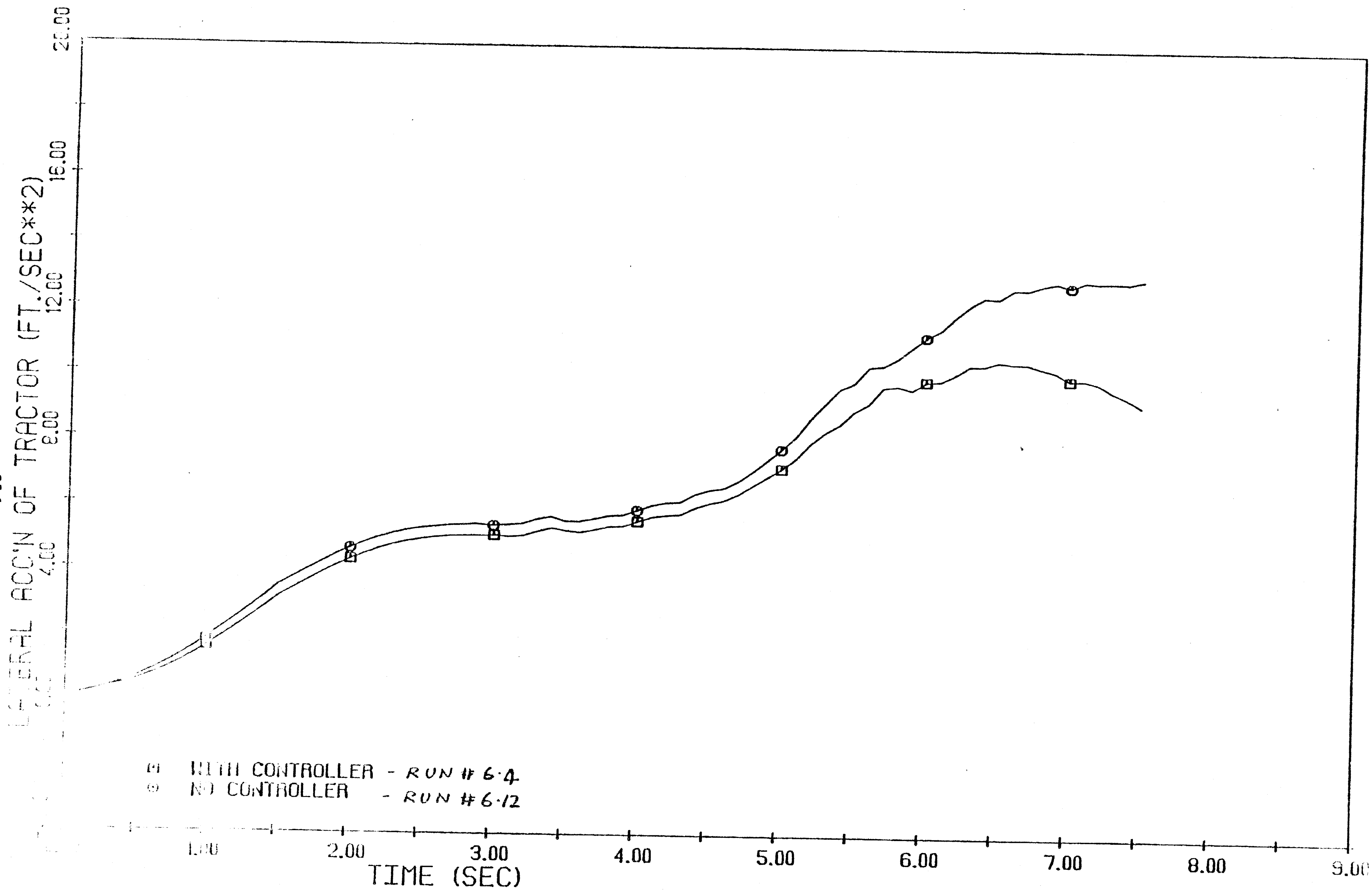
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROLLER



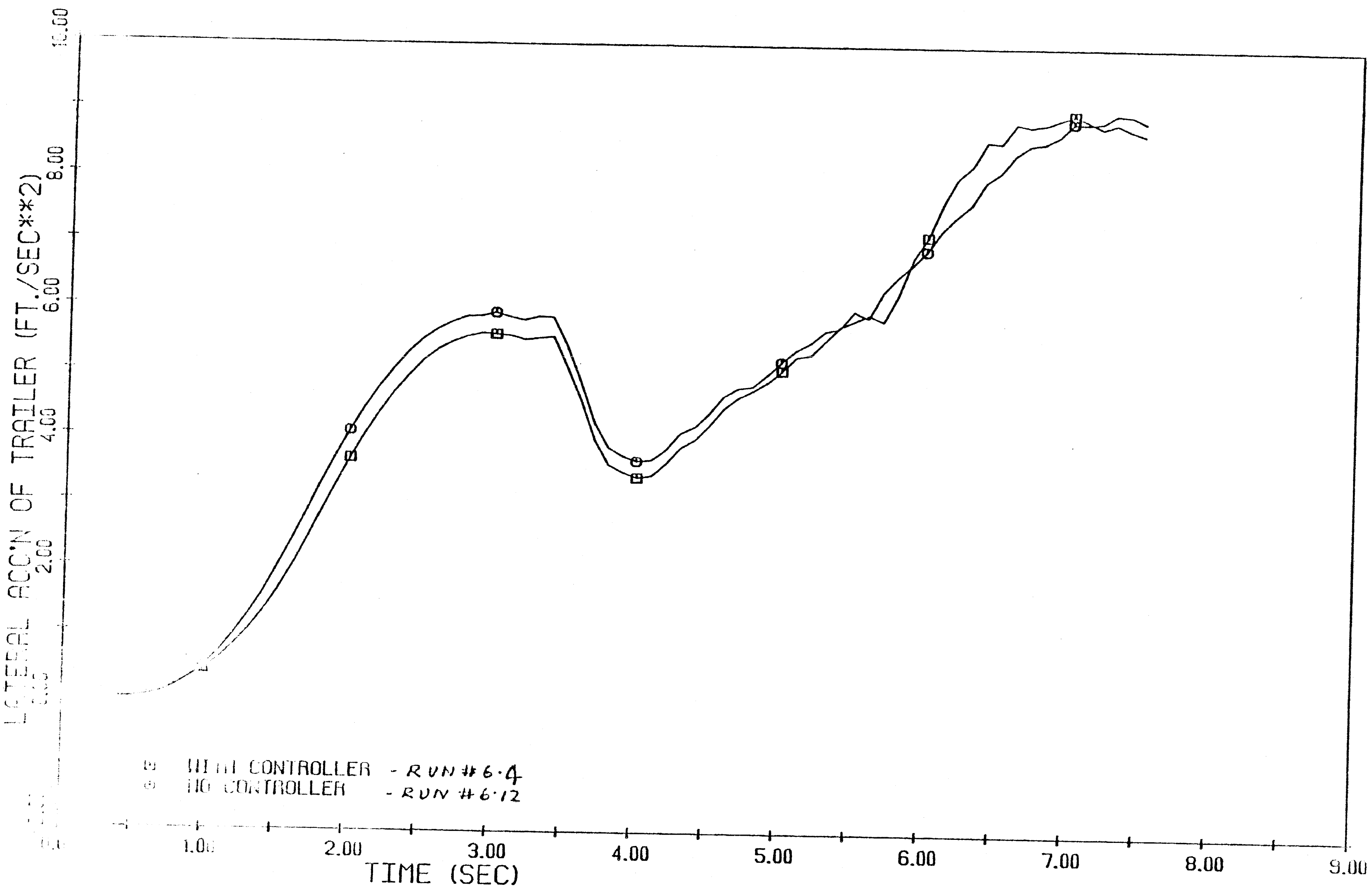
ADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROLLE



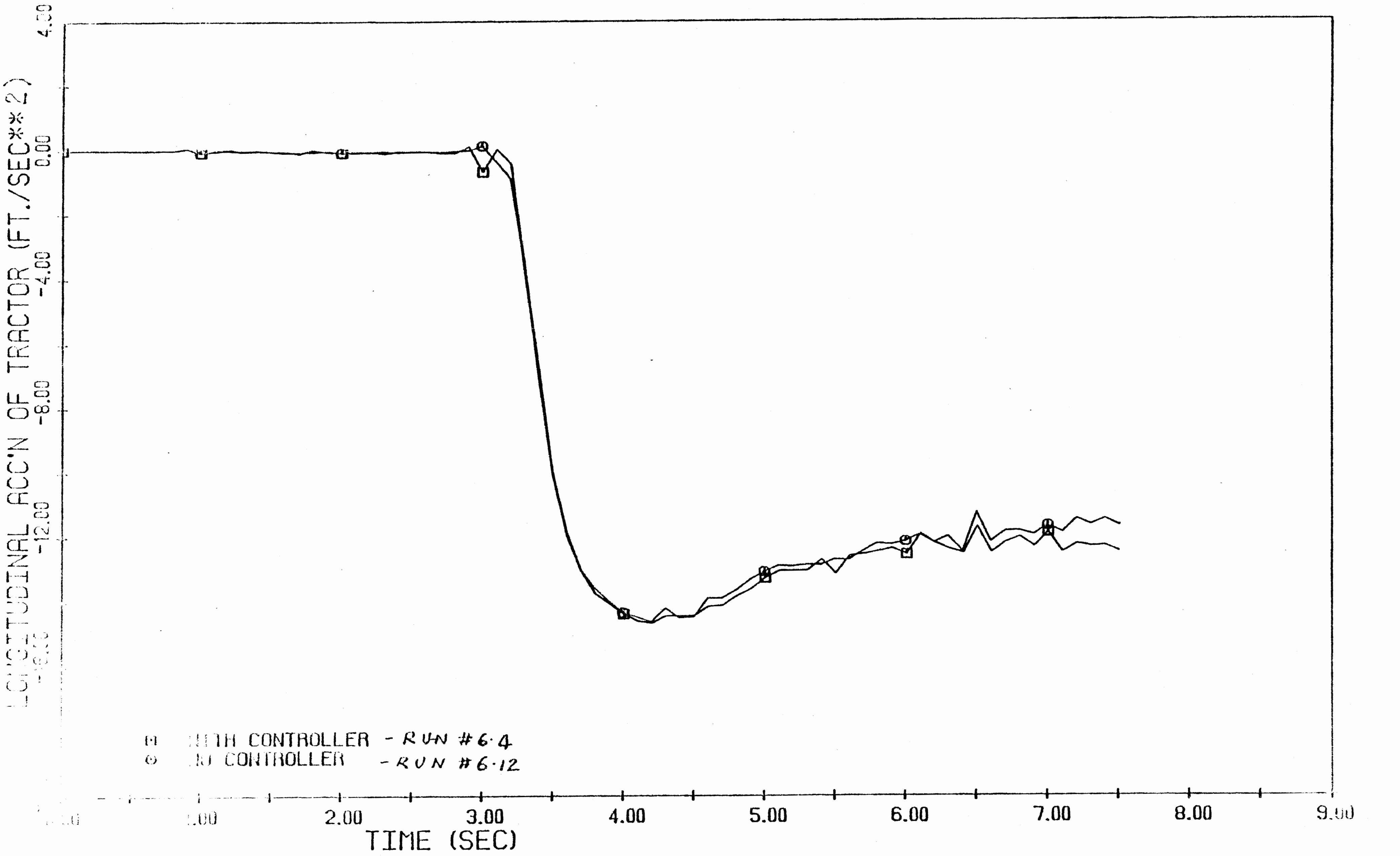
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROLLER



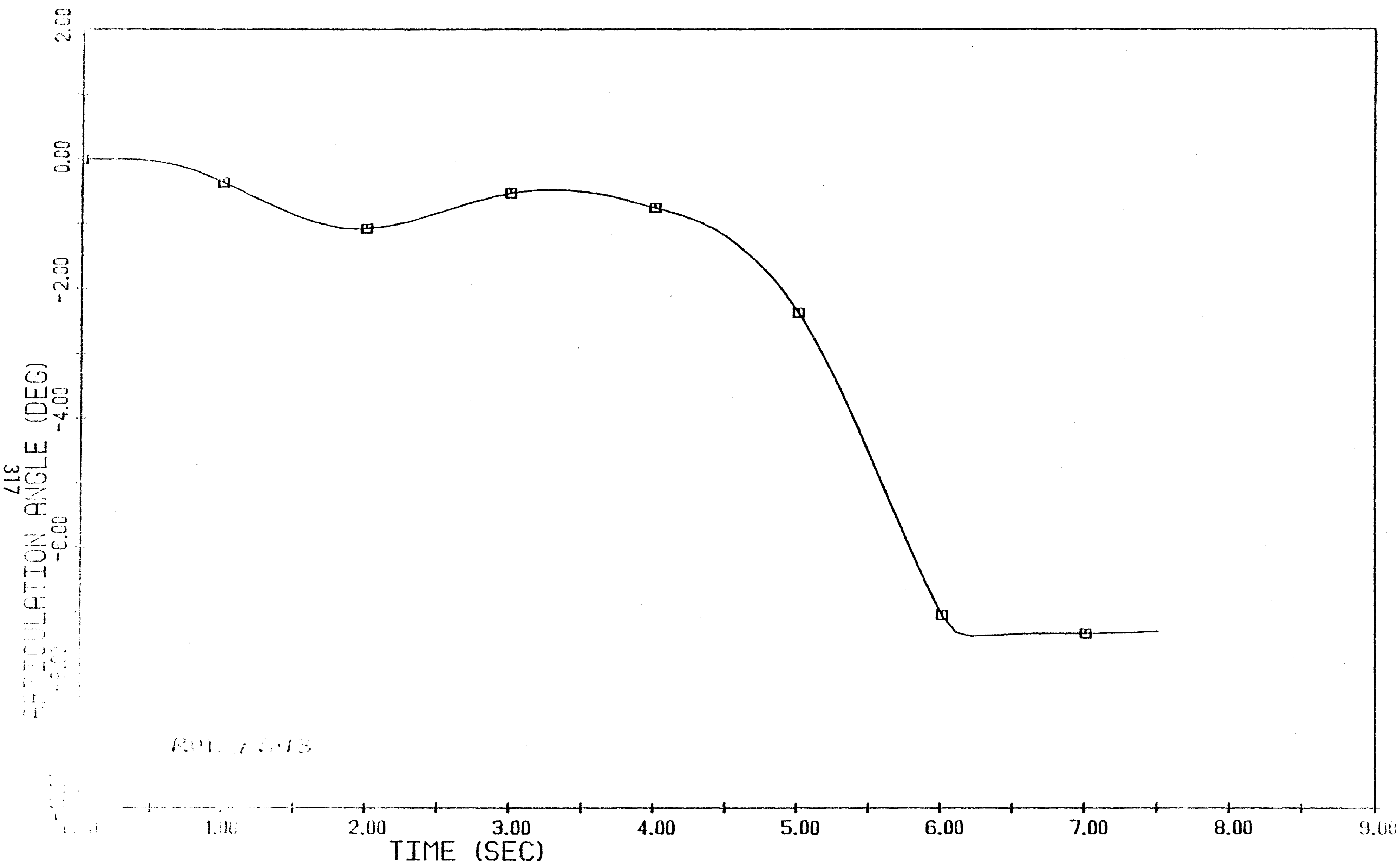
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROLLER



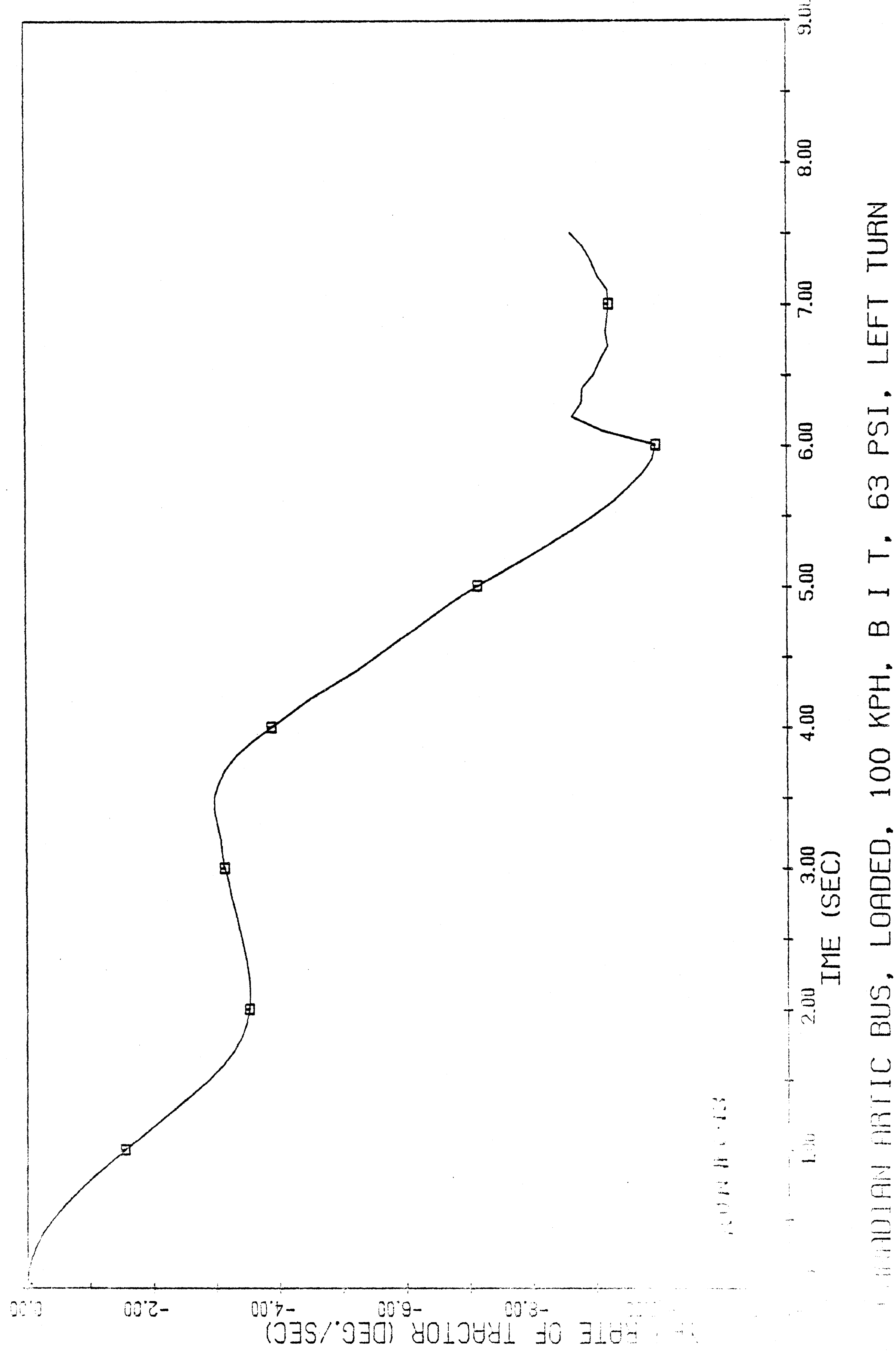
CANADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROLLER

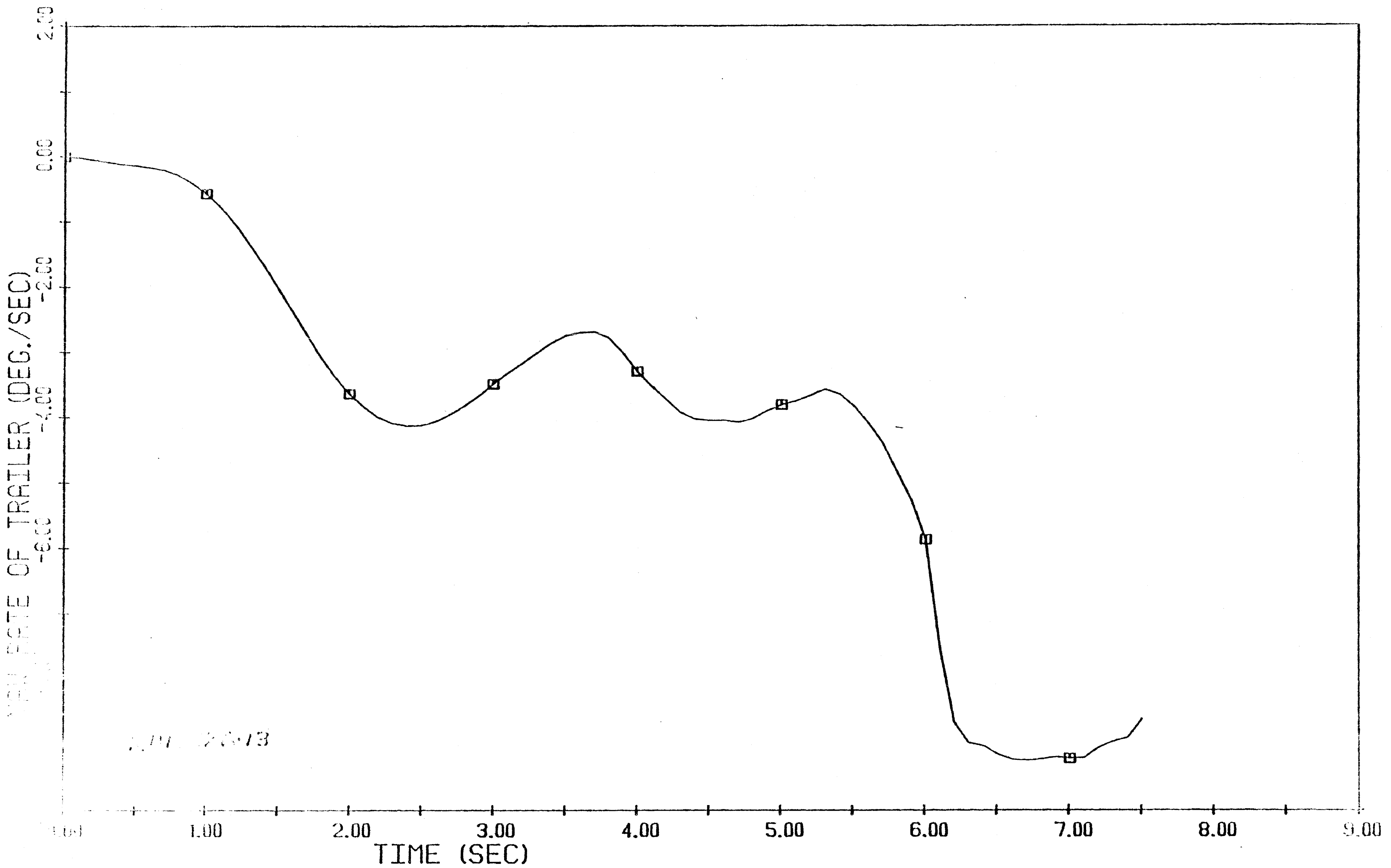


ADIAN ARTIC BUS, LOADED, B I T, 100 KPH, 63 PSI, INFLUENCE OF CONTROL

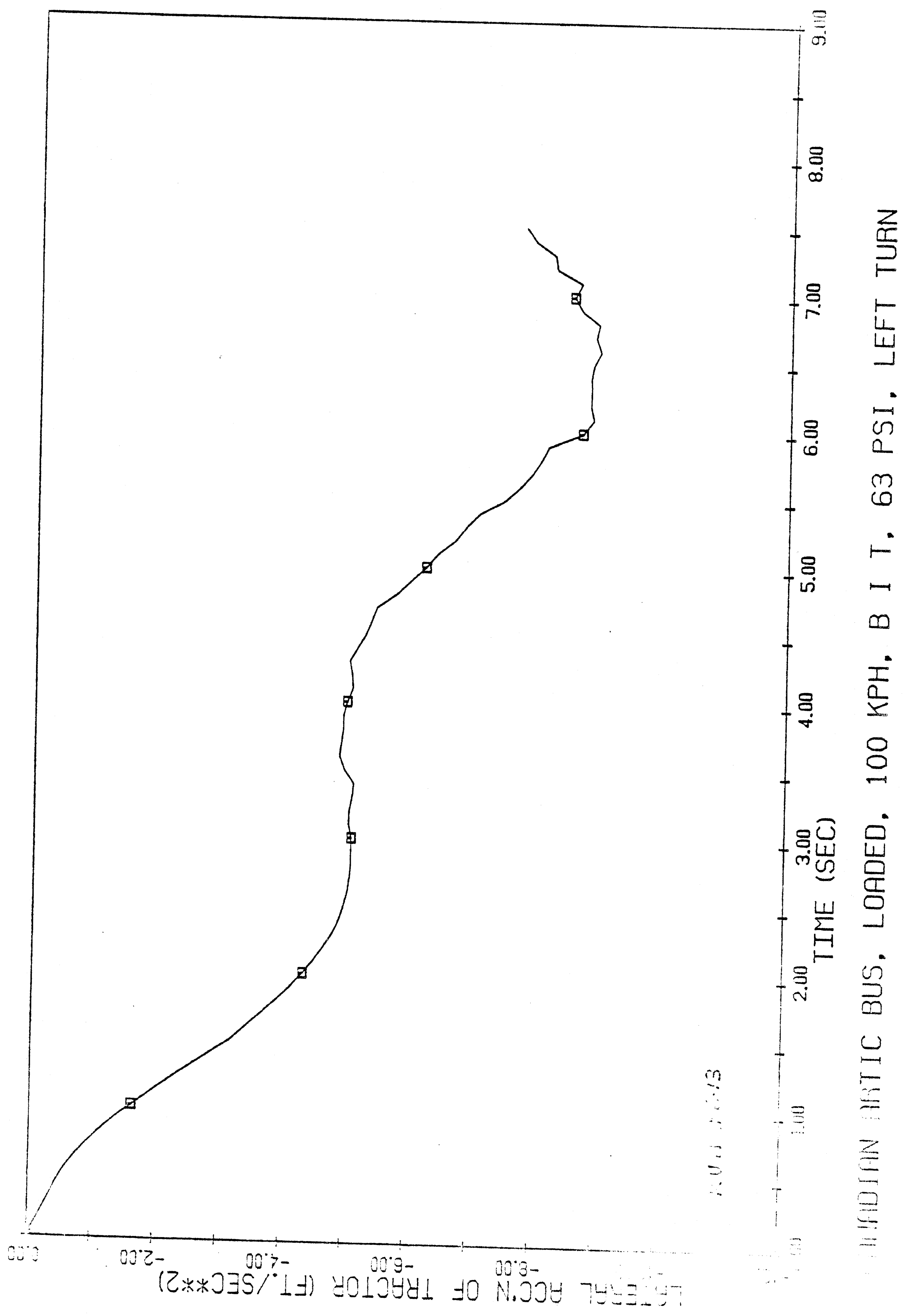


CANADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN

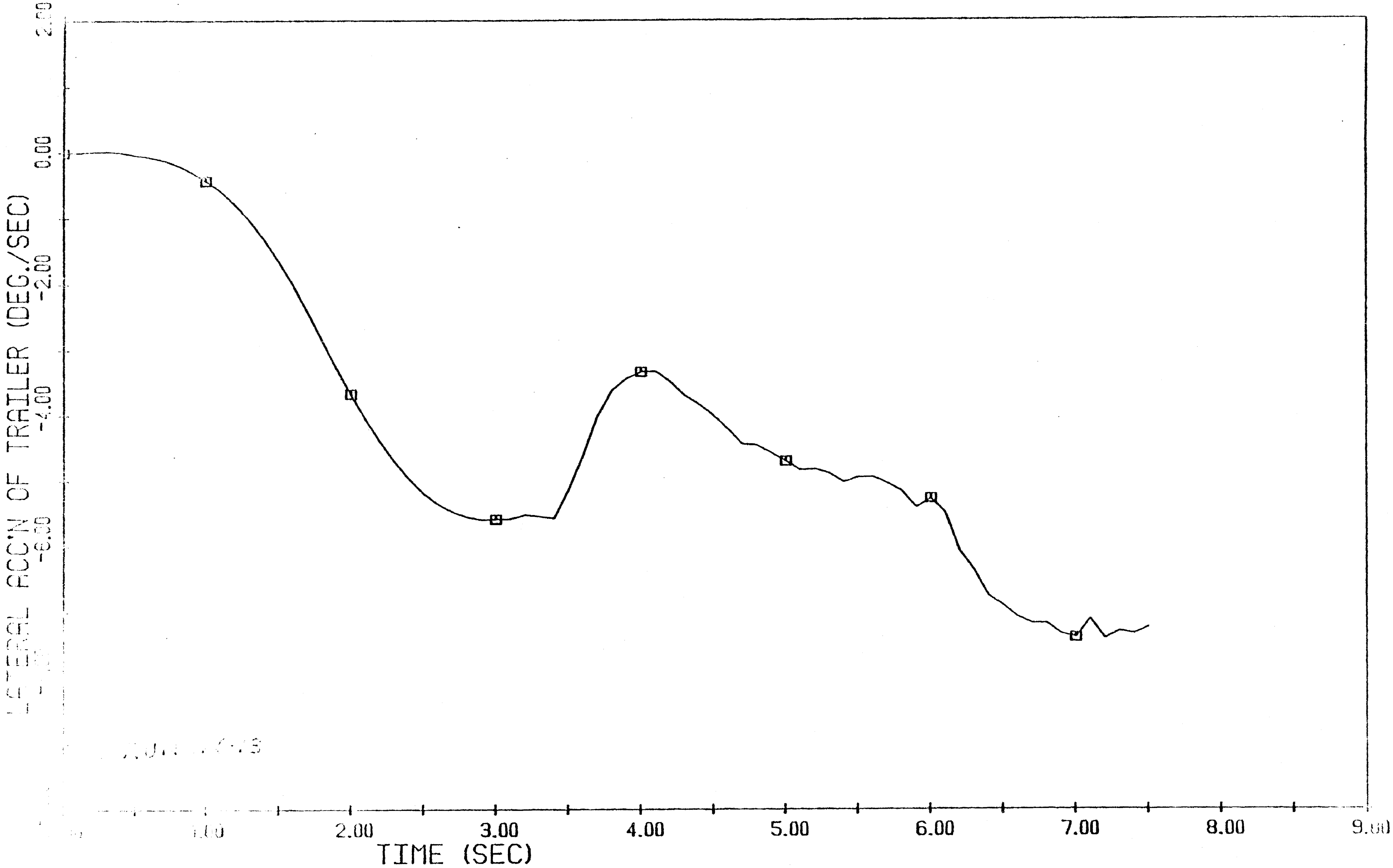

ADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN
IME (SEC)
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
ATE OF TRACTOR (DEG./SEC)
0.00
-2.00
-4.00
-6.00
-8.00



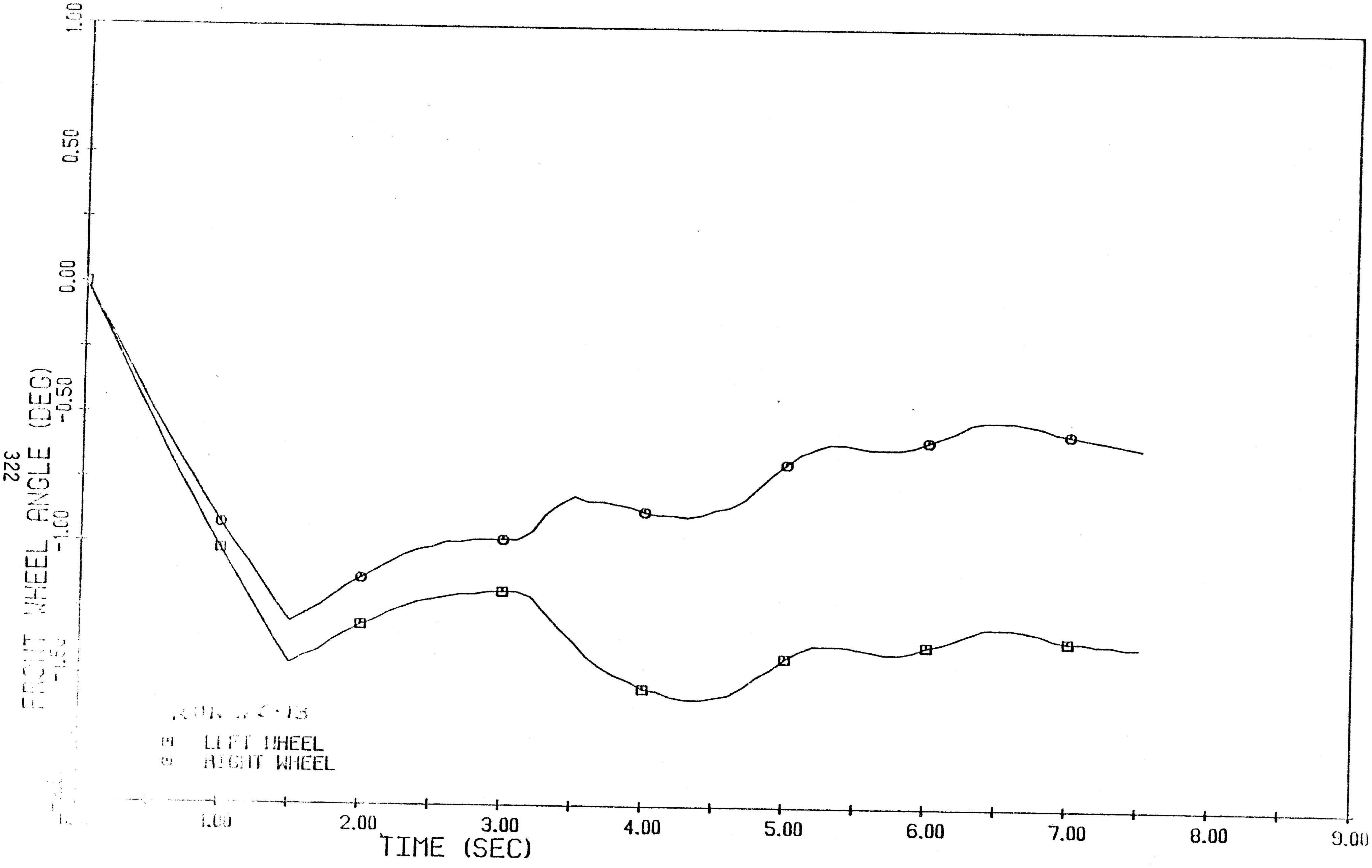
ANADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN



ADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN
TIME (SEC)
ACC'N OF TRACTOR (FT./SEC**2)
0.00
-2.00
-4.00
-6.00
-8.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00



ADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN



CANADIAN ARTIC BUS, LOADED, 100 KPH, B I T, 63 PSI, LEFT TURN

APPENDIX C

LINEAR ANALYSIS OF DIRECTIONAL RESPONSE CHARACTERISTICS

A broad understanding of the directional qualities of the articulated bus can be gained by conducting a linear yaw plane analysis of its directional response characteristics. In this appendix, eigenvalues of the articulated bus are utilized to establish the extent to which the directional qualities of the bus (at highway speeds) are affected by changes in the following design parameters and operating conditions:

1) Loading condition
2) Forward velocity
3) Tire properties
4) Location of trailer c.g.
5) Fifth wheel damping

In the discussion that follows, a brief description of the yaw plane model and eigenvalues is first given, following which the results of the calculations are presented.

Linear Yaw Plane Model

A linear yaw plane model which was developed by HSRI as part of an earlier study on double tankers [ ] was used for conducting the eigenvalue calculations. In the model, all motions are assumed to take place on a horizontal plane. Moreover, the cornering forces and aligning moments generated at the tire/road interfaces are assumed to be linear functions of the sideslip angles at the tires. Steering system dynamics are left out of the model and the steering input is assumed to be given directly to the front wheels. The only degrees of freedom permitted in the model are therefore: (1) the sideslip velocity of the tractor, (2) yaw rate of the tractor, and (3) articulation of each of the trailing units.

It was not possible to represent the articulation controller in the linear model due to the fact that, even for small articulation angles, the yaw moment produced by the controller is a highly nonlinar function of the articulation angle. The influence of the damping moment produced by the controller was studied separately by representing the controller as a viscous torsional damper whose damping moment is directly proportional to the rate of change of the articulation angle.

Eigenvalues

The two-unit articulated bus, as represented in the linear model, has a set of four complex eigenvalues and a corresponding set of four complex eigenvectors. The eigenvalues for a fully loaded bus, traveling at 100 KPH, are shown in Figure C.1. The pair of lightly damped eigenvalues marked A_1 correspond to the yaw motion of the rear unit (trailer) and the pair of heavily damped eigenvalues marked A_2 correspond to the front unit (or tractor). Expressions for the damping ratio and settling time for equivalent second-order systems are also included in Figure C.1. From these expressions it is obvious that the closer a pair of eigenvalues is to the imaginary axis, the less damped is the corresponding natural mode of oscillation. The time taken for a disturbance to settle down is also inversely proportional to distance of the rest from the imaginary axis. Hence, the influence of changes in operating conditions or design parameters on the directional response characteristics of a vehicle can be determined by studying the location of the eigenvalues in the complex plane.

Since the eigenvalues lying in the lower half of the complex plane are just a mirror image of the roots lying in the top half plane, we shall in all future references to eigenvalues show only the roots lying in the top half of the complex plane.

Influence of Loading Condition

The eigenvalues of the articulated bus for four different loading conditions, ranging from fully loaded to empty, are shown in Figure C.2. For each loading condition, the eigenvalues are shown for two

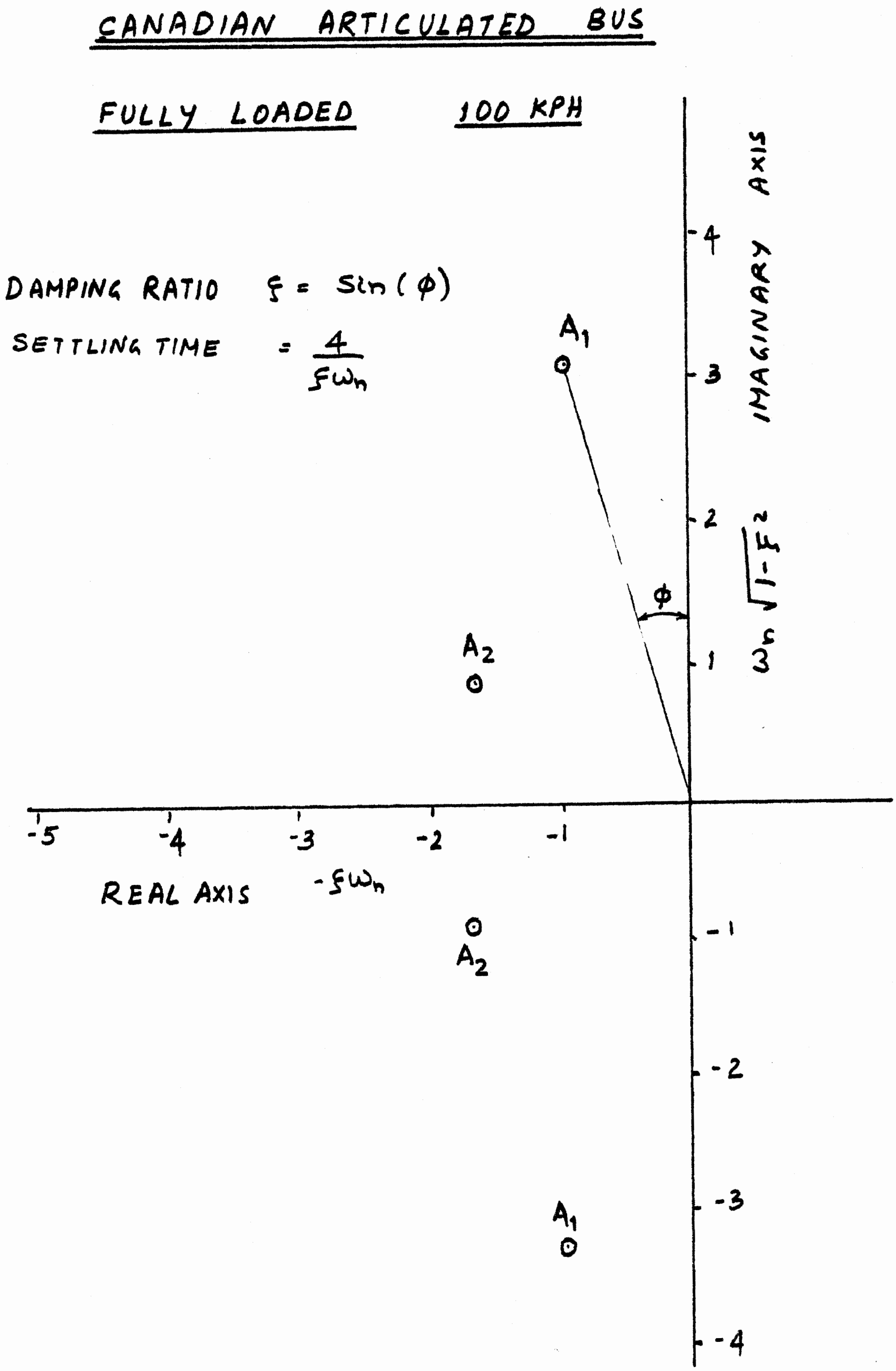


Figure C.1. Eigenvalues of the fully loaded articulated bus.

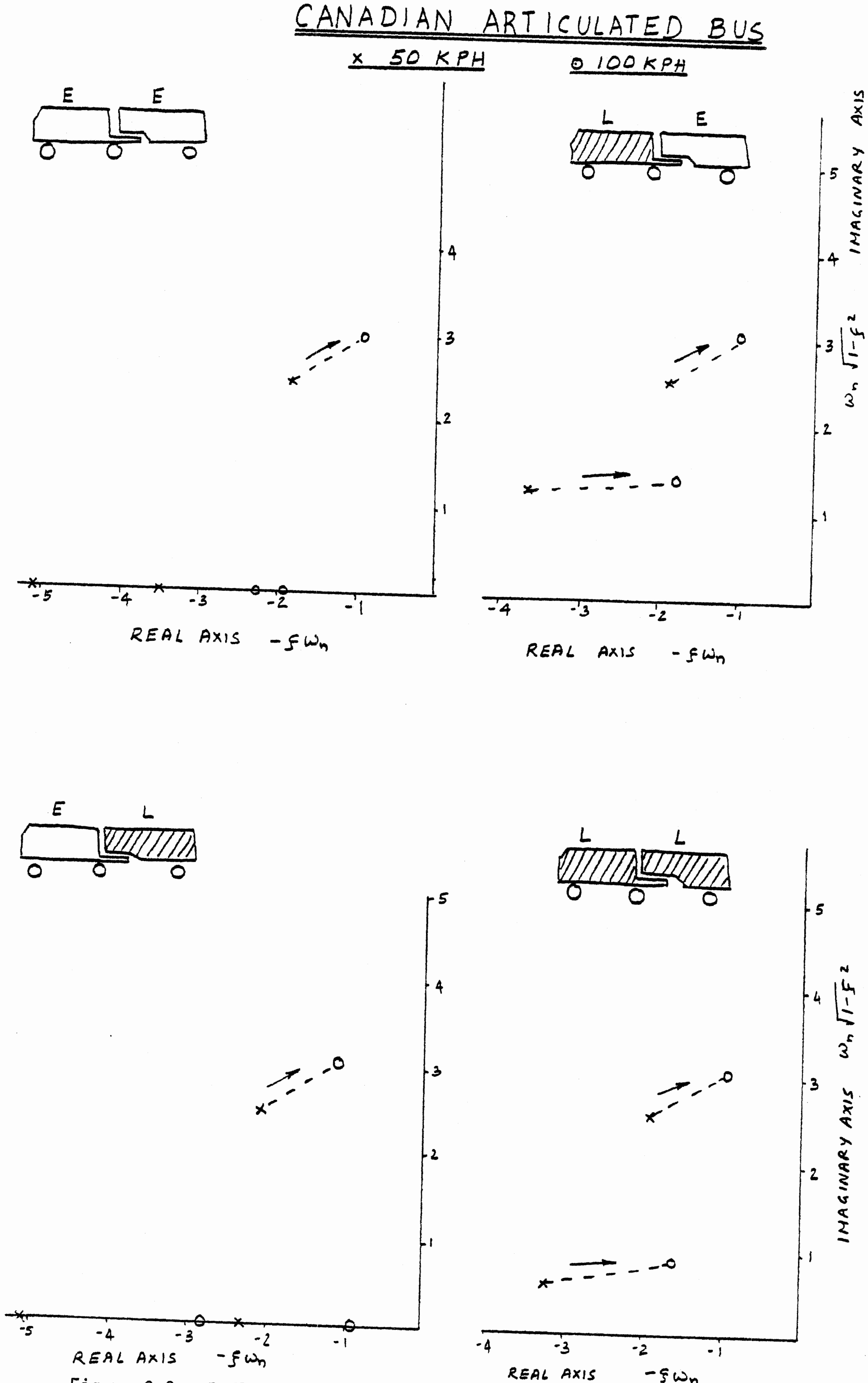


Figure C.2. Influence of speed and load distributions on the eigenvalues of the articulated bus.

forward speeds, namely, 50 and 100 KPH. It is interesting to note that changes in the loading condition do not have a significant impact on the lightly damped trailer oscillation mode. At 100 KPH, the eigenvalue corresponding to the trailer oscillation mode has an observed natural frequency of about 3 rad/sec (1/2 Hz) and a damping ratio of approximately 0.3 for all the four loading conditions. On the other hand, loading condition has a significant effect on the eigenvalues which correspond to the motion of the tractor. When the lead unit is empty, the eigenvalues of the tractor are characterized by a pair of real roots. When the lead unit is empty and the trailing unit is loaded, one of the real roots tends to cross over to the right half of the complex plane, resulting in a yaw divergence type instability at speeds exceeding 130 KPH.

Influence of Speed

In Figure C.2 we note that increasing the speed from 50 to 100 KPH results in the translation of all of the eigenvalues towards the right. The damping ratios of the roots decreases and the time needed for a disturbance to settle down increases. For example, the damping ratio of the trailer oscillation mode is reduced from 0.6 to 0.3 by an increase in the speed from 50 to 100 KPH.

Tire Properties

In this section we shall discuss the effects of reducing the cornering stiffness levels of the tires on each of the three axles of the articulated bus. The calculations were performed for a forward velocity of 100 KPH.

The influence of reducing the cornering stiffness of the tires on the tractor front axle is illustrated in Figure C.3 for the fully loaded bus. As the cornering stiffness is reduced, the observed natural frequency of the pair of eigenvalues which correspond to the tractor motion is increased and the damping ratio is reduced. Reducing the cornering stiffness of the tires on the front axle from 1220 lb/deg to 800 lb/deg reduces the damping ratio from 0.9 to 0.65. It

CANADIAN ARTICULATED BUS

FULLY LOADED, 100 KPH

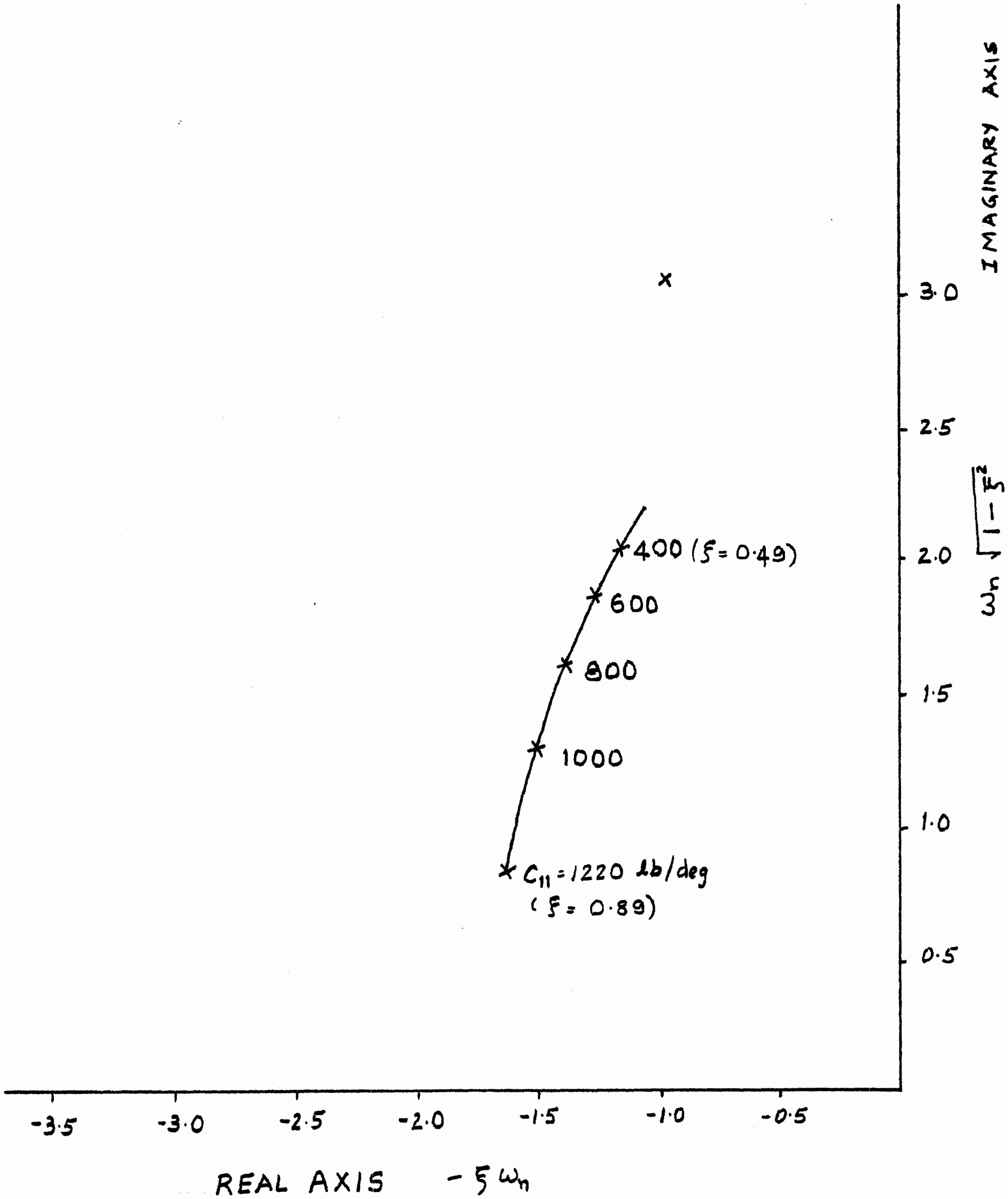


Figure C.3. Influence of reducing the cornering stiffness of the tractor's front tires.

is interesting to note that changing the cornering stiffness of the tires on the tractor front axle has a negligible effect on the eigenvalue of the trailer oscillation mode. This is due to the fact that there is very little participation of the tractor motion in the trailer oscillation mode.

The influence of reducing the cornering stiffness of the tires on the mid axle is portrayed in Figure C.4. As the cornering stiffness of the tires on the mid axle is reduced, the complex eigenvalues which correspond to the tractor move toward the real axis and split into a pair of real eigenvalues. When the cornering stiffness of the tires is reduced below 1600 lb/deg, one real root crosses over to the right half plane, resulting in a yaw divergence type instability at 100 KPH. The eigenvalue corresponding to the trailer oscillation mode can be seen to once again remain unaffected by a change in the cornering properties of the tractor tires.

The effect of changing the cornering stiffness of the tires on the trailer axle is illustrated in Figure C.5. It can be observed that the eigenvalue corresponding to the tractor motion is unaffected by changes in the cornering stiffness properties of the trailer tires. The eigenvalue corresponding to the trailer oscillation mode shows a decrease in the observed natural frequency and a decrease in the damping ratio as well. When the cornering stiffness of the trailer rear-axle tires is reduced from 2396 lb/deg to 1200 lb/deg (a 50 percent reduction), the damping ratio is reduced from 0.303 to 0.206 (a reduction of 32 percent).

Changes in the cornering stiffness of the tires on the tractor front axle, mid axle, and the trailer axle of an empty bus are illustrated in Figures C.6, C.7, and C.8, respectively. The comments made in connection with discussing the fully loaded vehicle (Figs. C.3-C.5) hold true for these figures as well.

From these figures it can be concluded that (1) a variation of 10 to 20 percent in the cornering properties of the tires should not make a significant difference in the high-speed transient response characteristics of the vehicle and (2) the damping ratio and natural frequency of the lightly damped trailer oscillation mode is primarily determined by the cornering stiffness of the trailer tires.

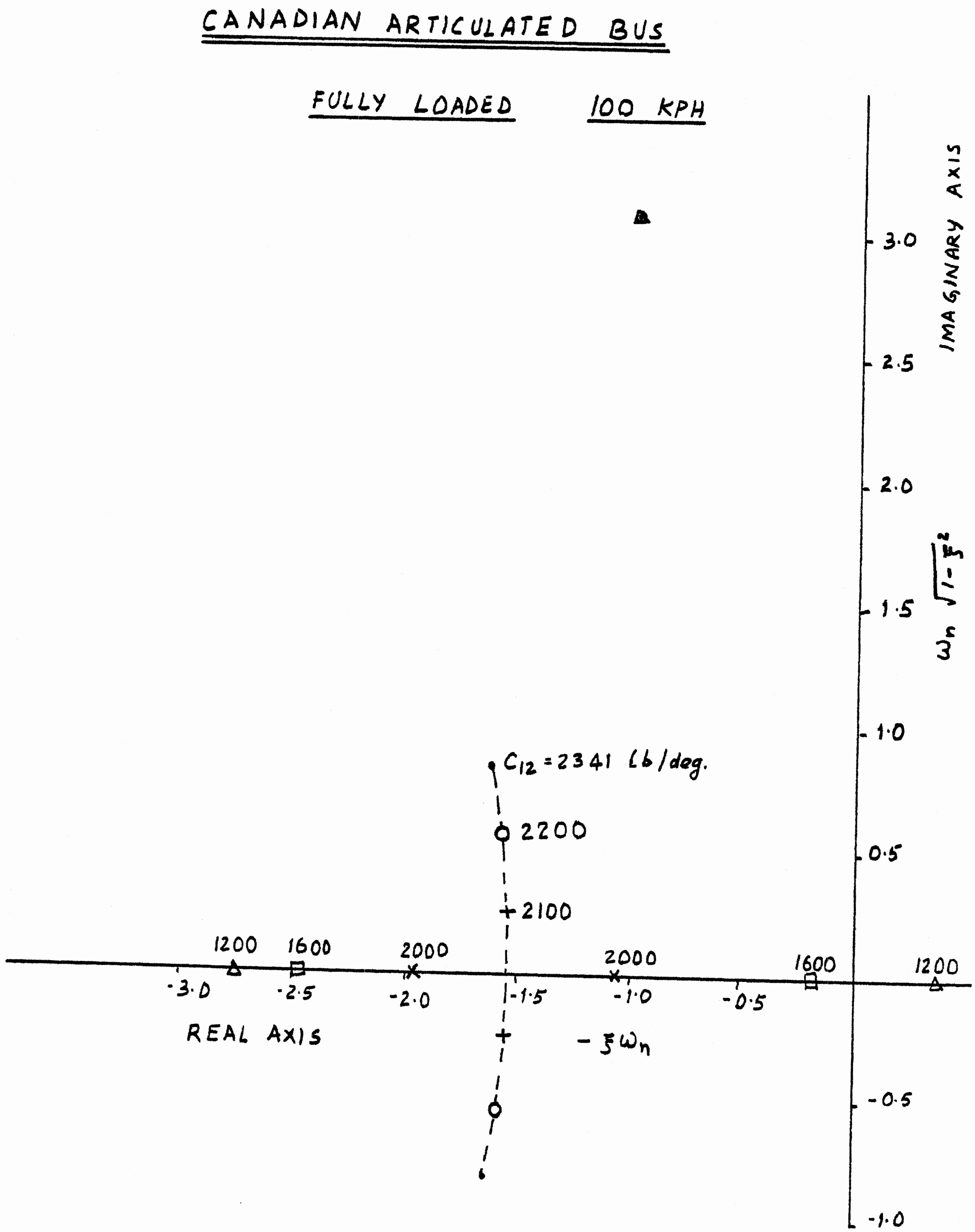


Figure C.4. Influence of reducing the cornering stiffness of the tires on the mid axle.

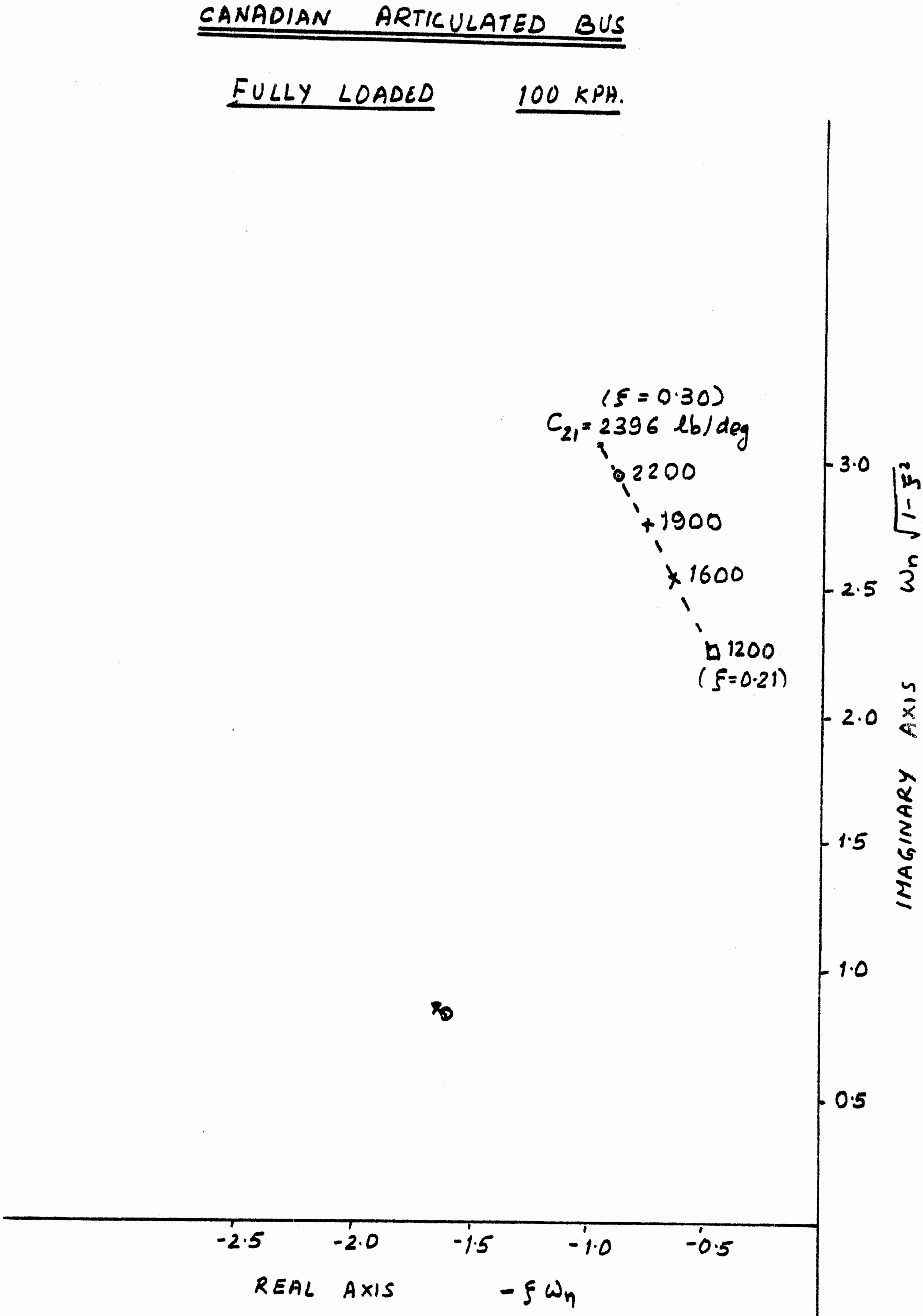


Figure C.5. Influence of reducing the cornering stiffness of the tires on the trailer axle.

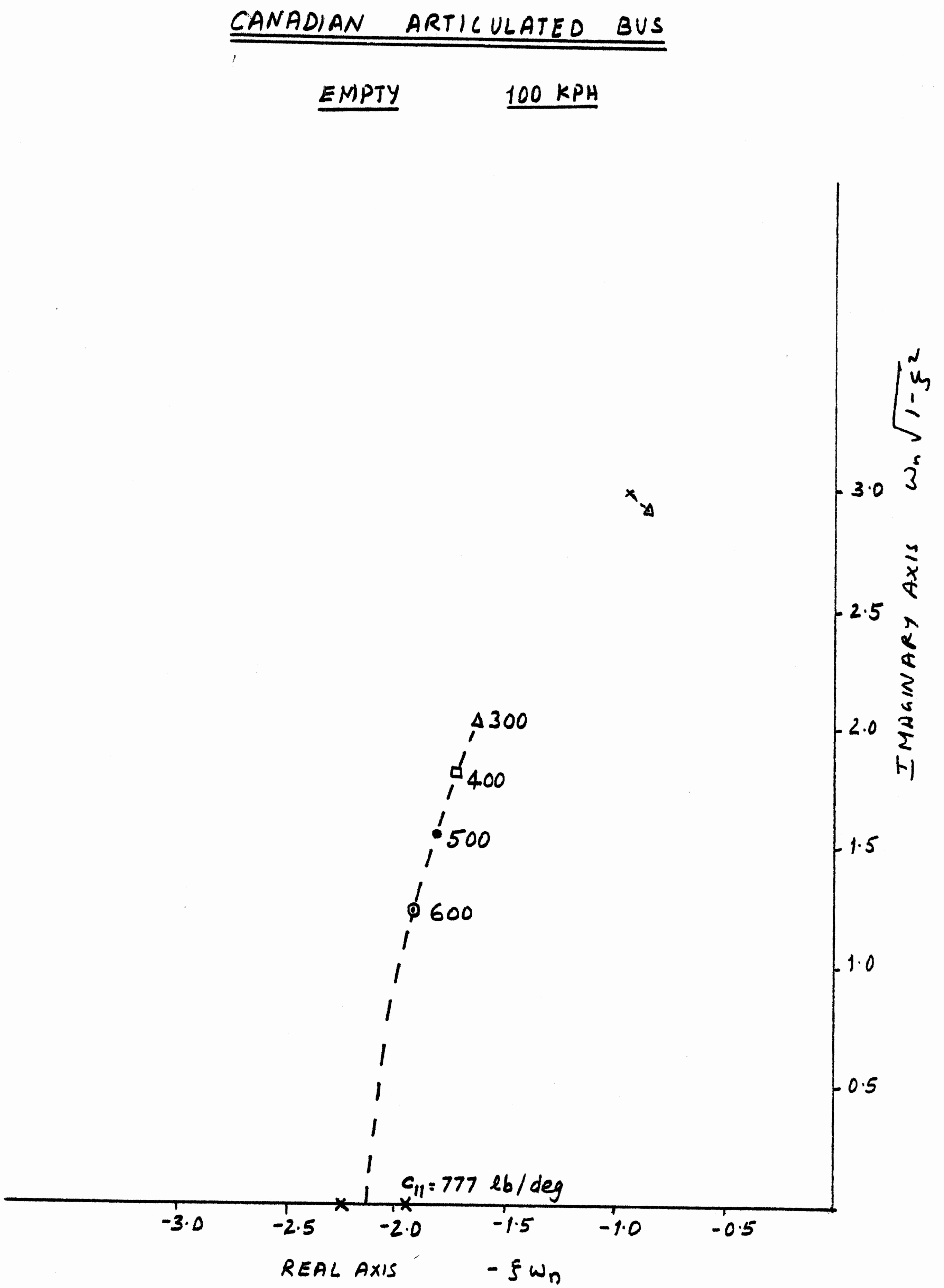


Figure C.6. Influence of reducing the cornering stiffness of the tractor front tires - empty bus.

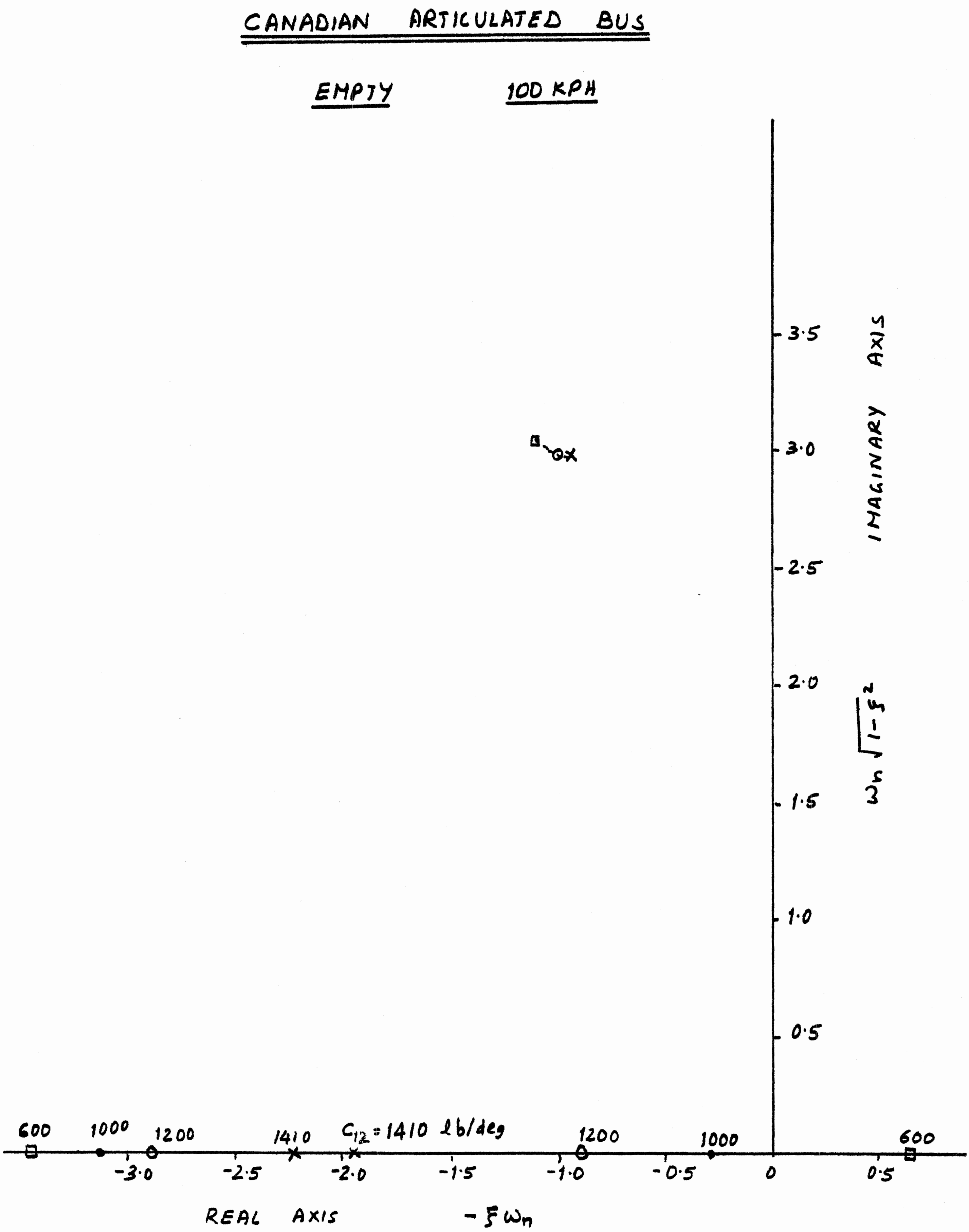


Figure C.7. Influence of reducing the cornering stiffness of the tires on the mid axle - empty bus.

CANADIAN ARTICULATED BUS

EMPTY 100 KPH

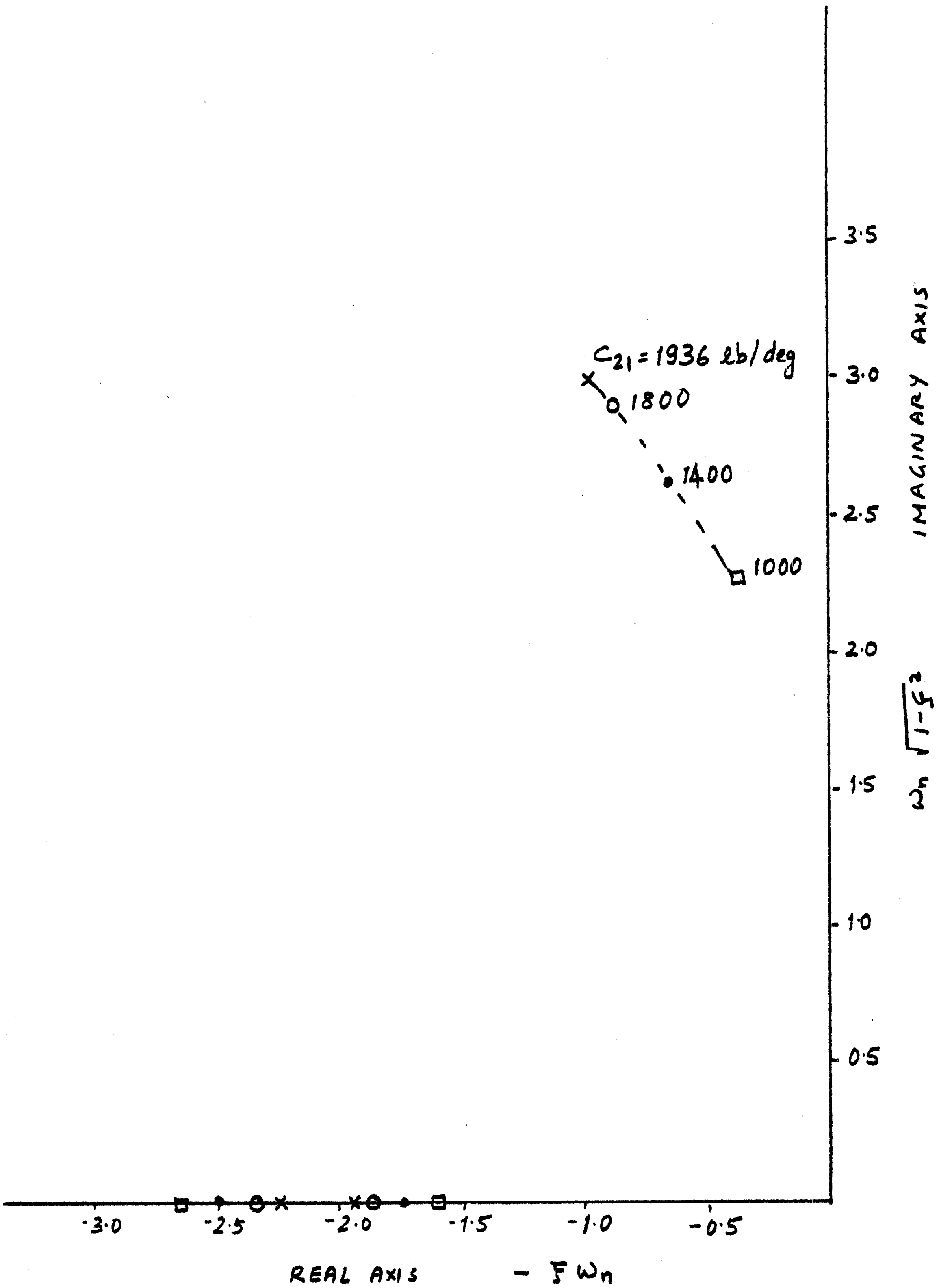


Figure C.8. Influence of reducing the cornering stiffness of the tires on the trailer axle.

Location of Trailer c.g.

In the baseline configuration, the c.g. of the trailer (when empty) is very close to the trailer axle. The vertical load carried by the fifth wheel is therefore very small—around 1900 lbs. We shall in this section discuss the effect of moving the trailer c.g. further back and closer to the trailer axle. Figure C.9 shows the eigenvalues of the empty articulated bus traveling at 100 KPH for three positions of the trailer c.g.—21.7 in., 12 in., and 0 in. ahead of the trailer axle. It can be seen that the location of the trailer c.g. has a significant impact on the damping ratio of the trailer oscillation mode. When the trailer c.g. is moved back by 21.7 in. (to a point which is exactly above the trailer axle), the damping ratio is reduced from 0.305 to 0.177—a reduction of 42 percent. The observed natural frequency is also reduced from about 3 rad/sec to 2.5 rad/sec.

Fifth Wheel Damping

For small articulation angles, the resisting moment produced by the articulation angle controller is composed of a damping moment which is dependent on angular velocity and a moment which is dependent on the angular displacement. The influence of the damping moment on the directional behavior of the vehicle was studied by incorporating a linear viscous damper at the fifth wheel of the linear model. Results of the eigenvalue calculations for various levels of damping varying from 0 to 2000 in-lb-sec/deg are shown in Figure 10 for an empty vehicle traveling at 100 KPH.

The presence of the damping element increases the damping ratio of the trailer oscillation mode to a small extent. The presence of a viscous damper of 2000 in-lb-sec/deg merely increases the damping ratio from 0.305 to 0.377 (an increase of 23 percent), thereby suggesting that the damping moment produced by the controller is not powerful enough to radically increase the damping ratio of the trailer oscillation mode.

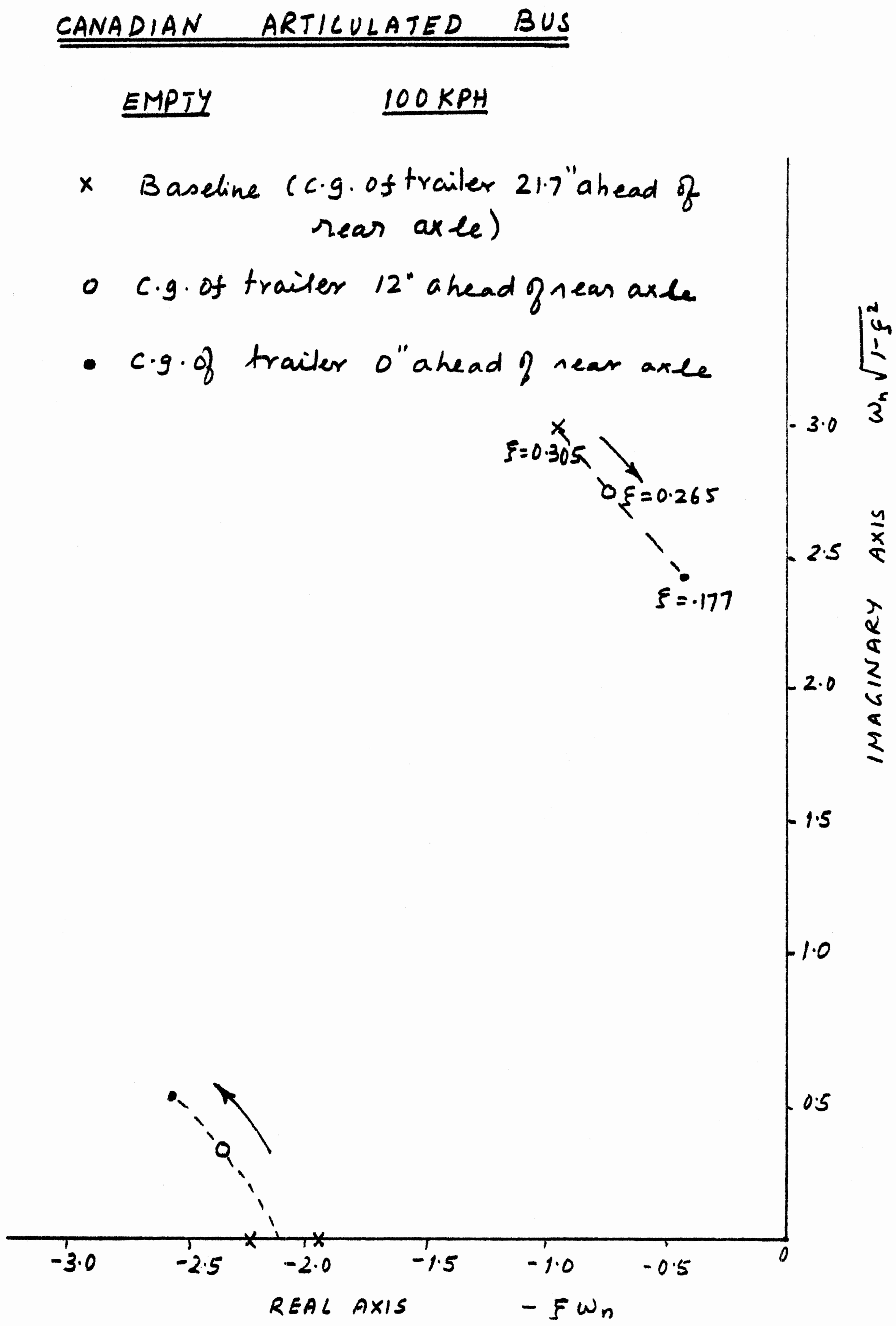


Figure C.9. Influence of shifting the c.g. of the trailer.

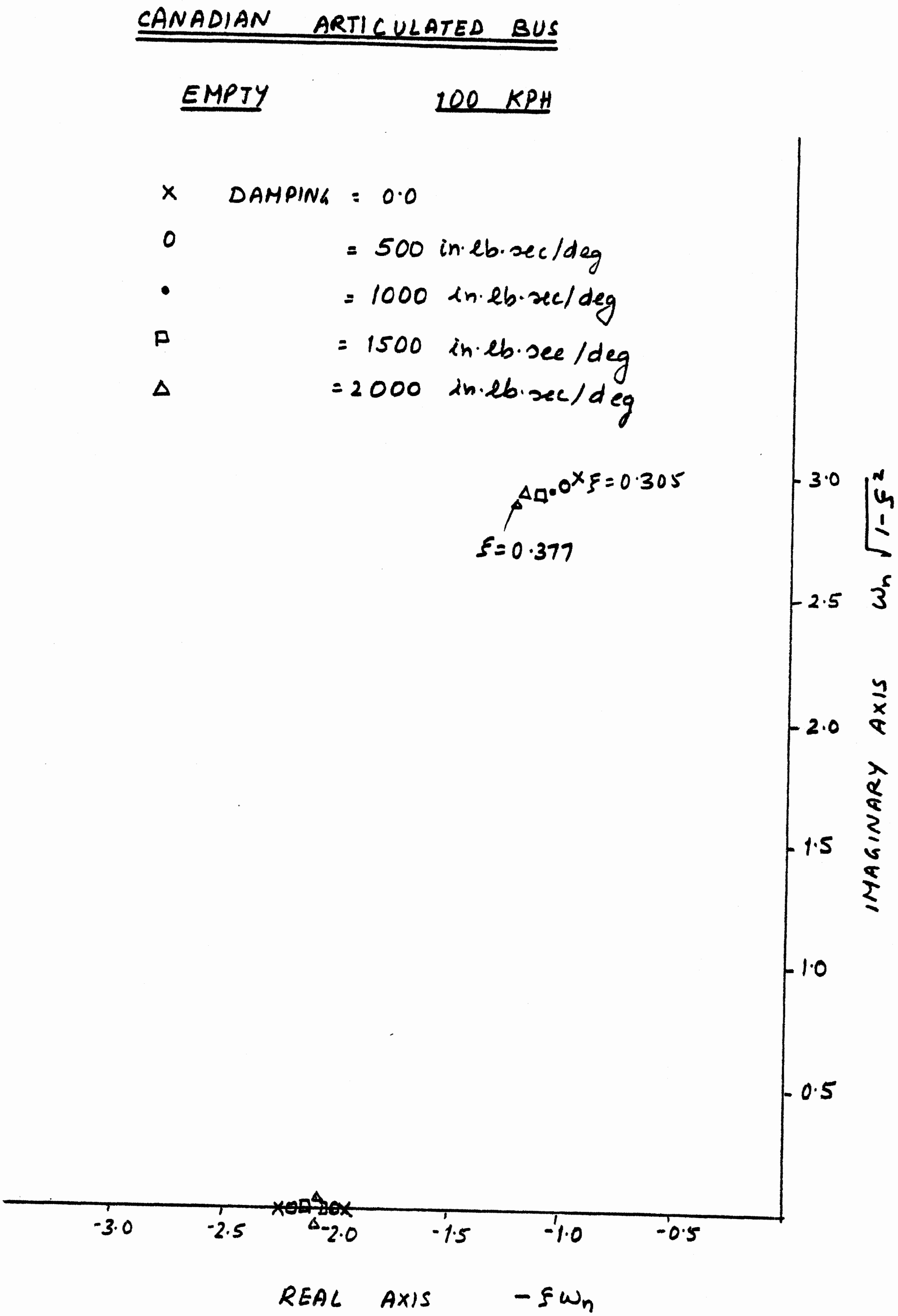


Figure C.10. Influence of fifth wheel damping.

APPENDIX D

SIMPLIFIED BRAKING ANALYSIS

The equations of "steady" motion for an articulated vehicle making a nearly constant deceleration stop are given in Equations (1) through (4) using the symbols illustrated in Figure D.1 and defined in Table D.1.

Tractor Plus Trailer Acceleration

$$A(W_1+W_2) = F_{x_1} + F_{x_2} + F_{x_3} \tag{1}$$

$$W_1 + W_2 = F_{z_1} + F_{z_2} + F_{z_3} \tag{2}$$

Trailer: Pitch Moments about the Fifth Wheel

$$0 = F_{x_3} h_f + F_{z_3}(a_2+b_2) - W_2 a_2 + AW_2(h_2-h_f) \tag{3}$$

Tractor: Pitch Moments about the Fifth Wheel

$$0 = (F_{x_1}+F_{x_2})h_f + F_{z_2}(b_1-b_f) + W_1 b_f - F_{z_1}(a_1+b_f) - AW_1(h_f-h_1) \tag{4}$$

The following calculation procedure, employing Equations (1) through (4), was used to determine operating conditions that will result in wheel lock:

1. Select a treadle pressure (based on a reasonable guess).

2. Look up the brake torques, T_i, using Figure 2.4.

3. Calculate the longitudinal forces, F_{x_i}, at each axle, i.e.,

$$F_{x_i} = \frac{2T_i}{20''} \quad \text{where}$$

20" ≈ tire rolling radius

2 = multiplying factor for 2 brakes on an axle.

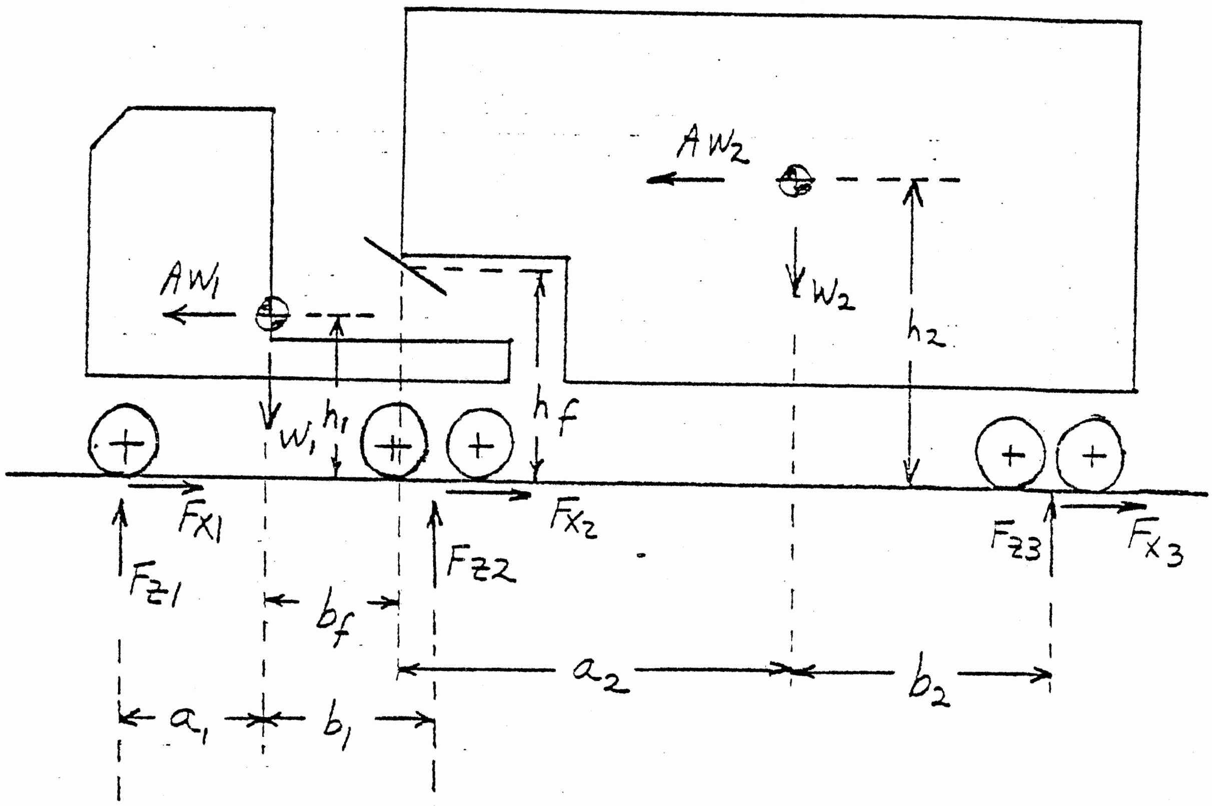


Figure D.1. Illustration of symbols. (For the bus, $b_f > b_1$ and tandem axles are replaced by single axles.)

Table D.1. Definition of Symbols

A	Deceleration of the vehicle in g's
a_1	Front axle to c.g. of the tractor
a_2	Fifth wheel to c.g. of the trailer
b_1	c.g. of tractor to center of tractor rear suspension
b_2	c.g. of trailer to center of trailer rear suspension
b_f	c.g. of tractor to fifth wheel
F_{x_1}	Brake force produced by the front tires
F_{x_2}	Brake force produced by the tires on the tractor rear suspension
F_{x_3}	Brake force produced by the tires on the trailer suspension
F_{z_1}	Vertical load on the front tires
F_{z_2}	Vertical load on the tires on the tractor rear suspension
F_{z_3}	Vertical load on the tires on the trailer suspension
h_1	Height of the tractor c.g.
h_2	Height of the trailer c.g.
h_f	Height of the fifth wheel
W_1	Weight of the tractor
W_2	Weight of the trailer

Note: For the bus

"tractor" ≡ "leading unit"

"trailer" ≡ "trailing unit"

4. Calculate deceleration, A, using Equation (1).

5. Compute vertical loads, F_{z_i}, at each axle. (Solve Equation (3) for F_{z_3}. Then solve (2) and (4) simultaneously for F_{z_2} and F_{z_1}.)

6. Compute friction utilizations, K_i, where $K_i = F_{x_i}/F_{z_i}$. (This assumes that the friction level is large enough to provide these utilizations.)

7. Choose μ slightly less than the largest K_i but greater than the other K_i values. The axle corresponding to the largest K_i is expected to lock up for this value of μ.

The results given in Section 2.5 are based on the above procedure using the parametric values listed in Table D.2.

Table D.2

	Empty	Full	
a_1	121.6	122	inches
a_2	181.7	167.9	"
b_1	113.4	113	"
b_2	21.7	35.5	"
b_f	191.7	191.3	"
h_1	39.4	53.5	"
h_2	43.3	51.9	"
h_f	27.5	27.5	"
W_1	14,135	31,337	lbs
W_2	18,205	29,007	"
W_1+W_2	32,340	60,344	"