MASTER

SOUTH COAST
TECHNOLOGY, INC.
Santa Barbara, California

NEAR-TERM HYBRID VEHICLE Program

APPENDICES B1 - B4

DESIGN TRADEOFF STUDIES

AND

SENSITIVITY ANALYSIS

PREPARED FOR:

JET PROPULSION LABORATORIES

CONTRACT NUMBER 955189

PREPARED BY:

SOUTH COAST TECHNOLOGY, INC.

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APPENDIX B1

DOCUMENTATION FOR "HYBRID"

COMPUTER PROGRAM

B1.1 PROGRAM DESCRIPTION

HYBRID computes the fuel and energy consumption of a hybrid vehicle with a bi-modal control strategy over specified component driving cycles. Fuel and energy consumption are computed separately for the two modes of operation. The program also computes yearly average fuel and energy consumption using a composite driving cycle which varies as a function of daily travel.

The distribution of daily travel is specified as input data, as well as the weights which the component driving cycles are given in each of the composite cycles

EQUATIONS for 'HYBRID' COMPUTER PROGRAM

1. REQUIRED TRACTIVE EFFORT

1.1 ACCELERATION

$$F_{AC} = \left(M_T + \frac{I_{DL}}{R_T^2}\right) a_V \qquad (N)$$

1.2 ROLLING RESISTANCE

$$F_R = M_T g \left(C_1 + C_2 V\right) \qquad (N)$$

1.3 AERODYNAMIC DRAG

$$F_A = C_D A \cdot \tfrac{1}{2} \rho V^2 \qquad (N)$$

1.4 NET TRACTIVE EFFORT

$$F_{NET} = F_A + F_R + F_{AC}$$

2. FINAL DRIVE ASSEMBLY

2.1 $$T_{DO} = F_{NET} R_T$$

2.2 $$T_{TO} = \begin{cases} T_{DO} / (\mu_D r_D), & F_{NET} \geq 0 \\ T_{DO} \mu_D / r_D, & F_{NET} < 0 \end{cases} \qquad (N\text{-}M)$$

2.3 $$\omega_{DO} = (60/2\pi) V / R_T \qquad (RPM)$$

2.4 $$\omega_{TO} = \omega_{DO} r_D$$

3. TRANSMISSION

3.1 $$P_{SO} = \begin{cases} \frac{2\pi}{60{,}000} T_{TO}\, \omega_{TO} / \mu_T , & F_{NET} \geq 0 \\ \frac{2\pi}{60{,}000} T_{TO}\, \omega_{TO}\, \mu , & F_{NET} < 0 \end{cases} \quad (KW)$$

4. HEAT ENGINE/MOTOR/BRAKES (OUTPUT)

A. FOR $F_{NET} \geq 0$, $V > 0$, OR $a_V > 0$

4.1 $P_{BRK} = 0$ (MODE 1 AND MODE 2)

4.2 $P_{GO} = 0$ (MODE 1 AND MODE 2)

A1. ON MODE 1:

4.3 $$P_{EO} = \begin{cases} 0, & P_{SO} \leq P_{EOMIN} \\ P_{EOMIN}, & P_{EOMIN} < P_{SO} \leq P_{mMAX} + P_{EOMIN} \\ P_{SO} - P_{mMAX}, & P_{mMAX} + P_{EOMIN} < P_{SO} \end{cases}$$

4.4 $$P_{mO} = \begin{cases} P_{SO}, & P_{SO} \leq P_{EOMIN} \\ P_{SO} - P_{EOMIN}, & P_{EOMIN} < P_{SO} \leq P_{mMAX} + P_{EOMIN} \\ P_{mMAX}, & P_{mMAX} + P_{EOMIN} < P_{SO} \end{cases}$$

A2. ON MODE 2:

4.5 $$P_{EO} = \begin{cases} P_{SO}, & P_{SO} \leq P_{HEMAX} \\ P_{HEMAX}, & P_{SO} > P_{HEMAX} \end{cases}$$

4.6 $$P_{mO} = \begin{cases} 0, & P_{SO} \leq P_{HEMAX} \\ P_{SO} - P_{HEMAX}, & P_{SO} > P_{HEMAX} \end{cases}$$

B. FOR $V = a_V = 0$ (CAR AT REST, MODE 1 AND MODE 2)

4.7 $$P_{EO} = P_{mO} = P_{GO} = P_{BRK} = 0$$

C. $F_{NET} < 0$ (DECELERATION, MODE 1 AND MODE 2)

4.8 $$P_{mO} = P_{EO} = 0$$

4.9 $$P_{GO} = \begin{cases} P_{SO}, & P_{SO} \geq P_{mMIN} \\ P_{mMIN}, & P_{SO} < P_{mMIN} \end{cases}$$

4.10 $$P_{BRK} = \begin{cases} 0, & P_{SO} \geq P_{mMIN} \\ P_{SO} - P_{mMIN}, & P_{SO} < P_{mMIN} \end{cases} \quad *$$

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* This representation is a bit fictitious in that it models the brakes as being at the transmission input. However, this is if no significance as far as the propulsion system computations are concerned.

5. HEAT ENGINE INPUT (FUEL, MODES 1 AND 2)

$$5.1 \quad F_c = \begin{cases} 0, & P_{EO} = 0 \\ P_{EO} \cdot BSFC = P_{EO} \cdot f(P_{EO}), & P_{EO} \neq 0 \end{cases} \quad (gm/hr)$$

6. BATTERY OUTPUT (ELECTRICAL, MODES 1 AND 2)

$$6.1 \quad P_B = \begin{cases} P_{NLD} + P_{mo}/\mu_m + P_{GO} \cdot \mu_G \, \mu_{RG} & (\text{MODE } 1) \\ P_{NLD} + P_{mo}/\mu_m + P_{GO} \cdot \mu_G \, \mu_{RG2} & (\text{MODE } 2) \end{cases}$$

** μ_{RG} and μ_{RG2} represent average battery regeneration efficiencies on Modes 1 and 2, respectively. μ_{RG2} is assumed to be higher than μ_{RG} because of the lower average state of charge on Mode 2.

7. ENERGY AND FUEL OVER THE INTERVAL (O, T) (MODE 1 AND MODE 2)

7.1 ROLLING RESISTANCE

$$\mathcal{E}_R = 10^{-3}\int_0^T P_R\, dt = 10^{-6}\int_0^T F_R\, V\, dt \qquad (mJ)$$

7.2 AERODYNAMIC

$$\mathcal{E}_A = 10^{-3}\int_0^T P_A\, dt = 10^{-6}\int_0^T F_A\, V\, dt \qquad (mJ)$$

7.3 FINAL DRIVE

$$\mathcal{E}_D = 10^{-3}\int_0^T |P_T - P_D|\, dt = 10^{-6}\cdot\frac{2\pi}{60}\int_0^T |T_{TO}\,\omega_{TO} - T_{DO}\,\omega_{DO}|\, dt \quad (mJ)$$

7.4 TRANSMISSION

$$\mathcal{E}_T = \int_0^T |P_{SO} - P_T|\, dt = 10^{-3}\int_0^T |P_{SO} - \frac{2\pi}{60{,}000} T_{TO}\,\omega_{TO}|\, dt \qquad (mJ)$$

7.5 BRAKES

$$\mathcal{E}_{BRK} = 10^{-3}\int_0^T |P_{BRK}|\, dt \qquad (mJ)$$

7.6 ENGINE OUTPUT

$$\mathcal{E}_{EO} = 10^{-3} \int_0^T P_{EO} \, dt \qquad (mJ)$$

7.7 MOTOR/GENERATOR OUTPUT

$$\mathcal{E}_{mo} = 10^{-3} \int_0^T P_{mo} \, dt \qquad (mJ)$$

$$\mathcal{E}_{GO} = 10^{-3} \int_0^T P_{GO} \, dt \qquad (mJ)$$

7.8 BATTERY OUTPUT

$$\mathcal{E}_{B} = 10^{-3} \int_0^T P_{B} \, dt \qquad (mJ)$$

7.9 FUEL

$$F_{CT} = 1/3600 \int_0^T F_c \, dt \qquad (g)$$

PARAMETERS		UNITS	DESCRIPTION
EQUATION	PROGRAM		
	NPWR	—	PHEZ, BSFC matrix size
	PHEZRO	KW	Heat engine power, nominal
	FCDL	g/hr	Fuel consumption at idle (unscaled)
	FUELSG		Fuel specific gravity
	PHEZ(20)	KW	Heat engine power (unscaled)
BSFC	BSFC(20)		Brake specific fuel consumption
μ_T	EMUT	—	Transmission efficiency
	NDDSCH	—	(DDISCH, CYCLES) matrix size
	CHGEFF	—	Battery charging efficiency
	DDISCH(20)		Battery discharge depth
	CYCLES(20)	—	Number of cycles at battery discharge depth
r_D	DRATIO	—	Differential ratio
μ_D	EMUD	—	Differential efficiency
R_T	RTIRE	m	Tire radius
C_1	CTIRE1	—	Rolling resistance coefficient
C_2	CTIRE2	—	Rolling resistance coefficient
	NCYCLE	—	Number of driving cycles
	NTC(3)	—	(TIMC, SPEDC) matrix size
	NPRTC(3)	—	Output printing flag for driving cycles
	NUNITS	—	MILES/HR to KM/HR conversion flag
	DTC(3)	sec	Time interval for driving cycles
	TFC(3)	sec	Final time for driving cycles
	TIMC(3,200)	sec	Time on driving cycles
	SPEDC(3,200)	KM/HR	Speed on driving cycles
	NCOMP	—	(DSUP, DNC, GAMMA) matrix size
	DSTAV	—	Average usage (Travel Distribution Data)
	DSUP(30)	KM	MAX. distance on driving cycle (Travel Distribution Data)
	DNC(30)	—	Fraction of total distance (Travel Distribution Data)
	GAMMA(30,3)	—	Driving cycle weights (Travel Distribution Data)
	NCASE	—	Number of cases
P_{eomin}	PEOMIN	KW	Heat engine minimum power
	DBMAX		Battery discharge limit
P_{HEmax}	PHEMAX	KW	Heat engine power, maximum
P_{mmax}	PMMAX	KW	Motor power, maximum
P_{eomin}	PMMIN	KW	Motor power, minimum
μ_m	EMUM	—	Motor efficiency
μ_G	EMUG	—	Generator efficiency (of motor)
P_{NLD}	PINNLD	KW	Motor no-load input
	WB	KG	Battery weight
	EBMAX		Battery energy density

PARAMETERS		UNITS	DESCRIPTION
EQUATION	PROGRAM		
μ_{RG}	EMURG	—	Average generating efficiency (of motor)
μ_{RG2}	EMURG2	—	Maximum generating efficiency (of motor)
m_T	VMASS	KG	Vehicle mass
I_{DL}	DLI		Driveline inertia
$C_D A$	CDA		Drag coefficient * Area

VARIABLES EQUATION	VARIABLES PROGRAM	UNITS	DESCRIPTION
	A(3)	m/sec²	Accelerations
	BLIFE	Km	Battery life (expected)
	DBAR(30)	KM	Interpolated values of driving cycle distances
	DDAV	Km	Avg. distance on driving cycle
	DELT	Sec	Time interval size
	DIST(3)	M	Distance on each cycle
	DLOW	KM	Minimum distance on driving cycle
	DT	SEC	Time increment
P_B	EB	MJ	Mode 1 battery power output
P_B	EB2	MJ	Mode 2 battery power output
	ECAV	MJ/KM	Yearly average energy consumption
	ECBAR(30)	MJ/KM	Mode 1 composite cycles energy consumption
	ECBAR2(30)	MJ/KM	Mode 2 composite cycles energy consumption
	ECHE(3)	MJ/KM	Heat engine energy consumption, each cycle
	ECMAV(30)	MJ/KM	Mode averaged composite cycles energy consumption
	ECONS(3)	MJ/KM	Mode 1 cycle energy consumption
	ECONS2(3)	MJ/KM	Mode 2 cycle energy consumption
	ECSYS(3)	MJ/KM	System energy consumption each cycle
	EHEAV	MJ/KM	Yr. avg. heat engine energy consumption
	EHEBAR(30)	MJ/KM	Heat engine energy consumption, composite
	EK(80)	—	Runga-Kutta integration variables
	ESYSAV	MJ/KM	Yr. avg. system energy consumption
	ESYBR(30)	MJ/KM	System energy consumption, composite
	FCAV	g./KM	Yearly average fuel consumption
	FCBAR(30)	g./KM	Mode 1 composite cycles fuel consumption
	FCBAR2(30)	g/KM	Mode 2 composite cycles fuel consumption
	FCIDLE	g/hr	Fuel consumption at idle (scaled)
	FCMAV(30)	g/KM	Mode averaged composite cycles fuel consumption
	FCONS(3)	g/KM	Mode 1, cycle fuel consumption
	FCONS2(3)	g/KM	Mode 2, cycle fuel consumption
	FEAV	Km/L	Yr. avg. fuel economy
	HEEF	—	Heat engine energy fraction
	INT1	—	Function subroutine, 1 demensional interpolation
	INT2	—	Function subroutine, 2 demensional interpolation
	K	—	Incremented print flag
	NPRNT	—	Print flag for specified cycle
	NTIME	—	Number of time points for specified cycle
P_{BRK}	PBRK	KW	Mode 1 braking power output
	PBRK2	KW	Mode 2 braking power output

VARIABLES EQUATION	VARIABLES PROGRAM	UNITS	DESCRIPTION
	PEO	KW	Mode 1 engine power output
	PEO2	KW	Mode 2 engine power output
	PGO	KW	Mode 1 generator power output
	PGO2	KW	Mode 2 generator power output
	PHE(20)	KW	Heat engine power (scaled)
	PMO	KW	Mode 1 motor power output
	PMO2	KW	Mode 2 motor power output
	PSO	KW	System power output
	RANGE(30)	KM	Range for new battery discharge limit
	REFRAC(30)	—	Fraction of total driving cycle
	SKALE	—	Heat engine scale factor
	SPEED(200)	KM/HR	Speeds for specified driving cycle
	T	SEC	Time (incremented for integration)
	TF	SEC	Final time for specified cycle
	TIME(200)	SEC	Times for specified driving cycle
	TTMP	SEC	Time holder
V	Y(6)	m/sec	Velocities
m_T	YMASS2		Vehicle inertial mass
	VTMP	m/sec	Velocity hold
	VTMPL	m/sec	Velocity hold
	WPAV	KW/KM	Yr. avg. wall plug output
E_A	Y(1)	MJ	Aerodynamic energy loss
E_R	Y(2)	MJ	Rolling resistance energy loss
E_D	Y(3)	MJ	Differential energy loss
E_T	Y(4)	MJ	Transmission energy loss
	Y(5)	MJ	System output energy
E_{mo}	Y(6)	MJ	Motor output energy, Mode 1
	Y(7)	MJ	Motor output energy, Mode 2
E_{EO}	Y(8)	MJ	Engine output energy, Mode 1
	Y(9)	MJ	Engine output energy, Mode 2
E_{GO}	Y(10)	MJ	Generator output energy, Mode 1
	Y(11)	m/sec	Velocity
	Y(12)	KM	Distance
	Y(13)	MJ	Generator output energy, Mode 2
E_{BRK}	Y(14)	MJ	Brake output energy, Mode 1
	Y(15)	MJ	Brake output energy, Mode 2
F_{CT}	Y(16)	g.	Fuel output energy, Mode 1
	Y(17)	g.	Fuel output energy, Mode 2
E_B	Y(18)	MJ	Battery output energy, Mode 1
	Y(19)	MJ	Battery output energy, Mode 2

VARIABLE		UNITS	DESCRIPTION
EQUATION	PROGRAM		
	YDOT(20)	—	RUNGA-KUTTA integration variables
	YTMP(20)	—	RUNGA-KUTTA integration variables

SUBROUTINE VEHIC

VARIABLES EQUATION	VARIABLES PROGRAM	UNITS	DESCRIPTION
F_A	FA*	N	Force of aerodynamic drag
F_{AC}	FAC	N	Force of acceleration
F_c	FC	g/hr	Mode 1 fuel consumption
	FC2	g/hr	Mode 2 fuel consumption
F_R	FR	N	Force of rolling resistance
F_{NET}	FNET	N	Net force on wheels
	PA	KW	Aerodynamic power
P_{BRK}	PBRK	KW	Mode 1 braking power output
	PBRK2	KW	Mode 2 braking power output
	PD	KW	Drive train power
P_{EO}	PEO	KW	Mode 1 engine power output
	PEO2	KW	Mode 2 engine power output
P_{GO}	PGO	KW	Mode 1 generator power output
	PGO2	KW	Mode 2 generator power output
P_{MO}	PMO	KW	Mode 1 motor power output
	PMO2	KW	Mode 2 motor power output
	PR	KW	Rolling resistance power
P_{SO}	PSO	KW	System power output
	PT	KW	Transmission power
ω_{DO}	RPMDO	RPM	Drive train output
ω_{TO}	RPMTO	RPM	Transmission output
T_{DO}	TDO	NT·M	Drive train output torque
T_{TO}	TTO	NT·M	Transmission output torque
	VMPS	m/sec²	Velocity (meters/sec²)
	YDOT(20)	—	Variables of integration

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FORTRAN CODING FORM

PROGRAM HYBRID
NAME
ROUTINE MAIN PROGRAM
DATE
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FORTRAN STATEMENT

0 ZERO / O ALPHA O · 1 = ONE / I = ALPHA I · 2 = TWO / Z = ALPHA Z

```
          ENGINE DATA:
      NPWR    PHEZRO       FCDL       FUELSG
   PHEC(1)    BSFC(1)  . . .  PHEZ(NPWR)  BSFC(NPWR)

          TRANSMISSION DATA
      EMUT

          BATTERY DATA
    NDDSCH    CAGEFF
 DDISCH(1)  CYCLES(1)  . . .  DDISCH(NDDSCH)  CYCLES(NDDSCH)

          DIFFERENTIAL AND TIRE DATA
    DRATIO        EMUD       RTIRE     CTIRE1     CTIRE2

          DRIVING CYCLE DATA
    NCYCLE
    NTC(1)    NPRTC(1)     NUNITS     DTC(1)     TFC(1)   . . .   NTC(NCYCLE)
NPRTC(NCYCLE)     NUNITS  DTC(NCYCLE)  TFC(NCYCLE)
 TIMC(1,1)  SPEDC(1,1)  . . .  TIMC(NCYCLE,NT)  SPEDC(NCYCLE,NT)
```

FORM NO. GRC 109 REV. I

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FORTRAN CODING FORM

PROGRAM HYBRID	NAME
ROUTINE MAIN PROGRAM	DATE · PAGE 2 OF 2

FORTRAN STATEMENT — 0 = ZERO, O = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

```
          TRAVEL DISTRIBUTION DATA
     NCOMP          DSTAV
   DSUP(1)          DNC(1)  GAMMA(1,1)   . . .    DSUP(NCOMP) DNC(NCOMP) GAMMA(NCOMP,NCYCLE)

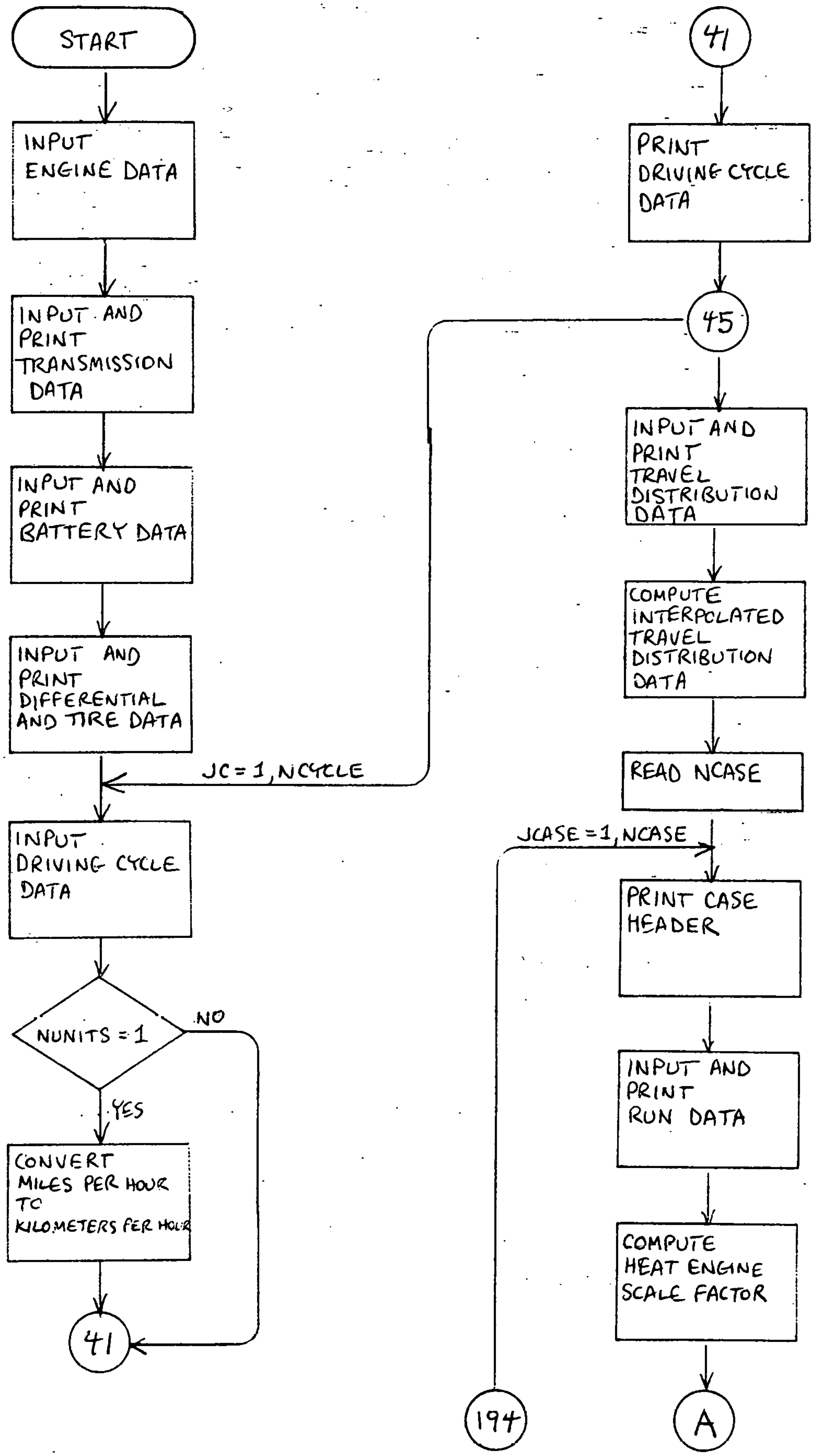
          RUN DATA
     NCASE
    TEOMIN          DBMAX        PEOMIN

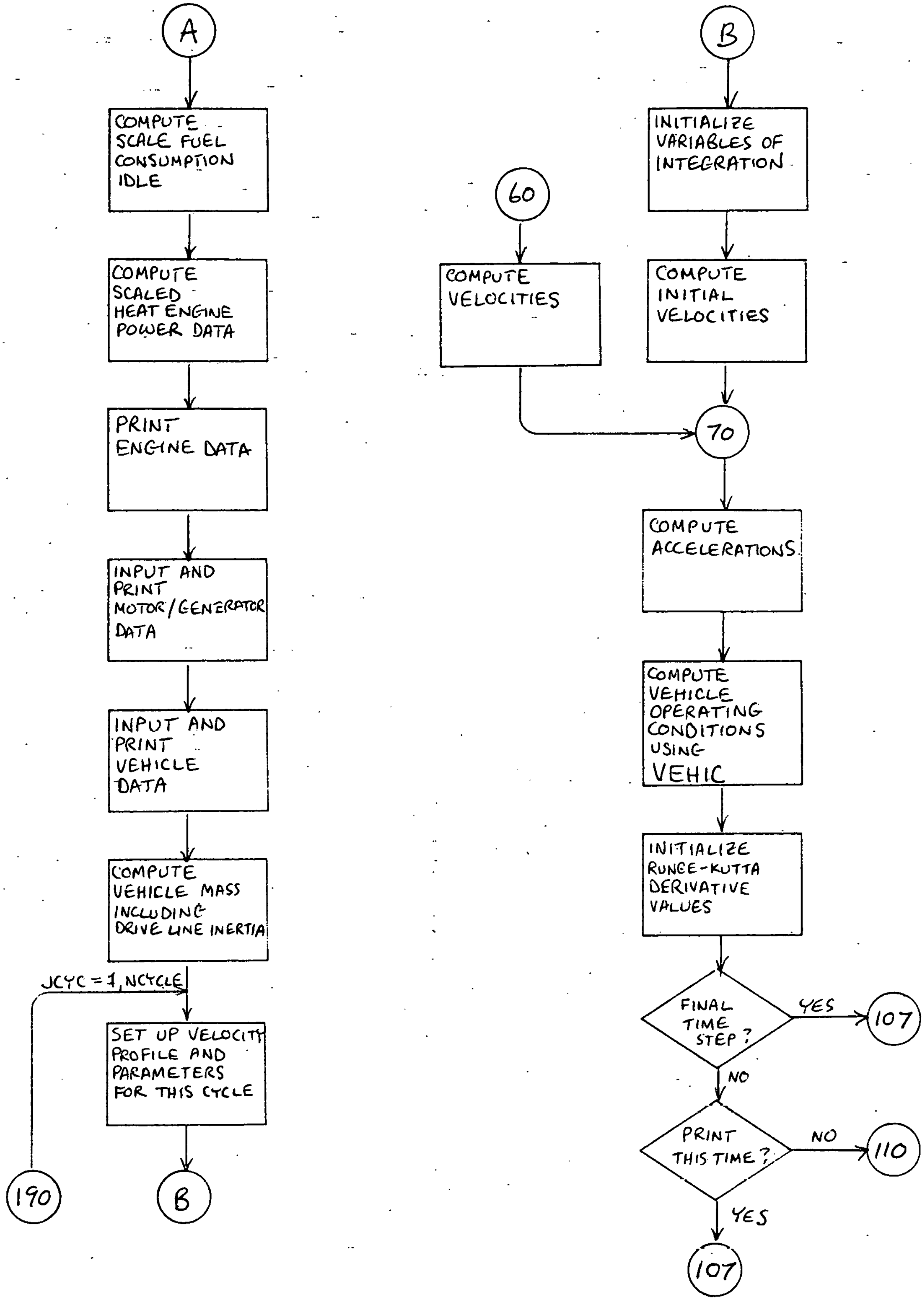
          MOTOR/GENERATOR DATA
    PMMAX           PMMIN         EMUM        EMUG      PINNLD
        WB          EBMAX         EMURG       EMURG2

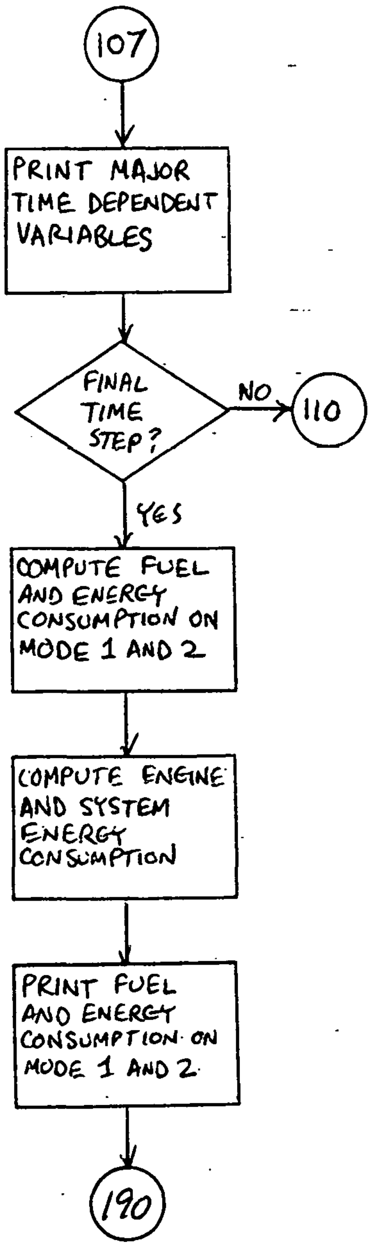
          VEHICLE DATA
     VMASS            DLI          CDA
```

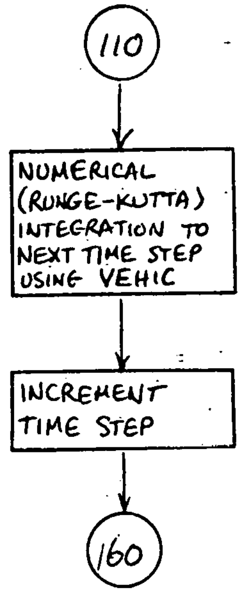
FORM NO. GRC 103 REV. I

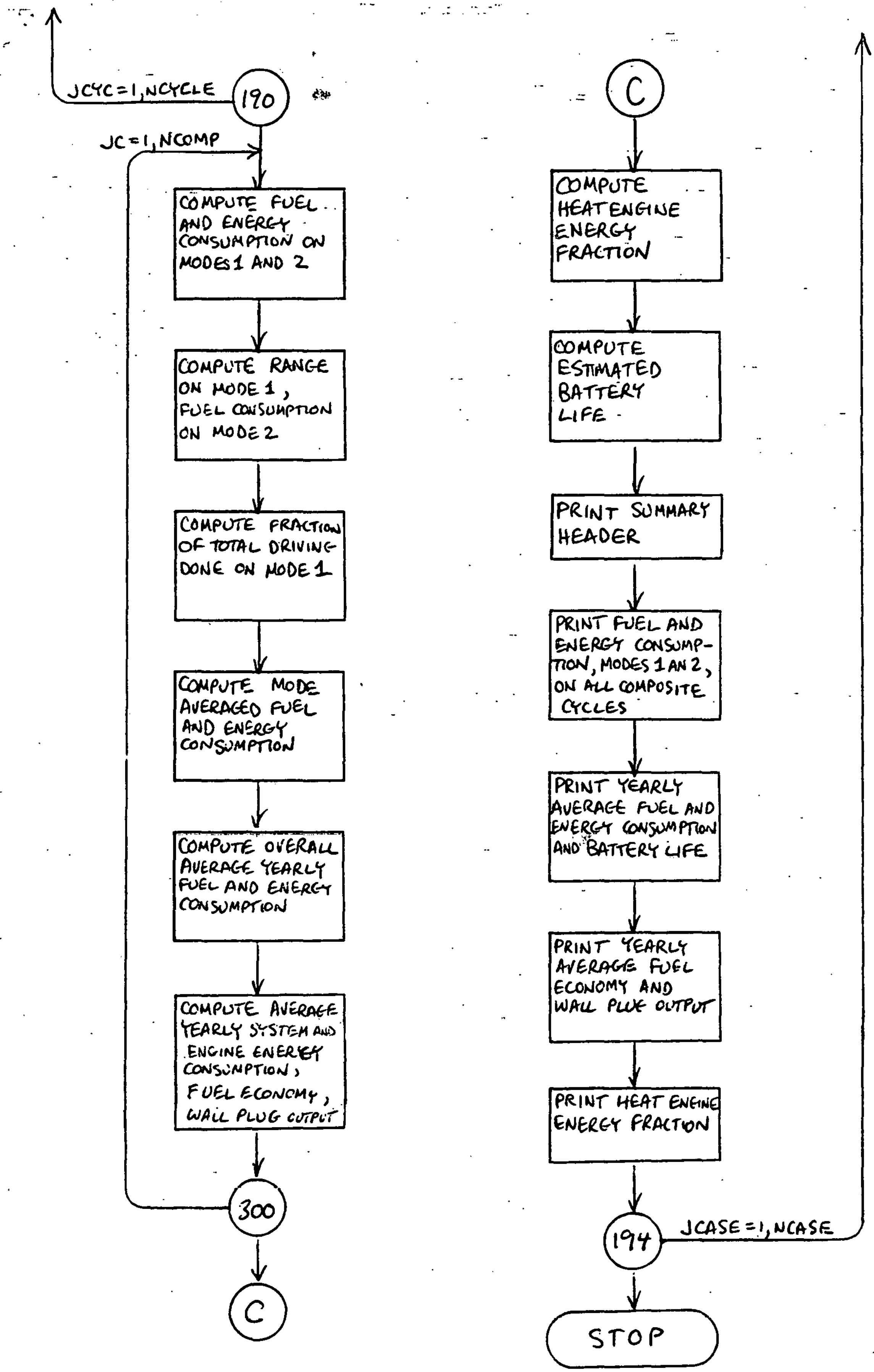
Hybrid Flowchart



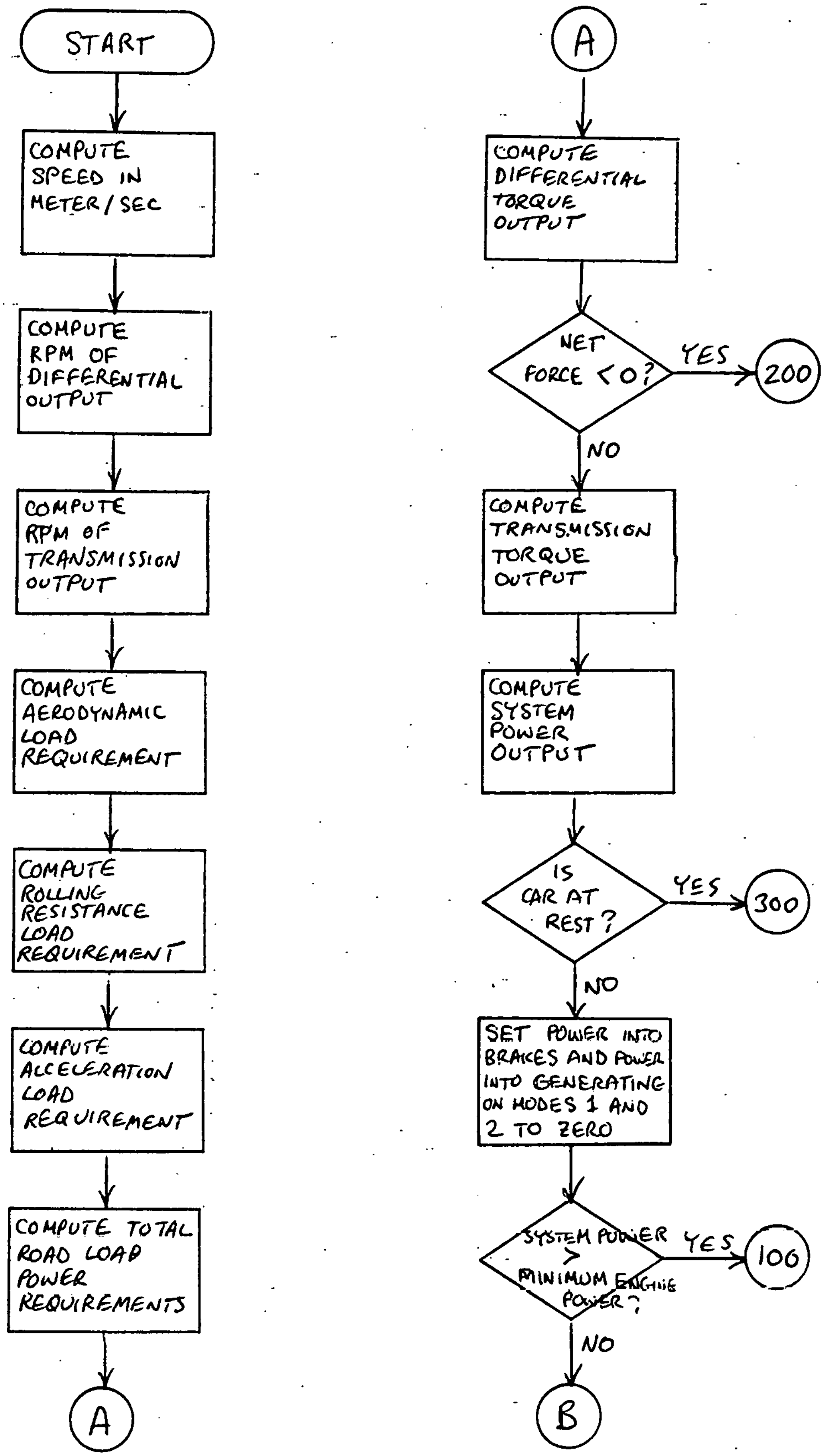

A
COMPUTE SCALE FUEL CONSUMPTION IDLE
COMPUTE SCALED HEAT ENGINE POWER DATA
PRINT ENGINE DATA
INPUT AND PRINT MOTOR/GENERATOR DATA
INPUT AND PRINT VEHICLE DATA
COMPUTE VEHICLE MASS INCLUDING DRIVE LINE INERTIA
JCYC = 1, NCYCLE
SET UP VELOCITY PROFILE AND PARAMETERS FOR THIS CYCLE
190
B
B
INITIALIZE VARIABLES OF INTEGRATION
60
COMPUTE VELOCITIES
COMPUTE INITIAL VELOCITIES
70
COMPUTE ACCELERATIONS
COMPUTE VEHICLE OPERATING CONDITIONS USING VEHIC
INITIALIZE RUNGE-KUTTA DERIVATIVE VALUES
FINAL TIME STEP?
YES
107
NO
PRINT THIS TIME?
NO
110
YES
107

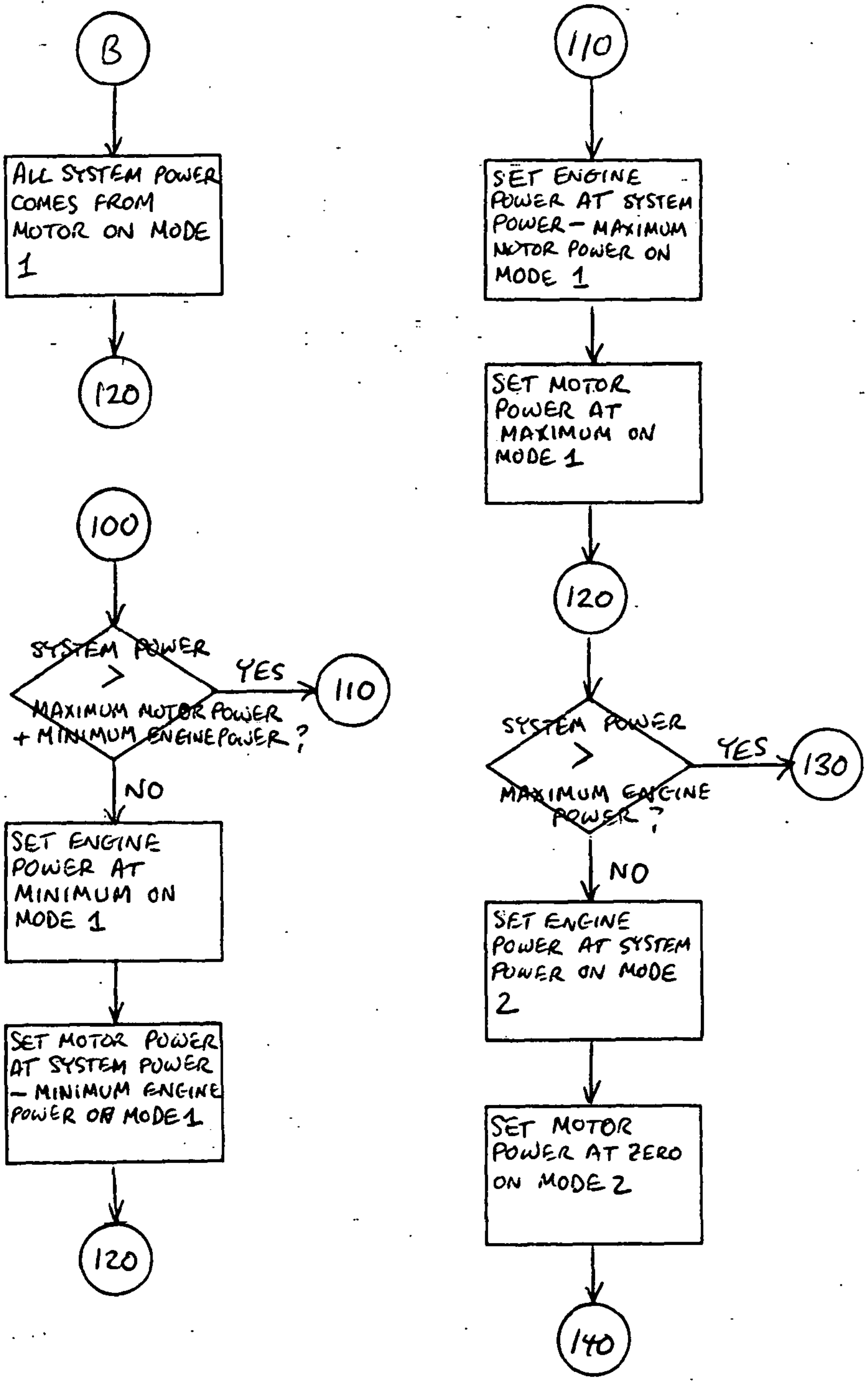

107
PRINT MAJOR TIME DEPENDENT VARIABLES
FINAL TIME STEP?
NO
110
YES
COMPUTE FUEL AND ENERGY CONSUMPTION ON MODE 1 AND 2
COMPUTE ENGINE AND SYSTEM ENERGY CONSUMPTION
PRINT FUEL AND ENERGY CONSUMPTION ON MODE 1 AND 2
190

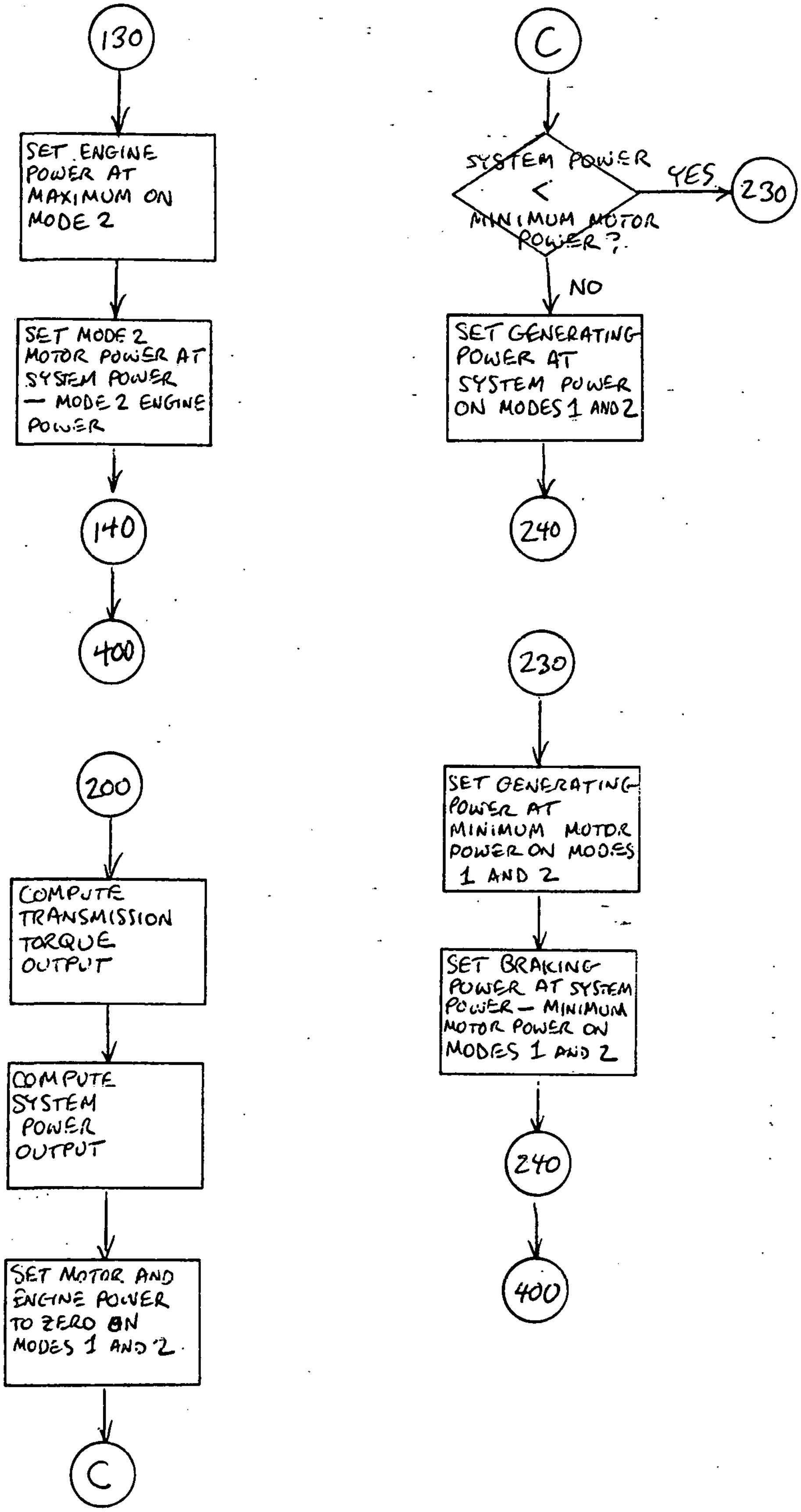

110
NUMERICAL (RUNGE-KUTTA) INTEGRATION TO NEXT TIME STEP USING VEHIC
INCREMENT TIME STEP
160

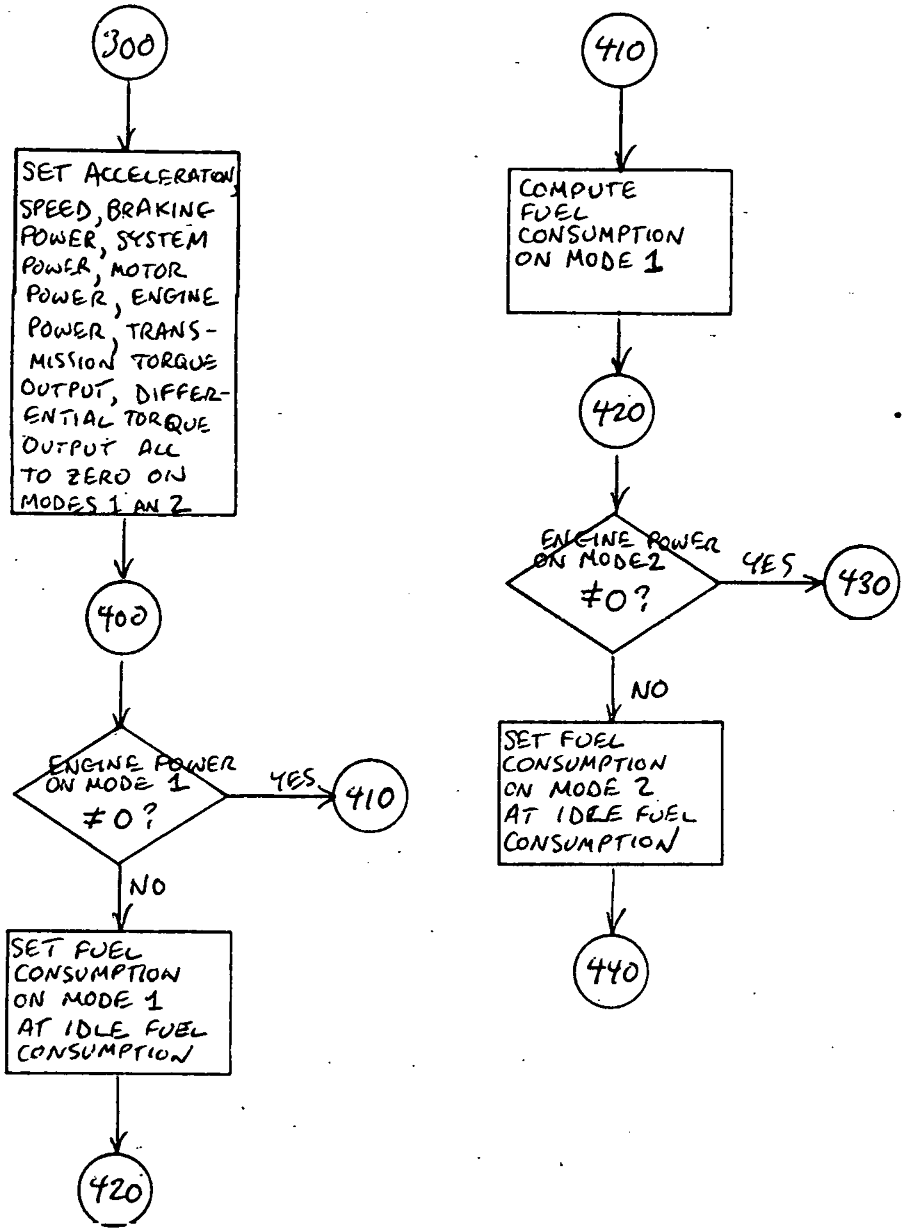

JCYC=1,NCYCLE
190
JC=1,NCOMP
COMPUTE FUEL AND ENERGY CONSUMPTION ON MODES 1 AND 2
COMPUTE RANGE ON MODE 1, FUEL CONSUMPTION ON MODE 2
COMPUTE FRACTION OF TOTAL DRIVING DONE ON MODE 1
COMPUTE MODE AVERAGED FUEL AND ENERGY CONSUMPTION
COMPUTE OVERALL AVERAGE YEARLY FUEL AND ENERGY CONSUMPTION
COMPUTE AVERAGE YEARLY SYSTEM AND ENGINE ENERGY CONSUMPTION, FUEL ECONOMY, WALL PLUG OUTPUT
300
C
C
COMPUTE HEATENGINE ENERGY FRACTION
COMPUTE ESTIMATED BATTERY LIFE
PRINT SUMMARY HEADER
PRINT FUEL AND ENERGY CONSUMPTION, MODES 1 AN 2, ON ALL COMPOSITE CYCLES
PRINT YEARLY AVERAGE FUEL AND ENERGY CONSUMPTION AND BATTERY LIFE
PRINT YEARLY AVERAGE FUEL ECONOMY AND WALL PLUG OUTPUT
PRINT HEAT ENGINE ENERGY FRACTION
194
JCASE=1,NCASE
STOP

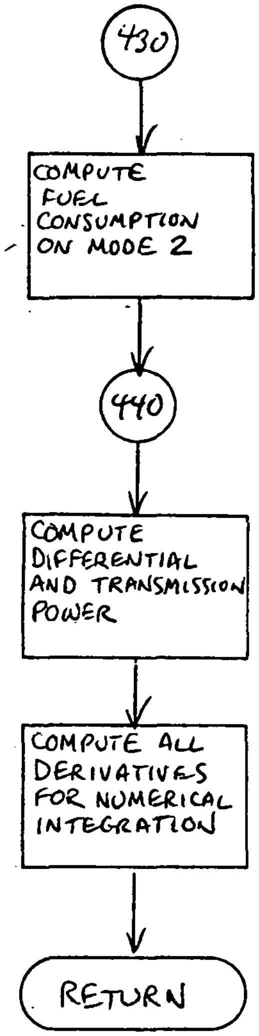
VEHIC Subroutine Flowchart



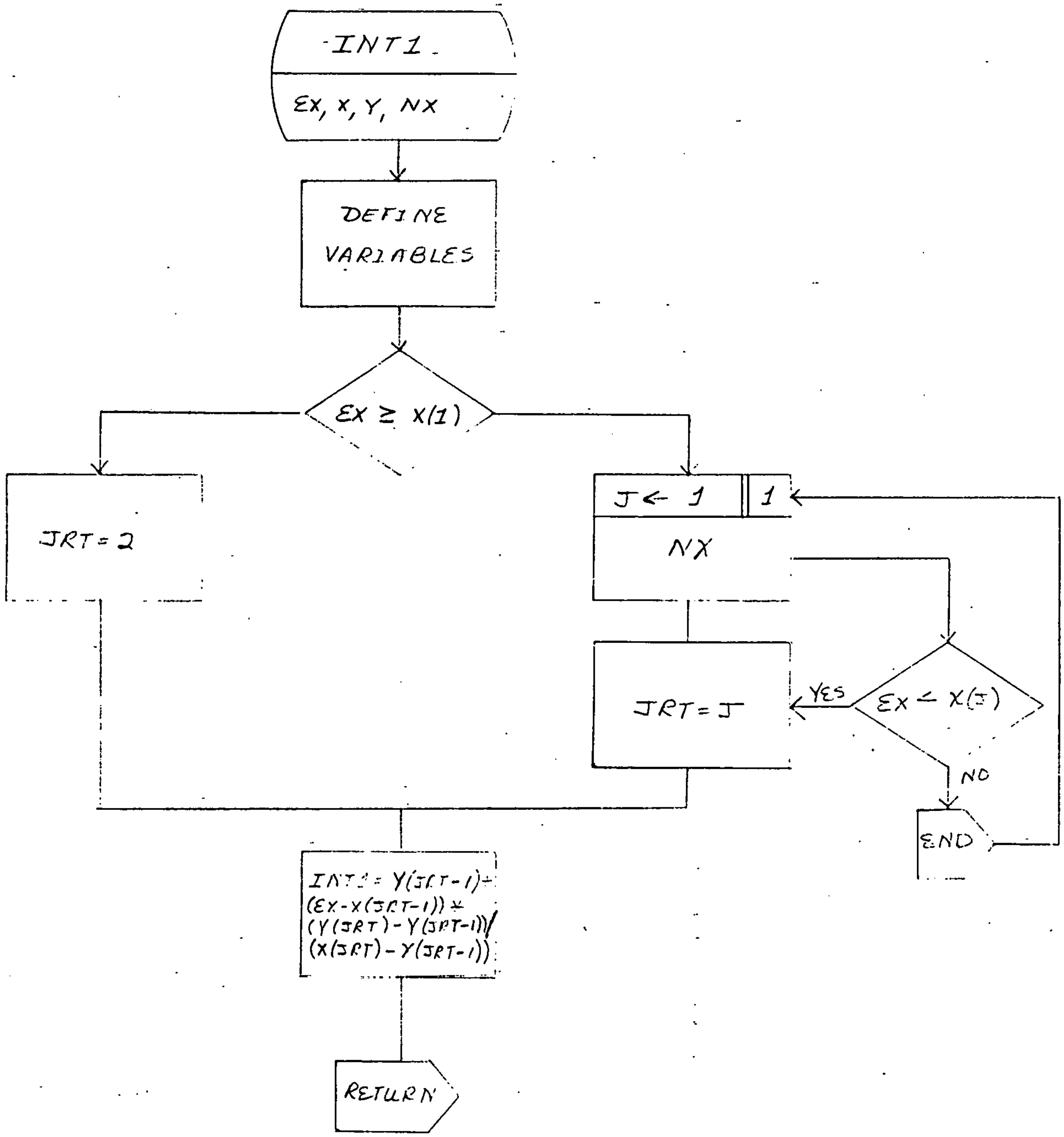

B
ALL SYSTEM POWER COMES FROM MOTOR ON MODE 1
120
100
SYSTEM POWER > MAXIMUM MOTOR POWER + MINIMUM ENGINE POWER ?
YES
110
NO
SET ENGINE POWER AT MINIMUM ON MODE 1
SET MOTOR POWER AT SYSTEM POWER — MINIMUM ENGINE POWER ON MODE 1
120
110
SET ENGINE POWER AT SYSTEM POWER — MAXIMUM MOTOR POWER ON MODE 1
SET MOTOR POWER AT MAXIMUM ON MODE 1
120
SYSTEM POWER > MAXIMUM ENGINE POWER ?
YES
130
NO
SET ENGINE POWER AT SYSTEM POWER ON MODE 2
SET MOTOR POWER AT ZERO ON MODE 2
140


130
SET ENGINE POWER AT MAXIMUM ON MODE 2
SET MODE 2 MOTOR POWER AT SYSTEM POWER — MODE 2 ENGINE POWER
140
400
200
COMPUTE TRANSMISSION TORQUE OUTPUT
COMPUTE SYSTEM POWER OUTPUT
SET MOTOR AND ENGINE POWER TO ZERO ON MODES 1 AND 2
C
C
SYSTEM POWER < MINIMUM MOTOR POWER?
YES
230
NO
SET GENERATING POWER AT SYSTEM POWER ON MODES 1 AND 2
240
230
SET GENERATING POWER AT MINIMUM MOTOR POWER ON MODES 1 AND 2
SET BRAKING POWER AT SYSTEM POWER — MINIMUM MOTOR POWER ON MODES 1 AND 2
240
400

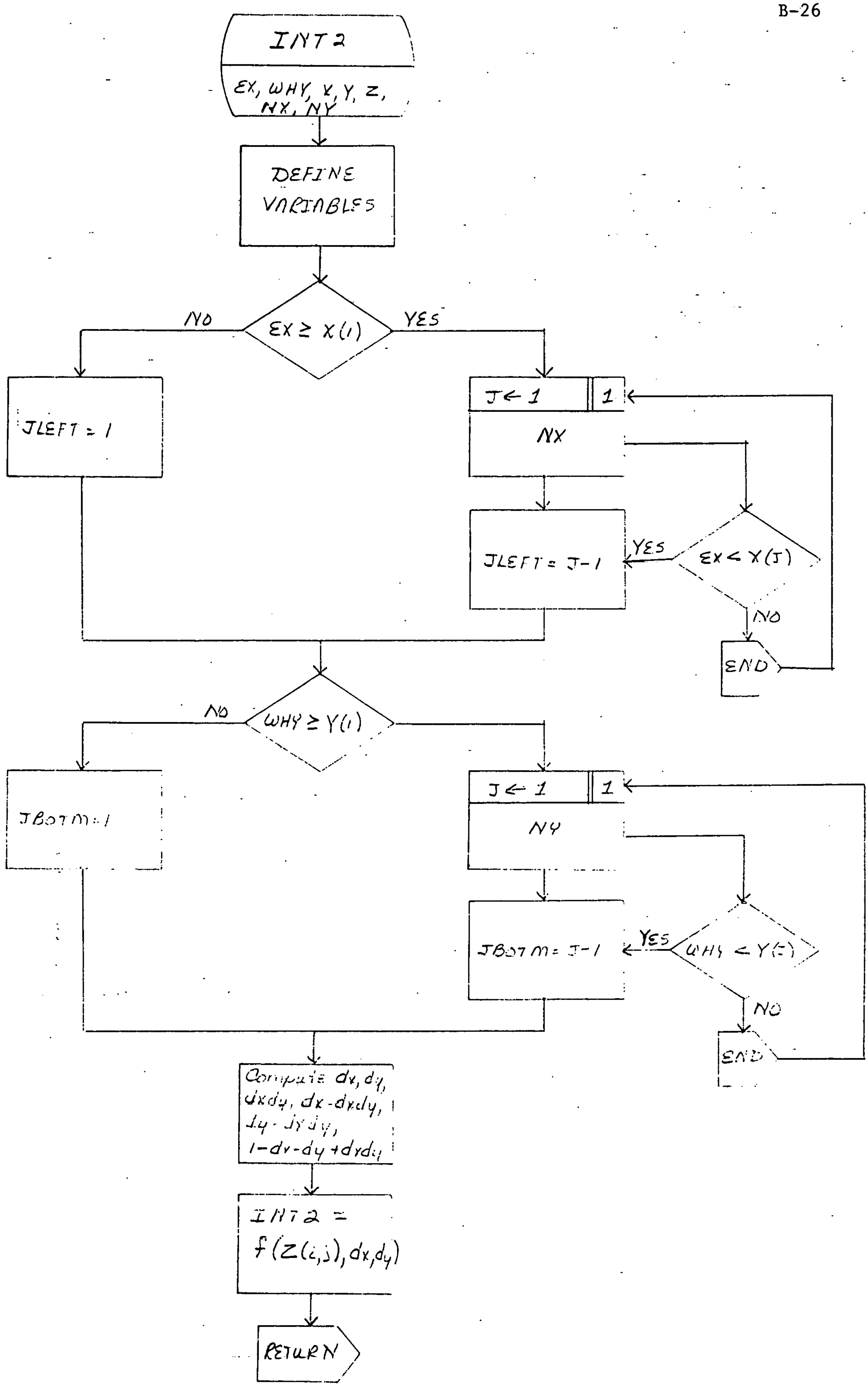

300
SET ACCELERATION, SPEED, BRAKING POWER, SYSTEM POWER, MOTOR POWER, ENGINE POWER, TRANSMISSION TORQUE OUTPUT, DIFFERENTIAL TORQUE OUTPUT ALL TO ZERO ON MODES 1 AN 2
400
ENGINE POWER ON MODE 1 ≠0?
YES
410
NO
SET FUEL CONSUMPTION ON MODE 1 AT IDLE FUEL CONSUMPTION
420
410
COMPUTE FUEL CONSUMPTION ON MODE 1
420
ENGINE POWER ON MODE2 ≠0?
YES
430
NO
SET FUEL CONSUMPTION ON MODE 2 AT IDLE FUEL CONSUMPTION
440


430
COMPUTE FUEL CONSUMPTION ON MODE 2
440
COMPUTE DIFFERENTIAL AND TRANSMISSION POWER
COMPUTE ALL DERIVATIVES FOR NUMERICAL INTEGRATION
RETURN

SUBROUTINE INT1



SUBROUTINE INT2



GOLETA FORTRAN 1.3 * SEMI-AUTO RFL * (01-10-73)

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                PROGRAM HYBRID
           C
           C    HYBRID MODELS OPERATION OF A HYBRID VEHICLE OVER SPECIFIED DRI
           C    CYCLES.
           C
           C    DATA IN COMMON -
000003          COMMON RTIRE,DRATIO,CDA,CTIRE1,CTIRE2,VMASS,DLI,EMUD,EMUT,NPWR
               1PHE(20),BSFC(20),PHEZRO,PHEMAX,PMMAX,PMMIN,EMUM,EMUG,EMURG,EMU
               2EBMAX,WB,NTC(3),TIMC(3,200),SPEDC(3,200),PEOMIN,DBMAX,NCYCLE,
               3TIME(200),SPEED(200),NPRTC(3),DTC(3),TFC(3)
               4,FCIDLE,PINNLD
           C
           C    VARIABLES IN COMMON -
000003          COMMON FA,FR,FAC,FNET,TDO,TTO,RPMDO,RPMTO,VMASS2,SKALE,PSO,PEO
               1PEO2,PMO,PMO2,PGO,PGO2,PBRK,PBRK2,FC,PD,PT
           C
000003          REAL YDOT(20),Y(20),INT1,INT2,V(6),A(3),YTMP(20)
000003          REAL EK(80)
000003          REAL DIST(3),FCONS(3),FCCNS2(3),ECONS(3),ECONS2(3)
000003          REAL DDISCH(20),CYCLES(20),DSUP(30),DNC(30),GAMMA(30,3),FCBAR(
               1FCBAR2(30),ECBAR(30),ECBAR2(30),RANGE(30),FCMAV(30),ECMAV(30),
               2RFRAC(30),DBAR(30),PHEZ(20)
000003          REAL ECHE(3),ECSYS(3),EHEBAR(30),ESYSBR(30)
           C    INPUT ENGINE DATA
           C
000003          READ 600,NPWR,PHEZRO,FCDL,FUELSG
000017          READ 610,(PHEZ(J),BSFC(J),J=1,NPWR)
           C
           C    INPUT TRANSMISSICN DATA
           C
000034          READ 610,EMUT
000042          PRINT 840
000046          PRINT 845,EMUT
           C
           C    INPUT BATTERY DATA
           C
000054          READ 600,NDDSCH,CHGEFF
000064          READ 610,(DDISCH(J),CYCLES(J),J=1,NDDSCH)
000101          PRINT 850
000105          PRINT 980
000111          PRINT 910,(DDISCH(J),CYCLES(J),J=1,NDDSCH)
           C
           C    INPUT DIFFERENTIAL AND TIRE DATA
           C
000126          READ 610,DRATIO,EMUD,RTIRE,CTIRE1,CTIRE2
000144          PRINT 875
000150          PRINT 880
000154          PRINT 885,DRATIO,EMUD,RTIRE,CTIRE1,CTIRE2
           C
           C    INPUT DRIVING CYCLE DATA
           C
000172          READ 620,NCYCLE
000200          PRINT 915
000204          DO 45 JC=1,NCYCLE
000206          READ 625,NTC(JC),NPRTC(JC),NUNITS,DTC(JC),TFC(JC)
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000223            NT=NTC(JC)
000225            READ 610,(TIMC(JC,J),SPEDC(JC,J),J=1,NT)
000245            IF(NUNITS.NE.1)GO TO 41
            C
            C     CONVERT MPH TO KILOMETERS PER HOUR
            C
000247         30 DO 40 J=1,NT
000251            SPEDC(JC,J)=SPEDC(JC,J)*1.6093
000254         40 CONTINUE
000256         41 PRINT 920
000262            PRINT 910,(TIMC(JC,J),SPEDC(JC,J),J=1,NT)
000302         45 CONTINUE
000305            READ 600,NCOMP,DSTAV
000314            PRINT 990,DSTAV
000322            PRINT 995
000326            DO 320 JC=1,NCOMP
000330            READ 610,DSUP(JC),DNC(JC),(GAMMA(JC,J),J=1,NCYCLE)
000347            PRINT 815,DSUP(JC),DNC(JC),(GAMMA(JC,J),J=1,NCYCLE)
000367        320 CONTINUE
000372            DBAR(1)=DSUP(1)/2.
000374            DO 46 J=2,NCOMP
000375            DBAR(J)=(DSUP(J)+DSUP(J-1))/2.
000401         46 CONTINUE
            C     INPUT RUN DATA
            C
000403            READ 600,NCASE
000410            DO 194 JCASE=1,NCASE
000412            PRINT 925,JCASE
000417            READ 610,PEOMIN,DBMAX,PHEMAX
000431            PRINT 930,PECMIN,DBMAX
000441            SKALE=PHEMAX/PHEZRO
000443            FCIDLE=FCDL*SKALE
000445            PRINT 800,FCIDLE
000452            DO 5 J=1,NPWR
000454            PHE(J)=PHEZ(J)*SKALE
000457          5 CONTINUE
000461            PRINT 805
000464            PRINT 820,(PHE(J),BSFC(J),J=1,NPWR)
            C
            C     INPUT MOTOR/GENERATOR DATA
            C
000501            READ 610,PMMAX,PMMIN,EMUM,EMUG,PINNLD
000517            PRINT 811
000523            PRINT 812
000527            PRINT 815,PMMAX,PMMIN,EMUM,EMUG,PINNLD
000545            READ 610,WB,EBMAX,EMURG,EMURG2
000561            PRINT 855
000565            PRINT 810,WB,EBMAX,EMURG,EMURG2
            C
            C     INFUT VEHICLE DATA
            C
000601            READ 610,VMASS,DLI,CDA
000613            PRINT 890,VMASS,DLI,CDA
000625            VMASS2=VMASS+DLI/RTIRE**2
000631            DO 190 JCYC=1,NCYCLE
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000632             PRINT 700
000635             NTIME=NTC(JCYC)
000637             NPRNT=NPRTC(JCYC)
000641             DELT=DTC(JCYC)
000642             TF=TFC(JCYC)
000644             DO 47 J=1,NTIME
000645             TIME(J)=TIMC(JCYC,J)
000651             SPEED(J)=SPEDC(JCYC,J)
000654          47 CONTINUE
             C
             C     INITIALIZE VARIABLES OF INTEGRATION
             C
000656             DO 50 J=1,20
000657             Y(J)=0.0
000660          50 CONTINUE
000662             T=0.0
000663             K=NPRNT
             C
             C     COMPUTE VELOCITY AND ACCELERATION
             C
000664             V(1)=0.0
000665             V(3)=SPEED(1)
000666             V(4)=INT1(DELT/2.,TIME,SPEED,NTIME)
000674             V(5)=INT1(DELT,TIME,SPEED,NTIME)
000700             V(6)=INT1(3.*DELT/2.,TIME,SPEED,NTIME)
000706             V(2)=V(3)+V(3)-V(4)
000710             GO TO 70
000711          60 V(1)=V(3)
000713             V(3)=Y(11)
000714             V(2)=(V(1)+V(3))/2.
000717             V(4)=V(6)
000720             V(5)=INT1(T+DELT,TIME,SPEED,NTIME)
000726             V(6)=INT1(T+3.*DELT/2.,TIME,SPEED,NTIME)
000736          70 A(1)=(V(4)-V(2))/(3.6*DELT)
000742             A(1)=AMIN1(A(1),9.8)
000745             A(2)=(V(5)-V(3))/(3.6*DELT)
000751             A(2)=AMIN1(A(2),9.8)
             C
             C     COMPUTE VEHICLE OPERATING CONDITIONS AT MAJOR TIME POINT
             C
000754             CALL VEHIC(V(3),A(1),T,YDOT)
000757         105 DO 106 JV=1,19
000761             EK(JV)=YDOT(JV)
000763         106 CONTINUE
             C
             C     TIME TO PRINT RESULTS -
             C
000765             IF(T.EQ.TF)GO TO 107
000767             K=K+1
000770             IF(K.LT.NPRNT)GO TO 110
000772             K=0
000773         107 EB=Y(18)
000775             EB2=Y(19)
000776             PRINT 710,T,Y(11),PSO,(Y(J),J=1,5),PMO,PEO,PGO,PBRK,Y(6),Y(8),
                  1),Y(14),Y(16),EB,PMO2,PEO2,PGO2,PBRK2,Y(7),Y(9),Y(13),Y(15),Y(
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                 2EB2
 01066           IF(T.LT.TF)GO TO 110
001071           DIST(JCYC)=Y(12)
001073           FCONS(JCYC)=Y(16)/Y(12)
001075           ECONS(JCYC)=EB/(3.6*Y(12))
001077           FCONS2(JCYC)=Y(17)/Y(12)
001101           ECONS2(JCYC)=EB2/(3.6*Y(12))
001104           ECHE(JCYC)=Y(8)/Y(12)
001106           ECSYS(JCYC)=(Y(6)+Y(8))/Y(12)
001110           PRINT 940,Y(12),FCONS(JCYC),FCONS2(JCYC),ECONS(JCYC),ECONS2(JCY
001126           IF(T.GE.TF)GO TO 190
           C
           C     INTEGRATE TO NEXT TIME STEP
           C
001131       110 TTMP=T
001133           DO 170 JV=1,3
001134           JA=MAX0(2,JV)
001137           IF(JV.EQ.2)GO TO 121
001140           TTMP=TTMP+DELT/2.
001143       121 DT=TTMP-T
001145           IF(JV.NE.3)GO TO 122
001147           A(3)=(V(6)-(VTMP+VTMPL)/2.)/(3.6*DELT)
001156           A(3)=AMIN1(A(3),9.8)
001161       122 VTMPL=VTMP
001163           VTMP=Y(11)+EK(11+(JV-1)*19)*DT
001172       130 CALL VEHIC(VTMP,A(JA),TTMP,YDOT)
001177       160 DO 170 JK=1,19
001201           EK(JK+19*JV)=YDOT(JK)
001206       170 CONTINUE
001212           DO 180 JK=1,19
001213           Y(JK)=Y(JK)+DELT*(EK(JK)+2.*(EK(JK+19)+EK(JK+38))+EK(JK+57))/6.
001224       180 CONTINUE
001226           T=T+DELT
001227           GO TO 60
001230       190 CONTINUE
001233           FCAV=0.0
001234           ECAV=0.0
001235           EHEAV=0.0
001236           ESYSAV=0.0
001237           DO 300 JC=1,NCOMP
           C
           C     COMPUTE FUEL AND ENERGY CONSUMPTION ON COMPOSITE DRIVING CYCLES
           C     FOR MODES1 AND 2.
           C
001240           FCBAR(JC)=0.0
001241           FCBAR2(JC)=0.0
001242           ECBAR(JC)=0.0
001243           ECBAR2(JC)=0.0
001244           EHEBAR(JC)=0.0
001245           ESYSBR(JC)=0.0
001246           DO 260 KC=1,NCYCLE
001250           FCBAR(JC)=FCBAR(JC)+GAMMA(JC,KC)*FCONS(KC)
001256           FCBAR2(JC)=FCBAR2(JC)+GAMMA(JC,KC)*FCONS2(KC)
001263           ECBAR(JC)=ECBAR(JC)+GAMMA(JC,KC)*ECONS(KC)
001270           ECBAR2(JC)=ECBAR2(JC)+GAMMA(JC,KC)*ECONS2(KC)
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001276          EHEBAR(JC)=EHEBAR(JC)+GAMMA(JC,KC)*ECHE(KC)
001303          ESYSBR(JC)=ESYSBR(JC)+GAMMA(JC,KC)*ECSYS(KC)
001311      260 CONTINUE
          C
          C     COMPUTE RANGE ON MODE 1 AND CORRECT FUEL CONSUMPTION FOR NON-Z
          C     BATTERY ENERGY USAGE ON MODE 2, FOR COMPOSITE DRIVING CYCLE.
          C
001313          RANGE(JC)=EBMAX*WB*DBMAX/(1000.*ECBAR(JC))
001320          FCBAR2(JC)=(FCBAR2(JC)*ECBAR(JC)-FCBAR(JC)*ECBAR2(JC))/(ECBAR(
               1ECBAR2(JC))
          C
          C      COMPUTE FRACTION OF TOTAL DRIVING DONE ON MODE 1 FOR EACH
          C     COMPOSITE CYCLE.
          C
001327          IF(JC.NE.1)GO TO 265
001331          DLOW=0.
001332          GO TO 266
001332      265 DLOW=DSUP(JC-1)
001334      266 IF(RANGE(JC).GT.DLOW)GO TO 270
001341          RFRAC(JC)=RANGE(JC)/DBAR(JC)
001343          GO TO 280
001344      270 IF(RANGE(JC).GT.DSUP(JC))GO TO 275
001351          RFRAC(JC)=(RANGE(JC)/DBAR(JC))*(1.-(RANGE(JC)-DLOW)**2/(2.*
               1RANGE(JC)*(DSUP(JC)-DLOW)))
001365          GO TO 280
001365      275 RFRAC(JC)=1.
001367      280 CONTINUE
          C
          C     COMPUTE MODE-AVERAGED FUEL AND ENERGY CONSUMPTION FOR COMPOSIT
          C     DRIVING CYCLE.
          C
001367          FCMAV(JC)=RFRAC(JC)*FCBAR(JC)+ (1.-RFRAC(JC))*FCBAR2(JC)
001375          ECMAV(JC)=RFRAC(JC)*ECBAR(JC)+(1.-RFRAC(JC))*ECBAR2(JC)
          C
          C     COMPUTE OVERALL FUEL AND ENERGY CONSUMPTION.
          C
001402          FCAV=FCAV+DNC(JC)*FCMAV(JC)
001406          ECAV=ECAV+DNC(JC)*ECMAV(JC)
001411          EHEAV=EHEAV+DNC(JC)*EHEBAR(JC)
001415          ESYSAV=ESYSAV+DNC(JC)*ESYSBR(JC)
001420          FEAV=1000.*FUELSG*.89/FCAV
001424          WPAV=ECAV/CHGEFF
001426      300 CONTINUE
          C
001430          HEEF=EHEAV/ESYSAV
          C     ESTIMATE BATTERY LIFE.
          C
001432          DDAV=ECAV*DSTAV*1000./(EBMAX*WB)
001437          BLIFE=DSTAV*INT1(DDAV,DDISCH,CYCLES,NDDSCH)
001444          PRINT 950
001447          PRINT 960,(FCBAR(J),FCBAR2(J),ECBAR(J),RANGE(J),FCMAV(J),ECMAV
               1J=1,NCOMP)
001474          PRINT 970,FCAV,ECAV,BLIFE
001506          PRINT 975,FEAV,WPAV
001516          PRINT 1010,HEEF
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^01524      194 CONTINUE
 01527      200 STOP
          C
          C       FORMAT STATEMENTS
 001531     600 FORMAT(I10,6F10.4)
 001531     610 FORMAT(7F10.4)
 001531     620 FORMAT(7I10)
 001531     625 FORMAT(3I10,2F10.4)
 001531     700 FORMAT(1H0,4X,4HTIME,8X,5HSPEED,5X,9HSYS. PWR.,5X,5HAERO.,7X,
               15HTIRES,7X,5HDIFF.,6X,6HTRANS.,4X,10HSYSTEM OUT/7X,9HMOT. PWR.
               23X,9HENG. PWR.,3X,9HGEN. PWR.,3X,9HBRK. PWR.,3X,9HMOTOR OUT,2X
               310HENGINE OUT,3X,7HGEN. IN,6X,6HBRAKES,7X,4HFUEL,6X,9HBATT. OU
 001531     710 FORMAT(1H ,8E12.4/6X,10E12.4/6X,10E12.4)
 001531     800 FORMAT(1H0,11HENGINE DATA/1X,16HIDLE FUEL RATE =,E12.4)
 001531     805 FORMAT(1H0,6X,5HPOWER,11X,4HBSFC)
 001531     810 FORMAT(1H ,4E16.6)
 001531     811 FORMAT(1H0,20HMOTOR/GENERATOR DATA)
 001531     812 FORMAT(1H0,3X,10HMAX. POWER,6X,10HMIN. POWER,6X,10HMOTOR EFF.,
               19HGEN. EFF.,5X,13HNO LOAD INPUT)
 001531     815 FORMAT(1H ,5E16.6)
 001531     820 FORMAT(1H ,2E16.6)
 001531     840 FORMAT(1H0,12HGEARBOX DATA)
 001531     845 FORMAT(1H0,5X,12HEFFICIENCY =,E16.6)
 001531     850 FORMAT(1H0,12HBATTERY DATA)
 001531     855 FORMAT(1H0,6X,4HMASS,7X,14HENERGY DENSITY,2X,15HAV. REGEN. EFF
               11X,15HMAX REGEN. EFF.)
 )01531     875 FORMAT(1H0,18HAXLE AND TIRE DATA )
 J01531     880 FORMAT(1H0,3X,11HDIFF. RATIO,5X,10HEFFICIENCY,4X 14HROLLING RA
               1,5X,25HROLL. RESIST. COEFFICIENTS)
 001531     885 FORMAT(1H ,5E16.6)
 001531     890 FORMAT(1H0,14HVEHICLE MASS =,E16.6,5X,19HDRIVELINE INERTIA =,E
               1,5X,19H(DRAG COEF.)*AREA =,E16.6)
 001531     910 FORMAT(1H ,2E16.6)
 001531     915 FORMAT(1H0,14HDRIVING CYCLES)
 001531     920 FORMAT(1H0,6X,4HTIME,12X,5HSPEED)
 001531     925 FORMAT(1H1,27HCONTROL PARAMETERS FOR CASE,I2)
 001531     930 FORMAT(1H0,5X,25HHEAT ENG. SHUTOFF POWER =,E11.4,22H  BATT. DI
               1 LIMIT =,E11.4)
 001531     950 FORMAT(1H0,47HFUEL AND ENERGY CONSUMPTION ON COMPOSITE CYCLES/
               113HFUEL - MODE 1,3X,13HFUEL - MODE 2,2X,15HENERGY - MODE 1,1X,
               214HRANGE - MODE 1,4X,10HFUEL - AV.,5X,12HENERGY - AV.)
 001531     960 FORMAT(1H ,6E16.6)
 001531     970 FORMAT(1H0,29HYEARLY AV. FUEL CONSUMPTION =,E16.6/1X,34HYEARLY
               1 BATTERY ENERGY OUTPUT =,E16.6/1X,23HEXPECTED BATTERY LIFE =,E
               2)
 001531     975 FORMAT(1H0,25HYEARLY AV. FUEL ECONOMY =,E16.6/1X,
               129HYEARLY AV. WALL PLUG OUTPUT =,E16.6)
 001531     940 FORMAT(1H0,16HCYCLE DISTANCE =,E12.4/1X,28HFUEL CONSUMPTION ON
               1E 1 =,E12.4/21X,8HMODE 2 =,E12.4/1X,36HBATT. ENERGY CONSUMPTIO
               2 MODE 1 =,E12.4/29X,8HMODE 2 =,E12.4)
 001531     980 FORMAT(1H0,1X,15HDEPTH OF DISCH.,6X,10HCYCLE LIFE)
 )01531     990 FORMAT(1H0,24HTRAVEL DISTRIBUTION DATA/1X,11HAV. USAGE =,E12.4
 )01531     995 FORMAT(1H0,3X,10HMAX. DIST.,4X,15HFRACT. OF TOTAL,14X,21HDRIVI
               1YCLE WEIGHTS)
 001531    1010 FORMAT(1H0,29HHEAT ENGINE ENERGY FRACTION =,E16.6)
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GOLETA FORTRAN 1.3 * SEMI-AUTO RFL * (01-10-73)

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                  SUBROUTINE VEHIC(V,A,T,YDOT)
            C
            C     VEHIC COMPUTES POWER REQUIREMENTS AND LOSSES FROM REAR WHEELS
            C         THROUGH ENGINE
            C
            C     DATA IN COMMON -
            C
 000007           COMMON RTIRE,DRATIO,CDA,CTIRE1,CTIRE2,VMASS,DLI,EMUD,EMUT,NPWR
                 1PHE(20),BSFC(20),PHEZRO,PHEMAX,PMMAX,PMMIN,EMUM,EMUG,EMURG,EMU
                 2EBMAX,WB,NTC(3),TIMC(3,200),SPEDC(3,200),PEOMIN,DBMAX,NCYCLE,
                 3TIME(200),SPEED(200),NPRTC(3),DTC(3),TFC(3)
                 4,FCIDLE,PINNLD
            C
            C     VARIABLES IN COMMON -
            C
 000007           COMMON FA,FR,FAC,FNET,TDO,TTO,RPMDO,RPMTO,VMASS2,SKALE,PSO,PEO
                 1PEO2,PMO,PMO2,PGO,PGO2,PBRK,PBRK2,FC,PD,PT
            C
 000007           REAL YDOT(20),INT1,INT2
            C
            C     COMPUTE SPEEDS AND LOAD-INDEPENDENT LOSSES THROUGH DRIVE TRAIN
            C
 000007           VMPS=V/3.6
 000011           RPMDO=9.5492967*VMPS/RTIRE
 000013           RPMTO=RPMDO*DRATIO
            C     COMPUTE ROAD LOAD POWER REQUIREMENTS
            C     AERODYNAMIC -
            C
 000015           FA=0.6125*CDA*VMPS**2
 000017           PA=FA*VMPS/1000.
 000021           YDOT(1)=PA/1000.
            C
            C     ROLLING RESISTANCE -
            C
 000022           FR=9.807*VMASS*(CTIRE1+CTIRE2*V)
 000027           PR=FR*VMPS/1000.
 000031           YDOT(2)=PR/1000.
            C
            C     ACCELERATION -
            C
 000033           FAC=VMASS2*A
 000034           FNET=FA+FR+FAC+FG
 000040           TDO=FNET*RTIRE
 000042           IF(FNET.LT.0.0)GO TO 200
            C
            C     NON-NEG. NET DRIVING FORCE TO THE WHEELS IS NEEDED
            C     DIFFERENTIAL -
            C
 000043           TTO=TDO/(EMUD*DRATIO)
            C
            C     TRANSMISSION -
            C
 000046           PSO=TTO*RPMTO*0.000104719 7/EMUT
            C
            C     IS CAR AT REST AND IDLING -
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              C
 000051             IF(ABS(VMPS).LT.0.2.AND.ABS(A).LT.0.1)GO TO 300
              C
 000063             PBRK=0.0
 000064             PGO=0.0
 000065             PBRK2=0.0
 000066             PGO2=0.0
 000067             IF(PSO.GT.PEOMIN)GO TO 100
 000072             PEO=0.0
 000072             PMC=PSO
 000073             GO TO 120
 000074         100 IF(PSO.GT.(PMMAX+PEOMIN))GO TO 110
 000101             PEO=PEOMIN
 000101             PMO=PSO-PEOMIN
 000103             GO TO 120
 000103         110 PEO=PSO-PMMAX
 000105             PMO=PMMAX
 000106         120 IF(PSO.GT.PHEMAX)GO TO 130
 000112             PEO2=PSO
 000112             PMO2=0.0
 000113             GO TO 140
 000114         130 PEO2=PHEMAX
 000116             PMO2=PSO-PEO2
 000120         140 GO TO 400
              C
              C     NET DRIVING FORCE AT WHEELS IS NEGATIVE
              C
 000121         200 TTO=TDO*EMUD/DRATIO
 000124             PSO=TTO*RPMTC*0.0001047197*EMUT
 000127             PMO=0.0
 000130             PEO=0.0
 000131             PMO2=0.0
 000132             PEO2=0.0
 000133             IF(PSO.LT.PMMIN)GO TO 230
 000135             PGO=PSO
 000136             PGO2=PSO
 000137             GO TO 240
 000137         230 PGO=PMMIN
 000141             PBRK=PSO-PMMIN
 000142             PGO2=PMMIN
 000143             PBRK2=PBRK
 000145         240 GO TO 400
              C
              C     CAR IS AT REST AND IDLING
              C
 000146         300 A=0.0
 000147             VMPS=0.0
 000150             PBRK=0.0
 000151             PBRK2=0.0
 000152             PSO=0.0
 000153             PMO=0.0
 000154             PMO2=0.0
 000155             PEO=0.0
 000156             PEO2=0.0
 000157             TTO=0.0
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000160           TDO=0.0
           C
           C     COMPUTE ENGINE FUEL RATE AND DERIVATIVES OF VARIABLES
           C
000161       400 IF(PEO.NE.0.0)GO TO 410
000162           FC=FCIDLE
000164           GO TO 420
000164       410 FC=INT1(PEO,PHE,BSFC,NPWR)*PEO
000171       420 IF(PEO2.NE.0.0)GO TO 430
000175           FC2=FCIDLE
000176           GO TO 440
000177       430 FC2=INT1(PEO2,PHE,BSFC,NPWR)*PEO2
000204       440 PD=TDO*RPMDO*0.0001047197
000207           PT=TTO*RPMTO*0.0001047197
000211           YDOT(3)=ABS(PT-PD)/1000.
000217           YDOT(4)=ABS(PSO-PT)/1000.
000222           YDOT(5)=PSO/1000.
000223           YDOT(6)=PMO/1000.
000225           YDOT(7)=PMO2/1000.
000226           YDOT(8)=PEO/1000.
000230           YDOT(9)=PEO2/1000.
000231           YDOT(10)=PGO/1000.
000233           YDOT(11)=A*3.6
000235           YDOT(12)=VMPS/1000.
000237           YDOT(13)=PGO2/1000.
000240           YDOT(14)=PBRK/1000.
000242           YDOT(15)=PBRK2/1000.
000243           YDOT(16)=FC/3600.
000245           YDOT(17)=FC2/3600.
000247           YDOT(18)=(PINNLD+PMO/EMUM+PGO*EMUG*EMURG)/1000.
000256           YDOT(19)=(PINNLD+PMO2/EMUM+PGO2*EMUG*EMURG2)/1000.
000265           RETURN
000266           END
```

GOLETA FORTRAN 1.3 * SEMI-AUTO RFL * (01-10-73)

```
                  REAL FUNCTION INT1(EX,X,Y,NX)
000007            REAL X(200),Y(200)
000007            IF(EX.GE.X(1))GO TO 5
000011            JRT=2
000012            GO TO 20
000013          5 DO 10 J=1,NX
000015            IF(EX.LT.X(J))GO TO 15
000020         10 CONTINUE
000022         15 JRT=J
000024         20 INT1=Y(JRT-1)+(EX-X(JRT-1))*(Y(JRT)-Y(JRT-1))/(X(JRT)-X(JRT-1)
000040            RETURN
000041            END
```

GOLETA FORTRAN 1.3 * SEMI-AUTO RFL * (01-10-73)

```
                  REAL FUNCTION INT2(EX,WHY,X,Y,Z,NX,NY)
            C
            C     INT2 INTERPOLATES IN TWO VARIAVLES INTERPOLATION SURFACE IS A
            C     RULED SURFACE.
            C
000012            REAL X(20),Y(20),Z(20,20)
000012            IF(EX.GE.X(1))GO TO 5
000014            JLEFT=1
000015            GO TO 20
000016          5 DO 10 J=1,NX
000020            IF(EX.LT.X(J))GO TO 15
000023         10 CONTINUE
000025         15 JLEFT=J-1
000027         20 IF(WHY.GE.Y(1))GO TO 25
000032            JBOTM=1
000033            GO TO 40
000033         25 DO 30 J=1,NY
000035            IF(WHY.LT.Y(J))GO TO 35
000040         30 CONTINUE
000043         35 JBOTM=J-1
000045         40 RX=(EX-X(JLEFT))/(X(JLEFT+1)-X(JLEFT))
000052            RY=(WHY-Y(JBCTM))/(Y(JBOTM+1)-Y(JBOTM))
000056            RXRY=RX*RY
000060            W1=1.-RX-RY+RXRY
000063            W2=RY-RXRY
000065            W3=RXRY
000066            W4=RX-RXRY
000067            INT2=W1*Z(JLEFT,JBOTM)+W2*Z(JLEFT,JBOTM+1)+W3*Z(JLEFT+1,JBOTM+
                 1+W4*Z(JLEFT+1,JBOTM)
000110            RETURN
000110            END
```

GEARBOX DATA

EFFICIENCY = 9.200000E-01

BATTERY DATA

DEPTH OF DISCH.	CYCLE LIFE
0.	9.000000E+03
2.000000E-01	4.800000E+03
4.000000E-01	3.300000E+03
5.000000E-01	2.700000E+03
6.000000E-01	2.250000E+03
7.000000E-01	1.800000E+03
8.000000E-01	1.500000E+03
9.000000E-01	1.230000E+03
1.000000E+00	1.000000E+03

AXLE AND TIRE DATA

DIFF. RATIO	EFFICIENCY	ROLLING RADIUS	ROLL. RESIST. COEFFICIENT	
3.080000E+00	9.600000E-01	3.160000E-01	1.000000E-02	0.

DRIVING CYCLES

TIME	SPEED
0.	0.
1.000000E+00	9.000000E+00
3.900000E+00	1.600000E+01
9.400000E+00	2.400000E+01
1.900000E+01	3.200000E+01
3.800000E+01	3.200000E+01
4.200000E+01	2.950000E+01
4.700000E+01	0.
7.200000E+01	0.

TIME	SPEED
0.	0.
2.000000E+01	0.
2.600000E+01	2.735910E+01
3.100000E+01	3.637018E+01
3.700000E+01	3.218600E+01
3.900000E+01	2.365671E+01
4.330000E+01	2.542694E+01
4.680000E+01	3.653111E+01
5.020000E+01	3.653111E+01
5.460000E+01	2.413950E+01
5.960000E+01	3.942795E+01
8.020000E+01	4.135991E+01
8.720000E+01	4.908365E+01
1.086000E+02	4.908365E+01
1.123000E+02	5.198039E+01
1.150000E+02	5.133667E+01
1.246000E+02	0.
1.630000E+02	0.
1.599000E+02	3.620925E+01
1.730000E+02	4.264645E+01
1.760000E+02	3.974971E+01
1.910000E+02	4.023250E+01
1.915000E+02	4.425575E+01
1.966000E+02	2.713717E+01
[illegible]	[illegible]

5.920000E+02	7.885570E+01
5.980000E+02	7.885570E+01
6.034000E+02	7.644175E+01
6.090000E+02	7.966035E+01
6.130000E+02	7.402780E+01
6.163000E+02	7.402780E+01
6.230000E+02	8.448825E+01
6.333000E+02	8.947708E+01
6.370000E+02	8.529290E+01
6.400000E+02	7.402780E+01
6.437000E+02	7.402780E+01
6.546000E+02	8.481011E+01
6.585000E+02	8.207430E+01
6.610000E+02	8.207430E+01
6.670000E+02	8.513197E+01
6.710000E+02	8.416539E+01
6.750000E+02	8.481011E+01
6.827000E+02	7.966035E+01
6.870000E+02	7.966035E+01
7.070000E+02	9.060359E+01
7.137000E+02	9.237382E+01
7.170000E+02	9.527056E+01
7.195000E+02	9.527056E+01
7.290000E+02	8.931615E+01
7.380000E+02	8.143058E+01
7.430000E+02	7.354501E+01
7.450000E+02	6.839525E+01
7.500000E+02	4.184180E+01
7.600000E+02	4.827900E+00
7.625000E+02	0.
8.000000E+02	0.

TRAVEL DISTRIBUTION DATA
AV. USAGE = 5.5780E+01

MAX. DIST.	FRACT. OF TOTAL	DRIVING CYCLE WEIGHTS		
2.000000E+01	4.607400E-02	2.040000E-01	7.960000E-01	0.
3.000000E+01	5.602400E-02	8.160000E-02	9.184000E-01	0.
4.000000E+01	7.592300E-02	5.828600E-02	9.417100E-01	0.
5.000000E+01	7.985700E-02	4.533300E-02	7.973300E-01	1.573300E-01
6.000000E+01	7.690900E-02	3.709100E-02	6.523600E-01	3.105500E-01
7.000000E+01	5.826500E-02	3.138500E-02	5.520000E-01	4.166200E-01
8.000000E+01	6.722800E-02	2.720000E-02	4.784000E-01	4.944000E-01
9.000000E+01	5.790600E-02	2.400000E-02	4.221200E-01	5.538800E-01
1.000000E+02	5.960900E-02	2.147400E-02	3.776800E-01	6.008400E-01
1.200000E+02	9.268600E-02	1.854500E-02	3.261800E-01	6.552700E-01
1.400000E+02	6.525600E-02	1.569200E-02	2.760000E-01	7.083100E-01
1.500000E+02	5.378300E-02	1.360000E-02	2.392000E-01	7.472000E-01
1.800000E+02	4.571500E-02	1.200000E-02	2.110600E-01	7.769400E-01
2.000000E+02	3.065600E-02	1.073700E-02	1.988400E-01	8.004200E-01
2.200000E+02	2.258900E-02	9.714000E-03	1.708600E-01	8.194300E-01
2.400000E+02	2.061700E-02	8.870000E-03	1.560000E-01	8.351300E-01
2.600000E+02	1.344600E-02	8.160000E-03	1.435200E-01	8.483200E-01
2.800000E+02	1.452100E-02	7.556000E-03	1.328900E-01	8.595600E-01
3.000000E+02	1.039800E-02	7.034000E-03	1.237200E-01	8.692400E-01
3.200000E+02	1.111500E-02	6.581000E-03	1.157400E-01	8.776800E-01
3.400000E+02	4.141300E-02	6.182000E-03	1.087300E-01	8.850900E-01

CONTROL PARAMETERS FOR CASE 1

HEAT ENG. SHUTOFF POWER = 1.0000E+01 BATT. DISCH. LIMIT = 8.0000E-01

ENGINE DATA
IDLE FUEL RATE = 0.

POWER	BSFC
8.753304E-01	1.765000E+03
1.750661E+00	9.130000E+02
2.632673E+00	6.090000E+02
3.501322E+00	4.900000E+02
5.251982E+00	3.830000E+02
7.009325E+00	3.350000E+02
1.051065E+01	2.830000E+02
1.401865E+01	2.650000E+02
1.751997E+01	2.880000E+02
2.636682E+01	3.270000E+02
3.390402E+01	3.470000E+02
4.237000E+01	3.530000E+02

MOTOR/GENERATOR DATA

MAX. POWER	MIN. POWER	MOTOR EFF.	GEN. EFF.	NO LOAD INPUT
2.824000E+01	-2.824000E+01	8.700000E-01	8.700000E-01	1.500000E+00

MASS	ENERGY DENSITY	AV. REGEN. EFF.	MAX REGEN. EFF.
2.420000E+02	5.000000E+01	6.000000E-01	8.500000E-01

VEHICLE MASS = 2.074000E+03 DRIVELINE INERTIA = 6.620000E+00 (DRAG COEF.)*AREA = 8.720000E-01

TIME / MOT. PWR.	SPEED / ENG. PWR.	SYS. PWR. / GEN. PWR.	AERO. / BRK. PWR.	TIRES / MOTOR OUT	DIFF. / ENGINE OUT	TRANS. / GEN. IN	SYSTEM OUT / BRAKES	FUEL	BATT. OUT
0.	0.	0.	0.	0.	0.	0.	0.		
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2.0000E+00	1.0792E+01	5.3405E+00	1.1417E-05	7.6118E-04	4.3264E-04	9.4052E-04	1.1756E-02		
5.9405E+00	0.	0.	0.	1.1756E-02	0.	0.	0.	0.	1.6513E-02
0.	5.9405E+00	0.	0.	0.	1.1756E-02	0.	0.	1.1764E+00	3.0000E-03
4.0000E+00	1.6118E+01	7.1234E+00	7.0131E-05	2.2874E-03	9.9187E-04	2.1562E-03	2.6953E-02		
7.1234E+00	0.	0.	0.	2.6953E-02	0.	0.	0.	0.	3.6980E-02
0.	7.1234E+00	0.	0.	0.	2.6953E-02	0.	0.	2.5542E+00	6.0000E-03
6.0000E+00	1.9054E+01	6.4960E+00	1.9603E-04	4.2775E-03	1.4353E-03	3.1202E-03	3.9002E-02		
6.4960E+00	0.	0.	0.	3.9002E-02	0.	0.	0.	0.	5.3830E-02
0.	6.4960E+00	0.	0.	0.	3.9002E-02	0.	0.	3.7637E+00	9.0000E-03
8.0000E+00	2.1964E+01	7.5160E+00	3.3453E-04	6.5950E-03	1.9507E-03	4.2407E-03	5.3009E-02		
7.5160E+00	0.	0.	0.	5.3009E-02	0.	0.	0.	0.	7.2930E-02
0.	7.5160E+00	0.	0.	0.	5.3009E-02	0.	0.	5.0723E+00	1.2000E-02
1.0000E+01	2.4514E+01	5.5756E+00	6.8740E-04	9.2349E-03	2.4807E-03	5.3928E-03	6.7410E-02		
5.5756E+00	0.	0.	0.	6.7410E-02	0.	0.	0.	0.	9.2483E-02
0.	5.5756E+00	0.	0.	0.	6.7410E-02	0.	0.	6.4030E+00	1.5000E-02
1.2000E+01	2.6167E+01	5.9847E+00	1.0601E-03	1.2098E-02	2.9037E-03	6.3125E-03	7.8906E-02		
5.9847E+00	0.	0.	0.	7.8906E-02	0.	0.	0.	0.	1.0870E-01
0.	5.9847E+00	0.	0.	0.	7.8906E-02	0.	0.	7.5874E+00	1.8000E-02
1.4000E+01	2.7833E+01	6.3971E+00	1.5112E-03	1.5149E-02	3.3593E-03	7.3028E-03	9.1285E-02		
6.3971E+00	0.	0.	0.	9.1285E-02	0.	0.	0.	0.	1.2593E-01
0.	6.3971E+00	0.	0.	0.	9.1285E-02	0.	0.	8.8151E+00	2.1000E-02
1.6000E+01	2.9500E+01	6.8166E+00	2.0510E-03	1.8388E-02	3.8455E-03	8.3598E-03	1.0450E-01		
6.8166E+00	0.	0.	0.	1.0450E-01	0.	0.	0.	0.	1.4411E-01
0.	6.8166E+00	0.	0.	0.	1.0450E-01	0.	0.	1.0036E+01	2.4000E-02
1.8000E+01	1.1167E+01	7.2426E+00	2.6905E-03	2.1816E-02	4.3629E-03	9.4945E-03	1.1856E-01		

APPENDIX B2

MATERIAL SUBSTITUTION STUDY

ADVANCED HYBRID VEHICLE

DATE: 26 March 1979

FOR:

South Coast Technology
5790 Thornwood
Goleta, CA 93017

BY:

Lonney S. Pauls
Technical Consultant
5569 Crestone Ct.
Ventura, CA 93003

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L.S. [signature] 26 MAR '79

1.0 INTRODUCTION

THIS STUDY IS CONCERNED WITH THE HYBRID VEHICLE WEIGHT REDUCTION PROGRAM BEING UNDERTAKEN BY SOUTH COAST TECHNOLOGY. THE HYBRID VEHICLE, WHICH IS BEING DEVELOPED AT SCT, WILL CONSIST OF A MODIFIED 1979 FORD LTD. THE PURPOSE OF THIS STUDY IS TO INVESTIGATE THE WEIGHT REDUCTION POSSIBILITIES OF THE LTD THRU MATERIAL SUBSTITUTIONS.

2.0 OBJECTIVE

THE OBJECTIVE OF THIS STUDY IS TO DETERMINE THE WEIGHT REDUCTION POTENTIAL OF VARIOUS MATERIAL SUBSTITUTES TAKING INTO ACCOUNT THEIR STRUCTURAL REQUIREMENTS.

3.0 ANALYTICAL APPROACH

THE WEIGHT REDUCTION POSSIBILITIES OF MATERIAL SUBSTITUTES ARE STUDIED IN THIS REPORT BY "REPLACING" THE ORIGINAL MATERIAL OF THE BASELINE 1979 FORD LTD WITH AN "EQUIVALENT" STRUCTURE (OF THE SUBSTITUTE MATERIAL) HAVING THE SAME MAJOR DIMENSIONS, GEOMETRICAL DESIGN CHARACTERISTICS, AND FUNCTION AS THAT OF THE ORIGINAL MATERIAL. IT IS NOTED THAT ALTHOUGH FURTHER WEIGHT REDUCTION POSSIBILITIES MAY EXIST THRU THE OPTIMIZATION OF THE GEOMETRY, GEOMETRICAL DESIGN CHARACTERISTICS AND FUNCTION OF THE SUBSTITUTE STRUCTURE, THESE ARE CONSIDERED TO BE BEYOND THE SCOPE OF THIS STUDY.

4.0 BASIC ASSUMPTIONS

ONE BASIC ASSUMPTION IN THIS STUDY IS THAT THE SUBSTITUTE MATERIALS PROVIDE AT LEAST THE SAME STRUCTURAL PERFORMANCE AS THE ORIGINAL MATERIALS. ANOTHER ASSUMPTION IS THAT THE SECTION GEOMETRY OF THE SUBSTITUTE STRUCTURE IS INVARIANT EXCEPT FOR THE MATERIAL THICKNESS. OTHER ASSUMPTIONS WILL BE IDENTIFIED LATER IN THIS REPORT.

5.0 THEORETICAL DEVELOPMENT

IN GENERAL, THE STRUCTURAL DESIGN REQUIREMENTS OF A PASSENGER VEHICLE MAY BE GROUPED IN THE FOLLOWING THREE CATEGORIES (1)':

1. STATIC DESIGN LOADS
2. DYNAMIC DESIGN LOADS
3. CRASHWORTHINESS

IN THE FIRST CATEGORY (STATIC DESIGN LOADS) ARE INCLUDED (A) VEHICLE BEAMING, (B) VEHICLE TORSION, (C) REAR-END BEAMING, (D) JACKING, (E) HOISTING AND TOWING, (F) DASHPANEL, DOOR, ROOF, CENTER-PILLAR AND DECK-LID LOADS ETC.

THE SECOND CATEGORY (DYNAMIC DESIGN LOADS) IS ASSOCIATED WITH LOADING FROM (A) TERRAIN, (B) BRAKING (C) MANEUVERING AND (D) VIBRATION.

THE THIRD CATEGORY (CRASHWORTHINESS) IS DERIVED FROM THE REQUIREMENTS OF THE CURRENT APPLICABLE FMVSS SPECIFICATIONS. INCLUDED HERE ARE,

- 30 MPH FRONTAL BARRIER IMPACT
- ROLLOVER
- SIDE DOOR PENETRATION
- BUMPER IMPACT
- ROOF CRUSH
- FUEL SYSTEM INTEGRITY

AS INDICATED EARLIER, THE OBJECTIVE OF THIS STUDY IS TO EVALUATE THE WEIGHT REDUCTION POTENTIAL THRU THE USE OF VARIOUS SUBSTITUTE MATERIALS. A REQUIREMENT OF THIS SUBSTITUTION IS THAT THE NEW MATERIALS PROVIDE AT LEAST THE SAME LEVEL OF STRUCTURAL PERFORMANCE, IN RESISTING THE LOADS IDENTIFIED ABOVE, AS THE

' ( ) INDICATES REFERENCES AT THE END OF THE REPORT. MOST OF THE THEORETICAL DEVELOPMENT PRESENTED HEREIN WAS OBTAINED FROM REFERENCE 1.

J.S. [signature] 26 Mar '79

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

ORIGINAL MATERIALS.

FROM THE STANDPOINT OF STRUCTURAL PERFORMANCE, THE STRUCTURAL DESIGN REQUIREMENTS OF A PASSENGER VEHICLE ARE RELATED TO THE FOLLOWING (1):

1. STIFFNESS
2. STRENGTH
3. VIBRATION
4. IMPACT

IN THIS REPORT, THE STIFFNESS DESIGN REQUIREMENT IS DEFINED AS THE MAXIMUM ALLOWABLE DEFLECTION FOR A SPECIFIED LOAD. THE STRENGTH DESIGN REQUIREMENT IS DEFINED AS THE MAXIMUM ALLOWABLE STRESS FOR A SPECIFIED LOAD. THE VIBRATION DESIGN REQUIREMENT IS DEFINED AS THE DESIRED FREQUENCY AND MODE RESPONSE. THE IMPACT DESIGN REQUIREMENTS ARE RELATED TO ENERGY ABSORPTION AND IMPACT ATTENUATION.

IN GENERAL, THE STRUCTURAL SYSTEM OF A PASSENGER VEHICLE CAN BE THOUGHT OF AS AN ASSEMBLAGE OF THE FOLLOWING STRUCTURAL ELEMENTS (1):

1. PANEL MEMBERS
2. THIN-WALL BEAM MEMBERS
3. SOLID SECTION MEMBERS

TO ILLUSTRATE, PANEL MEMBERS INCLUDE THE HOOD, ROOF AND DOOR PANELS. THIN-WALLED-BEAM ELEMENTS INCLUDE THE CHASSIS FRAME, PILLARS AND ROCKER PANELS. SOLID SECTION MEMBERS INCLUDE VARIOUS REINFORCEMENT BRACKETS, HINGES AND HOOD-LATCH SUPPORTS. THE FOLLOWING SECTIONS DISCUSS INDIVIDUALLY EACH OF THESE ELEMENT TYPES AND DERIVE THEIR GOVERNING EQUATIONS FOR MATERIAL SUBSTITUTION.

5.0 THEORETICAL DEVELOPMENT .... CONT'D

5.1 PANEL MEMBERS

PANEL MEMBERS ARE USED IN THE HOOD, ROOF, TRUNK, FLOOR AND SIDE-WALL ASSEMBLIES OF PASSENGER VEHICLES. THE STRUCTURAL REQUIREMENTS OF THESE PANELS INCLUDE:

- RESISTANCE TO "OIL-CANNING"
- RESISTANCE TO DENTING
- RESISTANCE TO ELASTIC BUCKLING
- RESISTANCE TO VIBRATION

5.1.1 RESISTANCE TO "OIL-CANNING" (1, 2, 3)

"OIL-CANNING" RESISTANCE IS DEFINED AS THE CONCENTRATED LOAD, APPLIED NORMAL TO THE PANEL SURFACE, REQUIRED TO PRODUCE UNIT DEFLECTION IN THE DIRECTION OF LOAD (1). "OIL-CANNING" RESISTANCE CAN BE EXPRESSED (APPROXIMATELY) AS

$$RESIST_{OIL-CAN} = COEF_{GEOM} \cdot E \cdot t^{m} \quad \ldots\ldots \quad (1)$$

WHERE,

$COEF_{GEOM}$ = GEOMETRICAL COEFFICIENT; A FUNCTION OF PANEL SIZE AND EDGE FIXITY.
E = YOUNG'S MODULUS
m = A CONSTANT DEPENDING ON PANEL CURVATURE
t = PANEL THICKNESS

LET THE SUBSCRIPT O, N DENOTES THE ORIGINAL AND NEW (SUBSTITUTE MATERIAL. THEN,

$$\frac{RESIST_{OIL-CAN_N}}{RESIST_{OIL-CAN_O}} = (COEF_{GEOM_N}\, E_N\, t_N^{m}) / (COEF_{GEOM_O}\, E_O\, t_O^{m}) \quad \ldots (2)$$

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5.0 THEORETICAL DEVELOPMENT ... CONT'D

SINCE THE GEOMETRY AND EDGE FIXITY OF THE ORIGINAL AND NEW PANEL ARE TO BE IDENTICAL (BY ASSUMPTION) THEN,

$$COEF_{GEOM_0} = COEF_{GEOM_N} \quad \ldots\ldots \quad (3)$$

THEREFORE,

$$\frac{RESIST_{OIL-CAN_N}}{RESIST_{OIL-CAN_0}} = \left(\frac{E_n}{E_0}\right) \cdot \left(\frac{t_n}{t_0}\right)^m \quad \ldots\ldots \quad (4)$$

FOR AUTOMOTIVE APPLICATIONS* $m \cong 2$ (m CAN VARY FROM 1, FOR A HIGHLY CURVED PANEL, TO 3, FOR A FLAT PANEL). FOR EQUAL RESISTANCE TO "OIL-CANNING" BY THE ORIGINAL AND SUBSTITUTE MATERIAL, WE HAVE:

$$\boxed{\frac{t_N}{t_0} = \sqrt{\frac{E_0}{E_N}} \quad \ldots\ldots \quad (5)}$$

PANEL OIL-CAN RESIST.

5.1.2 RESISTANCE TO DENTING (1,2,3)

THE RELATIVE DENT RESISTANCE $RESIST_{DENT_N} / RESIST_{DENT_0}$ IS DEFINED AS THE ENERGY REQUIRED TO PRODUCE A DENT OF A SPECIFIED DEPTH (2,3). THE PANEL DENT RESISTANCE DEPENDS ON THE MATERIAL YIELD STRENGTH, ITS STRAIN RATE SENSITIVITY, THE PANEL THICKNESS AND STIFFNESS (1). THUS (1),

$$RESIST_{DENT} \sim \frac{\left[S_{YLD}(\dot{\varepsilon})\, t^2\right]^2}{STIFF_{PANEL}} \quad \ldots\ldots \quad (6)$$

WHERE,

$S_{YLD}(\dot{\varepsilon})$ = MATERIAL YIELD STRENGTH AT THE STRAIN-RATE OF INDENTATION.

* REFERENCE 1.

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

t = PANEL THICKNESS

$$STIFF_{PANEL} = RESIST_{OIL-CAN} \quad \ldots\ldots \quad (7)$$

THEREFORE,

$$\frac{RESIST_{DENT_N}}{RESIST_{DENT_0}} = \left[\frac{S_{YLD}(\dot{\varepsilon})_N}{S_{YLD}(\dot{\varepsilon})_0}\right]^2 \left(\frac{t_N}{t_0}\right)^4 \frac{STIFF_0}{STIFF_N} \quad \ldots\ldots \quad (8)$$

USING (7) IN (8) WE HAVE,

$$\frac{RESIST_{DENT_N}}{RESIST_{DENT_0}} = \left[\frac{S_{YLD}(\dot{\varepsilon})_N}{S_{YLD}(\dot{\varepsilon})_0}\right]^2 \left(\frac{t_N}{t_0}\right)^2 \frac{E_0}{E_N} \quad \ldots\ldots \quad (9)$$

FOR EQUAL DENT RESISTANCE,

$$\frac{t_N}{t_0} = \left[\frac{S_{YLD}(\dot{\varepsilon})_0}{S_{YLD}(\dot{\varepsilon})_N}\right] \left(\frac{E_N}{E_0}\right)^{1/2} \quad \ldots\ldots \quad (10)$$

PANEL DENT RESISTANCE

5.1.3 RESISTANCE TO ELASTIC BUCKLING (5)

THE BUCKLING STRENGTH OF A CURVED PANEL IS GIVEN BY BRUHN (5), AS

$$RESIST_{BUCKLING} = K_C \cdot GEOM \cdot \frac{E}{1-\nu^2} t^3 \quad \ldots\ldots \quad (11)$$

WHERE,

K_C = PANEL BUCKLING COEFICIENT; DEPENDS ON TYPE OF LOADING.

GEOM = PANEL GEOMETRY CONSTANT; DEPENDS ON PANEL SHAPE AND LOADING CONDITIONS.

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

THUS, SINCE THE PANEL GEOMETRY IS INVARIANT WITH THE MATERIAL SUBSTITUTION WE HAVE:

$$\frac{RESIST_{BUCKLING_N}}{RESIST_{BUCKLING_0}} = \left(\frac{E_N}{E_0}\right)\left(\frac{1-\nu_0^2}{1-\nu_N^2}\right)\left(\frac{t_N}{t_0}\right)^3 \ldots\ldots (12)$$

FOR EQUAL BUCKLING RESISTANCE,

$$\frac{t_N}{t_0} = \left[\frac{1-\nu_N^2}{1-\nu_0^2} \cdot \frac{E_0}{E_N}\right]^{1/3} \ldots\ldots (13)$$

PANEL BUCKLING RESISTANCE

5.1.4 RESISTANCE TO VIBRATION

IN THIS STUDY, IT IS ASSUMED THAT THE RESISTANCE OF THE PANEL TO VIBRATION IS PROPORTIONAL TO THE FUNDAMENTAL FREQUENCY OF OSCILLATION OF THE PANEL (THE MODE OF VIBRATION IS ASSUMED TO BE INVARIANT WITH THE MATERIAL SUBSTITUTION). I.E.,

$$RESIST_{VIB} \sim \omega_{FUNDAMENTAL} \ldots\ldots (14)$$

NOW,

$$\omega_{FUNDAMENTAL} = C\sqrt{\frac{K}{m}} \ldots\ldots (15)$$

WHERE,

K = PANEL STIFFNESS ($= RESIST_{OIL-CAN}$)

$$m = \rho t \xi \ldots\ldots (16)$$

ρ = MATERIAL DENSITY

t = MATERIAL THICKNESS

5.0 THEORETICAL DEVELOPMENT .... CONT'D

ξ = CONSTANT DEPENDING ON PANEL GEOMETRY AND VIBRATION MODE SHAPE.

USING (1), AND (16) IN (15)

$$\omega_{FUNDAMENTAL} = C\sqrt{\frac{COEF_{GEOM} \cdot E \cdot t^{m}}{\rho t \xi}} \quad \ldots\ldots (17)$$

FOR PRACTICAL AUTOMOTIVE DESIGNS $m \simeq 2$. THEREFORE,

$$\frac{\omega_{FUNDAMENTAL_N}}{\omega_{FUNDAMENTAL_0}} = \sqrt{\frac{E_N}{E_0} \cdot \frac{\rho_0}{\rho_N} \cdot \frac{t_N}{t_0}} = \frac{RESIST_{VIB_N}}{RESIST_{VIB_0}} \quad \ldots\ldots (18)$$

FOR EQUAL RESISTANCE TO VIBRATION,

$$\frac{t_N}{t_0} = \frac{E_0}{E_N} \cdot \frac{\rho_N}{\rho_0} \quad \ldots\ldots (19)$$

PANEL RESISTANCE TO VIB.

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

5.2 THIN-WALL BEAM MEMBERS

THIN-WALL BEAM MEMBERS ARE USED FOR THE CHASSIS FRAME, SIDE-WALL PILLARS, ROCKER PANELS AND OTHER PARTS OF THE STRUCTURE. THE STRUCTURAL REQUIREMENTS OF THESE MEMBERS INCLUDE:

- BENDING STIFFNESS
- TORSIONAL STIFFNESS (CLOSED SECTIONS)
- TORSIONAL STIFFNESS (OPEN SECTIONS)
- RESISTANCE TO YIELDING
- RESISTANCE TO BUCKLING
- RESISTANCE TO VIBRATION
- ENERGY ABSORPTION (IMPACT PROTECTION)

5.2.1 BENDING STIFFNESS (1)

IT IS ASSUMED THAT THE SHAPE OF THE CROSS-SECTION OF THE BEAM ELEMENT CAN BE APPROXIMATED BY m STRAIGHT LINE SEGMENTS. THE LENGTH AND THICKNESS OF THE j^{th} SEGMENT IS DENOTED AS L_j AND t_j. NOW, SINCE THE "NEW" AND "ORIGINAL" BEAMS ARE TO HAVE THE SAME LENGTH AND END FIXITY, THE BEAM STIFFNESS WILL BE PROPORTIONAL TO THE MODULUS OF ELASTICITY OF THE MATERIAL AND THE AREA MOMENT OF INERTIA OF THE BEAM CROSS-SECTION (THE SHAPE OF THE CROSS-SECTION IS ASSUMED TO BE CONSTANT OVER THE BEAM LENGTH). I.E.,

$$STIFF_{BEND} \sim EI \quad ..... (20)$$

IF WE MAKE THE ASSUMPTION THAT THE CROSS-SECTIONAL SHAPE REMAINS INVARIANT WITH THE MATERIAL SUBSTITUTION (i.e. THE CENTROID WILL REMAIN CONSTANT) THEN THE AREA MOMENT OF INERTIA CAN BE APPROXIMATED AS FOLLOWS:

$$I \cong \sum_{j=1}^{m} L_j t_j \left(a_j t_j^2 + c_j \right) \quad ..... (21)$$

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5.0 THEORETICAL DEVELOPMENT ..... CONT'D

WHERE,

L = SECTION ELEMENT LENGTH
t = MATERIAL THICKNESS
a = SECTION SHAPE FACTOR
c = " " "

NOW LET $t_i = K_i \, t_{REF}$ .....(22)

USING (22) & (21) IN (20) AND NOTING THAT $a_j t_j^2$ IS USUALLY << C_j :

$$STIFF_{BEND} \sim E \, t_{REF} \sum_{j=}^{m} K_j L_j C_j \quad .....(23)$$

OR

$$\frac{STIFF_{BEND_N}}{STIFF_{BEND_o}} = \left(\frac{E_N}{E_o}\right) \cdot \left(\frac{t_{REF_N}}{t_{REF_o}}\right) \quad ......(24)$$

FOR EQUAL STIFFNESS,

$$\frac{t_N}{t_o} = \frac{t_{REF_N}}{t_{REF_o}} = \left(\frac{E_o}{E_N}\right) \quad .....(25)$$

BENDING STIFFNESS

5.2.2 TORSIONAL STIFFNESS (CLOSED SECTIONS) - REF 1

THE TORSIONAL STIFFNESS OF A THIN-WALL CLOSED SECTION BEAM IS EXPRESSED AS

$$STIFF_{TORSION} = C_{bg} \, G \, K_t \quad ......(26)$$

WHERE,

G = SHEAR MODULUS
K_t = TORSIONAL RIGIDITY
C_{bg} = BEAM TORSIONAL COEFFICIENT DEPENDING ON BEAM EFFECTIVE LENGTH AND BOUNDARY CONDITIONS.

5.0 THEORETICAL DEVELOPMENT .... CONT'D

NOW THE TORSIONAL RIGIDITY OF THE SECTION (K_t) IS,

$$K_t = \frac{t A_B^2}{\sum_{i=1}^{m} \left(\frac{S_i}{K_i} \right)} \quad \ldots\ldots (27)$$

WHERE,

t = MATERIAL THICKNESS
A_B = ENCLOSED MEAN AREA OF THE MEAN CROSS-SECTION
S_i = LENGTH OF i^{th} ELEMENT MAKING UP THE CROSS-SECTION
K_i = THICKNESS DISTRIBUTION FACTOR (CROSS-SECTION)

USING (27) IN (26),

$$STIFF_{TORSION} = \frac{C_{bq}\, G\, t\, A_B^2}{\sum_{i=1}^{m} \left(\frac{S_i}{K_i} \right)} \quad \ldots\ldots (28)$$

OR

$$\frac{STIFF_{TORSION_N}}{STIFF_{TORSION_o}} = \frac{G_N}{G_o} \cdot \frac{t_N}{t_o} \sim \frac{E_N}{E_o} \cdot \frac{t_N}{t_o} \quad \ldots\ldots (29)$$

FOR EQUAL STIFFNESS,

$$\frac{t_N}{t_o} = \frac{E_o}{E_N} \quad \ldots\ldots (30)$$

CLOSED SECTION TORSIONAL STIFFNESS

[signature] S. [signature] 26 MAY '79

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

5.2.3 TORSIONAL STIFFNESS (OPEN SECTION) - REF 1

FOR OPEN SECTIONS (THIN-WALLED) THE TORSIONAL STIFFNESS CONSISTS OF TWO PARTS, ONE PART DUE TO TORSIONAL RIGIDITY AND THE OTHER PART DUE TO WARPING RIGIDITY. THE STIFFNESS IS EXPRESSED AS FOLLOWS:

$$STIFF_{TORSION} = C_{bg}\left[\frac{Gt^3}{3}\sum_{i=1}^{m} S_i K_i^3 + \frac{Et}{3}\sum_{i=1}^{m} C_i S_i K_i\right] \quad \ldots\ (31)$$

IN GENERAL THE WARPING RIGIDITY >> TORSIONAL RIGIDITY. THEREFORE,

$$STIFF_{TORSION} \cong C_{bg}\frac{Et}{3}\sum_{i=1}^{m} C_i S_i K_i \quad \ldots\ (32)$$

THUS,

$$\frac{STIFF_{TORSION_N}}{STIFF_{TORSION_O}} \cong \frac{E_N}{E_O}\cdot\frac{t_N}{t_o} \quad \ldots\ (33)$$

FOR EQUAL STIFFNESS,

$$\frac{t_N}{t_o} = \frac{E_o}{E_N} \quad \ldots\ (34)$$

TORSIONAL STIFFNESS OPEN SECTION

5.2.4 RESISTANCE TO YIELDING

IT IS ASSUMED THAT BENDING IS THE PRINCIPAL MODE OF LOADING FOR THE BEAM. THUS THE STRESS ACTING ON THE SECTION IS,

$$STRESS = \frac{MC}{I} \quad \ldots\ (35)$$

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5.0 THEORETICAL DEVELOPMENT .... CONT'D

WHERE,

M = APPLIED SECTION MOMENT (INVARIANT WITH MATERIAL SUBSTITUTION).

C = FIBER DISTANCE FROM CENTROID

I = AREA MOMENT OF INERTIA

THE CROSS-SECTION IS ASSUMED TO BE COMPRISED OF m STRAIGHT LINE SEGMENTS. HENCE, THE AREA MOMENT OF INERTIA MAY BE EXPRESSED AS,

$$I = \sum_{j=1}^{m} L_j t_j \left(a_j t_j^2 + C_j \right) \quad \ldots\ldots (36)$$

WHERE,

L_j = LENGTH OF j^{th} ELEMENT

t_j = THICKNESS OF j^{th} "

a_j = SECTION SHAPE FACTOR

c_j = " " "

FROM (35),

$$M = \frac{STRESS \cdot I}{C} = \frac{STRESS}{C} \cdot \sum_{j=1}^{m} L_j t_j \left(a_j t_j^2 + C_j \right) \quad \ldots. (37)$$

NOW, NOTING THAT C_j IS USUALLY >> $a_j t_j^2$ AND LETTING $t_j = K_j t$:

$$\frac{M_N}{M_O} = \left(\frac{STRESS_{YLD_N}}{STRESS_{YLD_O}} \right) \cdot \frac{t_N}{t_O} \quad \ldots\ldots (38)$$

FOR EQUAL STRENGTH (OF SECTION)

$$\frac{t_N}{t_O} = \frac{STRESS_{YLD_O}}{STRESS_{YLD_N}} \quad \ldots. (39)$$

BENDING STRENGTH

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5.0 THEORETICAL DEVELOPMENT ..... CONT'D

5.2.5 RESISTANCE TO BUCKLING

THE BUCKLING MODES OF INTEREST HERE INCLUDE THE FOLLOWING:

- PRIMARY COLUMN BUCKLING
- LOCAL FLANGE BUCKLING
- CRIPPLING

PRIMARY COLUMN BUCKLING: THE PRIMARY COLUMN BUCKLING LOAD CAN BE EXPRESSED BY THE FOLLOWING,

$$RESIST_{BUCK} = C_{geom} E I \quad \ldots\ldots (40)$$

WHERE,

C_{geom} = geometry and end fixity factor
E = Modulus of Elasticity
I = Area Moment of Inertia

ASSUMING THAT THE SECTION IS MADE UP OF m STRAIGHT LINE SEGMENTS,

$$I = \sum_{j=1}^{m} L_j t_j (a_j t_j^2 + C_j) \quad \ldots\ldots (41)$$

USUALLY $C_j \gg a_j t_j^2$. ALSO, LETTING $t_j = t K_j$ WE HAVE:

$$I \cong t \sum_{j=1}^{m} L_j K_j C_j \quad \ldots\ldots (42)$$

USING (42) IN (40) WE HAVE

$$RESIST_{BUCK} = C_{geom} E t \sum_{j=1}^{m} L_j K_j C_j$$

OR

$$\frac{RESIST_{BUCK_N}}{RESIST_{BUCK_0}} = \frac{E_N}{E_0} \cdot \frac{t_N}{t_0} \quad \ldots\ldots (43)$$

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5.0 THEORETICAL DEVELOPMENT ..... CONT'D

FOR EQUAL RESISTANCE TO BUCKLING,

$$\frac{t_N}{t_o} = \frac{E_o}{E_N} \quad \ldots\ldots (44)$$

COLUMN BUCKLING

LOCAL FLANGE BUCKLING: THE LOCAL FLANGE BUCKLING RESISTANCE CAN BE EXPRESSED AS,

$$RESIST_{BUCK} = C_{geo} \frac{E}{1-\nu^2} t^3 \quad \ldots\ldots (45)$$

WHERE,

C_{geo} = COEFF. DEPENDING ON GEOMETRY, END FIXITY AND LOADING.

E = MODULUS OF ELASTICITY

ν = POISSONS' RATIO

t = MATERIAL THICKNESS

FOR MATERIAL SUBSTITUTION WE HAVE,

$$\frac{RESIST_{BUCK_N}}{RESIST_{BUCK_o}} = \left(\frac{E_N}{E_o}\right)\left(\frac{1-\nu_o^2}{1-\nu_N^2}\right)\left(\frac{t_N}{t_o}\right)^3 \quad \ldots\ldots (46)$$

FOR EQUAL RESISTANCE TO BUCKLING,

$$\frac{t_N}{t_o} = \left[\frac{E_o}{E_N} \cdot \frac{1-\nu_N^2}{1-\nu_o^2}\right]^{1/3} \quad \ldots\ldots (47)$$

FLANGE BUCKLING

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5.0 THEORETICAL DEVELOPMENT ..... CONT'D

CRIPPLING OF SECTION: THE CRIPPLING STRENGTH OF A THIN-WALL MEMBER MAY BE EXPRESSED AS, (NEEDHAM METHOD):

$$RESIST_{CRIPP} = C_{bg} \cdot C_s \cdot (S_{YLD} E)^{0.5} t^{1.75} \quad \ldots\ldots (48)$$

WHERE,

C_{bg} = GEOMETRY FACTOR

C_s = SECTION SHAPE FACTOR DEPENDING ON DEGREES OF EDGE SUPPORT.

S_{YLD} = YIELD STRENGTH OF MATERIAL

E = MODULUS OF ELASTICITY

t = MATERIAL THICKNESS

FOR MATERIAL SUBSTITUTION,

$$\frac{RESIST_{CRIPP_N}}{RESIST_{CRIPP_O}} = \left(\frac{S_{YLD_N}}{S_{YLD_O}} \cdot \frac{E_N}{E_O}\right)^{1/2} \left(\frac{t_N}{t_o}\right)^{1.75} \quad \ldots\ldots (49)$$

FOR EQUAL STRENGTH,

$$\frac{t_N}{t_o} = \left(\frac{S_{YLD_O}}{S_{YLD_N}} \cdot \frac{E_O}{E_N}\right)^{1/3.5} \quad \ldots\ldots (50)$$

CRIPPLING

5.2.6 RESISTANCE TO VIBRATION

VIBRATION OF BEAM ELEMENTS CAN TAKE ON TWO FORMS:

1. VIBRATION OF BEAM ELEMENT MASS
2. VIBRATION OF A SEPARATE MASS SUPPORTED BY A BEAM ELEMENT.

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5.0 THEORETICAL DEVELOPMENT .... CONT'D

VIBRATION OF BEAM ELEMENT MASS: THE VIBRATION OF THE BEAM ELEMENT MASS CAN BE MONITORED IN TERMS OF ITS FREQUENCY RESPONSE. THE FREQUENCY RESPONSE OF A THIN-WALLED BEAM MEMBER (HAVING NEGLIGIBLE DAMPING) IS,

$$\omega = C\left(\frac{K}{M_{BEAM}}\right)^{1/2} \quad \ldots\ldots (51)$$

NOW,

$$K \sim Et$$
$$M_{BEAM} \sim \rho t$$

$$\therefore \quad \omega = C\left(\frac{E}{\rho}\right)^{1/2} \quad \ldots\ldots (52)$$

THUS, IN THIS CASE, THE FREQUENCY RESPONSE IS INDEPENDENT OF THE THICKNESS.

$$\frac{\omega_N}{\omega_O} = \sqrt{\frac{E_N}{E_O} \cdot \frac{\rho_O}{\rho_N}} \quad \ldots\ldots (53)$$

VIBRATION OF BEAM SUPPORTED MASS: IN THIS CASE THE SUSPENDED MASS IS INDEPENDENT OF MATERIAL THICKNESS. IT IS ASSUMED THAT THE SUSPENDED MASS IS INVARIANT WITH THE MATERIAL SUBSTITUTION. THE FREQUENCY RESPONSE FOR THIS CASE IS,

$$\omega = C\left(\frac{K}{M}\right)^{1/2} \quad \ldots\ldots (54)$$

NOW,

$$K \sim Et \quad \ldots\ldots (55)$$
$$M = CONST$$

$$\therefore \quad \omega = C\left(\frac{Et}{M}\right)^{1/2} \quad \ldots\ldots (56)$$

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5.0 THEORETICAL DEVELOPMENT . . . . CONT'D

NOW,

$$\frac{\omega_N}{\omega_0} = \left[\frac{E_N}{E_0} \cdot \frac{t_N}{t_0}\right]^{1/2} \quad \ldots\ldots (57)$$

FOR EQUAL FREQUENCY RESPONSE,

$$\frac{t_N}{t_0} = \frac{E_0}{E_N} \quad \ldots\ldots (58)$$

BEAM SUPPORTED MASS

5.2.7 RESISTANCE TO IMPACT (ENERGY ABSORPTION) - REF 5

IN DETERMINING THE RESISTANCE TO IMPACT FOR THIN-SECTION BEAM ELEMENTS IT WILL BE ASSUMED THAT THE SECTION GEOMETRY IS THAT SHOWN IN FIGURE 1. FROM REF. 5 THE AVERAGE CRUSH STRENGTH OF THE SECTION IS GIVEN BY,

$$P^{*}_{MS} \cong \frac{t^2 S_{YLD}(\dot{\epsilon})}{h - K_2(t)} \left\{ (a+b+4c)\left(\frac{\pi}{2} + K_1\right) + 2h + 0.574\frac{h^2}{r} \right\} \quad \ldots\ldots (59)$$

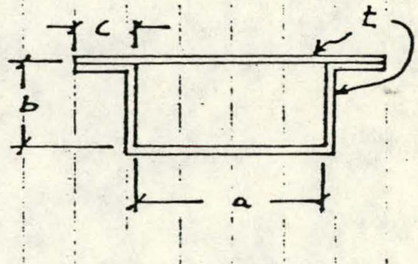


FIGURE 1

WHERE,

$$\left.\begin{aligned} h &= b/2 \\ r &= t \\ K_2(t) &= 5t \\ K_1 &= 2.96 \end{aligned}\right\} \quad \ldots\ldots (60)$$

* THIS EQUATION WAS DERIVED FOR STEEL. IT IS ASSUMED THAT IT APPLIES TO OTHER MATERIALS AS WELL.

5.0 THEORETICAL DEVELOPMENT . . . . CONT'D

USING (60) IN (59)

$$P_{MS} = \frac{t^2 S_{YLD}(\dot{\varepsilon})}{\frac{b}{2} - 5t} \left\{ (a+b+4c)\left(\frac{\pi}{2}+2.96\right) + b + .1435\frac{b^2}{t} \right\} \quad \ldots (61)$$

FOR PRACTICAL FRAME DESIGNS,

$$(a+b+4c)\left(\frac{\pi}{2}+2.96\right) + b >> .1435\frac{b^2}{t} \quad \ldots (62)$$

$\therefore$

$$P_{MS} \simeq \frac{t^2 S_{YLD}(\dot{\varepsilon}) \, \rho_{geom}}{\frac{b}{2} - 5t} \quad \ldots (63)$$

NOW, THE RESISTANCE TO IMPACT IS PROPORTIONAL TO THE ENERGY ABSORPTION CAPABILITY OF THE BEAM ELEMENT. I.E.,

$$RESIST_{IMPACT} \sim EN \quad \ldots (64)$$

BUT,

$$EN = P_{MS} \cdot \Delta_{CRUSH} \quad \ldots (65)$$

FOR A GIVEN AMOUNT OF CRUSH,

$$\frac{EN_N}{EN_O} = \frac{P_{MS_N}}{P_{MS_O}} = \frac{t_n^2 S_{YLD}(\dot{\varepsilon})_N}{\left(\frac{b}{2} - 5t_n\right)} \cdot \frac{\left(\frac{b}{2} - 5t_o\right)}{t_o^2 S_{YLD}(\dot{\varepsilon})_o}$$

$$\frac{EN_N}{EN_O} = \left(\frac{t_n}{t_o}\right)^2 \cdot \left(\frac{S_{YLD}(\dot{\varepsilon})_N}{S_{YLD}(\dot{\varepsilon})_o}\right) \cdot \frac{\left(\frac{b}{2} - 5t_o\right)}{\left(\frac{b}{2} - 5t_n\right)} \quad \ldots (66)$$

FOR $\frac{b}{2} >> t_o ; >> t_n$ AND FOR EQUAL ENERGY ABSORPTION,

$$\frac{t_n}{t_o} \doteq \sqrt{\frac{S_{YLD}(\dot{\varepsilon})_o}{S_{YLD}(\dot{\varepsilon})_N}} \quad \ldots (67)$$

ENERGY ABSORPTION

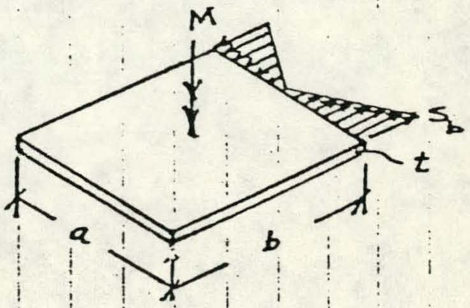
5.0 THEORETICAL DEVELOPMENT ... CONT'D

5.3 SOLID SECTION MEMBERS

SOLID SECTION MEMBERS INCLUDE SUCH ITEMS AS REINFORCEMENT BRACKETS, HINGES, HOOD-LATCH SUPPORTS etc. IN THIS REPORT, BENDING IS CONSIDERED TO BE THE PREDOMINANT LOADING. BOTH OUT-OF-PLANE AND IN-PLANE BENDING OF THE MEMBER ARE CONSIDERED. THE SOLID SECTION MEMBERS CONSIDERED IN THIS REPORT ARE ASSUMED TO BE PLATE ELEMENTS HAVING A THICKNESS (t).

5.3.1 OUT-OF-PLANE BENDING

OUT-OF-PLANE BENDING, AS USED IN THIS REPORT, IMPLIES THAT THE MOMENT VECTOR (USING THE RIGHT HAND RULE) IS NORMAL TO THE SURFACE OF THE PLATE AS SHOWN IN FIGURE 2. FOR THIS CASE,



$$S_b = \frac{M \, a/2}{I} \quad \ldots\ldots (68)$$

WHERE,

$$I = \frac{1}{12} t a^3 \quad \ldots\ldots (69)$$

USING (66) IN (65) WE HAVE:

$$S_b = \frac{6M}{t a^2} \quad \ldots\ldots (70)$$

OR,

$$M = \frac{S_b t a^2}{6} \quad \ldots\ldots (71)$$

FOR EQUAL MOMENTS (NEW AND ORIGINAL MATERIAL),

$$\frac{t_N}{t_o} = \frac{S_{b_{YLD_o}}}{S_{b_{YLD_N}}} \quad \ldots\ldots (72)$$

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5.0 THEORETICAL DEVELOPMENT ..... CONT'D

5.3.2 IN-PLANE BENDING

IN-PLANE BENDING, AS USED IN THIS REPORT, IMPLIES THAT THE APPLIED MOMENT VECTOR (USING THE RIGHT HAND RULE) IS IN THE PLANE OF THE PLATE MEMBER, AS SHOWN IN FIGURE 3. FOR THIS CASE,

$$S_b = \frac{M\, t/2}{I} \quad \ldots\ldots \quad (73)$$

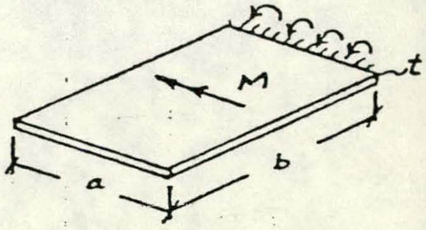

FIGURE 3

WHERE,

$$I = \frac{1}{12}\, a\, t^3 \quad \ldots\ldots \quad (74)$$

USING (71) IN (70) WE HAVE,

$$S_b = \frac{6M}{a t^2} \quad \ldots\ldots \quad (75)$$

OR,

$$M = \frac{S_b\, a\, t^2}{6} \quad \ldots\ldots \quad (76)$$

FOR EQUAL MOMENTS (NEW AND ORIGINAL MATERIAL) AND USING YIELD STRESS AS THE STRESS LEVEL,

$$\frac{t_N}{t_o} = \sqrt{\frac{S_{b_{YLD_o}}}{S_{b_{YLD_N}}}} \quad \ldots\ldots \quad (77)$$

5.0 THEORETICAL DEVELOPMENT .... CONT'D

5.4 WEIGHT ESTIMATES

IN THE FOREGOING DISCUSSIONS IT WAS ASSUMED THAT THE SHAPE OF THE MEMBER IN QUESTION REMAINED INVARIANT DURING MATERIAL SUBSTITUTION (EXCEPT FOR THE MATERIAL THICKNESS). THUS, THE WEIGHT OF THE NEW MATERIAL CAN BE RELATED TO THE WEIGHT OF THE ORIGINAL MATERIAL AS FOLLOWS:

$$\frac{W_N}{W_o} = \frac{t_N}{t_o} \cdot \frac{\rho_N}{\rho_o} \quad \ldots\ldots (78)$$

THE PERCENTAGE CHANGE IN WEIGHT IS,

$$\Delta W = \frac{100(W_N - W_o)}{W_o} = 100\left(\frac{W_N}{W_o} - 1\right) \quad \ldots\ldots (79)$$

OR,

$$\boxed{\Delta W = 100\left[\frac{t_N}{t_o} \cdot \frac{\rho_N}{\rho_o} - 1\right] \quad \ldots\ldots (80)}$$

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS

SECTION 5.0 PROVIDES THE ANALYTICAL TOOLS FOR ESTIMATING THE WEIGHT SAVING POTENTIAL OF VARIOUS CANDIDATE SUBSTITUTE MATERIALS. THIS SECTION UTILIZES THESE ANALYTICAL TOOLS IN ESTIMATING THE WEIGHT SAVING POSSIBILITIES, THRU MATERIAL SUBSTITUTION, FOR VARIOUS MAJOR STRUCTURAL SUBSYSTEMS COMPRISING THE 1979 FORD LTD. IN A SEPARATE EFFORT AT SOUTH COAST TECHNOLOGY, THE FOLLOWING MAJOR STRUCTURAL SUBSYSTEMS WERE IDENTIFIED AS PRIORTY ITEMS FOR WEIGHT REDUCTION THRU MATERIAL SUBSTITUTION (THE LIST IS PROVIDED IN DESCENDING ORDER OF PRIORITY):

1. FRAME ASSEMBLY
2. HOOD ASSEMBLY
3. DECK LID ASSEMBLY
4. FRONT FENDER (OUTER ONLY)
5. BUMPER ASSEMBLY
6. DOOR ASSEMBLY
7. HARDWARE
8. WHEELS

6.1 WEIGHT SAVING POTENTIAL - FRAME ASSEMBLY

THE FRAME ASSEMBLY OF THE FORD LTD IS ILLUSTRATED IN FIGURE 4. THE FIGURE IDENTIFIES THREE ZONES ON THE FRAME THAT WILL BE EVALUATED HEREIN. ZONES #1 AND #3 HAVE AS THEIR PREDOMINANT LOADING,

- 5 MPH BARRIER IMPACT PROTECTION PER FMVSS 215.
- CRASH PROTECTION PER FMVSS 208.
- JACKING / HOISTING / TOWING

ZONE #2 LOADING IS CONCERNED PRIMARILY WITH THE BEARING OF THE SUSPENDED WEIGHT OF THE VEHICLE TO THE FORE AND AFT AXLES AND THE STIFFNESS REQUIREMENTS FOR RIDING AND HANDLING.

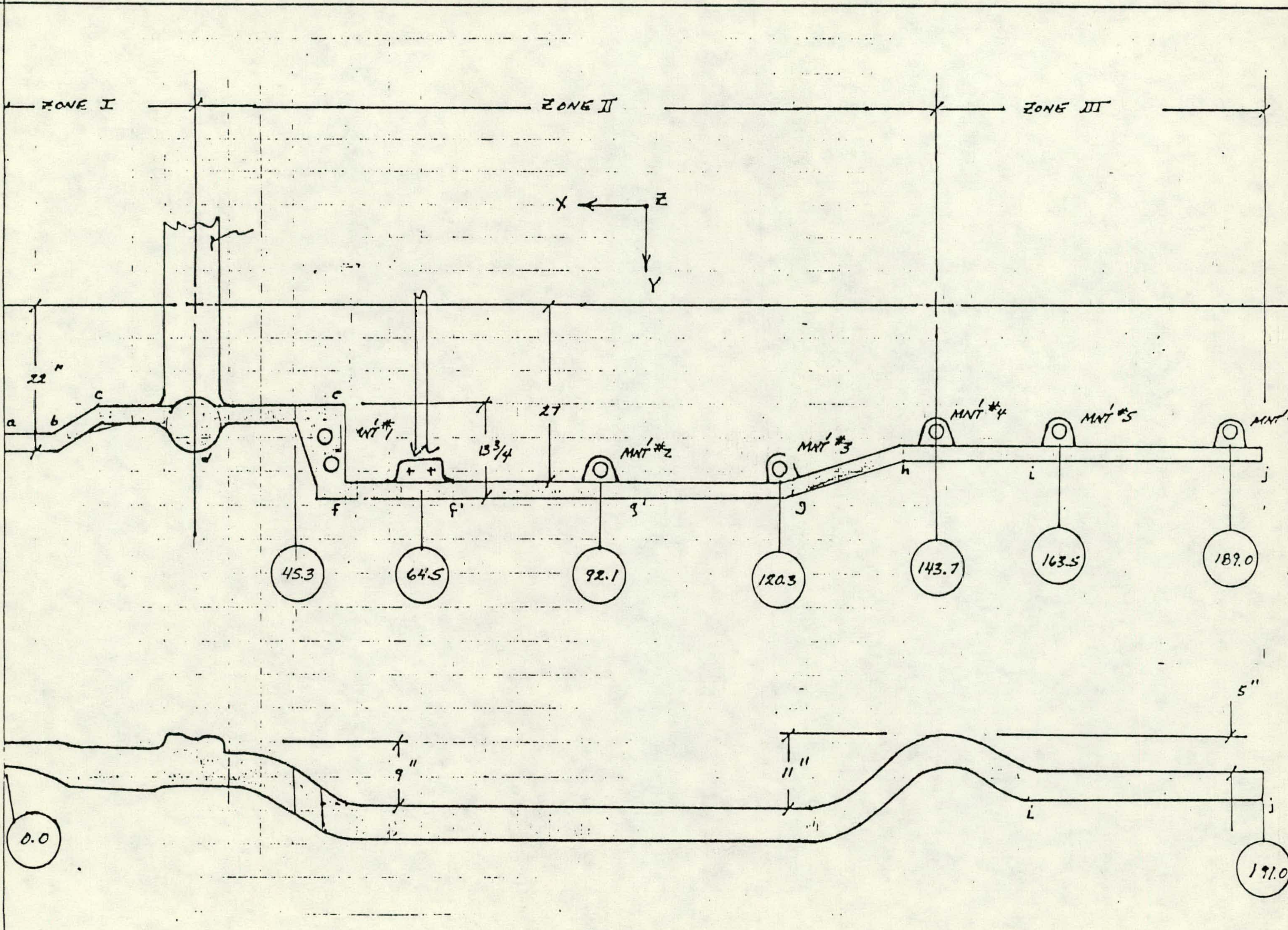

FIGURE 4

HYBRID VEHICLE

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS

6.1.1 ZONE 1 (FIGURE 4)

AS SHOWN IN FIGURE 4, THIS ZONE MAKES UP THE FORWARD END OF THE FRAME ASSEMBLY AND INCLUDES THE LATERAL BRACING WHICH SERVES AS A SUPPORT FOR THE ENGINE AND A TORSIONAL RESTRAINT FOR THE LONGITUDINAL FRAMES. THE LONGITUDINAL FRAME MEMBERS IN ZONE 1 ARE FABRICATED FROM HSLA grade 950X HAVING THE FOLLOWING MECHANICAL PROPERTIES:

- $S_{tu} = 65{,}000$ psi (min)
- $S_{tyld} = 50{,}000$ psi (min)
- $E = 30 \times 10^6$ psi
- $\nu \cong .25$

THE LATERAL BRACING IS ASSUMED TO BE FABRICATED FROM AN SAE 1006 STEEL ALLOY (OR EQUIVALENT) WITH THE FOLLOWING MECHANICAL PROPERTIES (7):

- $S_{tu} = 40{,}000$ psi (min)
- $S_{yld} = 25{,}000$ psi (min)
- $E = 30 \times 10^6$
- $\nu \cong .25$

THE ABOVE MATERIALS ARE FOR STATIC CONDITIONS. FOR DYNAMIC CONDITIONS, THE STRAIN RATE EFFECTS MUST BE CONSIDERED. REFERENCE 7 PROVIDES TEST DATA FROM THE CRUSH OF 4 INCH DIAMETER TUBES MADE FROM HSLA STEEL AND ALUMINUM. THE FOLLOWING STRAIN RATE FACTORS WERE DERIVED FROM THAT DATA.

$$\left.\begin{aligned} \Gamma_{STEEL} &= 1 + .02V \\ \Gamma_{AL} &= 1 + .0071V \end{aligned}\right\} \quad \ldots\ldots (B1)$$

WHERE,

V = IMPACT SPEED (MPH)

6.0 FORD LTD WEIGHT SAVING CALCULATIONS .... CONT'D

IN ZONE #1, OF THE FRAME, THE FOLLOWING MATERIAL PERFORMANCES ARE CONSIDERED TO BE CRUCIAL TO THE DESIGN:

1. YIELDING OF SECTION
2. BUCKLING OF SECTION ELEMENTS
   - FLANGE
   - CRIPPLING
3. IMPACT RESISTANCE

TABLE I SUMMARIZES THE CALCULATIONS FOR THIN-WALL BEAM ELEMENTS FOR A VARIETY OF ORIGINAL AND SUBSTITUTE MATERIALS AND FOR VARIOUS MATERIAL PERFORMANCE CATEGORIES, INCLUDING:

- STIFFNESS – COLUMNS 11 & 12
- YIELDING – " 13 & 14
- BUCKLING
  - COLUMN " 15 & 16
  - FLANGE " 17 & 18
  - CRIPPLING " 19 & 20
- VIBRATION –
  - ELEMENT MASS " 21 & 22
  - MASS SUPPORTED BY ELEMENT " 23 & 24
- IMPACT RESISTANCE " 25 & 26

CONSIDERING FIRST THE LONGITUDINAL FRAME MEMBER IN ZONE #1, WHICH IS ORIGINALLY A HSLA-950X STEEL, TABLE I SHOWS THE FOLLOWING MATERIAL PERFORMANCES FOR THE THREE PERFORMANCE CATEGORIES OF INTEREST HERE.

SUBSTITUTE MATERIAL	YIELDING		BUCKLING				IMPACT	
			FLANGE		CRIPPLING			
ALUMINUM ALLOY	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %
5182	1.72	−39.1	1.41	−50.2	1.60	−43.5	1.52	−46.4
2014-T4	1.35	−52.2	1.41	−50.2	1.49	−47.3	1.34	−52.6
6061-T6	1.25	−55.8	1.41	−50.2	1.46	−48.5	1.29	−54.6

TABLE I: SUMMARY OF CALCULATIONS FOR THIN-WALL BEAM ELEMENTS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
ORIGINAL MATERIAL					SUBSTITUTE MATERIAL					MATERIAL PERFORMANCE - t_N/t_o ; ΔW																
														BUCKLING						VIBRATION				IMPACT		
ALLOY	S_{YLD}	ρ	E	ν	ALLOY	S_{YLD}	ρ	E	ν [3]	STIFFN.		YIELDING		COLUMN		FLANGE		CRIPPL'G		ELE. MASS		SHR MASS				1
	$\times10^3$	#/in³	$\times10^6$			$\times10^3$	#/in³	$\times10^6$		t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	w_N/w_o		t_N/t_o	ΔW %	t_N/t_o	ΔW %	
HSLA-950X	50 [1]	.283	30	.25	5182	29 [2]	.1	10	.32	3.0 (25,30,34)	+67%	1.72 (39)	-39.1 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.60 (50)	-43.5 (80)	.97 (53)		3.0 (58)	+67% (80)	1.52 (67)	-96.9	2
"	50 [1]	.283	30	.25	2014-T4	37 [2]	.1	10	.32	3.0 (25,30,34)	+67%	1.35 (39)	-52.2 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.49 (50)	-47.3 (80)	.97 (53)		3.0 (58)	+67% (80)	1.34 (67)	-52.0	3
"	50 [1]	.283	30	.25	6061-T6	40 [2]	.1	10	.32	3.0 (25,30,34)	+67%	1.25 (39)	-55.8 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.46 (50)	-48.5 (80)	.97 (53)		3.0 (58)	+67% (80)	1.29 (67)	-54.4	4
1006 STEEL	25 [1]	.283	30	.25	5182	29 [2]	.1	10	.32	3.0 (25,30,34)	+67%	.86 (39)	-70.0 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.31 (50)	-53.0 (80)	.97 (53)		3.0 (58)	+67% (80)	1.07 (67)	-62.1	5
"	25 [1]	.283	30	.25	2014-T4	37 [2]	.1	10	.32	3.0 (25,30,34)	+67%	.68 (39)	-76. (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.22 (50)	-56.8 (80)	.97 (53)		3.0 (58)	+67% (80)	.95 (67)	-66.5	6
"	25 [1]	.283	30	.25	6061-T6	40 [2]	.1	10	.32	3.0 (25,30,34)	+67%	.63 (39)	-77.9 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.20 (50)	-57.7 (80)	.97 (53)		3.0 (58)	+67% (80)	.91 (67)	-67.7	7
1020-STEEL	36 [1]	.283	30	.25	5182	29 [2]	.1	10	.32	3.0 (25,30,34)	+67%	1.24 (39)	-51.7 (80)	3.0 (44)	+67% (80)	1.44 (47)	-50.2 (80)	1.46 (50)	-48.9 (80)	.97 (53)		3.0 (58)	+67% (80)	1.27 (67)	-54.5	8
"	36 [1]	.283	30	.25	2014-T4	37 [2]	.1	10	.32	3.0 (25,30,34)	+67%	.97 (39)	-65.0 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.36 (50)	-52.0 (80)	.97 (53)		3.0 (58)	+67% (80)	1.14	-59.8	9
"	36 [1]	.283	30	.25	6061-T6	40 [2]	.1	10	.32	3.0 (25,30,34)	+67%	.90 (39)	-68.2 (80)	3.0 (44)	+67% (80)	1.41 (47)	-50.2 (80)	1.33 (50)	-53.1 (80)	.97 (53)		3.0 (58)	+67% (80)	1.10	-61.2	10
"	36 [1]	.283	30	.25	PLASTIC P19C (TABLE II)	9.5	.067	1.45	.35	16.2	+284	3.79	-10.3	16.2	+284	2.48	-41.4	3.24	-23.2	.51		16.2	+284	2.46	-41.7	11

1. STATIC YIELD STRESS; DYNAMIC YIELD STRESS ≅ 1.6 $S_{YLD_{STAT}}$ (@ 30 MPH)
2. " " " ; " " " ≅ 1.2 $S_{YLD_{STAT}}$ (@ 30 MPH)
3. POISSON'S RATIO

NOTE: ( ) DENOTES THE EQUATION(S) USED IN THE CALCULATIONS

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS ..... CONT'D

THE RESULTS SHOW THAT FOR AL-5182, YIELDING LIMITS THE POTENTIAL WEIGHT SAVING TO 39.1 %. FOR THE OTHER TWO ALUMINUM ALLOYS, HAVING A SOMEWHAT HIGHER YIELD STRENGTH, THE CRIPPLING STRENGTH BECOMES THE LIMITING FACTOR FOR WEIGHT SAVINGS. FOR AL 2014-T4, THE WEIGHT SAVINGS IS LIMITED TO 47.3 % AN FOR AL-6061-T6 IS LIMITED TO 48.5 %.

NOTE, THAT IN THE ABOVE DISCUSSION IT WAS ASSUMED THAT THE STIFFNESS AND VIBRATION FACTORS ARE OF SECONDARY IMPORTANTS IN ZONE #1 OF THE FRAME. HENCE, WITH THE ALUMINUM MATERIAL SUBSTITUTION, IT CAN BE EXPECTED THAT THE FRONT END STRUCTURE WILL BE MORE FLEXIBLE (e.g. UNDER JACKING LOADS) THAN THE ORIGINAL CONFIGURATION.

THE LATERAL BRACING, ALSO LOCATED IN ZONE I, HAS BASICALLY THE SAME MATERIAL PERFORMANCE REQUIREMENTS AS THE LONGITUDINAL FRAME MATERIAL (EXCEPT FOR IMPACT RESISTANCE – i.e. ENERGY ABSORPTION). TABLE I (ROWS 5, 6 & 7) SHOWS THE THICKNESS REQUIREMENTS AND POTENTIAL WEIGHT SAVINGS, OF THE LATERAL MEMBER, FOR VARIOUS MATERIAL SUBSTITUTES AND MATERIAL PERFORMANCE CATEGORIES. THE FOLLOWING SUMMARIZE THE APPROPRIATE RESULTS FOR THE LATERAL MEMBER:

SUBSTITUTE MATERIAL	YIELDING		BUCKLING			
			FLANGE		CRIPPLING	
ALUMINUM ALLOY	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %
5182	.86	−70.0	1.41	−50.2	1.31	−50.2
2014-T4	.68	−76.0	1.41	−50.2	1.22	−56.8
6061-T6	.63	−77.9	1.41	−50.2	1.20	−57.7

THE RESULTS SHOW THAT FLANGE BUCKLING IS CRITICAL, LIMITING THE POTENTIAL WEIGHT SAVINGS TO ~ 50 % FOR ALL MATERIAL CANDIDATES. HERE, AN INCREASE IN MATERIAL YIELD STRENGTH IS OF NO VALUE IN REDUCING THE WEIGHT OF THE

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS ..... CONT'D

PART.

6.1.2 ZONE #2 (FIGURE 4)

ZONE #2 MAKES UP THE MIDSPAN OF THE FRAME BETWEEN THE FRONT AND REAR AXLES. THE LONGITUDINAL FRAME MEMBERS IN THIS ZONE ARE BELIEVED TO BE FABRICATED FROM A SAE 1020 STEEL ALLOY (OR EQUIVALENT) HAVING THE FOLLOWING MECHANICAL PROPERTIES:

- $S_{t_{YLD}} = 36{,}000$ psi
- $E = 30 \times 10^6$ psi
- $\nu = .25$

TABLE I (ROWS 8, 9, 10) SHOWS THE MATERIAL THICKNESS REQUIREMENTS AND POTENTIAL WEIGHT SAVINGS FOR A MATERIAL SUBSTITUTION IN ZONE 2 OF THE FRAME. THE MATERIAL PERFORMANCE REQUIREMENTS HERE INCLUDE:

- STIFFNESS
- YIELDING
- BUCKLING
  - FLANGE
  - CRIPPLING
- VIBRATION (SUPPORTED MASS)

COMPARING COLUMNS 11-24 IN ROWS 8, 9, 10 WE FIND THAT BOTH THE STIFFNESS (COLUMNS 11, 12) AND THE VIBRATION (COLUMNS 23 & 24) REQUIREMENTS OF THE FRAME MATERIAL IN ZONE #2 DOMINATES. THE RESULTS SHOW THAT THERE WILL BE AN INCREASE IN THE WEIGHT OF THE FRAME (6%) WHEN A SUBSTITUTION WITH ALUMINUM IS MADE. THE RESULTS IMPLY THAT WEIGHT SAVINGS CAN BE OBTAIN HERE ONLY AT THE EXPENSE OF THE VEHICLE BEAMING STIFFNESS, AND VIBRATION CHARACTERISTICS.

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS ..... CONT'D

6.1.3 ZONE #3 (FIGURE 4)

ZONE #3 OF THE FRAME MAKES UP THE REAR OVERHANG OF THE FRAME (REARWARD OF THE REAR AXLE). THE MATERIAL PERFORMANCE REQUIREMENTS FOR THIS ZONE ARE BASICALLY THE SAME AS THAT FOR ZONE #1. I.E. THE FOLLOWING,

- YIELDING RESISTANCE
- BUCKLING RESISTANCE
  - FLANGE
  - CRIPPLING
- IMPACT RESISTANCE

THE ORIGINAL MATERIAL FOR THE FRAME IN ZONE #3 IS THE SAME AS THAT FOR ZONE #2 (SEE PAGE 27). TABLE I, ROWS 8, 9 AND 10 SUMMARIZE THE CALCULATIONS APPROPRIATE FOR ZONE #3. COMPARING COLUMN 17 (TABLE I) WITH OTHER APPROPRIATE COLUMNS IN TABLE I SHOWS THAT FLANGE BUCKLING LIMITS THE POTENTIAL WEIGHT REDUCTION IN THIS ZONE TO APPROXIMATELY 50%. IT IS NOTED THAT THIS ZONE OF THE FRAME STRUCTURE WILL BE MORE FLEXIBLE THAN THE ORIGINAL SINCE IT WAS ASSUMED THAT STIFFNESS AND VIBRATION WERE NON-CRITICAL TO THE DESIGN HERE.

6.2 WEIGHT SAVING POTENTIAL – HOOD ASSEMBLY

THE HOOD ASSEMBLY CONSISTS OF AN INNER AND OUTER PANEL. THE INNER PANEL IS FORMED WITH STIFFENING RIBS TO SUPPORT THE OUTER PANEL. THUS, THE INNER PANEL CAN BE THOUGHT OF AS AN ASSEMBLY OF THIN-WALL BEAM TYPE ELEMENTS. THE OUTER PANEL IS PROVIDED PRIMARILY FOR "COSMETICS" AND CONSISTS PRIMARILY OF A CONTOURED SHEET.

Linney S. Paul 26 Mar '79

6.0 FORD LTD WEIGHT SAVING CALCULATIONS ..... CONT'D

6.2.1 INNER PANEL

THE INNER PANEL WILL FUNCTION PRIMARILY AS AN ASSEMBLY OF THIN-WALL BEAM TYPE ELEMENTS; HENCE, TABLE I IS APPLICABLE HERE. THE CRITICAL MATERIAL REQUIREMENTS FOR THIS PANEL INCLUDE:

- STIFFNESS
- YIELD STRENGTH
- BUCKLING RESISTANCE
  - FLANGE
  - CRIPPLING
- IMPACT RESISTANCE (ENERGY ABSORPTION)
- VIBRATION

ASSUMING THAT THE ORIGINAL MATERIAL IS AN SAE 1020 STEEL ALLOY (OR EQUIVALENT) THEN ROWS 8-11 OF TABLE I SUMMARIZE THE CALCULATIONS APPROPRIATE HERE. COMPARING COLUMNS 11-26 (TABLE I) REVEALS THAT STIFFNESS AND VIBRATION DOMINATES THE DESIGN AND NEITHER ALUMINUM OR PLASTIC OFFER A WEIGHT ADVANTAGE OVER THE ORIGINAL STEEL MATERIAL.

IF THE STIFFNESS AND VIBRATION CHARACTERISTICS ARE NOT CONSIDERED IMPORTANT, THEN THE CONTROLING FACTORS WILL BE:

1. ALUMINUM SUBSTITUTION - FLANGE BUCKLING, $\Delta W_{max} = -50.2\%$
2. PLASTIC SUBSTITUTION - YIELDING, $\Delta W_{max} = -10.3\%$

6.2.2 OUTER PANEL

THE OUTER HOOD PANEL IS PRIMARILY A COSMETIC SURFACE. TABLE II IS APPLICABLE HERE. IT IS ASSUMED THAT THE ORIGINAL MATERIAL IS SAE 1010 (COLD ROLLED), OR EQUIVALENT. ROWS 1-4 IN TABLE II SUMMARIZE THE CALCULATIONS FOR FOUR (4) SUBSTITUTE MATERIALS AND VARIOUS CRITICAL REQUIREMENTS (i.e., COLUMNS 11 - 18). THE TABLE SHOWS THAT THE "OIL-CANNING" RESISTANCE IS CRITICAL FOR ALL OF THE SUBSTITUTE MATERIALS CONSIDERED (COMPARE

TABLE II : SUMMARY OF CALCULATIONS FOR PANEL ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
ORIGINAL MATERIAL					SUBSTITUTE MATERIAL					MATERIAL PERFORMANCE - t_N/t_o ; ΔW								
										OIL-CAN RESIST.		DENT RESIST.		ELASTIC BUCKL.		VIBRATION		
ALLOY	S_{YLD}[1] $\times 10^3$	ρ #/in³	E $\times 10^6$	ν[3]	ALLOY	S_{YLD}[2] $\times 10^3$	ρ #/in³	E $\times 10^6$	ν[3]	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	t_N/t_o	ΔW %	
1010 C.R. STEEL	44	.283	30	.25	2036-T4	42	.1	10	.32	1.73 (5)	-38.8 (80)	.81 (10)	-71.5 (80)	1.42 (13)	-49.8 (80)	1.06 (19)	-62.5 (80)	1
"	44	.283	30	.25	6182	27	.1	10	.32	1.73 (5)	-38.8 (80)	1.25 (10)	-55.7 (80)	1.42 (13)	-49.8 (80)	1.06 (19)	-62.5 (80)	2
"	44	.283	30	.25	P19C[4] (PLASTIC)	9.5[6]	.067	1.85	~.35	4.03 (5)	-4.6 (80)	1.84 (10)	-56.4 (80)	2.48 (13)	-41.4 (80)	3.84 (19)	-9.1 (80)	3
"	44	.283	30	.25	DYLARK[5] (PLASTIC) 240	8.4[6]	.044	.9	~.35	5.77 (5)	-10.2 (80)	1.45 (10)	-77.4 (80)	3.15 (13)	-51.0 (80)	5.18 (19)	-19.4 (80)	4

NOTE: ( ) INDICATES THE EQUATIONS USED IN THE CALCULATIONS

1. STATIC YIELD STRESS; DYNAMIC YIELD STRESS ≅ 1.6 $S_{YLD_{STATIC}}$ (@ 30 MPH)
2. " " " ; DYNAMIC YIELD STRESS (ALUMINUM) ≅ 1.2 $S_{YLD_{STATIC}}$ (@ 30 MPH); DYNAMIC YIELD STRESS (PLASTIC) ≅ 1.0 $S_{YLD_{STATIC}}$
3. POISSON'S RATIO
4. PARAPLEX P19C, SHEET MOLDING COMPOUND BY ROHM & HAAS CO., HAS 30% GLASS REINFORCEMENT.
5. DYLARK 240, HAS 20% GLASS REINFORCEMENT; BY ARCO / POLYMERS INC.
6. YIELD STRENGTHS UNAVAILABLE; HENCE, S_{YLD} ≅ .7 S_{ULT} ASSUMED.

DATE: 19 MAR '79

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS .... CONT'D

COLUMN 11 WITH COLUMNS 13, 15 & 17). FOR ALUMINUM, THE WEIGHT REDUCTION POTENTIAL APPEARS TO BE LIMITED TO 39%. FOR PLASTIC, THE POTENTIAL FOR WEIGHT REDUCTION IS LIMITED TO APPROXIMATELY 10%.

6.3 WEIGHT SAVING POTENTIAL - DECK LID ASSEMBLY

THE RESULTS DISCUSSED IN SECTION 6.2 ARE APPLICABLE HERE.

6.4 WEIGHT SAVING POTENTIAL - FRONT FENDER (OUTER ONLY)

THE FRONT FENDER ASSEMBLY (OUTER). CAN BE THOUGHT OF AS A PANEL TYPE ELEMENT; HENCE, TABLE II IS APPLICABLE HERE. THE FRONT FENDER ASSEMBLY IS PRIMARILY FOR "COSMETICS". THE FOLLOWING MATERIAL REQUIREMENTS ARE CONSIDERED TO BE CRITICAL TO THE DESIGN:

- DENT RESISTANCE (COLUMNS 13 & 14, TABLE II)
- ELASTIC BUCKLING (COLUMNS 15 & 16, TABLE II)

THE TABLE SHOWS THAT ELASTIC BUCKLING DOMINATES FOR ALL SUBSTITUTE MATERIALS CONSIDERED. THIS DESIGN REQUIREMENT LIMITS THE POTENTIAL WEIGHT SAVING TO 50% FOR ALUMINUM AND 51% FOR PLASTIC.

6.5 WEIGHT SAVING POTENTIAL - BUMPER ASSEMBLY

THE BUMPER SYSTEM CONSISTS PRIMARILY OF THIN-WALL BEAM TYPE ELEMENTS; HENCE, TABLE I IS APPLICABLE HERE. THE CRITICAL MATERIAL REQUIREMENTS FOR THIS ASSEMBLY ARE,

- YIELDING (COLUMNS 13 & 14)
- CRIPPLING (COLUMNS 19 & 20)

IF IT IS ASSUMED THAT THE ORIGINAL MATERIAL IS SAE 1020. STEEL ALLOY (OR EQUIVALENT) THEN ROWS 8-11 OF TABLE I ARE APPLICABLE HERE. THE RESULTS IN THE

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS .... CONT'D

TABLE SHOW THAT FOR ALUMINUM SUBSTITUTES THE POTENTIAL WEIGHT SAVINGS ARE LIMITED TO APPROXIMATELY 53% BY CRIPPLING. FOR PLASTIC, YIELDING SEEMS TO BE CRITICAL, LIMITING THE POTENTIAL WEIGHT SAVINGS TO APPROXIMATELY 10%.

6.6 WEIGHT SAVING POTENTIAL - DOOR ASSEMBLY

THE DOOR ASSEMBLY IS COMPRISED OF AN OUTER PANEL, AN INNER PANEL, A DOOR FRAME (ONTO WHICH THE HINGES AND THE LATCHES ARE ATTACHED) AND AN INNER DOOR BEAM.

6.6.1 OUTER PANEL

THE OUTER PANEL OF THE DOOR ASSEMBLY IS PRIMARILY A "COSMETIC" SURFACE, AND CAN BE CONSIDERED A PANEL TYPE ELEMENT (HENCE, TABLE II IS APPLICABLE HERE). THE CRITICAL MATERIAL REQUIREMENTS FOR THIS PANEL ARE:

- OIL-CANNING RESISTANCE
- DENT RESISTANCE

TABLE II (COLUMNS 11 & 13) SHOWS THAT OIL-CANNING RESISTANCE IS CRITICAL FOR ALL THE SUBSTITUTE MATERIALS CONSIDERED. THIS REQUIREMENT LIMITS THE POTENTIAL WEIGHT SAVINGS TO 39% FOR AN ALUMINUM SUBSTITUTE AND TO 10% FOR A PLASTIC SUBSTITUTE.

6.6.2 INNER PANEL

THE INNER PANEL OF THE DOOR ASSEMBLY WILL HAVE THE SAME MATERIAL SUBSTITUTION LIMITATIONS AS THE OUTER PANEL SINCE THE CRITICAL MATERIAL REQUIREMENT HERE IS ALSO OIL-CANNING RESISTANCE. HENCE, THE POTENTIAL WEIGHT SAVINGS FOR THE INNER PANEL

James S. V[illegible] 26 Mar '79

6.0 FORD LTD WEIGHT SAVING CALCULATIONS.... CONT'D

WILL BE LIMITED TO APPROXIMATELY 59% FOR ALUMINUM AND 10% FOR PLASTIC MATERIAL SUBSTITUTES.

6.6.3 DOOR FRAME

THE DOOR FRAME CAN BE THOUGHT OF AS A SOLID BEAM ELEMENT WHICH MUST RESIST IN-PLANE BENDING FROM THE HINGE AND LATCH LOADS. THUS, EQUATION 77, P 21 IS APPLICABLE HERE. ASSUMING THAT THE DOOR FRAME IS AN SAE 1020 STEEL HAVING THE FOLLOWING MECHANICAL PROPERTIES,

- $S_{YLD} = 36$ ksi
- $E = 30 \times 10^6$ psi
- $\nu = .25$
- $\rho = .283$

THEN THE FOLLOWING POTENTIAL WEIGHT SAVINGS WILL BE POSSIBLE:

ALLOY	S_{YLD} $\times 10^3$ psi	IN-PLANE BENDING	
		t_N/t_o - EQ.77	ΔW(%) - EQ 80
2036-T4	42	.925	-67.3
5182	27	1.15	-59.2
P19C * (PLASTIC)	9.5	1.94	-53.9
DYLARK-240 * PLASTIC	8.4	2.04	-67.8

* SEE TABLE II

6.0 FORD LTD WEIGHT SAVING CALCULATIONS .... CONT'D

6.6.4 INNER DOOR BEAM

THE INNER DOOR BEAM IS A THIN-WALL BEAM TYPE ELEMENT. HENCE, TABLE I IS APPLICABLE HERE. ASSUMING THAT THE ORIGINAL MATERIAL IS SAE 1020 STEEL (OR EQUIVALENT) THEN ROWS 8-11, OF TABLE I, SUMMARIZES THE POTENTIAL WEIGHT SAVING CALCULATIONS. FOR THIS MEMBER, CRIPPLING WILL BE THE CRITICAL MATERIAL PERFORMANCE REQUIREMENT, HENCE COLUMNS 19 & 20 APPLY. TABLE I SHOWS THAT FOR AN ALUMINUM SUBSTITUTE, THE POTENTIAL WEIGHT SAVING IS LIMITED TO APPROXIMATELY 53%. THE WEIGHT SAVING POTENTIAL FOR PLASTIC IS LIMITED TO APPROXIMATELY 23%. ALTHOUGH NOT SHOWN IN THE TABLE, THE POTENTIAL WEIGHT SAVING FOR HSLA STEEL 980X ALLOY (S_{YLD} = 80 KSI) IS (SEE EQUATIONS 50 & 80):

$$\frac{t_N}{t_o} = \left[\frac{36}{80} \cdot \frac{30}{30} \right]^{1/3.5} = .796$$

$$\Delta W = -20.4\%$$

6.7 HARDWARE COMPONENTS

HARDWARE COMPONENTS INCLUDE SUCH ITEMS AS HINGES, LATCHES, BRACES ETC. USUALLY THESE COMPONENTS CONSIST OF SOLID, BENDING TYPE ELEMENTS HENCE, EQUATIONS 72 AND 77 APPLY. IF WE ASSUME THAT THE BASELINE MATERIAL IS SAE 1020 (S_{YLD} = 36 KSI) THEN THE FOLLOWING MATERIAL SUBSTITUTE REQUIREMENTS EXIST:

MAT'L SUBSTITUTE	SYLD	OUT-OF-PLANE BEND.		IN-PLANE BENDING	
		t_N/t_o	ΔW-%	t_N/t_o	ΔW-%
HSLA 980X	80	.45	-55	.67	-33
2014-T4	37	.973	-66	.986	-65
6061-T6	40	.9	-68.2	.949	-66.5
5182	29	1.24	-56.1	1.11	-60.6

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6.0 FORD LTD WEIGHT SAVING CALCULATIONS

6.8 WHEELS

THE WHEELS CAN BE THOUGHT OF AS A SOLID BENDING ELEMENT (ASSUMING THAT THE SIDE SKID LOADING OF THE WHEEL IS MOST CRITICAL) WITH IN-PLANE BENDING; HENCE, EQUATION 77 APPLIES HERE. ASSUMING THAT THE ORIGINAL MATERIAL IS SAE 1020 (S_{YLD} = 36 KSI), OR EQUIVALENT, THEN THE FOLLOWING WEIGHT REDUCTION POSSIBILITIES EXIST THRU MATERIAL SUBSTITUTION:

MATERIAL SUBSTITUTE	S_{YLD} KSI	t_N/t_o	ΔW - %
HSLA 950X	50	.849	-15.1
5182	29	1.11	-60.6
2014-T4	37	.986	-65.1
6061-T6	40	.949	-66.5

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WHARTON EFA, INC. WEFA

APPENDIX B3

THE MARKET POTENTIAL FOR HYBRID VEHICLES

by

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March 1979

A Report Prepared by

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for

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Santa Barbara, CA

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THE MARKET POTENTIAL FOR HYBRID VEHICLES

EXECUTIVE SUMMARY

This study used the Wharton EFA Motor Vehicle Model to analyze the market potential for "hybrid" vehicles: cars possessing both gasoline engines and electric motors. Sales volume was predicted under a range of alternative scenarios to examine the forecasts' sensitivity to particular assumptions.

The basic proposition underlying this study is that the hybrid technology can be proven to be both technically and economically feasible for mass production and sale, together with the provision of the required recharging facilities, in time to be offered for sale in 1985. The second basic premise is that the traditional U.S. auto market segments will continue to be valid as distinct marketing "targets" for different car models designed to meet different tastes, perceptions, and budgets.

The results of this study suggest that under certain conditions there is a significant market for a range of hybrid automobile models, and that the potential savings in petroleum fueld usage in the long run are substantial

Key findings are:

1. The added cost of hybrids is very important: a price differential in the 25% to 40% range yields a market share of 25%, with volume of between 3 and 4 million units annually; a 45%-80% price differential produces only a 5% share, with volume less than 1 million units.

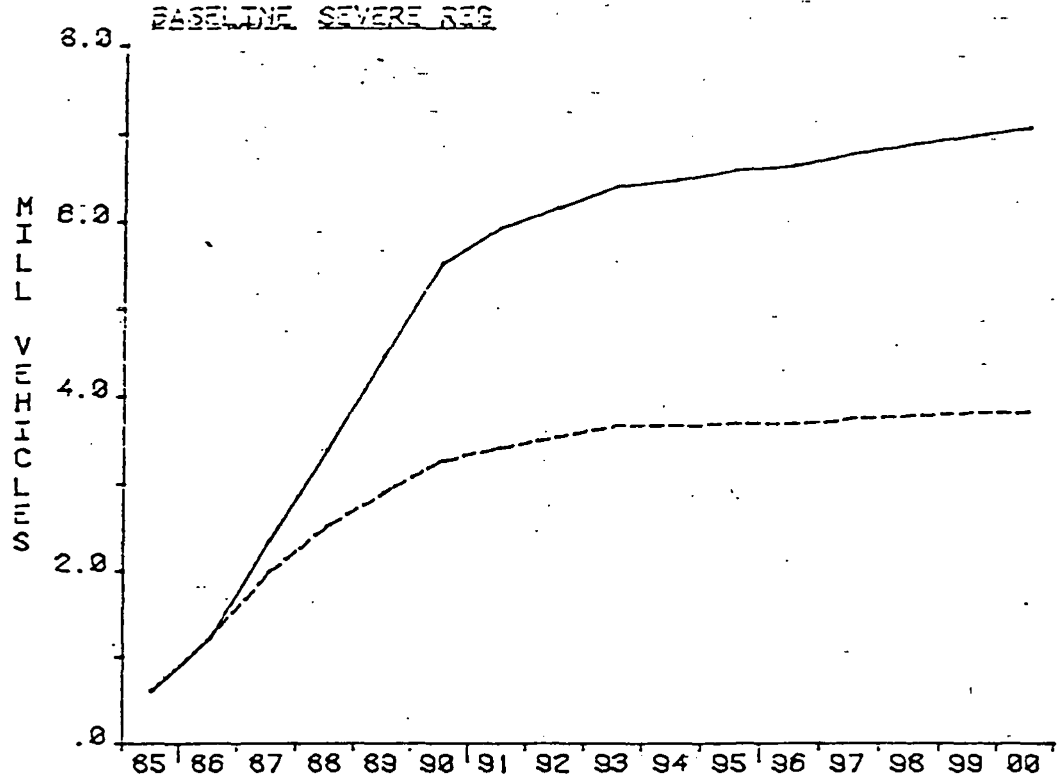
2. Maximum hybrid sales would occur if manufacturers had to replace all mid-size and larger vehicles with hybrids due to stringent CAFE and emissions requirements after 1985; this could yield a 45% market share, with sales of 5-7 million, although total domestic sales would be lower.

3. The real price of gasoline is critical: each 1% change produces almost a 1% change in hybrid sales; for real electricity prices, the effect is almost exactly half as important.

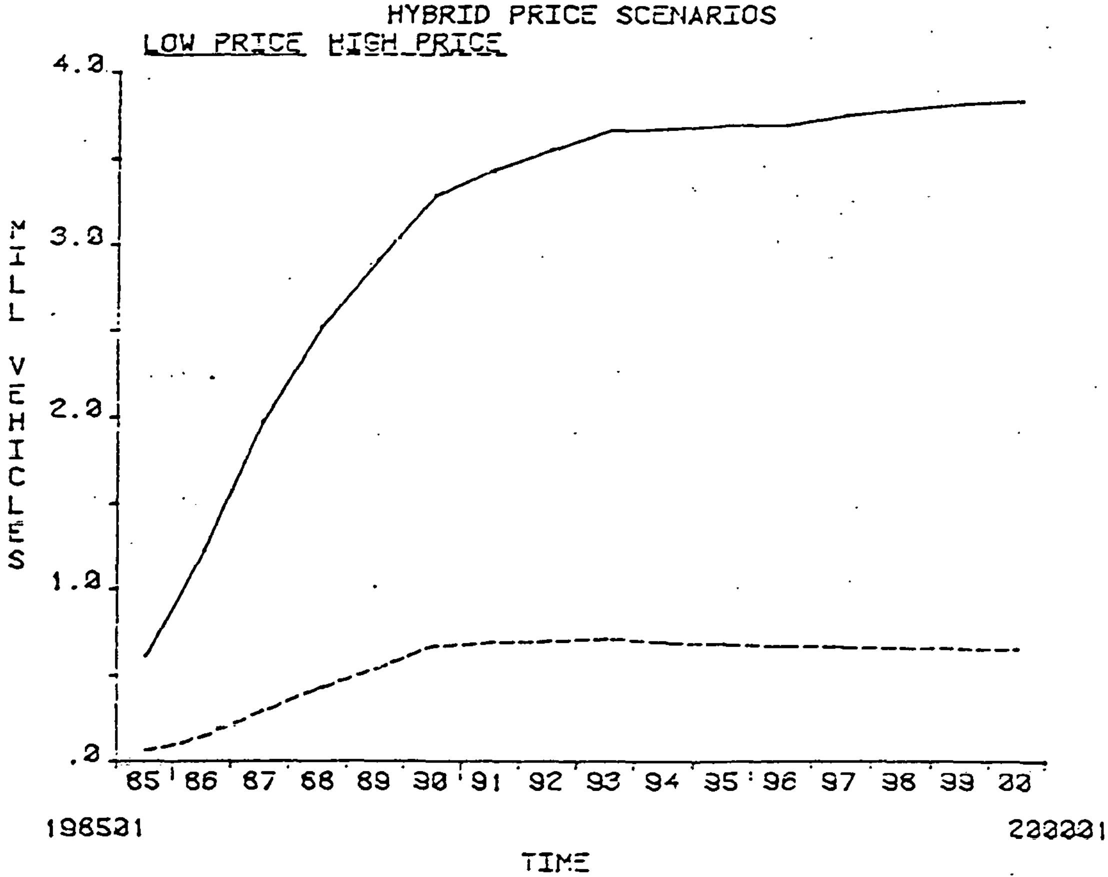
4. The most effective way to maximize hybrid sales is with models in each market segment: even though large cars benefit the most, the size of the mid-size/intermediate segment established in the U.S. market makes this a significant potential source of hybrid sales.

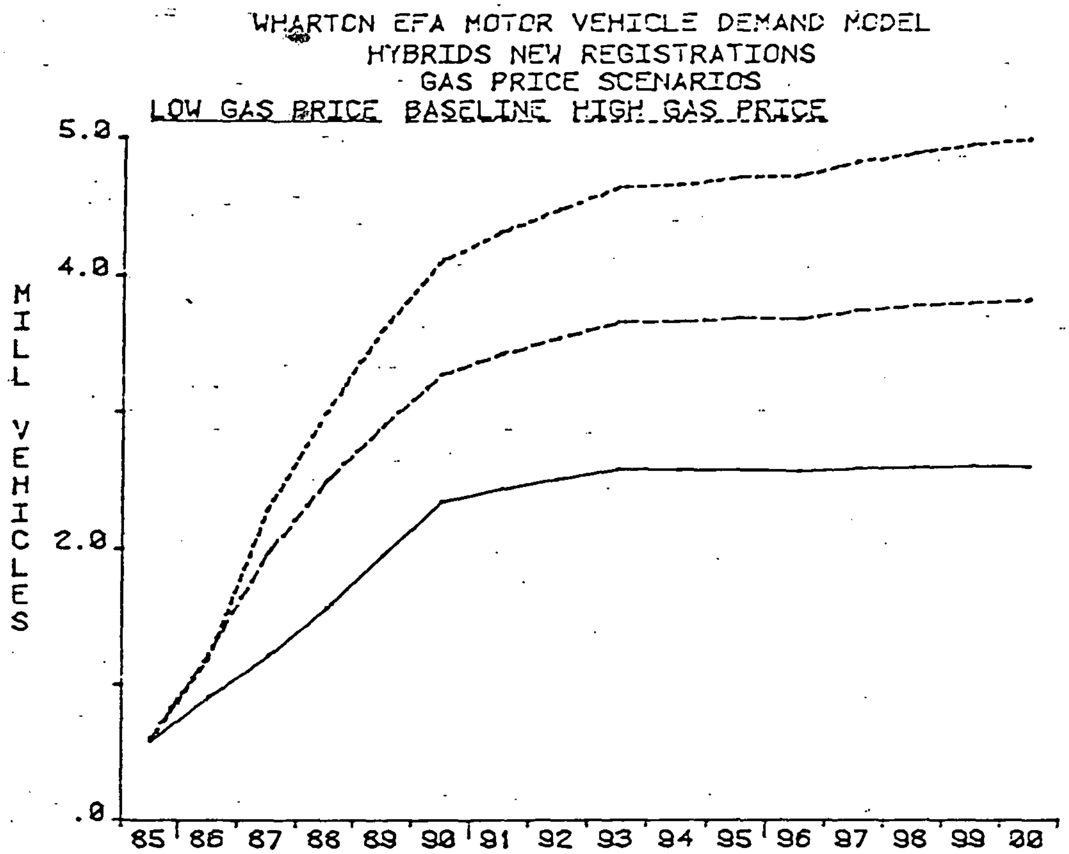
5. The long-term petroleum fuel savings are very substantial and very sensitive to the hybrid's sales volume as well as to gasoline prices: our baseline hybrid forecast suggests annual fuel savings of over 11 billion gallons by 1995, a 14% reduction.

WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
REGULATION SCENARIOS



WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
HYBRID PRICE SCENARIOS




WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
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LOW GAS PRICE BASELINE HIGH GAS PRICE
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MILL VEHICLES
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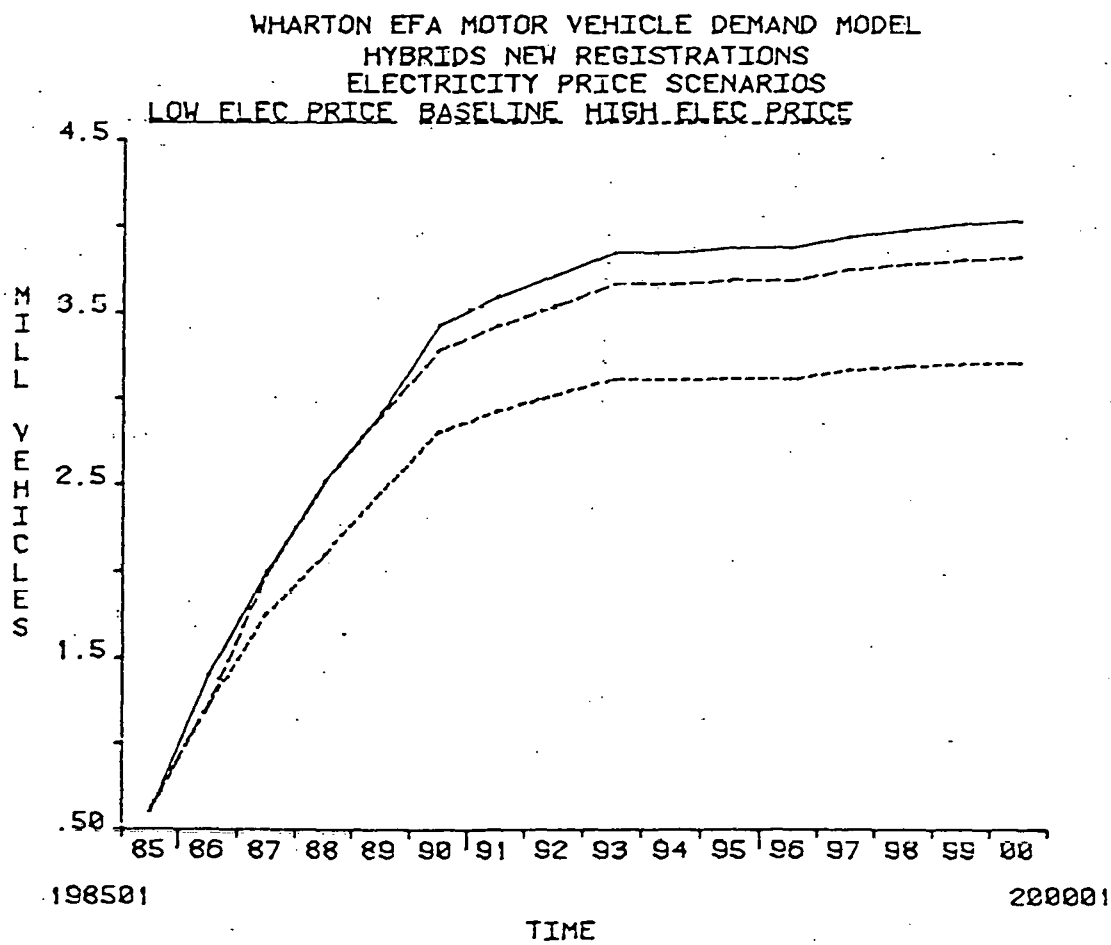
WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
ELECTRICITY PRICE SCENARIOS
LOW ELEC PRICE BASELINE HIGH ELEC PRICE
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3.5
2.5
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MILL VEHICLES
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200001
TIME

REVIEW OF FORECAST RESULTS

The first major issue is one of price. The additional cost for the electric motor and its components is obviously subject to a wide band around a particular estimate. The two "typical" vehicles specified as possible electrification candidates were the 1978 Ford Fairmont, a mid-size by 1985 standards, and the 1978 Ford LTD, a fullsize/luxury car currently slightly larger than the projected 1985 luxury cars.

The low estimates of increased price were specified as $2,000 and $1,750, respectively. The larger car is estimated to be cheaper in absolute terms as its suspension, etc., are already adequate for the increased weight. The high price estimates are specified as twice these values, $4,000 and $3,500, respectively. In order to maintain these estimates in constant dollars over the forecast period, we expressed the price changes in percentage terms, as follows:

	"Midsize" (1978 Fairmont)	"Fullsize" (Wharton Estimate)	"Luxury" (1978 Ford LTD)
Base Purchase Price with Options	$ 4,641	$	$ 7,297
Average Tax	226		355
Freight Charges	268		292
Total Price	$ 5,135	$	$ 7,944
For Hybrid Parts			
Low Price	$ 2,000	$	$ 1.750
% Increase	39% [1]	33%	22%
High Price	$ 4,000	$	$
% Increase	78%	67%	44%

---

[1] Since the Fairmont is at the lower end of our average compact /mid-size price range, and the LTD is priced intermediate between our average fullsized and luxury cars, these percentages may be slightly on the high side. On the other hand, it is likely that the additional hybrid cost would be varied according to the car's price.

Of course, given traditional marketing strategies, it is not implausible that the more expensive cars would be used to subsidize the cheaper, implying more nearly equal increases, or that non-hybrids might initially be used to subsidize some of the hybrids' costs.

The Scenarios

Severe Regulation

This presupposes increased pressure to raise CAFE's by a significant amount, probably implemented with formal legislation. At the same time, further downsizing after 1985 would be very problematic and of limited applicability. In addition, emissions standards by that time can be expected to pose severe constraints on technical changes to internal combustion engines. Hence, the hybrid technology becomes the major option, and it is assumed that domestic manufacturers change all their mid-size, fullsize, and luxury models to hybrids, at the low price differential--to encourage sales.

Low Price Hedonic Shares

This scenario is a "free market" prediction of the hybrid shares by segment, using an hedonic share estimation procedure to predict the hybrid share of the "desired" (long-run) mid-size, full-size, and luxury shares (see Methodology). This recognizes the importance of non-price attributes in the demand for hybrids. The low price increases are assumed to apply.

High Price Hedonic

This scenario is the same as the previous, but with the high price increases applied.

Since hybrid sales were so poor under the High Price assumptions, the remaining scenarios utilize the "Low Price Hedonic" results as their "baseline" or starting point.

High/Low Gasoline Prices

Gasoline prices per gallon are varied by +30% to -30% compared to the Low Price Hedonic assumptions.

High/Low Electricity Prices

Electricity prices per KWH are varied by +30% to -10% compared to the Low Price Hedonic assumption.

The Results

The following charts and tables summarize the forecast results under the different scenario conditions. A complete discussion of the underlying macroeconomic and demographic forecasts, and the results for the rest of the market, along with the output tables for the hybrid forecasts, are presented later in the report.

For each forecast, we have phased-in hybrid sales progressively over a five year period, 1985-1990. Hybrid mass production cannot start until 1985 at the earliest, and it would be unreasonable to immediately start with large-scale production. Rather, like the diesels, the process can be expected to extend over a four to five year period.

Not surprisingly, the Severe Regulation scenario produces the greatest demand for hybrid vehicles, in total and within each class. Total hybrid new registrations rise to 5.5 million by 1990 and grow to over 7 million by 2000, with over 45% of all sales being hybrids. This "forced" conversion is not without its side effects: as a result of switching all mid-size, fullsize, and luxury to hybrid models, a significant increase in small car sales occurs, both domestic and foreign, as buyers switch to cheaper cars. Since some of these are imports, total domestic sales of all types decrease--from 10.3 million in 1990 "before hybrids" to 9.8 million, a 5% drop.

In contrast, the Low Price Hedonic scenario (also labeled "Baseline" in the accompanying graphs) results in hybrid sales of from 3 to 4 million, approximately 25% of the total market. Hence, we see that the potential demand for hybrids at the lower price increase is quite good, despite their cost disadvantage. In fact, however, in the low price case, the fuel savings do provide a substantial offset: compared to their conventional counterparts, the mid-size hybrids capitalized cost per mile is 10% to 11% higher, the fullsize 9% to 10% higher, and the luxury only 6% to 7% higher.

These differences increase massively in the "high price" case, however, almost obliterating hybrid sales, and leaving them at only slightly over 0.5 million units annually. This is not surprising since the price differentials are so great, and the hybrid capitalized

TABLE 1

HYBRID VEHICLES NEW REGISTRATIONS
(millions)

Scenario	1985	1990	1995	2000
Severe Regulation	0.6	5.5	6.6	7.1
Low Price Hedonic	0.6	3.3	3.7	3.8
High Price Hedonic	0.1	0.6	0.7	0.6
Low Price Hedonic with (and % change):				
Low Gas Prices	0.6	2.4	2.6	2.6
(-30%) % change	--	-28%	-30%	-32%
High Gas Prices	0.6	4.1	4.7	5.0
(+30%) % change	--	+25%	+28%	+30%
Low Electricity Prices	0.6	3.4	3.9	4.0
(-10%) % change	--	+4%	+5%	+5%
High Electricity Prices	0.6	2.8	3.1	3.2
(+30%) % change	--	-14%	-15%	-16%

TABLE 2

HYBRID VEHICLES IN OPERATION
(millions)

Scenario	1985	1990	1995	2000
Severe Regulation	0.6	17.2	44.5	61.0
Low Price Hedonic	0.6	12.2	27.1	34.4
High Price Hedonic	0.1	2.1	5.0	6.2
Low Price Hedonic with:				
Low Gas Prices	0.6	8.4	18.9	23.9
High Gas Prices	0.6	14.5	33.7	44.0
Low Electricity Prices	0.6	12.6	28.2	36.1
High Electricity Prices	0.6	10.7	23.2	29.1

costs per mile are 27%, 24%, and 18% higher, for the mid-size, full-size, and luxury classes, respectively. Hence, the cost differential triples, and sales fall 80%. Given the availability of close substitutes within each class as well as between classes, this high response elasticity is not too surprising.

Using the Low Price Hedonic forecast, we now examine the sensitivity of hybrid sales to fuel costs: both gasoline and electricity. The importance of the gas price is dramatically illustrated. If we assume a more rapid rate of price increases over the 1985-1990 period such that by 1990, the gas price is 30% higher, hybrid new registrations are almost 30% higher. As noted later on, the base case gasoline price assumptions are already very high. A 30% higher level would thus represent almost crisis proportions (not only for transportation but for the economy in general). Of special interest here is that total new car registrations decline due to high gas prices--for instance, domestic new registrations fall to 9.9 million in 1990, so that hybrids increase their share of total new registrations (to one-third), slightly more than their volume increase. They would account for 40% of domestic sales in this scenario.

The Low Gas Price scenario has essentially symmetrical results in the opposite direction. Total sales increase, the hybrid share drops, and again the elasticity of response is around unity: a 1% change in hybrids for each 1% change in the real price of gasoline.

Changes in electricity prices are naturally less significant than gasoline, but still have substantial effects: each 1% change in real electricity prices yields a 0.5% change in hybrid sales, lower prices yielding higher sales.

The mid-size/intermediate segment of the market is too important to ignore as Table 4 shows. Despite the fact that the larger cars benefit more from "hybridization" and are relatively more cost effective, the total price and the capitalized cost per mile of mid-size hybrids are both lower than the fullsize/luxury hybrid models, and the size of the total mid-size market--one-third of domestic sales--makes this too important to ignore. In general, mid-size hybrids take a smaller share of the mid-size market than the large hybrids do of theirs, but mid-size hybrids account for between 41% and 49% of all hybrids in 1990 depending on the scenario. The higher the purchase cost differential, the lower the mid-size share of hybrids, while higher gasoline and electricity prices boost the mid-size share.

TABLE 3

HYBRID SHARES OF NEW REGISTRATIONS
(%)

Scenario	1985	1990	1995	2000
Severe Regulation	5.2	45.5	45.9	45.0
Low Price Hedonic	5.2	26.3	25.6	24.2
High Price Hedonic	0.5	5.2	4.6	4.0
Low Price Hedonic with:				
Low Gas Prices	4.9	18.7	17.6	16.3
High Gas Prices	5.1	33.4	33.0	32.0
Low Electricity Prices	5.2	27.6	26.8	25.6
High Electricity Prices	5.2	22.5	21.6	20.3

TABLE 4

MID-SIZE SHARE OF HYBRID SALES
(%)

Scenario	1985	1990	1995	2000
Severe Regulation	48.7	48.4	50.6	52.1
Low Price Hedonic	48.7	47.8	49.0	50.5
High Price Hedonic	49.2	40.7	40.9	42.2
Low Price Hedonic with:				
Low Gas Prices	51.6	47.3	48.2	49.7
High Gas Prices	49.9	48.9	50.1	51.6
Low Electricity Prices	48.7	47.5	48.9	50.5
High Electricity Prices	48.7	48.5	49.4	50.9

TABLE 5

GASOLINE CONSUMPTION
(billion gallons)

Scenario	1985	1990	1995	2000
Control - No Hybrids	79.5	76.2	82.6	93.7
Severe Regulation	79.5	69.3	62.6	64.4
Low Price Hedonic	79.5	71.3	70.8	77.7
High Price Hedonic	79.6	75.3	80.4	90.8
Low Price Hedonic with:				
Low Gas Prices	90.2	82.7	84.4	93.8
High Gas Prices	72.4	64.1	61.8	66.6
Low Electricity Prices	79.5	71.2	70.4	77.0
High Electricity Prices	79.5	71.8	72.4	80.0

TABLE 6

HYBRID ELECTRICITY CONSUMPTION
(billion KWH)

Scenario	1985	1990	1995	2000
Severe Regulation	1.71	82.78	255.22	391.07
Low Price Hedonic	1.71	60.73	156.81	222.38
High Price Hedonic	0.18	10.0	28.94	40.53
Low Price Hedonic with:				
Low Gas Prices	1.78	45.41	120.22	170.03
High Gas Prices	1.52	66.07	180.25	262.81
Low Electricity Prices	1.72	63.02	164.75	235.22
High Electricity Prices	1.66	51.74	131.0	183.76

Finally, we examine the implications for fuel use of hybrid sales. The petroleum fuel savings are a joint function of hybrid sales and gasoline prices. As shown in Table 5, the Severe Regulation scenario saves 20 billion gallons per year by 1995 (24%). The baseline Low Price Hedonic also saves substantial amounts--over 11 billion gallons. However, 30% lower gasoline prices would then increase conventional vehicle sales of less efficient vehicles, encourage more driving, and would be sufficient to completely offset the savings from hybrid vehicles. Interestingly, 30% higher gasoline prices, with low-priced hybrids, would yield the same results as enforced regulation of sales in the Severe Regulation scenario. Electricity prices have a slight effect, a 30% increase raising gasoline consumption by 2.3%—an elasticity of under 0.1%.

A GUIDE TO CONCEPTS AND MEASURES USED IN THE WHARTON EFA MOTOR VEHICLE MODEL

"CARS IN OPERATION, YEAR-END"
(See Tables 1.00, 4.00 - 5.20, MID-YEAR estimates in Tables 6.00 - 7.10)

Derived from R. L. Polk's estimates, adjusted to exclude compact passenger vans (Sportvan, Clubwagon, VW Bus, etc.). Lower than total registrations, which double-counts cars registered in more than one state and includes cars registered but scrapped. Vintage estimates are based on a twenty year life and vintage-specific survival probabilities, which vary over time with a given distribution. Vehicles by class and by domestic or foreign origin are derived from applying the same survival probabilities to the sales of each class.

"RETAIL SALES", and "NEW REGISTRATIONS"
(Tables 1.00 - 3.20)

Both exclude compact vans, and adjust for missing data. New registrations are cars put into use, therefore, are slightly lower than reported sales, and lag them by 1-2 months. New registrations detail is better and provides the data for the distributions by class and domestic versus foreign.

"SCRAPPAGE"
(Tables 1.00, 8.00, 801)

Historically, estimated by identity, given stock and new registrations data. Total scrappage is forecast behaviorally, allocated by vintage with the "normal" survival probabilities, and allocated by class based upon class shares in the stock.

"VEHICLE MILES"
(Tables 1.00, 9.00, 9.01)

Taken from Highway Statistics, these are for cars only, excluding motorcycles. Urban and rural travel are predicted separately due to their very different trends.

"MPG ESTIMATES"
"TOTAL FLEET MPG (WEFA)", "NEW CAR FLEET MPG (EPA)", "DOMESTIC", "FOREIGN", "MPG (WEFA)", "MPG (EPA)", (Tables 1.00, 14.00 - 15.10)

WEFA estimates are actual "on-road" performance, based on a massive database of individual car road tests by CONSUMER REPORTS. City and highway estimates and forecasts are based on vehicle curb weight, engine displacement, cylinders, transmission type, and technological changes. New car fleet estimates are sales-weighted class estimates. The total fleet estimate is a vintage stock-weighted estimate of past mpg's allowing for lower miles driven by older cars. It is consistent with the "Highway Statistics" average. The EPA estimates are also based on individual car drive-cycle results, city and highway being predicted by the same auto characteristics as the WEFA estimates. The class averages are 55-45 weighted, and sales-weighted to yield new car fleet estimates.

SIZE CLASSES

Five sizes are distinguished:

Subcompact - up to 100" wheelbase (historically); 1975 average curb weight = 2803 lbs. domestic, 2392 lbs. import; 1985 projections 2300, 2094; perceived as "tight" 4 passenger, primarily for 1-2 passenger travel, increasingly so by 1985.

Compact - 100" to 111" (historically); 1975 average curb weight = 3429 lbs. domestic, 2882 lbs. import, 1985 projections 2700, 2698; "roomy" 4 passenger, becoming "tight" 4 passenger.

Mid-Size (Domestic only) - 111" to 118" (historically); 1975 = 4170 lbs., 1985 = 3000; roomy 4-5 passenger, becoming 4 to "tight" 5; sportier/powered-up compact and "stripped"/low power fullsize substitutes, very few V8's (15%).

Fullsize (Domestic only) - over 118" (historically); 1975 = 4656 lbs., 1985 = 3200; 6 pasenger cars, becoming 5 to "tight" 6 by 1985, few V8's (20%), much lower power.

Luxury - classified by price; domestics are fullsize dimensions (except Corvette), foreign vary widely in size. Curb weights: 1975 domestic = 5022 lbs., foreign = 3595, 1985 domestic = 3500, foreign = 2808. Domestics are higher quality, more luxurious, fullsize, more power, more options and V8's. Foreign correspond to more luxurious compact-size cars.

METHODOLOGY

Our primary approach to this study was to modify the existing Wharton EFA Motor Vehicle Model to allow for the inclusion of hybrid vehicles and to utilize pre-existing empirical work relevant to the market penetration of a new technology.

The Motor Vehicle Model predicts the desired composition of the vehicle fleet, divided into eight classes: foreign subcompact, domestic subcompact, foreign compact, domestic compact, mid-size, fullsize, foreign luxury, and domestic luxury. The desired share equations are based upon 1972 cross-sectional state data, with each class share a function of income variables, family size variables, population age distribution, and the class cost per mile relative to competing (substitute) classes.[1/]

The procedure followed here is to first predict or assume the "desired" hybrid shares of each market segment, for mid-size, fullsize, and luxury domestics. Given the hybrid shares, the model then proceeds normally, consistently predicting desired shares for all mid-size, fullsize, etc. These then enter the predictions for desired stock, and the new registrations shares. Together with the predictions of total new registrations and scrappage, these yield hybrid new registrations and stocks by class.

In performing this analysis, we computed capitalized cost per mile measures for the hybrids corresponding to our methodology for regular cars. We assumed that repair, insurance, and other non-fuel operating costs would be proportionately similar to non-hybrids. Fuel costs were computed under the admittedly simplifying assumptions of all highway use being with the gasoline engine, at the same miles per gallon as non-hybrids, while 60% of urban driving was performed

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[1/] The Wharton EFA Motor Vehicle Model is fully documented in George R. Schink and Colin J. Loxley, An Analysis of the Automobile Market: Modeling the Long-Run Determinants of the Demand for Automobiles, February 1977, and in Colin J. Loxley, Tim Osiecki, Kate Rodenrys, and Sheela Thanawala, Revisions to the Wharton EFA Automobile Demand Model. The Wharton EFA Motor Vehicle Demand Model (Mark 1), draft, June 1978, both reports prepared by Wharton EFA for the Department of Transportation, Transportation Systems Center, Cambridge MA.

using the electric motor, at 1.6 miles per KWH for mid-size, and 1.3 miles per KWH for fullsize and luxury.[1/] Overall, these assumptions probably slightly favor the hybrids.

The analysis assumes that hybrid sales and scrappage adjust at the same speed with respect to the gap between desired and actural stocks as the non-hybrids of the corresponding class. It is also assumed that the survival probabilities by vintage are equal. On this basis, the vehicles in operation computation is modified to include hybrids, and the new domestic EPA mpg and total fleet average mpg identities are calculated with the hybrids included.

The final modification was to the urban vehicle miles equation. Miles per vehicle are a function of the "real" fuel cost per mile, real disposable income per capita, and the ratio of urban licensed drivers to total vehicle stock. The fuel cost term was modified to reflect the combined gas and electricity costs, yielding a specific hybrid urban mileage forecast.

HEDONIC SHARES

The shares of hybrids in the desired stock by class are estimated using the hedonic choice model outlined in "The Impact of Electric Passenger Automobiles on Utility System Loads, 1985-2000", by E. Patrick Marfisi, Charles U. Upton, and Carson E. Agnew, a report by MATHTECH, Inc. for EPRI, November 1977.

In this analysis, shares by size class are estimated relative to subcompacts as a function of vehicle attributes (capitalized cost per mile, automatic transmission fraction and passenger capacity) and variables shifting the attribute coefficients (SMSA population as a percent of total roadway per land area, and geographical dummies). The hybrid share can be estimated by using the hedonic choice equation and assuming a set of attributes for hybrids. The fraction of hybrids with automatic transmission is set at one (a desirable attribute); and the seating capacities are assumed to be slightly larger (by 0.5 on average) than regular cars in the same class, reflecting a perception of hybrids as "larger".

1/ Assumptions supplied by South Coast Technology, Inc.

The equation used is:

$$\ln(SHR_i) - \ln(SHRST) = (US_iFAUTO - USSTFAUTO) * (4.417 - .0052\ NPMET + .325\ RW/LA - 2.2150\ DUMW) + (CPM_iCAP - CPMSTCAP) * (-138.4 + .463\ NPMET - 5.09\ RW/LA + 21.72\ DUMW - 0.5DUMS) + (NP_i^2 - NPST^2) * (.19 - .00041\ NPMET + .002601\ RW/LA - .002959\ DUMW + .002345\ DUMS) + DUML + (1.357 + .008593\ NPMET + .234\ RW/LA - .296\ DUMW + .43\ DUMS)$$

where:

SHR_i	=	Share of size class i, i = subcompact, compact, mid-size, mid-size hybrid, fullsize, fullsize hybrid, luxury, and luxury hybrid
SHRST	=	Share of subcompacts
US_iFAUTO	=	Fraction of size class i with automatic transmission
USSTFAUTO	=	Fraction of subcompacts with automatic transmission
NPMET	=	SMSA population as percent of total
RW/LA	=	Roadway per land area
DUMW	=	Dummy for western states
DUMS	=	Dummy for southern states
CPM_iCAP	=	Capitalized cost per mile, size class i
CPMSTCAP	=	Capitalized cost per mile, subcompacts
NP_i	=	Passenger capacity, size class i
NPST	=	Passenger capacity, subcompacts
DUML	=	dummy for luxury cars, = 1 for luxury cars, 0 otherwise

What this procedure does is to enter some qualitative vehicle characteristics which induce purchases despite a possibly adverse relative cost, and which provides a tentative means of analyzing the appeal of a completely new design. Clearly the qualitative aspects are still very limited. Nonetheless, the predictions which result appear very reasonable. The unquantifiable component is the impact of uncertainty about future petroleum fuel supplies, although the present and near future should provide some useful insight from diesel sales developments.

HYBRID STUDY CONTROL FORECAST

ASSUMPTIONS

The Control Forecast, before the inclusion of hybrids, uses as its input assumptions for economic and demographic variables the February 1979 Wharton Annual Model Year 2000 Forecast. This predicts slow real growth and high inflation for 1979-80, with the probability of an actual recession and the strength of the recovery dependent upon the severity of fiscal and monetary restraint applied to control inflation, and what domestic and international energy policies are implemented.

In the absence of any severe shocks, the long-term trend for annual real GNP growth is projected at 3%, with real per capita disposable income averaging just below 2% annual growth, during the 1980's, and 2.6% for the decade 1990-2000. Inflation is projected to decline at a moderate pace, with growth in the consumer price index averaging over 6.5% for 1980-85, falling to 5% for 1985-90, and remaining at around 4.5% for the rest of the century.

Sectors of the economy experiencing strong growth are predicted to include investment expenditures and both exports and imports. Both consumer durables and services are expected to show above average growth. Mining, durables manufacturing, and utilities are the leading industrial sectors.

For fiscal policy, it is assumed that real government expenditures will show slower growth than past trends, and decline as a share of real GNP. As a consequence, the federal deficit is steadily diminished, moving into balance in the late 1980's. The key energy assumptions include a gradual progress towards decontrol of domestic oil prices, being completed in the later 1980's. The long-term OPEC policy is assumed to be to raise prices at about the U.S. inflation rate.

The demographic assumptions used are taken from the Bureau of the Census, Current Population Report P-20, July 1978. These utilize the Series II fertility assumption, implying population growth in the 0.9% range. The size of families continues to fall, with family formation and the number of single individuals outpacing general population growth. The aging population yields a declining proportion in the lower age brackets, and contributes to the rapid slowing down of growth in licensed drivers.

The gasoline price projection uses the rate of growth of real gas prices specified for the median case. The average 1978 price for regular gas is 65.3 cents/gallon (compared to the 72.0 specified in the sensitivity assumptions, Table B-1). Our 1990 "real" price deflated by the CPI is, therefore, 110.0 x 65.3/72.0 = 99.8¢/gallon. The rates of growth in gasoline prices are extremely high, and definitely in the upper range of the possible trend. The Wharton Annual Model forecasts the gasoline price consistently based on assumed OPEC prices and the domestic energy situation. Assuming an average imports price/bbl of $19.20 by 1980 (up 30% over 1978) with a 6.5% annual rate of increase thereafter, and with full domestic decontrol by 1986, the 1985 Annual Model gas price reaches $1.26 (vs. $1.38).

All of the specific assumptions utilized in the forecast are shown in the "MARCH CONTROL FOR HYBRIDS" output, Tables 17.00-23.10, and 32.10. Except for the specific variables changed in the various hybrid vehicles scenarios, these remain unchanged for all the hybrid forecasts.

Forecast Results

The following Summary Table presents the long-term trends for most of the key variables. Despite the current short-term weakness, the long-term outlook is for a moderately good growth path. A decline in real income and high inflation cause a decline in sales in 1979-80, but the sales rebound during the early 1980's averages 2.7% per year. Sales growth slows during the late 1980's, but averages over 2% during the 1990's. This robust long-term trend is supported by good turnover of the stock, with both the sales and scrappage rates registering levels close to their historical averages.

HYBRID STUDY CONTROL FORECAST SUMMARY TABLE

		1970		1975		1978		1980		1985		1990		1995		2000
RETAIL SALES, TOTAL	(millions)	8.4		8.7		11.3		11.0		12.6		13.3		15.2		16.7
average annual growth rate			0.5		9.2		-1.3		2.8		1.1		2.7		1.9	
COMPACT VANS	(millions)	0.115		0.124		0.175		0.185		0.260		0.290		0.350		0.410
average annual growth rate			1.5		12.2		2.8		7.0		2.2		3.8		3.2	
NEW CAR SALES	(millions)	8.3		8.6		11.1		10.8		12.3		13.0		14.9		16.3
average annual growth rate			0.5		9.2		-1.4		2.7		1.1		2.7		1.8	
IMPORTS SHARE	(%)	14.2		18.2		17.8		17.0		16.4		18.9		20.1		20.7
AVERAGE NEW CAR PRICE	($)	3,833		5,427		6,830		7,896		11,043		14,462		18,749		24,091
average annual growth rate			7.2		8.0		7.5		6.9		5.5		5.3		5.1	
COST PER MILE	(¢)	13.9		20.3		25.2		29.3		41.6		57.0		75.2		98.6
average annual growth rate			7.9		7.5		7.8		7.3		6.5		5.7		5.6	
CONSUMER PRICE INDEX	(1967=100))	116.3		161.2		195.3		227.2		311.6		396.8		497.7		618.4
average annual growth rate			6.7		6.6		7.9		6.5		5.0		4.6		4.4	
DISP. FAMILY INCOME	(1972$)	9,810		9,420		9,830		9,720		10,000		10,490		11,340		12,300
average annual growth rate			0.8		1.4		-0.6		0.6		1.0		1.6		1.6	
SALES RATE		0.105		0.088		0.110		0.105		0.110		0.107		0.114		0.115
SCRAPPAGE RATE		0.077		0.062		0.107		0.085		0.092		0.094		0.098		0.097
CARS IN OPERATION YEAR END	(millions)	81.4		95.6		99.4		102.9		112.1		120.5		129.5		140.7
average annual growth rate			3.3		1.3		1.7		1.7		1.5		1.5		1.7	
TOTAL POPULATION	(millions)	204.9		213.5		218.5		222.2		233.0		243.6		252.9		260.5
average annual growth rate			0.8		0.8		0.8		1.0		0.9		0.8		0.6	
LICENSED DRIVERS	(millions)	111.5		129.8		141.2		147.2		159.5		169.7		178.2		188.2
average annual growth rate			3.1		2.8		2.1		1.6		1.2		1.0		1.1	
VEHICLE MILES	(millions)	891		1,028		1,186		1,245		1,347		1,499		1,694		1,916
average annual growth rate			2.9		4.9		2.5		1.6		2.2		2.5		2.5	
AVERAGE TOTAL FLEET MPG		13.6		13.5		13.8		14.2		16.9		19.7		20.5		20.5
average annual growth rate			-0.1		0.7		1.4		3.5		3.0		0.9		0.0	
FUEL CONSUMPTION	(billions)	65.7		76.0		86.2		87.6		79.6		76.2		82.6		93.7
average annual growth rate			3.0		4.3		0.8		-1.9		-0.9		1.6		2.6	
[illegible]	[illegible]	35.7		57.2		65.3		80.7		138.2		202.8		254.3		316.0
[illegible]							[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	

WHARTON EFA, INC.

The composition of sales is not expected to shift dramatically in the short-term as each segment goes through a downsizing program through 1985. The downsizing, together with technological improvement to engines and transmissions, is assumed to yield compliance with the CAFE standards, provided significantly stricter emissions and safety requirements are not imposed. Small domestic car base prices do increase less rapidly than the larger models' in order to maintain their market share versus imports. The imports share drops in 1979 due to discontinued "captives" and VW of America production. We project increasing domestic production of former imports through 1985.

In the long-run, we project increases in the small car shares, at the expense of fullsize. The fullsize declines from an 18.4% share of the total in 1979 to 11.5% by 2000, while subcompacts grow from 25.1% to 28.1%. The foreign share increases reaching a plateau of 20% in the mid-1990's, largely due to less rapid increases in imports prices. The composition of the stock of vehicles changes accordingly, and more dramatically. From 1978 to 2000, the subcompact share of total stock grows from 20.7% to 27.4%, compacts grow from 19.5% to 22.9% mid-size go from 24% to 25.8%, fullsize declines from 26.5% to 13%, and luxury rises from 9.3% to 15.4%. The overall foreign share climbs from 14.5% to 20%.

The average new car purchase cost is projected to rise rapidly, at 7% per year through 1985, and averaging over 5% through the end of the century. With the rapid rates of increase of other operating costs, particularly insurance and gasoline, the total capitalized cost per mile rises even more rapidly, despite the offset of rapidly improving new car fuel economy up to 1985. These high inflation rates are, of course, general throughout the economy and hence the "real" cost per mile (relative to the CPI) increases by slightly under 1% annually during the forecast period.

The number of cars in operation reaches 141 million by 2000, a 1.6% annual average growth rate. Market saturation increases slightly, the ratio of cars to licensed drivers rising from 0.7 in 1978 to 0.75 by 2000. With the very rapid fuel price increases combined with only moderate income growth, vehicle miles per car shows no growth through the mid-1980's, and averages only 0.6% per annum for 1985-90. Thereafter, "real" gasoline prices are assumed to remain constant, and stronger real income growth yields an average annual growth rate of 0.9%. The growth of vehicle stock and miles per vehicle thus combine to yield vehicle miles traveled (VMT) growth well below historical trends, at only 1.6% per year for the early 1980's, and slightly under 2.5% thereafter. Urban travel continues to grow substantially more rapidly than rural/highway, reaching 67% by 2000.

The low vehicle miles growth, together with the better than 3% per year average improvement in fleet average fuel efficiency during the decade 1980-1990, leads to declining fuel consumption. From the peak of 87.6 billion gallons in 1980, consumption falls to a low of 76.2 in 1990, a 13% decline. Consumption rises significantly during the late 1990's with the onset of renewed VMT growth, zero mpg improvement, and constant real gas prices; nonetheless, it is 1998 before the 1980 peak is exceeded.

TABLE 1.10 HYBRID CARS

LINE	I T E M		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	20.00	40.00	60.00	80.00	100.00	100.00	100.00	100.00
2	FULL SIZE		10.00	20.00	40.00	60.00	80.00	100.00	100.00	100.00	100.00
3	LUXURY		10.00	20.00	40.00	60.00	80.00	100.00	100.00	100.00	100.00
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.608	1.224	2.338	3.383	4.466	5.519	5.921	6.154	6.404
6		%SHARE	5.2	10.2	19.8	28.8	37.3	45.5	45.6	45.7	45.9
7	MID-SIZE		0.296	0.593	1.128	1.636	2.162	2.673	2.902	3.042	3.188
8		%SHARE	2.5	4.9	9.5	13.9	18.1	22.0	22.3	22.6	22.9
9	FULL SIZE		0.207	0.411	0.758	1.048	1.327	1.578	1.667	1.715	1.768
10		%SHARE	1.8	3.4	6.4	8.9	11.1	13.0	12.8	12.7	12.7
11	LUXURY		0.104	0.220	0.452	0.699	0.977	1.268	1.352	1.397	1.448
12		%SHARE	0.9	1.8	3.8	5.9	8.2	10.4	10.4	10.4	10.4
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.607	1.825	4.145	7.486	11.864	17.221	22.860	28.540	34.187
15	MID-SIZE		0.296	0.886	2.005	3.621	5.741	8.335	11.101	13.913	16.734
16	FULL SIZE		0.207	0.616	1.368	2.403	3.701	5.227	6.806	8.373	9.908
17	LUXURY		0.104	0.323	0.771	1.462	2.422	3.658	4.954	6.254	7.546
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.477	0.508	0.540	0.573	0.608	0.644	0.680	0.719	0.760
26	FULL SIZE		0.503	0.535	0.569	0.604	0.641	0.678	0.716	0.757	0.800
27	LUXURY		0.613	0.651	0.691	0.732	0.776	0.820	0.865	0.914	0.964
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.439	9.789	24.094	47.078	78.420	118.352	164.743	213.678	264.481
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.705	6.844	16.851	32.929	54.851	82.779	115.203	149.370	184.810
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.14	28.62	29.64	30.71	31.80	32.94	32.96	32.97	32.98
34											
35	OVERALL FLEET MPG (WEFA)		16.94	17.73	18.58	19.60	20.78	22.07	23.50	24.79	26.01
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	79.502	77.818	76.234	74.155	71.770	69.262	67.078	65.357	64.048

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL WITH LOW PRICE HYBRIDS IN 1985

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2	FULL SIZE		100.00	100.00	100.00	100.00	100.00	100.00	100.00
3	LUXURY		100.00	100.00	100.00	100.00	100.00	100.00	100.00
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	6.470	6.584	6.627	6.777	6.873	6.974	7.064
6		%SHARE	45.9	45.9	45.7	45.4	45.3	45.1	45.0
7	MID-SIZE		3.250	3.334	3.386	3.491	3.558	3.624	3.683
8		%SHARE	23.1	23.2	23.3	23.4	23.4	23.5	23.5
9	FULL SIZE		1.751	1.745	1.708	1.700	1.690	1.680	1.668
10		%SHARE	12.4	12.2	11.8	11.4	11.1	10.9	10.6
11	LUXURY		1.469	1.506	1.532	1.586	1.626	1.670	1.713
12		%SHARE	10.4	10.5	10.6	10.6	10.7	10.8	10.9
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	39.540	44.528	48.964	52.841	56.117	58.818	60.981
15	MID-SIZE		19.444	21.997	24.316	26.391	28.187	29.711	30.976
16	FULL SIZE		11.320	12.579	13.631	14.474	15.115	15.569	15.853
17	LUXURY		8.784	9.952	11.017	11.977	12.815	13.537	14.151
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.803	0.849	0.898	0.946	0.998	1.052	1.110
26	FULL SIZE		0.845	0.893	0.944	0.994	1.048	1.105	1.166
27	LUXURY		1.018	1.074	1.134	1.194	1.257	1.324	1.396
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	315.771	365.577	412.024	454.964	494.568	530.283	561.747
30									
31	ELECTRICITY CONSUMED	BILL KWH	220.555	255.223	287.503	317.289	344.706	369.381	391.069
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		32.98	32.98	32.98	32.98	32.97	32.97	32.95
34									
35	OVERALL FLEET MPG (WEFA)		27.11	28.11	28.97	29.69	30.23	30.62	30.88
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	63.159	62.564	62.190	62.136	62.557	63.353	64.418

A PRODUCT OF WHARTON EFA, INC.

TABLE 1.10 HYBRID CARS

LINE	ITEM		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	20.00	30.00	40.00	45.00	52.30	52.20	52.10	51.70
2	FULL SIZE		10.00	20.00	40.00	50.00	60.00	67.10	67.10	66.90	66.70
3	LUXURY		10.00	20.00	30.00	40.00	45.00	49.80	49.90	49.90	49.70
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.608	1.224	1.973	2.513	2.899	3.278	3.424	3.543	3.661
6		%SHARE	5.2	10.2	16.4	20.9	23.6	26.3	26.3	26.2	26.1
7	MID-SIZE		0.296	0.593	0.888	1.168	1.348	1.566	1.646	1.709	1.770
8		%SHARE	2.5	4.9	7.4	9.7	11.0	12.6	12.6	12.6	12.6
9	FULL SIZE		0.207	0.411	0.737	0.871	0.994	1.079	1.116	1.148	1.181
10		%SHARE	1.8	3.4	6.1	7.2	8.1	8.7	8.6	8.5	8.4
11	LUXURY		0.104	0.220	0.348	0.474	0.557	0.633	0.663	0.686	0.710
12		%SHARE	0.9	1.8	2.9	3.9	4.5	5.1	5.1	5.1	5.1
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.607	1.825	3.780	6.255	9.078	12.219	15.417	18.589	21.674
15	MID-SIZE		0.296	0.886	1.766	2.916	4.228	5.730	7.269	8.804	10.302
16	FULL SIZE		0.207	0.616	1.347	2.204	3.171	4.203	5.240	6.259	7.242
17	LUXURY		0.104	0.323	0.668	1.134	1.678	2.287	2.908	3.526	4.130
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.477	0.508	0.540	0.573	0.608	0.644	0.680	0.719	0.760
26	FULL SIZE		0.503	0.535	0.569	0.604	0.641	0.678	0.716	0.757	0.800
27	LUXURY		0.613	0.651	0.691	0.732	0.776	0.820	0.865	0.914	0.964
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.439	9.789	22.614	40.585	62.060	86.530	113.427	141.193	169.567
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.705	6.844	15.853	28.488	43.567	60.726	79.556	98.984	118.831
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.14	28.62	29.30	29.81	30.14	30.48	30.48	30.47	30.44
34											
35	OVERALL FLEET MPG (WEFA)		16.94	17.73	18.56	19.48	20.42	21.32	22.21	22.95	23.57
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	79.502	77.818	76.290	74.540	72.786	71.264	70.324	69.806	69.741

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MO' VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	51.30	50.90	50.60	50.50	50.20	49.90	49.40
2	FULL SIZE		66.30	65.90	65.70	65.70	65.50	65.20	64.70
3	LUXURY		49.40	49.00	48.90	48.90	48.80	48.60	48.20
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	3.663	3.691	3.685	3.749	3.781	3.812	3.827
6		%SHARE	25.8	25.6	25.3	25.0	24.8	24.5	24.2
7	MID-SIZE		1.783	1.808	1.821	1.867	1.892	1.917	1.934
8		%SHARE	12.6	12.5	12.5	12.5	12.4	12.3	12.3
9	FULL SIZE		1.163	1.153	1.124	1.115	1.104	1.092	1.076
10		%SHARE	8.2	8.0	7.7	7.4	7.2	7.0	6.8
11	LUXURY		0.717	0.730	0.741	0.767	0.785	0.803	0.817
12		%SHARE	5.1	5.1	5.1	5.1	5.1	5.2	5.2
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	24.515	27.045	29.192	30.979	32.422	33.560	34.418
15	MID-SIZE		11.697	12.958	14.053	14.993	15.777	16.422	16.934
16	FULL SIZE		8.122	8.878	9.478	9.928	10.246	10.450	10.553
17	LUXURY		4.695	5.209	5.662	6.058	6.398	6.688	6.931
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.804	0.849	0.898	0.946	0.998	1.052	1.110
26	FULL SIZE		0.845	0.893	0.944	0.995	1.048	1.105	1.166
27	LUXURY		1.018	1.074	1.134	1.194	1.258	1.325	1.396
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	197.578	223.936	247.559	268.604	287.461	304.085	318.393
30									
31	ELECTRICITY CONSUMED	BILL KWH	138.410	156.813	173.281	187.918	201.002	212.509	222.384
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		30.41	30.39	30.37	30.37	30.35	30.33	30.29
34									
35	OVERALL FLEET MPG (WEFA)		24.06	24.46	24.75	24.98	25.10	25.17	25.19
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	70.141	70.800	71.603	72.645	74.080	75.798	77.689

TABLE 1.10 HYBRID CARS

LINE	ITEM		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	1.00	2.00	4.00	6.00	7.00	8.30	8.20	8.10	7.90
2	FULL SIZE		1.00	3.00	6.00	9.00	12.00	16.70	16.60	16.30	16.00
3	LUXURY		1.00	2.00	4.00	6.00	8.00	9.30	9.30	9.20	9.00
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.063	0.149	0.294	0.428	0.538	0.672	0.688	0.700	0.710
6		%SHARE	0.5	1.2	2.4	3.5	4.3	5.3	5.3	5.2	5.0
7	MID-SIZE		0.031	0.063	0.126	0.188	0.223	0.268	0.275	0.281	0.285
8		%SHARE	0.3	0.5	1.0	1.5	1.8	2.1	2.1	2.1	2.0
9	FULL SIZE		0.021	0.064	0.123	0.172	0.221	0.292	0.296	0.299	0.302
10		%SHARE	0.2	0.5	1.0	1.4	1.8	2.3	2.3	2.2	2.1
11	LUXURY		0.011	0.022	0.045	0.068	0.094	0.112	0.117	0.121	0.123
12		%SHARE	0.1	0.2	0.4	0.6	0.8	0.9	0.9	0.9	0.9
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.063	0.211	0.503	0.926	1.454	2.106	2.759	3.400	4.017
15	MID-SIZE		0.031	0.093	0.219	0.404	0.623	0.881	1.141	1.397	1.643
16	FULL SIZE		0.021	0.085	0.207	0.378	0.594	0.878	1.160	1.435	1.698
17	LUXURY		0.011	0.032	0.077	0.145	0.237	0.346	0.457	0.568	0.676
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.477	0.508	0.540	0.573	0.608	0.644	0.680	0.719	0.760
26	FULL SIZE		0.503	0.535	0.569	0.604	0.641	0.678	0.716	0.757	0.800
27	LUXURY		0.613	0.651	0.691	0.732	0.776	0.820	0.865	0.914	0.964
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	0.253	1.101	2.877	5.770	9.612	14.422	19.903	25.490	31.134
30											
31	ELECTRICITY CONSUMED	BILL KWH	0.176	0.775	2.032	4.076	6.796	10.215	14.116	18.093	22.109
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		27.69	27.74	27.86	27.98	28.08	28.21	28.19	28.18	28.15
34											
35	OVERALL FLEET MPG (WEFA)		16.93	17.58	18.21	18.83	19.42	19.93	20.38	20.72	20.94
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	79.578	78.327	77.461	76.608	75.847	75.379	75.577	76.173	77.233

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOT(EHICLE DEMAND MODEL
HIGH PRICE HYBRIDS - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	7.60	7.40	7.20	7.10	7.00	6.80	6.60
2	FULL SIZE		15.60	15.20	14.90	14.70	14.50	14.20	13.80
3	LUXURY		8.80	8.60	8.50	8.40	8.30	8.20	8.00
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.691	0.681	0.666	0.667	0.665	0.657	0.646
6		%SHARE	4.9	4.7	4.5	4.4	4.3	4.2	4.1
7	MID-SIZE		0.278	0.276	0.271	0.275	0.276	0.273	0.270
8		%SHARE	1.9	1.9	1.9	1.8	1.8	1.8	1.7
9	FULL SIZE		0.291	0.282	0.270	0.265	0.260	0.253	0.245
10		%SHARE	2.0	1.9	1.8	1.8	1.7	1.6	1.5
11	LUXURY		0.123	0.123	0.124	0.127	0.129	0.131	0.131
12		%SHARE	0.9	0.8	0.8	0.8	0.8	0.8	0.8
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	4.572	5.059	5.461	5.783	6.026	6.189	6.277
15	MID-SIZE		1.863	2.057	2.219	2.351	2.453	2.524	2.567
16	FULL SIZE		1.932	2.133	2.293	2.414	2.496	2.542	2.552
17	LUXURY		0.777	0.868	0.949	1.019	1.076	1.123	1.158
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.804	0.849	0.898	0.946	0.998	1.052	1.111
26	FULL SIZE		0.845	0.893	0.944	0.995	1.048	1.105	1.166
27	LUXURY		1.018	1.074	1.134	1.194	1.258	1.325	1.396
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	36.616	41.684	46.146	50.014	53.344	56.079	58.162
30									
31	ELECTRICITY CONSUMED	BILL KWH	26.011	29.617	32.791	35.541	37.904	39.843	41.314
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.13	28.12	28.12	28.12	28.12	28.11	28.10
34									
35	OVERALL FLEET MPG (MEFA)		21.06	21.15	21.20	21.24	21.23	21.20	21.17
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	78.738	80.409	82.083	83.890	86.026	88.380	90.843

A PRODUCT OF WHARTON EFA, INC.

TABLE 1.10 HYBRID CARS

LINE	ITEM		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	20.00	30.00	40.00	45.00	54.70	54.70	54.50	54.20
2	FULL SIZE		10.00	30.00	40.00	50.00	60.00	69.60	69.60	69.50	69.30
3	LUXURY		10.00	20.00	30.00	40.00	45.00	52.80	52.90	52.90	52.70
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.608	1.401	1.998	2.524	2.915	3.420	3.593	3.716	3.842
6		%SHARE	5.2	11.8	16.5	21.0	23.7	27.6	27.6	27.5	27.4
7	MID-SIZE		0.296	0.597	0.896	1.170	1.350	1.626	1.721	1.786	1.853
8		%SHARE	2.5	5.0	7.4	9.7	11.0	13.1	13.2	13.2	13.2
9	FULL SIZE		0.208	0.580	0.753	0.883	1.010	1.128	1.171	1.204	1.237
10		%SHARE	1.8	4.9	6.2	7.3	8.2	9.1	9.0	8.9	8.8
11	LUXURY		0.104	0.224	0.349	0.472	0.555	0.666	0.701	0.726	0.752
12		%SHARE	0.9	1.9	2.9	3.9	4.5	5.4	5.4	5.4	5.4
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.607	2.001	3.981	6.464	9.300	12.578	15.937	19.269	22.512
15	MID-SIZE		0.296	0.890	1.777	2.929	4.242	5.804	7.418	9.028	10.606
16	FULL SIZE		0.207	0.785	1.531	2.398	3.379	4.454	5.539	6.604	7.625
17	LUXURY		0.104	0.327	0.673	1.137	1.679	2.320	2.980	3.637	4.282
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.475	0.505	0.537	0.570	0.605	0.640	0.677	0.715	0.756
26	FULL SIZE		0.500	0.532	0.566	0.600	0.636	0.673	0.712	0.752	0.795
27	LUXURY		0.610	0.648	0.688	0.728	0.772	0.815	0.861	0.909	0.959
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.463	10.589	24.337	42.594	64.343	89.640	118.024	147.404	177.440
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.722	7.451	17.155	29.997	45.273	63.016	82.895	103.457	124.467
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.14	28.80	29.30	29.81	30.14	30.62	30.62	30.61	30.59
34											
35	OVERALL FLEET MPG (WEFA)		16.94	17.73	18.60	19.50	20.44	21.36	22.28	23.06	23.71
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	79.503	77.797	76.176	74.477	72.735	71.191	70.157	69.574	69.443

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA M   VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - LO   __EC PRICE - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	53.70	53.30	53.10	53.00	52.80	52.50	52.00
2	FULL SIZE		69.00	68.60	68.40	68.40	68.20	68.00	67.60
3	LUXURY		52.40	52.10	52.00	52.00	51.90	51.70	51.30
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	3.844	3.875	3.873	3.941	3.979	4.014	4.033
6		%SHARE	27.1	26.8	26.5	26.3	26.1	25.8	25.6
7	MID-SIZE		1.865	1.893	1.910	1.960	1.990	2.017	2.035
8		%SHARE	13.2	13.1	13.1	13.1	13.0	13.0	12.9
9	FULL SIZE		1.219	1.206	1.175	1.166	1.155	1.144	1.129
10		%SHARE	8.6	8.4	8.1	7.8	7.6	7.4	7.2
11	LUXURY		0.760	0.776	0.788	0.815	0.835	0.854	0.869
12		%SHARE	5.4	5.4	5.4	5.4	5.5	5.5	5.5
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	25.504	28.176	30.453	32.362	33.922	35.166	36.112
15	MID-SIZE		12.077	13.414	14.584	15.597	16.451	17.158	17.723
16	FULL SIZE		8.539	9.319	9.933	10.395	10.724	10.939	11.049
17	LUXURY		4.887	5.442	5.935	6.371	6.747	7.070	7.340
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.799	0.844	0.893	0.941	0.992	1.047	1.104
26	FULL SIZE		0.840	0.887	0.938	0.988	1.042	1.098	1.159
27	LUXURY		1.013	1.068	1.128	1.188	1.251	1.318	1.389
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	207.128	235.114	260.264	282.766	303.063	321.088	336.676
30									
31	ELECTRICITY CONSUMED	BILL KWH	145.217	164.754	182.276	197.916	211.992	224.462	235.219
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		30.56	30.53	30.52	30.51	30.50	30.48	30.44
34									
35	OVERALL FLEET MPG (WEFA)		24.23	24.66	24.97	25.22	25.36	25.45	25.48
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	69.769	70.365	71.113	72.096	73.472	75.135	76.978

A PRODUCT OF WHARTON EFA, INC.

TABLE 1.10 HYBRID CARS

LINE	ITEM		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	20.00	30.00	35.00	40.00	45.10	45.00	44.70	44.30
2	FULL SIZE		10.00	20.00	30.00	40.00	50.00	58.80	58.80	58.50	58.20
3	LUXURY		10.00	20.00	25.00	30.00	35.00	41.10	41.10	41.00	40.70
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.606	1.218	1.750	2.093	2.456	2.805	2.927	3.021	3.116
6		%SHARE	5.2	10.1	14.5	17.3	20.0	22.5	22.5	22.3	22.2
7	MID-SIZE		0.295	0.590	0.877	1.027	1.194	1.360	1.426	1.474	1.523
8		%SHARE	2.5	4.9	7.2	8.5	9.7	10.9	10.9	10.9	10.9
9	FULL SIZE		0.206	0.408	0.582	0.707	0.826	0.921	0.954	0.981	1.011
10		%SHARE	1.8	3.4	4.8	5.8	6.7	7.4	7.3	7.3	7.2
11	LUXURY		0.104	0.220	0.291	0.359	0.436	0.524	0.547	0.565	0.583
12		%SHARE	0.9	1.8	2.4	3.0	3.5	4.2	4.2	4.2	4.2
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.605	1.817	3.550	5.607	7.992	10.672	13.393	16.080	18.680
15	MID-SIZE		0.295	0.882	1.751	2.760	3.920	5.218	6.544	7.854	9.124
16	FULL SIZE		0.206	0.612	1.188	1.882	2.684	3.562	4.447	5.317	6.155
17	LUXURY		0.104	0.323	0.612	0.964	1.388	1.891	2.402	2.909	3.400
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.485	0.516	0.549	0.582	0.618	0.654	0.692	0.731	0.773
26	FULL SIZE		0.512	0.545	0.580	0.615	0.653	0.691	0.730	0.772	0.815
27	LUXURY		0.622	0.661	0.702	0.744	0.788	0.833	0.879	0.928	0.980
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.370	9.507	21.132	36.164	53.750	74.062	96.462	119.508	142.958
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.656	6.647	14.760	25.249	37.538	51.741	67.402	83.509	99.896
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.14	28.63	29.06	29.41	29.73	30.06	30.06	30.04	30.01
34											
35	OVERALL FLEET MPG (WEFA)		16.94	17.73	18.56	19.41	20.27	21.10	21.90	22.56	23.09
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	79.498	77.802	76.293	74.710	73.168	71.814	71.063	70.747	70.887

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	43.80	43.30	43.00	42.90	42.60	42.20	41.60
2	FULL SIZE		57.70	57.20	56.90	56.80	56.50	56.10	55.60
3	LUXURY		40.30	39.90	39.70	39.70	39.50	39.20	38.70
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	3.110	3.125	3.115	3.166	3.188	3.204	3.205
6		%SHARE	21.9	21.6	21.3	21.1	20.9	20.6	20.3
7	MID-SIZE		1.528	1.544	1.552	1.589	1.609	1.624	1.632
8		%SHARE	10.8	10.7	10.6	10.6	10.5	10.5	10.3
9	FULL SIZE		0.996	0.986	0.961	0.954	0.944	0.932	0.917
10		%SHARE	7.0	6.8	6.6	6.4	6.2	6.0	5.8
11	LUXURY		0.586	0.595	0.602	0.622	0.635	0.648	0.656
12		%SHARE	4.1	4.1	4.1	4.2	4.2	4.2	4.2
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	21.058	23.157	24.921	26.382	27.557	28.471	29.140
15	MID-SIZE		10.294	11.336	12.226	12.901	13.604	14.107	14.498
16	FULL SIZE		6.907	7.552	8.065	8.455	8.735	8.916	9.007
17	LUXURY		3.857	4.269	4.630	4.947	5.218	5.448	5.635
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.817	0.863	0.912	0.962	1.014	1.069	1.128
26	FULL SIZE		0.861	0.910	0.962	1.013	1.068	1.126	1.188
27	LUXURY		1.034	1.091	1.152	1.213	1.277	1.345	1.418
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	165.983	187.496	206.638	223.606	238.774	252.084	263.413
30									
31	ELECTRICITY CONSUMED	BILL KWH	115.981	130.998	144.346	156.158	166.699	175.928	183.761
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		29.98	29.94	29.93	29.92	29.91	29.88	29.84
34									
35	OVERALL FLEET MPG (WEFA)		23.49	23.81	24.04	24.21	24.29	24.33	24.34
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	71.488	72.346	73.329	74.525	76.097	77.943	79.954

A PRODUCT OF WHARTON EFA, INC.

TABLE 1.10 HYBRID CARS

LINE	ITEM	UNIT	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	15.00	20.00	25.00	30.00	36.10	35.90	35.50	35.10
2	FULL SIZE		10.00	15.00	20.00	30.00	40.00	50.00	49.80	49.40	49.00
3	LUXURY		5.00	10.00	15.00	20.00	25.00	31.10	31.00	30.70	30.40
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.581	0.913	1.221	1.576	1.952	2.351	2.449	2.514	2.586
6		%SHARE	4.9	7.4	9.8	12.9	15.7	18.7	18.6	18.4	18.2
7	MID-SIZE		0.300	0.458	0.610	0.755	0.921	1.111	1.164	1.198	1.234
8		%SHARE	2.5	3.7	4.9	6.2	7.4	8.8	8.8	8.7	8.7
9	FULL SIZE		0.227	0.341	0.436	0.583	0.719	0.839	0.867	0.888	0.912
10		%SHARE	1.9	2.8	3.5	4.8	5.8	6.7	6.6	6.5	6.4
11	LUXURY		0.054	0.113	0.175	0.239	0.312	0.401	0.418	0.428	0.441
12		%SHARE	0.4	0.9	1.4	1.9	2.5	3.2	3.2	3.1	3.1
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.580	1.487	2.694	4.241	6.138	8.390	10.677	12.926	15.104
15	MID-SIZE		0.299	0.755	1.358	2.099	2.992	4.054	5.138	6.205	7.239
16	FULL SIZE		0.227	0.566	0.997	1.568	2.266	3.069	3.876	4.666	5.428
17	LUXURY		0.054	0.166	0.339	0.574	0.879	1.267	1.663	2.055	2.437
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.471	0.501	0.533	0.566	0.600	0.635	0.672	0.710	0.751
26	FULL SIZE		0.496	0.528	0.562	0.596	0.632	0.669	0.707	0.748	0.790
27	LUXURY		0.606	0.644	0.683	0.724	0.766	0.810	0.855	0.903	0.954
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.566	9.162	18.568	30.873	46.219	64.938	86.082	107.786	129.825
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.783	6.374	12.930	21.529	32.283	45.410	60.231	75.441	90.884
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.03	28.27	28.52	28.88	29.21	29.58	29.57	29.54	29.51
34											
35	OVERALL FLEET MPG (WEFA)		17.03	17.79	18.54	19.29	20.08	20.84	21.58	22.16	22.62
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	90.261	88.465	87.053	85.593	84.074	82.745	82.083	81.939	82.317

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TABLE. 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	34.60	34.10	33.70	33.50	33.10	32.80	32.20
2	FULL SIZE		48.50	47.90	47.60	47.30	46.90	46.50	45.90
3	LUXURY		30.00	29.60	29.40	29.20	29.00	28.70	28.30
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	2.573	2.576	2.559	2.589	2.597	2.606	2.597
6		%SHARE	17.9	17.6	17.3	17.1	16.8	16.6	16.3
7	MID-SIZE		1.234	1.242	1.243	1.268	1.278	1.290	1.292
8		%SHARE	8.6	8.5	8.4	8.4	8.3	8.2	8.1
9	FULL SIZE		0.898	0.888	0.866	0.858	0.848	0.837	0.821
10		%SHARE	6.3	6.1	5.9	5.7	5.5	5.3	5.1
11	LUXURY		0.441	0.446	0.450	0.462	0.471	0.479	0.484
12		%SHARE	3.1	3.1	3.0	3.0	3.0	3.0	3.0
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	17.090	18.861	20.354	21.594	22.586	23.346	23.877
15	MID-SIZE		8.190	9.036	9.762	10.379	10.885	11.291	11.594
16	FULL SIZE		6.114	6.705	7.183	7.554	7.825	8.001	8.089
17	LUXURY		2.794	3.120	3.409	3.662	3.876	4.053	4.193
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.794	0.839	0.887	0.936	0.987	1.041	1.099
26	FULL SIZE		0.835	0.882	0.933	0.983	1.037	1.094	1.154
27	LUXURY		1.007	1.063	1.123	1.182	1.245	1.312	1.383
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	151.468	171.709	189.790	205.880	220.232	232.713	243.130
30									
31	ELECTRICITY CONSUMED	BILL KWH	106.047	120.220	132.871	144.113	154.122	162.805	170.034
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		29.48	29.45	29.43	29.42	29.40	29.38	29.34
34									
35	OVERALL FLEET MPG (WEFA)		22.96	23.23	23.41	23.55	23.62	23.64	23.63
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	83.218	84.391	85.671	87.173	89.101	91.338	93.754

TABLE 1.10 HYBRID CARS

LINE	ITEM		1985	1986	1987	1988	1989	1990	1991	1992	1993
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	10.00	20.00	40.00	50.00	60.00	67.80	67.90	67.90	67.80
2	FULL SIZE		10.00	20.00	40.00	60.00	70.00	80.40	80.50	80.50	80.50
3	LUXURY		10.00	20.00	40.00	50.00	60.00	68.00	68.70	68.80	68.90
4											
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	0.585	1.188	2.297	3.008	3.610	4.110	4.319	4.478	4.646
6		%SHARE	5.1	10.0	19.6	25.4	29.8	33.4	33.5	33.4	33.5
7	MID-SIZE		0.292	0.590	1.137	1.438	1.755	2.008	2.121	2.208	2.297
8		%SHARE	2.5	5.0	9.7	12.2	14.5	16.3	16.4	16.5	16.6
9	FULL SIZE		0.189	0.378	0.710	0.983	1.123	1.249	1.296	1.334	1.374
10		%SHARE	1.6	3.2	6.1	8.3	9.3	10.2	10.0	10.0	9.9
11	LUXURY		0.104	0.219	0.450	0.587	0.732	0.852	0.902	0.936	0.975
12		%SHARE	0.9	1.8	3.8	5.0	6.0	6.9	7.0	7.0	7.0
13											
14	YEAR END STOCK OF HYBRIDS	MILL VEH	0.584	1.766	4.045	7.013	10.542	14.502	18.569	22.628	26.615
15	MID-SIZE		0.292	0.879	2.007	3.426	5.141	7.076	9.073	11.076	13.051
16	FULL SIZE		0.188	0.565	1.269	2.239	3.336	4.538	5.754	6.957	8.125
17	LUXURY		0.104	0.322	0.769	1.348	2.065	2.888	3.741	4.595	5.440
18											
19	HYBRID PURCHASE PRICE										
20	MID-SIZE		15405.	16309.	17246.	18199.	19165.	20184.	21263.	22400.	23582.
21	FULL SIZE		16098.	17038.	18013.	19005.	20007.	21064.	22181.	23361.	24585.
22	LUXURY		22106.	23366.	24672.	26003.	27348.	28769.	30268.	31851.	33492.
23											
24	HYBRID CAPITALIZED COST PER MILE	$/MILE									
25	MID-SIZE		0.483	0.515	0.548	0.581	0.616	0.652	0.689	0.729	0.770
26	FULL SIZE		0.509	0.542	0.577	0.612	0.649	0.687	0.726	0.767	0.810
27	LUXURY		0.620	0.659	0.700	0.741	0.785	0.830	0.876	0.924	0.975
28											
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	2.182	8.790	21.790	41.562	66.031	94.533	126.066	158.834	192.560
30											
31	ELECTRICITY CONSUMED	BILL KWH	1.521	6.130	15.201	29.025	46.146	66.066	88.095	110.976	134.516
32											
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		28.19	28.65	29.66	30.34	30.87	31.34	31.35	31.36	31.35
34											
35	OVERALL FLEET MPG (WEFA)		16.89	17.68	18.53	19.53	20.57	21.61	22.66	23.58	24.39
36											
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	72.382	70.830	69.406	67.599	65.760	64.063	62.862	62.031	61.604

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOI HICLE DEMAND MODEL
LOW PRICE HYBRIDS - HIGH PRICE GAS - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

LINE	ITEM		1994	1995	1996	1997	1998	1999	2000
1	DESIRED SHARE OF HYBRIDS IN MID-SIZE	%	67.50	67.20	67.20	67.20	67.00	67.00	66.60
2	FULL SIZE		80.30	80.10	80.10	80.10	80.10	80.00	79.70
3	LUXURY		68.70	68.40	68.50	68.80	68.80	68.70	68.50
4									
5	NEW REGISTRATIONS OF HYBRIDS	MILL VEH	4.665	4.716	4.732	4.830	4.807	4.951	4.994
6		%SHARE	33.3	33.0	32.8	32.5	32.3	32.2	32.0
7	MID-SIZE		2.322	2.363	2.391	2.459	2.498	2.544	2.575
8		%SHARE	16.6	16.5	16.6	16.6	16.5	16.5	16.5
9	FULL SIZE		1.355	1.343	1.311	1.300	1.290	1.280	1.267
10		%SHARE	9.7	9.4	9.1	8.8	8.5	8.3	8.1
11	LUXURY		0.989	1.011	1.030	1.071	1.099	1.127	1.153
12		%SHARE	7.0	7.1	7.1	7.2	7.3	7.3	7.4
13									
14	YEAR END STOCK OF HYBRIDS	MILL VEH	30.328	33.687	36.597	39.064	41.091	42.734	44.021
15	MID-SIZE		14.905	16.603	18.101	19.401	20.497	21.416	22.164
16	FULL SIZE		9.183	10.104	10.850	11.423	11.838	12.115	12.271
17	LUXURY		6.240	6.981	7.646	8.240	8.756	9.203	9.585
18									
19	HYBRID PURCHASE PRICE								
20	MID-SIZE		24863.	26173.	27543.	28940.	30426.	31954.	33595.
21	FULL SIZE		25911.	27265.	28678.	30122.	31658.	33232.	34925.
22	LUXURY		35270.	37084.	38979.	40915.	42975.	45085.	47360.
23									
24	HYBRID CAPITALIZED COST PER MILE	$/MILE							
25	MID-SIZE		0.813	0.859	0.908	0.957	1.009	1.064	1.122
26	FULL SIZE		0.856	0.903	0.955	1.006	1.060	1.117	1.178
27	LUXURY		1.029	1.086	1.146	1.206	1.270	1.337	1.409
28									
29	HYBRID VEHICLE MILES(ELECTRIC)	BILL MILES	226.162	258.148	287.240	313.530	337.345	358.589	377.172
30									
31	ELECTRICITY CONSUMED	BILL KWH	157.957	180.249	200.498	218.763	235.277	249.978	262.805
32									
33	TOTAL DOMESTIC NEW CAR MPG (EPA)		31.32	31.30	31.29	31.29	31.28	31.27	31.24
34									
35	OVERALL FLEET MPG (WEFA)		25.06	25.63	26.07	26.43	26.65	26.80	26.89
36									
37	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	61.588	61.822	62.213	62.848	63.865	65.160	66.630

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INDEX OF TABLES

TABLE 1,00 SELECTED MARKET INDICATORS

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CARS IN OPERATION; YR-END	MILL AUTOS	100,877	102,857	104,471	106,272	108,254	110,212	112,130	113,944	115,777	117,522	119,072
2		%GROWTH	1,4	2,0	1,6	1,7	1,9	1,8	1,7	1,6	1,6	1,5	1,3
3													
4	NEW CAR RETAIL SALES	MILL AUTOS	11,052	10,789	11,049	11,621	11,798	11,847	12,345	12,615	12,712	12,622	12,828
5		%GROWTH	-1,5	-2,4	2,4	5,2	1,5	0,4	4,2	2,2	0,8	-0,7	1,6
6													
7	TOTAL NEW CAR REGISTRATIONS	MILL AUTOS	10,802	10,543	10,798	11,362	11,537	11,585	12,076	12,337	12,429	12,336	12,534
8		%GROWTH	-1,6	-2,4	2,4	5,2	1,5	0,4	4,2	2,2	0,7	-0,7	1,6
9													
10	DOMESTIC	MILL AUTOS	8,989	8,756	8,958	9,462	9,633	9,670	10,100	10,263	10,273	10,126	10,229
11		%GROWTH	-0,4	-2,6	2,3	5,6	1,8	0,4	4,4	1,6	0,1	-1,4	1,0
12	FOREIGN	MILL AUTOS	1,813	1,787	1,839	1,900	1,904	1,915	1,975	2,079	2,156	2,210	2,305
13		%GROWTH	-7,3	-1,4	2,9	3,3	0,2	0,6	3,2	5,0	3,9	2,5	4,3
14													
15	% FOREIGN		16,79	16,95	17,03	16,72	16,50	16,53	16,36	16,82	17,35	17,92	18,39
16		%GROWTH	-5,8	1,0	0,5	-1,8	-1,3	0,2	-1,0	2,8	3,2	3,3	2,7
17	% SMALL CARS (SUB + COMP)		46,68	46,79	46,92	46,65	46,49	46,63	46,66	46,90	47,41	48,10	48,64
18		%GROWTH	-1,7	0,2	0,3	-0,6	-0,3	0,3	0,1	0,5	1,1	1,5	1,1
19													
20	TOTAL AUTOS SCRAPPED	MILL AUTOS	9,415	8,563	9,184	9,562	9,555	9,627	10,158	10,523	10,596	10,592	10,984
21		%GROWTH	-11,1	-9,1	7,3	4,1	-0,1	0,8	5,5	3,6	0,7	-0,0	3,7
22													
23	VEHICLE MILES TRAVELLED	MILL MILES	1208,28	1244,92	1255,22	1270,15	1288,96	1315,56	1346,89	1376,57	1409,97	1440,59	1470,12
24		%GROWTH	1,9	3,0	0,8	1,2	1,5	2,1	2,4	2,2	2,4	2,2	2,0
25													
26	TOTAL FLEET MPG (WEFA EST.)		13,93	14,22	14,59	15,07	15,63	16,25	16,92	17,56	18,16	18,72	19,24
27		%GROWTH	1,3	2,0	2,6	3,3	3,7	4,0	4,2	3,8	3,4	3,1	2,8
28													
29	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	86,72	87,57	86,05	84,30	82,49	80,96	79,59	78,39	77,63	76,95	76,42
30		%GROWTH	0,6	1,0	-1,7	-2,0	-2,1	-1,9	-1,7	-1,5	-1,0	-0,9	-0,7
31	AUTO MOTOR FUEL EXPENDITURES	BILL 72 $	29,15	30,14	29,79	29,35	28,89	28,51	28,19	27,92	27,81	27,72	27,68
32		%GROWTH	2,9	3,4	-1,2	-1,5	-1,6	-1,3	-1,1	-0,9	-0,4	-0,3	-0,1
33													
34	NEW CAR FLEET MPG (EPA EST.)		20,38	21,46	22,83	24,68	26,60	27,67	28,09	28,09	28,11	28,15	28,17
35		%GROWTH	5,7	5,3	6,4	8,1	7,8	4,0	1,5	0,0	0,1	0,1	0,1
36													
37	DOMESTIC		19,57	20,66	22,05	24,00	26,07	27,12	27,55	27,53	27,53	27,55	27,56
38		%GROWTH	6,5	5,6	6,7	8,8	8,6	4,0	1,6	-0,1	0,0	0,1	0,0
39	FOREIGN		25,68	26,51	27,63	28,78	29,67	30,87	31,20	31,22	31,25	31,26	31,28
40		%GROWTH	2,2	3,2	4,2	4,2	3,1	4,0	1,1	0,1	0,1	0,0	0,1
41													
42	AVERAGE NEW CAR PURCHASE COST	DOLLARS	7369,	7896,	8512,	9108,	9742,	10395,	11043,	11698,	12362,	13040,	13726,
43		%GROWTH	7,9	7,1	7,8	7,0	7,0	6,7	6,2	5,9	5,7	5,5	5,3
44	NEW CAR EXPENDITURES	BILL 72 $	33,77	32,40	33,13	35,69	37,14	38,14	40,37	41,78	42,50	42,63	43,79
45		%GROWTH	-6,1	-4,0	2,2	7,7	4,1	2,7	5,8	3,5	1,7	0,3	2,7
46													
47	AVG CAP. COST PER MILE	CENTS/MILE	27,35	29,27	31,69	34,05	36,37	38,91	41,59	44,50	47,48	50,55	53,71
48		%GROWTH	8,6	7,0	8,3	7,5	6,8	7,0	6,9	7,0	6,7	6,5	6,3
49													
50	AVG USED CAR WHOLESALE PRICE	DOLLARS	3436,	3734,	4050,	4371,	4709,	5054,	5398,	5758,	6134,	6516,	6896,
51		%GROWTH	10,7	8,7	8,5	7,9	7,7	7,3	6,8	6,7	6,5	6,2	5,8
52	TOTAL USED CAR PURCHASES	MILL AUTOS	15,663	16,641	17,288	17,233	16,971	17,463	18,156	18,072	18,339	18,818	19,370
53		%GROWTH	7,1	6,2	3,9	-0,3	-1,5	2,9	4,0	-0,5	1,5	2,6	2,9

TABLE 1,00 SELECTED MARKET INDICATORS

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CARS IN OPERATION, YR-END	MILL AUTOS	120,535	122,237	123,893	125,548	127,484	129,463	131,497	133,625	135,915	138,323	140,709
2		%GROWTH	1,2	1,4	1,4	1,3	1,5	1,6	1,6	1,6	1,7	1,8	1,7
3													
4	NEW CAR RETAIL SALES	MILL AUTOS	12,989	13,415	13,920	14,440	14,600	14,874	15,031	15,446	15,727	16,003	16,255
5		%GROWTH	1,3	3,3	3,8	3,7	1,1	1,9	1,1	2,8	1,8	1,8	1,6
6													
7	TOTAL NEW CAR REGISTRATIONS	MILL AUTOS	12,688	13,103	13,595	14,104	14,258	14,525	14,676	15,079	15,394	15,623	15,870
8		%GROWTH	1,2	3,3	3,8	3,7	1,1	1,9	1,0	2,7	1,8	1,8	1,6
9													
10	DOMESTIC	MILL AUTOS	10,291	10,585	10,941	11,324	11,416	11,607	11,704	11,977	12,178	12,389	12,585
11		%GROWTH	0,6	2,9	3,4	3,5	0,8	1,7	0,8	2,3	1,7	1,7	1,6
12	FOREIGN	MILL AUTOS	2,397	2,519	2,654	2,779	2,842	2,918	2,972	3,102	3,176	3,234	3,285
13		%GROWTH	4,0	5,1	5,4	4,7	2,3	2,7	1,9	4,4	2,4	1,8	1,6
14													
15	% FOREIGN		18,89	19,22	19,52	19,71	19,93	20,09	20,25	20,57	20,68	20,70	20,70
16		%GROWTH	2,7	1,7	1,6	0,9	1,1	0,8	0,8	1,6	0,5	0,1	-0,0
17	% SMALL CARS (SUB + COMP)		49,19	49,41	49,57	49,65	49,91	50,14	50,49	50,85	51,04	51,18	51,29
18		%GROWTH	1,1	0,4	0,3	0,2	0,5	0,5	0,7	0,7	0,4	0,3	0,2
19													
20	TOTAL AUTOS SCRAPPED	MILL AUTOS	11,225	11,402	11,939	12,448	12,322	12,546	12,642	12,952	13,063	13,216	13,483
21		%GROWTH	2,2	1,6	4,7	4,3	-1,0	1,8	0,8	2,4	0,9	1,2	2,0
22													
23	VEHICLE MILES TRAVELLED	MILL MILES	1498,50	1535,56	1572,44	1610,76	1651,46	1693,52	1732,91	1774,01	1818,51	1866,47	1915,76
24		%GROWTH	1,9	2,5	2,4	2,4	2,5	2,5	2,3	2,4	2,5	2,6	2,6
25													
26	TOTAL FLEET MPG (WEFA EST.)		19,66	20,02	20,27	20,41	20,47	20,51	20,53	20,53	20,51	20,48	20,45
27		%GROWTH	2,2	1,8	1,3	0,7	0,3	0,2	0,1	0,0	-0,1	-0,1	-0,2
28													
29	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	76,21	76,72	77,59	78,91	80,67	82,57	84,43	86,39	88,66	91,13	93,68
30		%GROWTH	-0,3	0,7	1,1	1,7	2,2	2,3	2,3	2,3	2,6	2,8	2,8
31	AUTO MOTOR FUEL EXPENDITURES	BILL 72 $	27,76	27,94	28,26	28,74	29,38	30,07	30,75	31,46	32,29	33,19	34,12
32		%GROWTH	0,3	0,7	1,1	1,7	2,2	2,3	2,3	2,3	2,6	2,8	2,8
33													
34	NEW CAR FLEET MPG (EPA EST.)		28,20	28,21	28,22	28,22	28,24	28,25	28,27	28,29	28,30	28,30	28,31
35		%GROWTH	0,1	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0
36													
37	DOMESTIC		27,57	27,57	27,57	27,56	27,55	27,56	27,57	27,58	27,59	27,59	27,59
38		%GROWTH	0,1	-0,0	-0,0	-0,0	-0,0	0,0	0,0	0,0	0,0	0,0	-0,0
39	FOREIGN		31,28	31,29	31,29	31,32	31,35	31,38	31,39	31,39	31,40	31,41	31,44
40		%GROWTH	-0,0	0,0	0,0	0,1	0,1	0,1	0,1	-0,0	0,0	0,0	0,1
41													
42	AVERAGE NEW CAR PURCHASE COST	DOLLARS	14462,	15240,	16070,	16918,	17818,	18749,	19718,	20737,	21811,	22922,	24091,
43		%GROWTH	5,4	5,4	5,4	5,3	5,3	5,2	5,2	5,2	5,2	5,1	5,1
44	NEW CAR EXPENDITURES	BILL 72 $	44,85	47,08	49,68	52,42	53,79	55,64	57,28	59,79	61,87	64,00	66,10
45		%GROWTH	2,4	5,0	5,5	5,5	2,6	3,4	2,9	4,4	3,5	3,4	3,3
46													
47	AVG CAP. COST PER MILE	CENTS/MILE	56,97	60,29	63,77	67,41	71,24	75,24	79,59	83,96	88,57	93,47	98,62
48		%GROWTH	6,1	5,8	5,8	5,7	5,7	5,6	5,8	5,5	5,5	5,5	5,5
49													
50	AVG USED CAR WHOLESALE PRICE	DOLLARS	7301,	7738,	8220,	8741,	9295,	9860,	10445,	11040,	11682,	12347,	13051,
51		%GROWTH	5,9	6,0	6,2	6,3	6,3	6,1	5,9	5,7	5,8	5,7	5,7
52	TOTAL USED CAR PURCHASES	MILL AUTOS	19,424	19,673	19,754	19,857	20,059	20,689	21,047	21,499	21,680	22,072	22,510
53		%GROWTH	0,3	1,3	0,4	0,5	1,0	3,1	1,7	2,1	0,9	1,8	2,0

TABLE 2.00 NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL NEW REGISTRATIONS	10.802	10.943	10.798	11.362	11.537	11.585	12.076	12.337	12.429	12.336	12.534
2												
3	SUBCOMPACT	2.712	2.651	2.717	2.818	2.839	2.854	2.976	3.067	3.136	3.166	3.261
4	%SHARE	25.11	25.15	25.16	24.80	24.60	24.64	24.65	24.86	25.23	25.66	26.02
5	COMPACT	2.330	2.281	2.350	2.482	2.525	2.548	2.658	2.719	2.756	2.768	2.836
6	%SHARE	21.57	21.64	21.76	21.84	21.89	21.99	22.02	22.04	22.18	22.44	22.63
7	MID-SIZE	2.742	2.692	2.746	2.914	2.972	2.975	3.105	3.164	3.190	3.169	3.224
8	%SHARE	25.38	25.54	25.43	25.64	25.76	25.68	25.71	25.65	25.67	25.69	25.72
9	FULL SIZE	1.986	1.919	1.957	2.071	2.114	2.109	2.158	2.163	2.095	1.969	1.912
10	%SHARE	18.39	18.20	18.12	18.23	18.32	18.21	17.87	17.54	16.85	15.96	15.25
11	LUXURY	1.032	0.999	1.028	1.077	1.007	1.099	1.177	1.224	1.252	1.264	1.302
12	%SHARE	9.55	9.48	9.52	9.48	9.42	9.48	9.75	9.92	10.07	10.25	10.38

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TABLE 2.10 TOTAL DOMESTIC NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL DOMESTIC NEW REGISTRATIONS	8.989	8.756	8.958	9.462	9.633	9.670	10.100	10.263	10.273	10.126	10.229
2												
3	SUBCOMPACTS	1.085	1.044	1.060	1.103	1.119	1.122	1.194	1.187	1.172	1.149	1.151
4	%SHARE	12.07	11.92	11.83	11.66	11.62	11.60	11.82	11.56	11.41	11.35	11.26
5	COMPACT	2.237	2.193	2.266	2.402	2.449	2.476	2.590	2.653	2.694	2.709	2.780
6	%SHARE	24.88	25.04	25.29	25.38	25.42	25.60	25.64	25.85	26.23	26.75	27.18
7	MID-SIZE	2.742	2.692	2.746	2.914	2.972	2.975	3.105	3.164	3.190	3.169	3.224
8	%SHARE	30.50	30.75	30.65	30.79	30.86	30.76	30.74	30.84	31.05	31.30	31.52
9	FULL SIZE	1.986	1.919	1.957	2.071	2.114	2.109	2.158	2.163	2.095	1.969	1.912
10	%SHARE	22.10	21.92	21.85	21.89	21.94	21.81	21.37	21.08	20.39	19.45	18.69
11	LUXURY	0.939	0.908	0.930	0.972	0.979	0.989	1.053	1.095	1.122	1.129	1.162
12	%SHARE	10.45	10.37	10.38	10.27	10.16	10.23	10.43	10.67	10.92	11.15	11.36

MARCH CONTROL FOR HYBRIDS

TABLE 2.20 FOREIGN NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL FOREIGN NEW REGISTRATIONS	1.813	1.787	1.839	1.900	1.904	1.915	1.975	2.075	2.196	2.210	2.305
2												
3	SUBCOMPACT	1.628	1.607	1.657	1.714	1.719	1.733	1.783	1.881	1.964	2.017	2.110
4	%SHARE	89.76	89.94	90.09	90.24	90.32	90.50	90.25	90.64	91.08	91.25	91.52
5	COMPACT	0.093	0.089	0.084	0.080	0.076	0.072	0.069	0.065	0.062	0.059	0.056
6	%SHARE	5.15	4.97	4.59	4.22	4.00	3.78	3.48	3.15	2.88	2.67	2.43
7	LUXURY	0.092	0.091	0.098	0.105	0.108	0.110	0.124	0.129	0.130	0.134	0.140
8	%SHARE	5.09	5.09	5.32	5.54	5.68	5.72	6.27	6.22	6.04	6.08	6.05
9												
10	FOREIGN MARKET SHARES: % OF TOTAL	16.79	16.95	17.03	16.72	16.50	16.53	16.36	16.82	17.35	17.92	18.39
11	% OF SUBCOMPACT	60.01	60.62	60.99	60.84	60.57	60.71	59.90	61.31	62.63	63.71	64.69
12	% OF COMPACT	4.01	3.89	3.59	3.23	3.01	2.84	2.58	2.40	2.25	2.13	1.97
13	% OF LUXURY	8.95	9.11	9.52	9.78	9.95	9.97	10.53	10.54	10.40	10.64	10.72

TABLE 2,00 NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL NEW REGISTRATIONS		12,688	13,103	13,595	14,104	14,258	14,525	14,676	15,079	15,354	15,623	15,870
2													
3	SUBCOMPACT		3,356	3,495	3,657	3,806	3,873	3,970	4,043	4,208	4,307	4,393	4,461
4		XSHARE	26,45	26,68	26,90	26,99	27,17	27,33	27,55	27,91	28,05	28,12	28,11
5	COMPACT		2,885	2,979	3,082	3,196	3,242	3,313	3,367	3,459	3,529	3,603	3,679
6		XSHARE	22,74	22,73	22,67	22,66	22,74	22,81	22,94	22,94	22,99	23,06	23,18
7	MID-SIZE		3,257	3,365	3,488	3,625	3,670	3,744	3,787	3,888	3,962	4,037	4,114
8		XSHARE	25,67	25,68	25,66	25,70	25,74	25,78	25,81	25,78	25,80	25,84	25,92
9	FULL SIZE		1,853	1,871	1,910	1,956	1,928	1,913	1,866	1,849	1,838	1,828	1,821
10		XSHARE	14,60	14,28	14,05	13,87	13,52	13,17	12,71	12,26	11,97	11,70	11,47
11	LUXURY		1,337	1,393	1,458	1,520	1,545	1,585	1,612	1,675	1,718	1,761	1,795
12		XSHARE	10,54	10,63	10,72	10,78	10,84	10,91	10,99	11,11	11,19	11,27	11,31

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TABLE 2,10 TOTAL DOMESTIC NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL DOMESTIC NEW REGISTRATIONS		10,291	10,585	10,941	11,324	11,416	11,607	11,704	11,977	12,178	12,389	12,585
2													
3	SUBCOMPACTS		1,163	1,186	1,221	1,244	1,242	1,260	1,275	1,319	1,345	1,373	1,381
4		XSHARE	11,30	11,21	11,16	10,98	10,88	10,85	10,89	11,01	11,04	11,08	10,98
5	COMPACT		2,832	2,928	3,034	3,150	3,199	3,271	3,328	3,422	3,494	3,569	3,647
6		XSHARE	27,52	27,67	27,73	27,82	28,02	28,18	28,44	28,57	28,69	28,81	28,98
7	MID-SIZE		3,257	3,365	3,488	3,625	3,670	3,744	3,787	3,888	3,962	4,037	4,114
8		XSHARE	31,65	31,79	31,88	32,01	32,15	32,26	32,36	32,46	32,53	32,59	32,69
9	FULL SIZE		1,853	1,871	1,910	1,956	1,928	1,913	1,866	1,849	1,838	1,828	1,821
10		XSHARE	18,01	17,68	17,46	17,28	16,88	16,48	15,94	15,44	15,09	14,76	14,47
11	LUXURY		1,186	1,234	1,288	1,349	1,378	1,419	1,448	1,499	1,539	1,581	1,622
12		XSHARE	11,53	11,66	11,77	11,91	12,07	12,22	12,37	12,52	12,64	12,76	12,89

MARCH CONTROL FOR HYBRIDS

TABLE 2,20 FOREIGN NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL FOREIGN NEW REGISTRATIONS		2,397	2,519	2,654	2,779	2,842	2,918	2,972	3,102	3,176	3,234	3,285
2													
3	SUBCOMPACT		2,194	2,309	2,436	2,562	2,632	2,711	2,769	2,889	2,962	3,021	3,079
4		XSHARE	91,50	91,70	91,79	92,20	92,60	92,90	93,15	93,13	93,26	93,41	93,75
5	COMPACT		0,053	0,051	0,048	0,046	0,043	0,041	0,039	0,037	0,035	0,034	0,032
6		XSHARE	2,22	2,01	1,81	1,64	1,52	1,41	1,31	1,20	1,11	1,04	0,97
7	LUXURY		0,151	0,159	0,170	0,171	0,167	0,166	0,165	0,176	0,179	0,180	0,174
8		XSHARE	6,28	6,30	6,40	6,16	5,88	5,69	5,54	5,67	5,62	5,55	5,28
9													
10	FOREIGN MARKET SHARES:	% OF TOTAL	18,89	19,22	19,52	19,71	19,93	20,09	20,25	20,57	20,68	20,70	20,70
11		% OF SUBCOMPACT	65,36	66,07	66,61	67,32	67,94	68,27	68,47	68,66	68,77	68,76	69,03
12		% OF COMPACT	1,84	1,70	1,56	1,43	1,34	1,24	1,16	1,07	1,00	0,93	0,87
13		% OF LUXURY	11,26	11,39	11,65	11,27	10,81	10,47	10,21	10,50	10,40	10,20	9,67

TABLE 3.00 GROWTH RATES, NEW REGISTRATIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL NEW REGISTRATIONS	-1,6	-2,4	2,4	5,2	1,5	0,4	4,2	2,2	0,7	-0,7	1,6
2												
3	SUBCOMPACT	-6,7	-2,2	2,5	3,7	0,7	0,6	4,3	3,1	2,2	1,0	3,0
4												
5	COMPACT	1,1	-2,1	3,0	5,6	1,7	0,9	4,3	2,3	1,4	0,4	2,5
6												
7	MID-SIZE	-1,7	-1,8	2,0	6,1	2,0	0,1	4,4	1,9	0,8	-0,6	1,7
8												
9	FULL SIZE	3,5	-3,4	2,0	5,8	2,0	-0,2	2,3	0,2	-3,2	-6,0	-2,9
10												
11	LUXURY	-2,5	-3,2	2,9	4,8	0,9	1,1	7,1	4,0	2,3	0,9	3,0

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TABLE 3.10 GROWTH RATES, DOMESTIC NEW REGISTRATIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL DOMESTIC NEW REGISTRATIONS	-0,4	-2,6	2,3	5,6	1,8	0,4	4,4	1,6	0,1	-1,4	1,0
2												
3	SUBCOMPACTS	-7,1	-3,8	1,5	4,1	1,4	0,2	6,4	-0,6	-1,2	-2,0	0,2
4												
5	COMPACT	1,4	-2,0	3,3	6,0	2,0	1,1	4,6	2,5	1,5	0,5	2,6
6												
7	MID-SIZE	-1,7	-1,8	2,0	6,1	2,0	0,1	4,4	1,9	0,8	-0,6	1,7
8												
9	FULL SIZE	3,5	-3,4	2,0	5,8	2,0	-0,2	2,3	0,2	-3,2	-6,0	-2,9
10												
11	LUXURY	-0,0	-3,3	2,4	4,5	0,7	1,0	6,5	3,9	2,5	0,7	2,9

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TABLE 3.20 GROWTH RATES, FOREIGN NEW REGISTRATIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL FOREIGN NEW REGISTRATIONS	-7,3	-1,4	2,9	3,3	0,2	0,6	3,2	5,0	3,9	2,5	4,3
2												
3	SUBCOMPACT	-6,4	-1,2	3,1	3,5	0,3	0,8	2,9	5,5	4,4	2,7	4,6
4												
5	COMPACT	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0
6												
7	LUXURY	-22,4	-1,4	7,6	7,6	2,7	1,3	13,1	4,1	1,0	3,3	3,7

TABLE 3,00 GROWTH RATES, NEW REGISTRATIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL NEW REGISTRATIONS	1,2	3,3	3,8	3,7	1,1	1,9	1,0	2,7	1,8	1,8	1,6
2												
3	SUBCOMPACT	2,9	4,1	4,6	4,1	1,8	2,5	1,8	4,1	2,3	2,0	1,5
4												
5	COMPACT	1,7	3,3	3,5	3,7	1,4	2,2	1,7	2,7	2,0	2,1	2,1
6												
7	MID-SIZE	1,0	3,3	3,7	3,9	1,2	2,0	1,1	2,7	1,9	1,9	1,9
8												
9	FULL SIZE	-3,1	1,0	2,1	2,4	-1,5	-0,8	-2,5	-0,9	-0,6	-0,5	-0,4
10												
11	LUXURY	2,7	4,2	4,7	4,3	1,6	2,6	1,7	3,9	2,6	2,5	2,0

MARCH CONTROL FOR HYBRIDS

TABLE 3,10 GROWTH RATES, DOMESTIC NEW REGISTRATIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL DOMESTIC NEW REGISTRATIONS	0,6	2,9	3,4	3,5	0,8	1,7	0,8	2,3	1,7	1,7	1,6
2												
3	SUBCOMPACTS	1,0	2,0	3,0	1,9	-0,2	1,4	1,2	3,5	2,0	2,1	0,6
4												
5	COMPACT	1,9	3,4	3,6	3,8	1,5	2,3	1,7	2,8	2,1	2,2	2,2
6												
7	MID-SIZE	1,0	3,3	3,7	3,9	1,2	2,0	1,1	2,7	1,9	1,9	1,9
8												
9	FULL SIZE	-3,1	1,0	2,1	2,4	-1,5	-0,8	-2,5	-0,9	-0,6	-0,5	-0,4
10												
11	LUXURY	2,1	4,0	4,4	4,7	2,1	3,0	2,0	3,6	2,7	2,7	2,6

MARCH CONTROL FOR HYBRIDS

TABLE 3,20 GROWTH RATES, FOREIGN NEW REGISTRATIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL FOREIGN NEW REGISTRATIONS	4,0	5,1	5,4	4,7	2,3	2,7	1,9	4,4	2,4	1,8	1,6
2												
3	SUBCOMPACT	4,0	5,3	5,5	5,2	2,7	3,0	2,1	4,4	2,5	2,0	1,9
4												
5	COMPACT	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0	-5,0
6												
7	LUXURY	7,9	5,3	7,1	0,9	-2,5	-0,6	-0,8	6,9	1,5	0,6	-3,4

TABLE 4.00 PASSENGER CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL CARS IN OPERATION YEAR-END		100,877	102,857	104,471	106,272	108,254	110,212	112,130	113,944	115,777	117,522	119,072
2													
3	SUBCOMPACT		22,074	23,370	24,464	25,426	26,274	26,999	27,630	28,200	28,770	29,333	29,879
4		%SHARE	21.88	22.72	23.42	23.93	24.27	24.50	24.64	24.75	24.85	24.96	25.09
5	COMPACT		20,086	20,826	21,484	22,168	22,848	23,488	24,076	24,608	25,137	25,658	26,149
6		%SHARE	19.91	20.25	20.56	20.86	21.11	21.31	21.47	21.60	21.71	21.83	21.96
7	MID-SIZE		24,421	25,124	25,758	26,466	27,198	27,871	28,502	29,054	29,576	30,065	30,498
8		%SHARE	24.21	24.43	24.66	24.90	25.12	25.29	25.42	25.50	25.55	25.58	25.61
9	FULL SIZE		24,804	23,806	22,836	22,084	21,608	21,330	21,181	21,120	21,099	21,027	20,864
10		%SHARE	24.59	23.14	21.86	20.78	19.96	19.35	18.89	18.54	18.22	17.89	17.52
11	LUXURY		9,492	9,730	9,929	10,127	10,326	10,523	10,741	10,961	11,195	11,438	11,682
12		%SHARE	9.41	9.46	9.50	9.53	9.54	9.55	9.58	9.62	9.67	9.73	9.81

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TABLE 4.10 DOMESTIC CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	DOMESTIC CARS IN OPERATION		85,614	86,865	87,849	89,077	90,537	92,031	93,555	94,972	96,380	97,672	98,751
2													
3	SUBCOMPACTS		8,680	9,299	9,797	10,206	10,543	10,803	11,035	11,200	11,335	11,441	11,512
4		%SHARE	10.14	10.71	11.15	11.46	11.64	11.74	11.80	11.79	11.76	11.71	11.66
5	COMPACTS		19,095	19,817	20,471	21,166	21,864	22,530	23,154	23,726	24,295	24,854	25,385
6		%SHARE	22.30	22.81	23.30	23.76	24.15	24.48	24.75	24.98	25.21	25.45	25.71
7	MID-SIZE		24,421	25,124	25,758	26,466	27,198	27,871	28,502	29,054	29,576	30,065	30,498
8		%SHARE	28.52	28.92	29.32	29.71	30.04	30.28	30.47	30.59	30.69	30.78	30.88
9	FULL SIZE		24,804	23,806	22,836	22,084	21,608	21,330	21,181	21,120	21,099	21,027	20,864
10		%SHARE	28.97	27.41	25.99	24.79	23.87	23.18	22.64	22.24	21.89	21.53	21.13
11	LUXURY		8,614	8,819	8,986	9,154	9,325	9,497	9,683	9,872	10,075	10,284	10,492
12		%SHARE	10.06	10.15	10.23	10.28	10.30	10.32	10.35	10.39	10.45	10.53	10.63

MARCH CONTROL FOR HYBRIDS

TABLE 4.20 FOREIGN CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	FOREIGN CARS IN OPERATION		15,263	15,992	16,623	17,195	17,717	18,181	18,575	18,972	19,397	19,850	20,321
2													
3	SUBCOMPACTS		13,394	14,071	14,667	15,219	15,731	16,196	16,595	17,000	17,435	17,892	18,367
4		%SHARE	87.75	87.99	88.24	88.51	88.79	89.08	89.34	89.61	89.89	90.14	90.38
5	COMPACTS		0,991	1,010	1,013	1,003	0,984	0,958	0,922	0,882	0,842	0,804	0,765
6		%SHARE	6.49	6.31	6.09	5.83	5.56	5.27	4.96	4.65	4.34	4.05	3.76
7	LUXURY		0,878	0,912	0,942	0,973	1,001	1,027	1,058	1,089	1,120	1,154	1,190
8		%SHARE	5.75	5.70	5.67	5.66	5.65	5.65	5.70	5.74	5.77	5.81	5.86
9													
10	FOREIGN SHARES:	% OF TOTAL	15.13	15.55	15.91	16.18	16.37	16.50	16.57	16.65	16.75	16.89	17.07
11		% OF SUBCOMPACT	60.68	60.21	59.95	59.86	59.87	59.99	60.06	60.28	60.60	61.00	61.47
12		% OF COMPACT	4.93	4.85	4.71	4.52	4.31	4.08	3.83	3.58	3.35	3.13	2.92
13		% OF LUXURY	9.25	9.37	9.49	9.60	9.70	9.76	9.85	9.94	10.00	10.09	10.19

TABLE 4.00 PASSENGER CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL CARS IN OPERATION YEAR-END		120,535	122,237	123,893	125,548	127,484	129,463	131,497	133,625	135,915	138,323	140,709
2													
3	SUBCOMPACT		30,449	31,103	31,776	32,468	33,249	34,054	34,884	35,778	36,707	37,648	38,551
4		%SHARE	25.26	25.44	25.65	25.86	26.08	26.30	26.53	26.78	27.01	27.22	27.40
5	COMPACT		26,619	27,127	27,614	28,090	28,624	29,163	29,723	30,293	30,897	31,527	32,162
6		%SHARE	22.08	22.19	22.29	22.37	22.45	22.53	22.60	22.67	22.73	22.79	22.86
7	MID-SIZE		30,899	31,356	31,797	32,237	32,749	33,272	33,813	34,372	34,977	35,620	36,269
8		%SHARE	25.63	25.65	25.67	25.68	25.69	25.70	25.71	25.72	25.73	25.75	25.78
9	FULL SIZE		20,628	20,415	20,165	19,901	19,671	19,438	19,193	18,935	18,710	18,515	18,334
10		%SHARE	17.11	16.70	16.28	15.85	15.43	15.01	14.60	14.17	13.77	13.39	13.03
11	LUXURY		11,939	12,236	12,540	12,852	13,191	13,537	13,884	14,247	14,624	15,013	15,393
12		%SHARE	9.91	10.01	10.12	10.24	10.35	10.46	10.56	10.66	10.76	10.85	10.94

MARCH CONTROL FOR HYBRIDS

TABLE 4.10 DOMESTIC CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	DOMESTIC CARS IN OPERATION		99,698	100,801	101,816	102,799	103,992	105,214	106,485	107,811	109,295	110,910	112,549
2													
3	SUBCOMPACTS		11,573	11,640	11,689	11,719	11,766	11,818	11,887	11,986	12,117	12,272	12,424
4		%SHARE	11.61	11.55	11.48	11.40	11.31	11.23	11.16	11.12	11.09	11.06	11.04
5	COMPACTS		25,894	26,439	26,965	27,480	28,048	28,620	29,211	29,809	30,440	31,096	31,753
6		%SHARE	25.97	26.23	26.48	26.73	26.97	27.20	27.43	27.65	27.85	28.04	28.21
7	MID-SIZE		30,899	31,356	31,797	32,237	32,749	33,272	33,813	34,372	34,977	35,620	36,269
8		%SHARE	30.99	31.11	31.23	31.36	31.49	31.62	31.75	31.88	32.00	32.12	32.22
9	FULL SIZE		20,628	20,415	20,165	19,901	19,671	19,438	19,193	18,935	18,710	18,515	18,334
10		%SHARE	20.69	20.25	19.81	19.36	18.92	18.47	18.02	17.56	17.12	16.69	16.29
11	LUXURY		10,704	10,950	11,200	11,462	11,758	12,066	12,382	12,708	13,050	13,408	13,768
12		%SHARE	10.74	10.86	11.00	11.15	11.31	11.47	11.63	11.79	11.94	12.09	12.23

MARCH CONTROL FOR HYBRIDS

TABLE 4.20 FOREIGN CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	FOREIGN CARS IN OPERATION		20,837	21,436	22,076	22,749	23,492	24,249	25,012	25,814	26,621	27,412	28,160
2													
3	SUBCOMPACTS		18,877	19,463	20,087	20,749	21,483	22,236	22,998	23,792	24,590	25,376	26,127
4		%SHARE	90.59	90.80	90.99	91.21	91.45	91.70	91.95	92.17	92.37	92.57	92.78
5	COMPACTS		0,726	0,688	0,649	0,610	0,575	0,542	0,512	0,483	0,457	0,432	0,408
6		%SHARE	3.48	3.21	2.94	2.68	2.45	2.24	2.05	1.87	1.72	1.58	1.45
7	LUXURY		1,235	1,285	1,340	1,390	1,433	1,471	1,502	1,539	1,574	1,605	1,624
8		%SHARE	5.93	6.00	6.07	6.11	6.10	6.06	6.01	5.96	5.91	5.85	5.77
9													
10	FOREIGN SHARES:	% OF TOTAL	17.29	17.54	17.82	18.12	18.43	18.73	19.02	19.32	19.59	19.82	20.01
11		% OF SUBCOMPACT	61.99	62.58	63.21	63.91	64.61	65.30	65.93	66.50	66.99	67.40	67.77
12		% OF COMPACT	2.73	2.54	2.35	2.17	2.01	1.86	1.72	1.60	1.48	1.37	1.27
13		% OF LUXURY	10.34	10.50	10.69	10.81	10.87	10.86	10.82	10.80	10.76	10.69	10.55

TABLE 5,00 GROWTH RATES, CARS IN OPERATION: YEAR-END

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL CARS IN OPERATION YEAR-END	1,4	2,0	1,6	1,7	1,9	1,8	1,7	1,6	1,6	1,5	1,3
2												
3	SUBCOMPACT	6,8	5,9	4,7	3,9	3,3	2,8	2,3	2,1	2,0	2,0	1,9
4												
5	COMPACT	3,5	3,7	3,2	3,2	3,1	2,8	2,5	2,2	2,2	2,1	1,9
6												
7	MID-SIZE	2,2	2,9	2,5	2,7	2,8	2,5	2,3	1,9	1,8	1,7	1,4
8												
9	FULL SIZE	-5,5	-4,0	-4,1	-3,3	-2,2	-1,3	-0,7	-0,3	-0,1	-0,3	-0,8
10												
11	LUXURY	2,2	2,5	2,0	2,0	2,0	1,9	2,1	2,1	2,1	2,2	2,1

MARCH CONTROL FOR HYBRIDS

TABLE 5,10 GROWTH RATES, DOMESTIC CARS IN OPERATION: YEAR-END

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	DOMESTIC CARS IN OPERATION	0,8	1,5	1,1	1,4	1,6	1,6	1,7	1,5	1,5	1,3	1,1
2												
3	SUBCOMPACTS	9,0	7,1	5,3	4,2	3,3	2,5	2,1	1,5	1,2	0,9	0,6
4												
5	COMPACTS	3,6	3,8	3,3	3,4	3,3	3,0	2,8	2,5	2,4	2,3	2,1
6												
7	MID-SIZE	2,2	2,9	2,5	2,7	2,8	2,5	2,3	1,9	1,8	1,7	1,4
8												
9	FULL SIZE	-5,5	-4,0	-4,1	-3,3	-2,2	-1,3	-0,7	-0,3	-0,1	-0,3	-0,8
10												
11	LUXURY	2,1	2,4	1,9	1,9	1,9	1,8	2,0	2,0	2,1	2,1	2,0

MARCH CONTROL FOR HYBRIDS

TABLE 5,20 GROWTH RATES, FOREIGN CARS IN OPERATION: YEAR-END

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	FOREIGN CARS IN OPERATION	5,1	4,8	3,9	3,4	3,0	2,6	2,2	2,1	2,2	2,3	2,4
2												
3	SUBCOMPACTS	5,4	5,1	4,2	3,8	3,4	3,0	2,5	2,4	2,6	2,6	2,7
4												
5	COMPACTS	2,5	1,9	0,3	-1,0	-1,8	-2,7	-3,8	-4,4	-4,5	-4,5	-4,9
6												
7	LUXURY	4,1	3,8	3,4	3,2	2,9	2,5	3,1	3,0	2,8	3,1	3,1

MARCH CONTROL FOR HYBRIDS

TABLE 5.00 GROWTH RATES, CARS IN OPERATION; YEAR-END

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL CARS IN OPERATION YEAR-END	1.2	1.4	1.4	1.3	1.5	1.6	1.6	1.6	1.7	1.8	1.7
2												
3	SUBCOMPACT	1.9	2.1	2.2	2.2	2.4	2.4	2.4	2.6	2.6	2.6	2.4
4												
5	COMPACT	1.8	1.9	1.8	1.7	1.9	1.9	1.9	1.9	2.0	2.0	2.0
6												
7	MID-SIZE	1.3	1.5	1.4	1.4	1.6	1.6	1.6	1.7	1.8	1.8	1.8
8												
9	FULL SIZE	-1.1	-1.0	-1.2	-1.3	-1.2	-1.2	-1.3	-1.3	-1.2	-1.0	-1.0
10												
11	LUXURY	2.2	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.5

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TABLE 5.10 GROWTH RATES, DOMESTIC CARS IN OPERATION; YEAR-END

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	DOMESTIC CARS IN OPERATION	1.0	1.1	1.0	1.0	1.2	1.2	1.2	1.2	1.4	1.5	1.5
2												
3	SUBCOMPACTS	0.5	0.6	0.4	0.3	0.4	0.4	0.6	0.8	1.1	1.3	1.2
4												
5	COMPACTS	2.0	2.1	2.0	1.9	2.1	2.0	2.1	2.0	2.1	2.2	2.1
6												
7	MID-SIZE	1.3	1.5	1.4	1.4	1.6	1.6	1.6	1.7	1.8	1.8	1.8
8												
9	FULL SIZE	-1.1	-1.0	-1.2	-1.3	-1.2	-1.2	-1.3	-1.3	-1.2	-1.0	-1.0
10												
11	LUXURY	2.0	2.3	2.3	2.3	2.6	2.6	2.6	2.6	2.7	2.7	2.7

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TABLE 5.20 GROWTH RATES, FOREIGN CARS IN OPERATION; YEAR-END

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	FOREIGN CARS IN OPERATION	2.5	2.9	3.0	3.0	3.3	3.2	3.1	3.2	3.1	3.0	2.7
2												
3	SUBCOMPACTS	2.8	3.1	3.2	3.3	3.5	3.5	3.4	3.5	3.4	3.2	3.0
4												
5	COMPACTS	-5.1	-5.2	-5.6	-6.0	-5.7	-5.7	-5.6	-5.6	-5.5	-5.4	-5.4
6												
7	LUXURY	3.8	4.1	4.3	3.7	3.1	2.6	2.2	2.4	2.3	2.0	1.2

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TABLE 6.00 CARS IN OPERATION BY AGE: MID YEAR (MILL AUTOS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CARS IN OPERATION: ALL VINTAGES	100.144	101.815	103.605	105.317	107.196	109.157	111.088	112.944	114.775	116.573	118.212
2												
3	LESS THAN 1 YEAR OLD	5.391	5.262	5.389	5.671	5.758	5.782	6.027	6.157	6.203	6.156	6.255
4	AGE: 1 YEAR OLD	10.924	10.753	10.495	10.748	11.310	11.484	11.531	12.017	12.277	12.369	12.276
5	AGE: 2 YEARS OLD	10.594	10.838	10.669	10.412	10.663	11.221	11.391	11.434	11.916	12.175	12.265
6	AGE: 3 YEARS OLD	9.438	10.455	10.698	10.528	10.274	10.523	11.070	11.233	11.275	11.751	12.005
7	AGE: 4 YEARS OLD	7.832	9.246	10.247	10.480	10.314	10.067	10.305	10.833	10.991	11.033	11.498
8	AGE: 5 YEARS OLD	8.003	7.595	8.972	9.936	10.162	10.003	9.756	9.977	10.485	10.641	10.679
9	AGE: 6 YEARS OLD	9.990	7.644	7.262	8.568	9.489	9.709	9.546	9.296	9.502	9.990	10.135
10	AGE: 7 YEARS OLD	8.578	9.307	7.133	6.763	7.981	8.844	9.032	8.859	8.621	8.818	9.266
11	AGE: 8 YEARS OLD	7.258	7.766	8.452	6.460	6.125	7.235	7.999	8.139	7.974	7.767	7.940
12	AGE: 9 YEARS OLD	5.343	6.321	6.789	7.360	5.627	5.342	6.287	6.916	7.027	6.894	6.708
13	AGE: 10 YEARS OLD	4.894	4.347	5.175	5.524	5.991	4.589	4.333	5.060	5.554	5.655	5.539
14	AGE: 11 YEARS OLD	3.637	3.718	3.342	3.945	4.209	4.579	3.485	3.254	3.786	4.165	4.236
15	AGE: 12 YEARS OLD	2.374	2.666	2.769	2.464	2.905	3.111	3.362	2.526	2.347	2.738	3.010
16	AGE: 13 YEARS OLD	1.891	1.720	1.966	2.020	1.795	2.125	2.261	2.410	1.801	1.678	1.957
17	AGE: 14 YEARS OLD	1.468	1.370	1.268	1.435	1.472	1.313	1.544	1.621	1.718	1.288	1.199
18	AGE: 15 YEARS OLD	0.938	1.064	1.011	0.926	1.045	1.077	0.954	1.107	1.156	1.228	0.920
19	AGE: 16 YEARS OLD	0.627	0.680	0.785	0.737	0.674	0.765	0.783	0.684	0.789	0.826	0.878
20	AGE: 17 YEARS OLD	0.405	0.454	0.502	0.572	0.537	0.493	0.556	0.561	0.488	0.564	0.590
21	AGE: 18 YEARS OLD	0.242	0.294	0.335	0.366	0.417	0.393	0.359	0.398	0.400	0.349	0.403
22	AGE: 19 YEARS OLD	0.193	0.175	0.217	0.244	0.267	0.305	0.286	0.257	0.284	0.286	0.249
23	AGE: 20 YEARS OLD	0.125	0.140	0.129	0.158	0.178	0.195	0.222	0.205	0.183	0.203	0.204

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TABLE 6.10 CARS IN OPERATION: SHARES BY AGE (PERCENT)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	LESS THAN 1 YEAR OLD	5.38	5.17	5.20	5.38	5.37	5.30	5.42	5.45	5.40	5.28	5.29
2	AGE: 1 YEAR OLD	10.91	10.56	10.13	10.21	10.55	10.52	10.38	10.64	10.70	10.61	10.38
3	AGE: 2 YEARS OLD	10.58	10.64	10.30	9.89	9.95	10.28	10.25	10.12	10.38	10.44	10.38
4	AGE: 3 YEARS OLD	9.42	10.27	10.33	10.00	9.58	9.64	9.97	9.95	9.82	10.08	10.16
5	AGE: 4 YEARS OLD	7.82	9.08	9.89	9.95	9.62	9.22	9.28	9.59	9.58	9.46	9.73
6	AGE: 5 YEARS OLD	7.99	7.46	8.66	9.43	9.48	9.16	8.78	8.83	9.14	9.13	9.03
7	AGE: 6 YEARS OLD	9.98	7.51	7.01	8.14	8.85	8.89	8.59	8.23	8.28	8.57	8.97
8	AGE: 7 YEARS OLD	8.57	9.14	6.88	6.42	7.45	8.10	8.13	7.84	7.51	7.56	7.84
9	AGE: 8 YEARS OLD	7.25	7.63	8.16	6.13	5.71	6.63	7.20	7.21	6.95	6.66	6.72
10	AGE: 9 YEARS OLD	5.33	6.21	6.55	6.99	5.25	4.89	5.66	6.12	6.12	5.91	5.67
11	AGE: 10 YEARS OLD	4.89	4.27	4.99	5.25	5.59	4.20	3.90	4.48	4.84	4.85	4.69
12	AGE: 11 YEARS OLD	3.63	3.65	3.23	3.75	3.93	4.19	3.14	2.88	3.30	3.57	3.58
13	AGE: 12 YEARS OLD	2.37	2.62	2.67	2.34	2.71	2.85	3.03	2.24	2.04	2.35	2.55
14	AGE: 13 YEARS OLD	1.89	1.69	1.90	1.92	1.67	1.95	2.04	2.13	1.57	1.44	1.66
15	AGE: 14 YEARS OLD	1.47	1.35	1.22	1.36	1.37	1.20	1.39	1.43	1.50	1.10	1.01
16	AGE: 15 YEARS OLD	0.94	1.04	0.98	0.88	0.98	0.99	0.86	0.98	1.01	1.05	0.78
17	AGE: 16 YEARS OLD	0.63	0.67	0.76	0.70	0.63	0.70	0.70	0.61	0.69	0.71	0.74
18	AGE: 17 YEARS OLD	0.40	0.45	0.48	0.54	0.50	0.45	0.50	0.50	0.42	0.48	0.50
19	AGE: 18 YEARS OLD	0.24	0.29	0.32	0.35	0.39	0.36	0.32	0.35	0.35	0.30	0.34
20	AGE: 19 YEARS OLD	0.19	0.17	0.21	0.23	0.25	0.28	0.26	0.23	0.25	0.25	0.21
21	AGE: 20 YEARS OLD	0.12	0.14	0.12	0.15	0.17	0.18	0.20	0.18	0.16	0.17	0.17

TABLE 6.00 CARS IN OPERATION BY AGE: MID YEAR (MILL AUTOS)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CARS IN OPERATION: ALL VINTAGES	119,719	121,312	122,981	124,635	126,430	128,412	130,425	132,500	134,707	137,058	139,060
2												
3	LESS THAN 1 YEAR OLD	6,332	6,539	6,784	7,037	7,114	7,247	7,323	7,523	7,660	7,794	7,917
4	AGE: 1 YEAR OLD	12,472	12,625	13,036	13,523	14,028	14,181	14,446	14,596	14,996	15,268	15,535
5	AGE: 2 YEARS OLD	12,171	12,365	12,513	12,917	13,398	13,898	14,048	14,309	14,456	14,852	15,120
6	AGE: 3 YEARS OLD	12,091	11,997	12,183	12,322	12,718	13,191	13,681	13,827	14,082	14,225	14,613
7	AGE: 4 YEARS OLD	11,742	11,823	11,725	11,897	12,030	12,415	12,874	13,349	13,488	13,735	13,873
8	AGE: 5 YEARS OLD	11,123	11,355	11,424	11,315	11,477	11,603	11,971	12,408	12,861	12,993	13,228
9	AGE: 6 YEARS OLD	10,163	10,580	10,787	10,832	10,723	10,873	10,988	11,329	11,737	12,162	12,282
10	AGE: 7 YEARS OLD	9,388	9,407	9,773	9,935	9,969	9,864	9,995	10,090	10,395	10,765	11,149
11	AGE: 8 YEARS OLD	8,328	8,428	8,423	8,714	8,846	8,871	8,768	8,872	8,946	9,211	9,532
12	AGE: 9 YEARS OLD	6,840	7,162	7,221	7,173	7,408	7,513	7,523	7,421	7,497	7,554	7,768
13	AGE: 10 YEARS OLD	5,369	5,460	5,685	5,678	5,624	5,800	5,869	5,859	5,764	5,817	5,850
14	AGE: 11 YEARS OLD	4,127	3,985	4,024	4,136	4,107	4,064	4,177	4,210	4,185	4,111	4,139
15	AGE: 12 YEARS OLD	3,041	2,950	2,826	2,811	2,868	2,847	2,804	2,870	2,878	2,856	2,798
16	AGE: 13 YEARS OLD	2,136	2,148	2,067	1,950	1,924	1,962	1,938	1,901	1,935	1,937	1,916
17	AGE: 14 YEARS OLD	1,388	1,509	1,505	1,426	1,334	1,316	1,336	1,314	1,281	1,302	1,299
18	AGE: 15 YEARS OLD	0,851	0,981	1,057	1,039	0,976	0,913	0,896	0,905	0,886	0,862	0,873
19	AGE: 16 YEARS OLD	0,653	0,601	0,687	0,729	0,711	0,668	0,621	0,607	0,610	0,596	0,579
20	AGE: 17 YEARS OLD	0,623	0,461	0,421	0,474	0,499	0,486	0,454	0,421	0,409	0,411	0,400
21	AGE: 18 YEARS OLD	0,419	0,440	0,323	0,291	0,324	0,341	0,331	0,308	0,284	0,275	0,276
22	AGE: 19 YEARS OLD	0,286	0,296	0,308	0,223	0,199	0,222	0,232	0,224	0,208	0,191	0,189
23	AGE: 20 YEARS OLD	0,177	0,202	0,207	0,213	0,153	0,136	0,151	0,158	0,151	0,140	0,128

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TABLE 6.10 CARS IN OPERATION: SHARES BY AGE (PERCENT)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	LESS THAN 1 YEAR OLD	5.29	5.39	5.52	5.65	5.63	5.64	5.61	5.68	5.69	5.69	5.68
2	AGE: 1 YEAR OLD	10.42	10.41	10.60	10.85	11.10	11.04	11.08	11.02	11.13	11.14	11.14
3	AGE: 2 YEARS OLD	10.17	10.19	10.17	10.36	10.60	10.82	10.77	10.80	10.73	10.84	10.84
4	AGE: 3 YEARS OLD	10.10	9.89	9.91	9.89	10.06	10.27	10.49	10.44	10.45	10.38	10.48
5	AGE: 4 YEARS OLD	9.81	9.75	9.53	9.55	9.52	9.67	9.87	10.07	10.01	10.02	9.95
6	AGE: 5 YEARS OLD	9.29	9.36	9.29	9.08	9.08	9.04	9.18	9.36	9.55	9.48	9.48
7	AGE: 6 YEARS OLD	8.49	8.72	8.77	8.69	8.48	8.47	8.42	8.55	8.71	8.87	8.81
8	AGE: 7 YEARS OLD	7.84	7.75	7.95	7.97	7.88	7.68	7.66	7.62	7.72	7.85	7.99
9	AGE: 8 YEARS OLD	6.96	6.95	6.85	6.99	7.00	6.91	6.72	6.70	6.64	6.72	6.83
10	AGE: 9 YEARS OLD	5.71	5.90	5.87	5.76	5.86	5.89	5.77	5.60	5.57	5.51	5.57
11	AGE: 10 YEARS OLD	4.48	4.50	4.62	4.56	4.45	4.52	4.50	4.42	4.28	4.24	4.19
12	AGE: 11 YEARS OLD	3.45	3.28	3.27	3.32	3.25	3.17	3.20	3.18	3.11	3.00	2.97
13	AGE: 12 YEARS OLD	2.54	2.43	2.30	2.26	2.27	2.22	2.15	2.17	2.14	2.08	2.01
14	AGE: 13 YEARS OLD	1.78	1.77	1.68	1.56	1.52	1.53	1.49	1.43	1.44	1.41	1.37
15	AGE: 14 YEARS OLD	1.16	1.24	1.22	1.14	1.06	1.02	1.02	0.99	0.95	0.95	0.93
16	AGE: 15 YEARS OLD	0.71	0.81	0.86	0.83	0.77	0.71	0.69	0.68	0.66	0.63	0.63
17	AGE: 16 YEARS OLD	0.55	0.50	0.56	0.59	0.56	0.52	0.48	0.46	0.45	0.43	0.41
18	AGE: 17 YEARS OLD	0.52	0.38	0.34	0.38	0.39	0.38	0.35	0.32	0.30	0.30	0.29
19	AGE: 18 YEARS OLD	0.35	0.36	0.26	0.23	0.26	0.27	0.25	0.23	0.21	0.20	0.20
20	AGE: 19 YEARS OLD	0.24	0.24	0.25	0.18	0.16	0.17	0.18	0.17	0.15	0.14	0.13
21	AGE: 20 YEARS OLD	0.15	0.17	0.17	0.17	0.12	0.11	0.12	0.12	0.11	0.10	0.09

TABLE 7.00 GROWTH RATES, CARS IN OPERATION: MID-YEAR

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CARS IN OPERATION: ALL VINTAGES	0.9	1.7	1.8	1.7	1.8	1.8	1.8	1.7	1.6	1.6	1.4
2												
3	LESS THAN 1 YEAR OLD	-1.6	-2.4	2.4	5.2	1.5	0.4	4.2	2.2	0.7	-0.7	1.6
4	AGE: 1 YEAR OLD	2.2	-1.6	-2.4	2.4	5.2	1.5	0.4	4.2	2.2	0.7	-0.7
5	AGE: 2 YEARS OLD	10.6	2.3	-1.6	-2.4	2.4	5.2	1.5	0.4	4.2	2.2	0.7
6	AGE: 3 YEARS OLD	17.8	10.8	2.3	-1.6	-2.4	2.4	5.2	1.5	0.4	4.2	2.2
7	AGE: 4 YEARS OLD	-5.4	18.1	10.8	2.3	-1.6	-2.4	2.4	5.1	1.5	0.4	4.2
8	AGE: 5 YEARS OLD	-23.9	-5.1	18.1	10.7	2.3	-1.6	-2.5	2.3	5.1	1.5	0.4
9	AGE: 6 YEARS OLD	7.6	-23.5	-5.0	18.0	10.8	2.3	-1.7	-2.6	2.2	5.1	1.4
10	AGE: 7 YEARS OLD	5.8	8.5	-23.4	-5.2	18.0	10.8	2.1	-1.9	-2.7	2.3	5.1
11	AGE: 8 YEARS OLD	16.4	7.0	8.8	-23.6	-5.2	18.1	10.5	1.8	-2.0	-2.6	2.2
12	AGE: 9 YEARS OLD	-13.4	18.3	7.4	8.4	-23.6	-5.1	17.7	10.0	1.6	-1.9	-2.7
13	AGE: 10 YEARS OLD	-1.3	-11.2	19.1	6.8	8.4	-23.4	-5.6	16.8	9.7	1.8	-2.0
14	AGE: 11 YEARS OLD	7.9	2.2	-10.1	18.0	6.7	8.8	-23.9	-6.6	16.3	10.0	1.7
15	AGE: 12 YEARS OLD	-12.8	12.3	3.9	-11.0	17.9	7.1	8.1	-24.9	-7.1	16.6	9.9
16	AGE: 13 YEARS OLD	-10.5	-9.0	14.3	2.7	-11.1	18.4	6.4	6.6	-25.3	-6.8	16.6
17	AGE: 14 YEARS OLD	8.7	-6.7	-7.4	13.1	2.6	-10.8	17.6	4.9	6.0	-25.1	-6.9
18	AGE: 15 YEARS OLD	4.0	13.4	-5.0	-8.4	13.0	3.0	-11.4	16.0	4.4	6.3	-25.1
19	AGE: 16 YEARS OLD	7.5	8.5	15.4	-6.0	-8.5	13.4	2.3	-12.6	15.4	4.7	6.3
20	AGE: 17 YEARS OLD	16.5	12.1	10.4	14.1	-6.1	-8.2	12.6	0.9	-13.0	15.7	4.6
21	AGE: 18 YEARS OLD	-12.9	21.5	14.1	9.2	14.0	-5.8	-8.8	11.1	0.4	-12.8	15.6
22	AGE: 19 YEARS OLD	7.3	-9.1	23.7	12.9	9.1	14.4	-6.4	-10.0	10.5	0.7	-12.9
23	AGE: 20 YEARS OLD	27.5	11.9	-7.5	22.4	12.7	9.5	13.7	-7.7	-10.5	10.8	0.6

MARCH CONTROL FOR HYBRIDS

TABLE 7.10 GROWTH RATES, CARS IN OPERATION: SHARES BY AGE

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	LESS THAN 1 YEAR OLD	-2.5	-4.0	0.6	3.5	-0.2	-1.4	2.4	0.5	-0.9	-2.3	0.2
2	AGE: 1 YEAR OLD	1.3	-3.2	-4.1	0.7	3.4	-0.3	-1.3	2.5	0.5	-0.8	-2.1
3	AGE: 2 YEARS OLD	9.6	0.6	-3.3	-4.0	0.6	3.3	-0.2	-1.3	2.5	0.6	-0.7
4	AGE: 3 YEARS OLD	16.7	9.0	0.6	-3.2	-4.1	0.6	3.4	-0.2	-1.2	2.6	0.7
5	AGE: 4 YEARS OLD	-6.3	16.1	8.9	0.6	-3.3	-4.1	0.6	3.4	-0.2	-1.2	2.8
6	AGE: 5 YEARS OLD	-24.6	-6.7	16.1	8.9	0.5	-3.3	-4.2	0.6	3.4	-0.1	-1.0
7	AGE: 6 YEARS OLD	6.7	-24.7	-6.6	16.1	8.8	0.5	-3.4	-4.2	0.6	3.5	0.0
8	AGE: 7 YEARS OLD	4.8	6.7	-24.7	-6.7	15.9	8.8	0.4	-3.5	-4.2	0.7	3.6
9	AGE: 8 YEARS OLD	15.4	5.2	7.0	-24.8	-6.8	16.0	8.6	0.1	-3.6	-4.1	0.8
10	AGE: 9 YEARS OLD	-14.2	16.4	5.5	6.7	-24.9	-6.8	15.6	8.2	-0.0	-3.4	-4.0
11	AGE: 10 YEARS OLD	-2.1	-12.6	17.0	5.0	6.5	-24.8	-7.2	14.9	8.0	0.2	-3.4
12	AGE: 11 YEARS OLD	6.9	0.5	-11.7	16.1	4.8	6.8	-25.2	-8.1	14.5	8.3	0.3
13	AGE: 12 YEARS OLD	-13.6	10.5	2.1	-12.5	15.8	5.2	6.2	-26.1	-8.6	14.9	8.4
14	AGE: 13 YEARS OLD	-11.3	-10.5	12.3	1.1	-12.7	16.2	4.5	4.8	-26.5	-8.3	15.0
15	AGE: 14 YEARS OLD	7.7	-8.2	-9.0	11.3	0.8	-12.4	15.6	3.2	4.3	-26.2	-8.2
16	AGE: 15 YEARS OLD	3.0	11.5	-6.6	-9.9	11.0	1.2	-12.9	14.1	2.7	4.7	-26.1
17	AGE: 16 YEARS OLD	6.5	6.7	13.4	-7.5	-10.1	11.4	0.6	-14.0	13.5	3.1	4.8
18	AGE: 17 YEARS OLD	15.5	10.2	8.5	12.3	-7.8	-9.8	10.7	-0.7	-14.4	13.9	3.2
19	AGE: 18 YEARS OLD	-13.7	19.5	12.1	7.4	12.0	-7.5	-10.4	9.3	-1.2	-14.2	14.0
20	AGE: 19 YEARS OLD	6.3	-10.6	21.6	11.0	7.2	12.4	-8.0	-11.5	8.8	-0.9	-14.1
21	AGE: 20 YEARS OLD	26.3	10.1	-9.1	20.4	10.7	7.5	11.7	-9.2	-11.9	9.1	-0.8

TABLE 7.00 GROWTH RATES, CARS IN OPERATION; MID-YEAR

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CARS IN OPERATION; ALL VINTAGES	1.3	1.3	1.4	1.3	1.4	1.6	1.6	1.6	1.7	1.7	1.8
2												
3	LESS THAN 1 YEAR OLD	1.2	3.3	3.7	3.7	1.1	1.9	1.0	2.7	1.8	1.8	1.6
4	AGE: 1 YEAR OLD	1.6	1.2	3.3	3.7	3.7	1.1	1.9	1.0	2.7	1.8	1.8
5	AGE: 2 YEARS OLD	-0.8	1.6	1.2	3.2	3.7	3.7	1.1	1.9	1.0	2.7	1.8
6	AGE: 3 YEARS OLD	0.7	-0.8	1.6	1.1	3.2	3.7	3.7	1.1	1.8	1.0	2.7
7	AGE: 4 YEARS OLD	2.1	0.7	-0.8	1.5	1.1	3.2	3.7	3.7	1.0	1.8	1.0
8	AGE: 5 YEARS OLD	4.2	2.1	0.6	-1.0	1.4	1.1	3.2	3.7	3.6	1.0	1.8
9	AGE: 6 YEARS OLD	0.3	4.1	2.0	0.4	-1.0	1.4	1.1	3.1	3.6	3.6	1.0
10	AGE: 7 YEARS OLD	1.3	0.2	3.9	1.7	0.3	-1.1	1.3	1.0	3.0	3.6	3.6
11	AGE: 8 YEARS OLD	4.9	1.2	-0.1	3.9	1.5	0.3	-1.2	1.2	0.8	3.0	3.5
12	AGE: 9 YEARS OLD	2.0	4.7	0.8	-0.7	3.3	1.4	0.1	-1.4	1.0	0.8	2.8
13	AGE: 10 YEARS OLD	-3.1	1.7	4.1	-0.1	-1.0	3.1	1.2	-0.2	-1.6	0.9	0.6
14	AGE: 11 YEARS OLD	-2.6	-3.4	1.0	2.8	-0.7	-1.0	2.8	0.8	-0.6	-1.8	0.7
15	AGE: 12 YEARS OLD	1.0	-3.0	-4.2	-0.5	2.0	-0.7	-1.5	2.3	0.3	-0.8	-2.0
16	AGE: 13 YEARS OLD	9.2	0.6	-3.8	-5.7	-1.3	2.0	-1.2	-1.7	1.8	0.1	-1.0
17	AGE: 14 YEARS OLD	15.8	8.7	-0.2	-5.3	-6.4	-1.4	1.5	-1.6	-2.5	1.6	-0.2
18	AGE: 15 YEARS OLD	-7.5	15.2	7.8	-1.8	-6.0	-6.5	-1.8	1.1	-2.2	-2.6	1.3
19	AGE: 16 YEARS OLD	-25.6	-7.9	14.3	6.1	-2.6	-6.1	-6.9	-2.3	0.5	-2.4	-2.9
20	AGE: 17 YEARS OLD	5.5	-26.0	-8.7	12.6	5.3	-2.6	-6.5	-7.3	-2.8	0.3	-2.6
21	AGE: 18 YEARS OLD	3.9	5.0	-26.6	-10.1	11.6	5.2	-3.1	-6.9	-7.8	-3.0	0.0
22	AGE: 19 YEARS OLD	14.8	3.4	4.2	-27.7	-10.8	11.6	4.7	-3.5	-7.4	-8.0	-3.3
23	AGE: 20 YEARS OLD	-13.5	14.3	2.6	2.6	-28.3	-10.8	11.1	4.3	-4.0	-7.6	-8.3

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TABLE 7.10 GROWTH RATES, CARS IN OPERATION; SHARES BY AGE

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	LESS THAN 1 YEAR OLD	-0.0	1.9	2.3	2.4	-0.3	0.3	-0.5	1.1	0.1	0.0	-0.2
2	AGE: 1 YEAR OLD	0.3	-0.1	1.9	2.4	2.3	-0.5	0.3	-0.5	1.1	0.1	-0.0
3	AGE: 2 YEARS OLD	-2.0	0.3	-0.2	1.9	2.3	2.1	-0.5	0.3	-0.6	1.0	0.1
4	AGE: 3 YEARS OLD	-0.6	-2.1	0.2	-0.2	1.7	2.1	2.1	-0.5	0.2	-0.7	1.0
5	AGE: 4 YEARS OLD	0.8	-0.6	-2.2	0.1	-0.3	1.6	2.1	2.1	-0.6	0.1	-0.7
6	AGE: 5 YEARS OLD	2.8	0.7	-0.8	-2.3	-0.0	-0.5	1.6	2.0	2.0	-0.7	0.1
7	AGE: 6 YEARS OLD	-1.0	2.7	0.6	-0.9	-2.4	-0.2	-0.5	1.5	1.9	1.8	-0.8
8	AGE: 7 YEARS OLD	0.0	-1.1	2.5	0.3	-1.1	-2.6	-0.2	-0.6	1.3	1.8	1.8
9	AGE: 8 YEARS OLD	3.6	-0.1	-1.4	2.1	0.1	-1.3	-2.7	-0.4	-0.8	1.2	1.7
10	AGE: 9 YEARS OLD	0.7	3.3	-0.5	-2.0	1.8	-0.1	-1.4	-2.9	-0.6	-1.0	1.1
11	AGE: 10 YEARS OLD	-4.3	0.4	2.7	-1.4	-2.4	1.6	-0.4	-1.7	-3.2	-0.8	-1.2
12	AGE: 11 YEARS OLD	-3.8	-4.7	-0.4	1.4	-2.1	-2.6	1.2	-0.8	-2.2	-3.5	-1.1
13	AGE: 12 YEARS OLD	-0.2	-4.3	-5.5	-1.8	0.6	-2.3	-3.0	0.7	-1.4	-2.5	-3.7
14	AGE: 13 YEARS OLD	7.8	-0.7	-5.1	-6.9	-2.7	0.4	-2.8	-3.4	0.1	-1.6	-2.7
15	AGE: 14 YEARS OLD	14.3	7.2	-1.6	-6.5	-7.8	-2.9	-0.1	-3.2	-4.1	-0.1	-1.9
16	AGE: 15 YEARS OLD	-8.7	13.7	6.3	-3.1	-7.4	-7.9	-3.4	-0.5	-3.8	-4.3	-0.4
17	AGE: 16 YEARS OLD	-26.6	-9.1	12.8	4.7	-4.0	-7.5	-8.4	-3.8	-1.1	-4.0	-4.6
18	AGE: 17 YEARS OLD	4.2	-26.9	-9.9	11.1	3.8	-4.1	-8.0	-8.8	-4.4	-1.4	-4.3
19	AGE: 18 YEARS OLD	2.6	3.6	-27.6	-11.3	10.1	3.6	-4.6	-8.4	-9.3	-4.6	-1.7
20	AGE: 19 YEARS OLD	13.4	2.1	2.8	-28.6	-12.1	9.9	3.1	-5.0	-9.0	-9.6	-4.9
21	AGE: 20 YEARS OLD	-14.6	12.8	1.2	1.2	-29.3	-12.2	9.3	2.7	-5.6	-9.2	-9.8

TABLE 8.00 SCRAPPAGE (MILL AUTOS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN	9,415	8,563	9,184	9,562	9,555	9,627	10,198	10,523	10,596	10,592	10,984
2												
3	SUBCOMPACT DOMESTIC	0,371	0,424	0,562	0,694	0,783	0,861	0,962	1,022	1,037	1,042	1,080
4	SUBCOMPACT FOREIGN	0,944	0,931	1,060	1,162	1,208	1,267	1,384	1,475	1,529	1,560	1,635
5	SUBCOMPACT TOTAL	1,315	1,355	1,623	1,856	1,991	2,129	2,346	2,497	2,567	2,602	2,716
6												
7	COMPACT DOMESTIC	1,578	1,471	1,611	1,707	1,751	1,809	1,966	2,081	2,125	2,150	2,249
8	COMPACT FOREIGN	0,070	0,070	0,081	0,090	0,095	0,099	0,105	0,105	0,102	0,097	0,095
9	COMPACT TOTAL	1,647	1,541	1,693	1,797	1,846	1,908	2,071	2,186	2,227	2,247	2,344
10												
11	MID-SIZE	2,212	1,989	2,112	2,206	2,240	2,302	2,475	2,612	2,668	2,680	2,791
12												
13	FULL SIZE	3,418	2,918	2,927	2,823	2,590	2,387	2,307	2,225	2,115	2,042	2,075
14												
15	LUXURY DOMESTIC	0,766	0,703	0,762	0,804	0,808	0,817	0,866	0,906	0,919	0,921	0,954
16	LUXURY FOREIGN	0,058	0,058	0,067	0,075	0,079	0,084	0,092	0,098	0,100	0,100	0,104
17	LUXURY TOTAL	0,823	0,761	0,829	0,879	0,888	0,902	0,959	1,003	1,019	1,021	1,057

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TABLE 8.10 GROWTH RATES, SCRAPPAGE

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN	-11,1	-9,1	7,3	4,1	-0,1	0,8	5,5	3,6	0,7	-0,0	3,7
2												
3	SUBCOMPACT DOMESTIC	9,4	14,3	32,6	23,4	12,8	10,0	11,6	6,3	1,5	0,5	3,7
4	SUBCOMPACT FOREIGN	-2,0	-1,4	13,9	9,6	3,9	4,9	9,2	6,5	3,7	2,0	4,8
5	SUBCOMPACT TOTAL	1,0	3,1	19,8	14,4	7,3	6,9	10,2	6,4	2,8	1,4	4,4
6												
7	COMPACT DOMESTIC	-8,3	-6,7	9,5	5,9	2,6	3,3	8,7	5,8	2,1	1,2	4,6
8	COMPACT FOREIGN	-1,0	0,4	16,0	11,3	4,8	4,3	6,2	0,7	-3,4	-4,7	-1,7
9	COMPACT TOTAL	-8,1	-6,4	9,8	6,2	2,7	3,4	8,6	5,6	1,9	0,9	4,3
10												
11	MID-SIZE	-13,0	-10,1	6,2	4,5	1,6	2,7	7,5	5,5	2,2	0,4	4,2
12												
13	FULL SIZE	-15,6	-14,6	0,3	-3,6	-8,3	-7,8	-3,4	-3,6	-4,9	-3,5	1,7
14												
15	LUXURY DOMESTIC	-9,5	-8,2	8,5	5,5	0,5	1,1	6,0	4,5	1,5	0,2	3,6
16	LUXURY FOREIGN	-0,3	0,0	16,3	11,9	5,8	6,0	9,8	5,6	2,1	0,5	3,3
17	LUXURY TOTAL	-8,9	-7,6	9,1	6,0	1,0	1,5	6,4	4,6	1,5	0,2	3,6

A PRODUCT OF WHARTON EFA, INC.

TABLE 8,00 SCRAPPAGE (MILL AUTOS)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN	11,225	11,402	11,939	12,448	12,322	12,546	12,642	12,952	13,063	13,216	13,483
2												
3	SUBCOMPACT DOMESTIC	1,102	1,119	1,172	1,214	1,194	1,208	1,206	1,219	1,215	1,218	1,229
4	SUBCOMPACT FOREIGN	1,683	1,723	1,812	1,900	1,898	1,957	2,007	2,095	2,163	2,236	2,328
5	SUBCOMPACT TOTAL	2,786	2,842	2,984	3,114	3,092	3,166	3,213	3,314	3,378	3,453	3,557
6												
7	COMPACT DOMESTIC	2,323	2,383	2,509	2,635	2,630	2,700	2,738	2,824	2,863	2,914	2,989
8	COMPACT FOREIGN	0,092	0,088	0,087	0,084	0,078	0,074	0,069	0,066	0,062	0,058	0,055
9	COMPACT TOTAL	2,415	2,471	2,595	2,720	2,708	2,774	2,807	2,889	2,925	2,973	3,045
10												
11	MID-SIZE	2,856	2,907	3,047	3,185	3,158	3,221	3,246	3,329	3,357	3,395	3,465
12												
13	FULL SIZE	2,088	2,085	2,159	2,220	2,158	2,146	2,111	2,107	2,063	2,023	2,001
14												
15	LUXURY DOMESTIC	0,974	0,988	1,039	1,087	1,082	1,110	1,132	1,173	1,197	1,223	1,261
16	LUXURY FOREIGN	0,106	0,108	0,115	0,122	0,123	0,129	0,133	0,139	0,144	0,149	0,154
17	LUXURY TOTAL	1,080	1,096	1,153	1,209	1,205	1,239	1,265	1,312	1,341	1,372	1,415

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TABLE 8,10 GROWTH RATES, SCRAPPAGE

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN	2,2	1,6	4,7	4,3	-1,0	1,8	0,8	2,4	0,9	1,2	2,0
2												
3	SUBCOMPACT DOMESTIC	2,0	1,5	4,7	3,6	-1,6	1,2	-0,2	1,1	-0,4	0,2	1,0
4	SUBCOMPACT FOREIGN	2,9	2,3	5,2	4,8	-0,1	3,1	2,6	4,4	3,3	3,3	4,1
5	SUBCOMPACT TOTAL	2,6	2,0	5,0	4,3	-0,7	2,4	1,5	3,2	1,9	2,2	3,0
6												
7	COMPACT DOMESTIC	3,3	2,6	5,3	5,0	-0,2	2,6	1,4	3,1	1,4	1,8	2,6
8	COMPACT FOREIGN	-3,4	-4,0	-1,9	-2,6	-7,5	-5,2	-6,2	-5,3	-5,9	-5,9	-5,2
9	COMPACT TOTAL	3,0	2,3	5,0	4,8	-0,4	2,4	1,2	2,9	1,2	1,6	2,4
10												
11	MID-SIZE	2,3	1,8	4,8	4,5	-0,9	2,0	0,8	2,6	0,8	1,1	2,1
12												
13	FULL SIZE	0,6	-0,2	3,6	2,8	-2,8	-0,6	-1,6	-0,2	-2,1	-1,9	-1,1
14												
15	LUXURY DOMESTIC	2,2	1,4	5,1	4,6	-0,4	2,6	2,0	3,6	2,1	2,2	3,1
16	LUXURY FOREIGN	2,1	2,5	6,0	6,1	1,1	4,5	3,3	4,8	3,2	3,4	3,7
17	LUXURY TOTAL	2,2	1,5	5,2	4,8	-0,3	2,8	2,1	3,7	2,2	2,3	3,2

TABLE 9.00 MISCELLANEOUS MARKET VARIABLES

LINE	ITEM	UNITS	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES												
2	DESIRED STOCK	MILL AUTOS	101.308	103.668	105.598	107.860	110.297	112.336	114.812	117.074	119.276	121.211	122.977
3	DESIRED STOCK PER DRIVER	AUTOS	0.702	0.704	0.704	0.707	0.712	0.716	0.720	0.724	0.727	0.730	0.732
4													
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)												
6	TOTAL DOMESTIC		86.42	86.19	86.02	86.14	86.23	86.16	86.26	85.91	85.52	85.10	84.73
7	SUBCOMPACT		10.86	11.08	11.26	11.36	11.45	11.49	11.63	11.47	11.33	11.21	11.09
8	COMPACT		19.24	19.41	19.65	19.89	20.07	20.26	20.39	20.47	20.61	20.83	21.02
9	MID-SIZE		24.48	24.68	24.77	25.04	25.25	25.31	25.41	25.41	25.43	25.44	25.45
10	FULL SIZE		23.19	22.37	21.68	21.20	20.83	20.45	20.06	19.70	19.20	18.59	18.04
11	LUXURY		8.67	8.64	8.66	8.65	8.62	8.66	8.77	8.86	8.96	9.04	9.13
12													
13	TOTAL FOREIGN		13.58	13.81	13.98	13.86	13.77	13.84	13.74	14.09	14.48	14.90	15.27
14	SUBCOMPACT		12.02	12.26	12.44	12.36	12.30	12.39	12.29	12.66	13.08	13.49	13.87
15	COMPACT AND LUXURY		1.55	1.55	1.54	1.50	1.47	1.45	1.46	1.43	1.40	1.41	1.40
16													
17	AVG AGE OF AUTO STOCK	YEARS	5.612	5.625	5.656	5.657	5.641	5.635	5.619	5.586	5.559	5.552	5.550
18													
19	YEAR-END STOCK PER FAMILY	AUTOS	1.239	1.240	1.236	1.234	1.235	1.236	1.238	1.239	1.240	1.241	1.240
20	VEHICLE MILES PER AUTO; TOTAL	MILES	12.06	12.22	12.11	12.05	12.02	12.04	12.12	12.18	12.28	12.35	12.43
21	URBAN	MILES	6.936	7.065	7.029	7.034	7.064	7.148	7.254	7.353	7.462	7.558	7.650
22	RURAL	MILES	5.124	5.156	5.080	5.020	4.953	4.896	4.862	4.825	4.813	4.792	4.777
23	NEW REGIS. TO BEGINNING STOCK	RATIO	0.109	0.105	0.105	0.109	0.109	0.107	0.110	0.110	0.109	0.107	0.107
24	SCRAPPAGE TO BEGINNING STOCK	RATIO	0.095	0.085	0.089	0.092	0.090	0.089	0.092	0.094	0.093	0.091	0.091

MARCH CONTROL FOR HYBRIDS

TABLE 9.10 GROWTH RATES, MISCELLANEOUS MARKET VARIABLES

LINE	ITEM	UNITS	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES												
2	DESIRED STOCK	MILL AUTOS	2.1	2.3	1.9	2.1	2.3	2.0	2.0	2.0	1.9	1.6	1.5
3	DESIRED STOCK PER DRIVER	AUTOS	-0.1	0.3	-0.0	0.4	0.7	0.5	0.6	0.5	0.4	0.4	0.4
4													
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)												
6	TOTAL DOMESTIC		0.7	-0.3	-0.2	0.1	0.1	-0.1	0.1	-0.4	-0.5	-0.5	-0.4
7	SUBCOMPACT		1.4	2.1	1.6	0.9	0.8	0.3	1.3	-1.4	-1.3	-1.0	-1.1
8	COMPACT		3.1	0.9	1.2	1.2	0.9	0.9	0.6	0.4	0.7	1.0	0.9
9	MID-SIZE		0.5	0.8	0.4	1.1	0.8	0.2	0.4	0.0	0.1	0.0	0.1
10	FULL SIZE		-1.6	-3.6	-3.1	-2.2	-1.8	-1.8	-1.9	-1.8	-2.5	-3.2	-2.9
11	LUXURY		1.3	-0.3	0.2	-0.1	-0.3	0.4	1.3	1.0	1.0	0.9	1.0
12													
13	TOTAL FOREIGN		-4.2	1.8	1.2	-0.9	-0.6	0.5	-0.7	2.5	2.8	2.9	2.5
14	SUBCOMPACT		-2.9	2.0	1.4	-0.7	-0.4	0.7	-0.8	3.0	3.3	3.2	2.8
15	COMPACT AND LUXURY		-12.6	-0.3	-0.6	-2.5	-1.9	-1.8	0.7	-1.6	-2.1	0.4	-0.9
16													
17	AVG AGE OF AUTO STOCK	YEARS	-0.9	0.2	0.6	0.0	-0.3	-0.1	-0.3	-0.6	-0.5	-0.1	-0.0
18													
19	YEAR-END STOCK PER FAMILY	AUTOS	-0.6	0.1	-0.3	-0.1	0.1	0.1	0.1	0.1	0.1	0.1	-0.1
20	VEHICLE MILES PER AUTO; TOTAL	MILES	1.0	1.3	-0.9	-0.4	-0.3	0.2	0.6	0.5	0.8	0.6	0.6
21	URBAN	MILES	0.8	1.9	-0.5	0.1	0.4	1.2	1.5	1.4	1.5	1.3	1.2
22	RURAL	MILES	1.2	0.6	-1.5	-1.2	-1.3	-1.2	-0.7	-0.8	-0.2	-0.4	-0.3
23	NEW REGIS. TO BEGINNING STOCK	RATIO		-3.7	0.4	3.6	-0.2	-1.4	2.4	0.4	-0.9	-2.3	0.1
24	SCRAPPAGE TO BEGINNING STOCK	RATIO		-10.3	5.2	2.5	-1.8	-1.1	3.6	1.8	-0.9	-1.6	2.2

TABLE 9.00 MISCELLANEOUS MARKET VARIABLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES												
2	DESIRED STOCK	MILL AUTOS	124.689	126.598	128.671	130.859	132.991	135.144	137.217	139.644	142.096	144.501	146.970
3	DESIRED STOCK PER DRIVER	AUTOS	0.735	0.739	0.744	0.749	0.754	0.759	0.762	0.767	0.772	0.776	0.781
4													
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)												
6	TOTAL DOMESTIC		84.33	84.03	83.73	83.50	83.24	83.04	82.84	82.52	82.36	82.27	82.21
7	SUBCOMPACT		11.04	10.93	10.84	10.69	10.57	10.49	10.45	10.44	10.42	10.41	10.35
8	COMPACT		21.15	21.22	21.26	21.33	21.45	21.55	21.70	21.75	21.84	21.94	22.07
9	MID-SIZE		25.44	25.46	25.47	25.52	25.55	25.59	25.62	25.62	25.65	25.69	25.76
10	FULL SIZE		17.51	17.14	16.82	16.52	16.13	15.75	15.31	14.87	14.52	14.19	13.89
11	LUXURY		9.20	9.27	9.35	9.45	9.55	9.66	9.76	9.84	9.94	10.04	10.14
12													
13	TOTAL FOREIGN		15.67	15.97	16.27	16.50	16.76	16.96	17.16	17.47	17.64	17.73	17.79
14	SUBCOMPACT		14.25	14.56	14.85	15.13	15.43	15.68	15.91	16.21	16.39	16.50	16.62
15	COMPACT AND LUXURY		1.42	1.41	1.42	1.37	1.32	1.29	1.25	1.27	1.25	1.22	1.17
16													
17	AVG AGE OF AUTO STOCK	YEARS	5.543	5.533	5.504	5.453	5.400	5.363	5.331	5.301	5.271	5.249	5.235
18													
19	YEAR-END STOCK PER FAMILY	AUTOS	1.238	1.239	1.239	1.239	1.241	1.244	1.246	1.250	1.254	1.259	1.264
20	VEHICLE MILES PER AUTO: TOTAL	MILES	12.51	12.65	12.78	12.91	13.05	13.18	13.28	13.38	13.49	13.61	13.73
21	URBAN	MILES	7.742	7.878	8.015	8.160	8.307	8.452	8.575	8.703	8.845	8.996	9.150
22	RURAL	MILES	4.766	4.772	4.762	4.755	4.746	4.730	4.706	4.680	4.649	4.616	4.582
23	NEW REGIS. TO BEGINNING STOCK	RATIO	0.107	0.109	0.111	0.114	0.114	0.114	0.113	0.115	0.115	0.115	0.115
24	SCRAPPAGE TO BEGINNING STOCK	RATIO	0.094	0.095	0.098	0.100	0.098	0.098	0.098	0.098	0.098	0.097	0.097

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TABLE 9.10 GROWTH RATES, MISCELLANEOUS MARKET VARIABLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES												
2	DESIRED STOCK	MILL AUTOS	1.4	1.5	1.6	1.7	1.6	1.6	1.5	1.8	1.8	1.7	1.7
3	DESIRED STOCK PER DRIVER	AUTOS	0.4	0.5	0.7	0.8	0.6	0.6	0.5	0.7	0.6	0.6	0.6
4													
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)												
6	TOTAL DOMESTIC		-0.5	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.4	-0.2	-0.1	-0.1
7	SUBCOMPACT		-0.5	-1.0	-0.8	-1.4	-1.2	-0.7	-0.4	-0.0	-0.2	-0.1	-0.7
8	COMPACT		0.6	0.3	0.2	0.3	0.5	0.5	0.7	0.2	0.4	0.5	0.6
9	MID-SIZE		-0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.0	0.1	0.2	0.2
10	FULL SIZE		-2.9	-2.1	-1.9	-1.8	-2.3	-2.4	-2.8	-2.9	-2.4	-2.3	-2.1
11	LUXURY		0.8	0.8	0.8	1.0	1.1	1.1	1.0	0.9	1.0	1.0	1.0
12													
13	TOTAL FOREIGN		2.6	1.9	1.9	1.4	1.5	1.2	1.2	1.8	0.9	0.5	0.4
14	SUBCOMPACT		2.7	2.2	2.0	1.9	2.0	1.6	1.5	1.9	1.1	0.7	0.7
15	COMPACT AND LUXURY		2.0	-0.7	0.2	-3.2	-3.4	-2.9	-2.5	1.1	-1.4	-2.0	-4.5
16													
17	AVG AGE OF AUTO STOCK	YEARS	-0.1	-0.2	-0.5	-0.9	-1.0	-0.7	-0.6	-0.6	-0.6	-0.4	-0.3
18													
19	YEAR-END STOCK PER FAMILY	AUTOS	-0.1	0.1	0.0	-0.0	0.2	0.2	0.2	0.3	0.4	0.4	0.4
20	VEHICLE MILES PER AUTO: TOTAL	MILES	0.6	1.1	1.0	1.1	1.1	1.0	0.8	0.8	0.8	0.9	0.9
21	URBAN	MILES	1.2	1.8	1.7	1.8	1.8	1.7	1.5	1.5	1.6	1.7	1.7
22	RURAL	MILES	-0.2	0.1	-0.2	-0.2	-0.2	-0.3	-0.5	-0.6	-0.7	-0.7	-0.7
23	NEW REGIS. TO BEGINNING STOCK	RATIO		2.0	2.3	2.4	-0.2	0.3	-0.5	1.2	0.2	0.0	-0.2
24	SCRAPPAGE TO BEGINNING STOCK	RATIO		0.3	3.3	2.9	-2.3	0.3	-0.8	0.9	-0.7	-0.5	0.3

TABLE 10.00 DOMESTIC AUTO PRICES (DOLLARS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	5126.	5486.	5897.	6303.	6751.	7213.	7694.	8198.	8718.	9238.	9761.
3	COMPACT	6313.	6759.	7275.	7757.	8277.	8816.	9370.	9940.	10532.	11141.	11759.
4	MID-SIZE	7409.	7949.	8573.	9165.	9799.	10454.	11087.	11737.	12412.	13098.	13793.
5	FULL SIZE	7903.	8508.	9218.	9899.	10625.	11376.	12060.	12764.	13494.	14237.	14988.
6	LUXURY	11989.	12873.	13936.	14938.	16007.	17112.	18115.	19148.	20218.	21308.	22411.
7												
8	STATE AND LOCAL TAXES:											
9	SUBCOMPACT	234.	258.	285.	314.	345.	378.	414.	452.	492.	533.	577.
10	COMPACT	288.	316.	351.	385.	422.	462.	504.	548.	595.	645.	698.
11	MID-SIZE	340.	375.	416.	458.	504.	552.	601.	652.	707.	764.	825.
12	FULL SIZE	363.	402.	449.	496.	548.	603.	656.	712.	771.	833.	899.
13	LUXURY	558.	617.	688.	759.	836.	918.	997.	1081.	1170.	1263.	1362.
14												
15	TRANSPORTATION CHARGES:											
16	SUBCOMPACT	225.	251.	268.	285.	309.	336.	360.	389.	427.	467.	507.
17	COMPACT	294.	333.	354.	370.	391.	416.	437.	461.	492.	525.	556.
18	MID-SIZE	299.	335.	354.	370.	391.	416.	437.	461.	492.	525.	556.
19	FULL SIZE	314.	339.	354.	370.	391.	416.	437.	461.	492.	525.	556.
20	LUXURY	314.	339.	354.	370.	391.	416.	437.	461.	492.	525.	556.
21												
22	BASE PRICE: FIXED WTD AVERAGE TOTAL	5711.	6107.	6603.	7062.	7554.	8063.	8548.	9046.	9560.	10084.	10611.
23	SUBCOMPACT	4119.	4377.	4702.	5000.	5320.	5651.	5994.	6347.	6709.	7078.	7448.
24	COMPACT	4771.	5076.	5466.	5819.	6199.	6594.	6998.	7415.	7844.	8281.	8722.
25	MID-SIZE	5536.	5905.	6367.	6794.	7252.	7725.	8177.	8641.	9119.	9607.	10099.
26	FULL SIZE	5854.	6294.	6835.	7344.	7886.	8445.	8940.	9449.	9975.	10510.	11049.
27	LUXURY	9544.	10237.	11098.	11898.	12752.	13633.	14421.	15231.	16066.	16917.	17775.
28												
29	MAX OPTIONS PRICE: FIXED WTD AVERAGE	1624.	1730.	1846.	1959.	2074.	2190.	2302.	2413.	2525.	2637.	2748.
30	SUBCOMPACT	1498.	1594.	1702.	1806.	1912.	2019.	2122.	2224.	2328.	2431.	2533.
31	COMPACT	1574.	1676.	1789.	1898.	2009.	2122.	2230.	2338.	2446.	2555.	2663.
32	MID-SIZE	1652.	1759.	1877.	1992.	2109.	2227.	2340.	2454.	2567.	2681.	2794.
33	FULL SIZE	1647.	1754.	1872.	1986.	2103.	2220.	2334.	2446.	2560.	2673.	2786.
34	LUXURY	1679.	1788.	1909.	2026.	2144.	2264.	2380.	2495.	2610.	2726.	2841.
35												
36	VALUE OF OPTIONS INSTALLED:											
37	SUBCOMPACT	548.	600.	642.	705.	778.	848.	926.	1010.	1090.	1160.	1229.
38	COMPACT	961.	1034.	1105.	1183.	1264.	1345.	1431.	1516.	1601.	1690.	1783.
39	MID-SIZE	1234.	1334.	1436.	1543.	1652.	1761.	1873.	1983.	2093.	2202.	2313.
40	FULL SIZE	1372.	1473.	1579.	1688.	1800.	1913.	2027.	2141.	2256.	2369.	2483.
41	LUXURY	1573.	1681.	1796.	1911.	2028.	2145.	2260.	2375.	2489.	2604.	2718.

TABLE 10.00 DOMESTIC AUTO PRICES (DOLLARS)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	10316.	10916.	11555.	12221.	12921.	13638.	14388.	15165.	15996.	16855.	17777.
3	COMPACT	12413.	13108.	13842.	14607.	15439.	16291.	17186.	18097.	19069.	20074.	21151.
4	MID-SIZE	14526.	15302.	16121.	16972.	17894.	18837.	19822.	20827.	21897.	22997.	24178.
5	FULL SIZE	15779.	16616.	17500.	18417.	19410.	20425.	21484.	22565.	23715.	24894.	26163.
6	LUXURY	23576.	24804.	26101.	27445.	28903.	30389.	31942.	33529.	35217.	36945.	38810.
7												
8	STATE AND LOCAL TAXES:											
9	SUBCOMPACT	624.	676.	732.	792.	858.	928.	1002.	1082.	1168.	1260.	1360.
10	COMPACT	755.	818.	885.	957.	1036.	1120.	1210.	1304.	1407.	1517.	1636.
11	MID-SIZE	890.	961.	1038.	1119.	1209.	1304.	1405.	1512.	1628.	1750.	1883.
12	FULL SIZE	970.	1047.	1130.	1219.	1316.	1419.	1528.	1644.	1769.	1901.	2046.
13	LUXURY	1468.	1584.	1708.	1840.	1986.	2139.	2304.	2477.	2665.	2863.	3080.
14												
15	TRANSPORTATION CHARGES:											
16	SUBCOMPACT	549.	598.	652.	709.	758.	811.	869.	929.	997.	1071.	1151.
17	COMPACT	589.	626.	666.	709.	758.	811.	869.	929.	997.	1071.	1151.
18	MID-SIZE	589.	626.	666.	709.	758.	811.	869.	929.	997.	1071.	1151.
19	FULL SIZE	589.	626.	666.	709.	758.	811.	869.	929.	997.	1071.	1151.
20	LUXURY	589.	626.	666.	709.	758.	811.	869.	929.	997.	1071.	1151.
21												
22	BASE PRICE: FIXED WTD AVERAGE TOTAL	11170.	11758.	12378.	13019.	13715.	14420.	15159.	15903.	16698.	17506.	18380.
23	SUBCOMPACT	7840.	8251.	8685.	9132.	9617.	10108.	10619.	11138.	11688.	12247.	12850.
24	COMPACT	9189.	9680.	10198.	10734.	11315.	11905.	12519.	13144.	13809.	14485.	15216.
25	MID-SIZE	10619.	11167.	11745.	12343.	12991.	13648.	14333.	15031.	15772.	16526.	17341.
26	FULL SIZE	11620.	12220.	12855.	13510.	14221.	14942.	15693.	16459.	17272.	18098.	18993.
27	LUXURY	18683.	19638.	20648.	21690.	22821.	23968.	25163.	26381.	27674.	28989.	30412.
28												
29	MAX OPTIONS PRICE: FIXED WTD AVERAGE	2862.	2978.	3096.	3217.	3342.	3468.	3596.	3724.	3856.	3988.	4125.
30	SUBCOMPACT	2638.	2745.	2859.	2966.	3081.	3197.	3315.	3433.	3555.	3677.	3803.
31	COMPACT	2772.	2885.	3000.	3117.	3238.	3360.	3484.	3608.	3736.	3864.	3997.
32	MID-SIZE	2910.	3028.	3149.	3271.	3398.	3527.	3657.	3787.	3921.	4055.	4195.
33	FULL SIZE	2901.	3019.	3139.	3262.	3388.	3516.	3646.	3776.	3909.	4043.	4183.
34	LUXURY	2958.	3078.	3201.	3326.	3455.	3586.	3718.	3850.	3986.	4123.	4265.
35												
36	VALUE OF OPTIONS INSTALLED:											
37	SUBCOMPACT	1304.	1391.	1486.	1987.	1687.	1791.	1898.	2017.	2143.	2278.	2416.
38	COMPACT	1880.	1985.	2093.	2208.	2329.	2456.	2589.	2719.	2856.	3002.	3149.
39	MID-SIZE	2428.	2548.	2672.	2801.	2936.	3074.	3215.	3356.	3501.	3650.	3803.
40	FULL SIZE	2600.	2722.	2849.	2979.	3115.	3253.	3393.	3533.	3677.	3824.	3974.
41	LUXURY	2835.	2956.	3080.	3206.	3338.	3471.	3607.	3742.	3881.	4022.	4168.

TABLE 11.00 GROWTH RATES, DOMESTIC AUTO PRICES

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	7,5	7,0	7,5	6,9	7,1	6,8	6,7	6,5	6,3	6,0	5,7
3	COMPACT	8,0	7,1	7,6	6,6	6,7	6,5	6,3	6,1	6,0	5,8	5,5
4	MID-SIZE	7,8	7,3	7,8	6,9	6,9	6,7	6,1	5,9	5,7	5,5	5,3
5	FULL SIZE	8,1	7,6	8,3	7,4	7,3	7,1	6,0	5,8	5,7	5,5	5,3
6	LUXURY	7,9	7,4	8,3	7,2	7,2	6,9	5,9	5,7	5,6	5,4	5,2
7												
8	STATE AND LOCAL TAXES:											
9	SUBCOMPACT	10,6	10,0	10,7	9,9	10,0	9,7	9,4	9,2	8,8	8,4	8,2
10	COMPACT	11,1	10,0	10,8	9,8	9,7	9,4	9,1	8,8	8,6	8,3	8,2
11	MID-SIZE	10,9	10,3	11,1	10,0	9,9	9,6	8,8	8,6	8,4	8,1	7,9
12	FULL SIZE	11,5	10,9	11,7	10,5	10,4	10,0	8,8	8,6	8,3	8,1	7,9
13	LUXURY	11,2	10,6	11,5	10,3	10,1	9,8	8,6	8,4	8,2	8,0	7,8
14												
15	TRANSPORTATION CHARGES:											
16	SUBCOMPACT	11,0	11,4	6,8	6,5	8,2	8,8	7,2	8,0	9,7	9,4	8,6
17	COMPACT	12,8	13,2	6,6	4,5	5,7	6,2	5,1	5,6	6,8	6,6	6,0
18	MID-SIZE	11,6	12,0	5,7	4,5	5,7	6,2	5,1	5,6	6,8	6,6	6,0
19	FULL SIZE	7,5	7,8	4,7	4,5	5,7	6,2	5,1	5,6	6,8	6,6	6,0
20	LUXURY	7,5	7,8	4,7	4,5	5,7	6,2	5,1	5,6	6,8	6,6	6,0
21												
22	BASE PRICE: FIXED WTD AVERAGE TOTAL	7,4	6,9	8,1	7,0	7,0	6,7	6,0	5,8	5,7	5,5	5,2
23	SUBCOMPACT	6,8	6,3	7,4	6,3	6,4	6,2	6,1	5,9	5,7	5,5	5,2
24	COMPACT	7,4	6,4	7,7	6,5	6,5	6,4	6,1	5,9	5,8	5,6	5,3
25	MID-SIZE	7,1	6,7	7,8	6,7	6,7	6,5	5,8	5,7	5,5	5,3	5,1
26	FULL SIZE	8,0	7,5	8,6	7,4	7,4	7,1	5,9	5,7	5,6	5,4	5,1
27	LUXURY	7,8	7,3	8,4	7,2	7,2	6,9	5,8	5,6	5,5	5,3	5,1
28												
29	MAX OPTIONS PRICE: FIXED WTD AVERAGE	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
30	SUBCOMPACT	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
31	COMPACT	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
32	MID-SIZE	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
33	FULL SIZE	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
34	LUXURY	7,0	6,5	6,7	6,1	5,9	5,6	5,1	4,8	4,6	4,4	4,2
35												
36	VALUE OF OPTIONS INSTALLED:											
37	SUBCOMPACT	9,8	9,6	6,9	9,9	10,3	9,0	9,2	9,1	7,9	6,4	6,0
38	COMPACT	8,5	7,6	6,8	7,1	6,8	6,4	6,4	5,9	5,6	5,6	5,5
39	MID-SIZE	9,1	8,1	7,6	7,4	7,1	6,6	6,3	5,9	5,6	5,2	5,0
40	FULL SIZE	8,2	7,4	7,2	6,9	6,6	6,3	6,0	5,6	5,4	5,0	4,8
41	LUXURY	7,5	6,8	6,9	6,4	6,1	5,8	5,4	5,1	4,8	4,6	4,4

TABLE 11,00 GROWTH RATES, DOMESTIC AUTO PRICES

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	5,7	5,8	5,9	5,8	5,7	5,6	5,5	5,4	5,5	5,4	5,5
3	COMPACT	5,6	5,6	5,6	5,5	5,7	5,5	5,5	5,3	5,4	5,3	5,4
4	MID-SIZE	5,3	5,3	5,4	5,3	5,4	5,3	5,2	5,1	5,1	5,0	5,1
5	FULL SIZE	5,3	5,3	5,3	5,2	5,4	5,2	5,2	5,0	5,1	5,0	5,1
6	LUXURY	5,2	5,2	5,2	5,1	5,3	5,1	5,1	5,0	5,0	4,9	5,0
7												
8	STATE AND LOCAL TAXES:											
9	SUBCOMPACT	8,2	8,3	8,3	8,2	8,3	8,1	8,0	7,9	8,0	7,8	7,9
10	COMPACT	8,2	8,2	8,2	8,1	8,3	8,1	8,0	7,8	7,9	7,8	7,9
11	MID-SIZE	8,0	8,0	8,0	7,9	8,0	7,8	7,8	7,6	7,7	7,5	7,6
12	FULL SIZE	7,9	7,9	7,9	7,8	8,0	7,8	7,7	7,6	7,6	7,5	7,6
13	LUXURY	7,8	7,8	7,9	7,8	7,9	7,7	7,7	7,5	7,6	7,4	7,6
14												
15	TRANSPORTATION CHARGES:											
16	SUBCOMPACT	8,2	9,0	9,0	8,8	7,0	7,0	7,1	6,9	7,3	7,4	7,4
17	COMPACT	5,8	6,4	6,3	6,5	7,0	7,0	7,1	6,9	7,3	7,4	7,4
18	MID-SIZE	5,8	6,4	6,3	6,5	7,0	7,0	7,1	6,9	7,3	7,4	7,4
19	FULL SIZE	5,8	6,4	6,3	6,5	7,0	7,0	7,1	6,9	7,3	7,4	7,4
20	LUXURY	5,8	6,4	6,3	6,5	7,0	7,0	7,1	6,9	7,3	7,4	7,4
21												
22	BASE PRICE: FIXED WTD AVERAGE TOTAL	5,3	5,3	5,3	5,2	5,3	5,1	5,1	4,9	5,0	4,8	5,0
23	SUBCOMPACT	5,3	5,2	5,3	5,2	5,3	5,1	5,0	4,9	4,9	4,8	4,9
24	COMPACT	5,4	5,3	5,4	5,3	5,4	5,2	5,2	5,0	5,1	4,9	5,0
25	MID-SIZE	5,2	5,2	5,2	5,1	5,3	5,1	5,0	4,9	4,9	4,8	4,9
26	FULL SIZE	5,2	5,2	5,2	5,1	5,3	5,1	5,0	4,9	4,9	4,8	4,9
27	LUXURY	5,1	5,1	5,1	5,0	5,2	5,0	5,0	4,8	4,9	4,8	4,9
28												
29	MAX OPTIONS PRICE: FIXED WTD AVERAGE	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
30	SUBCOMPACT	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
31	COMPACT	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
32	MID-SIZE	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
33	FULL SIZE	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
34	LUXURY	4,1	4,1	4,0	3,9	3,9	3,8	3,7	3,6	3,5	3,4	3,4
35												
36	VALUE OF OPTIONS INSTALLED:											
37	SUBCOMPACT	6,1	6,7	6,9	6,8	6,3	6,2	6,0	6,2	6,2	6,3	6,1
38	COMPACT	5,5	5,6	5,5	5,4	5,5	5,4	5,4	5,1	5,0	5,1	4,9
39	MID-SIZE	5,0	5,0	4,9	4,8	4,8	4,7	4,6	4,4	4,3	4,3	4,2
40	FULL SIZE	4,7	4,7	4,6	4,6	4,6	4,4	4,3	4,1	4,1	4,0	3,9
41	LUXURY	4,3	4,3	4,2	4,1	4,1	4,0	3,9	3,8	3,7	3,6	3,6

TABLE 12.00 FOREIGN AUTO PRICES (DOLLARS)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	6000.	6385.	6793.	7224.	7684.	8143.	8579.	9039.	9509.	9988.	10479.
3	COMPACT	10101.	10744.	11458.	12183.	12941.	13699.	14414.	15154.	15914.	16710.	17544.
4	LUXURY	21033.	22723.	24684.	26683.	28799.	30942.	32965.	35090.	37290.	39627.	42080.
5												
6	STATE AND LOCAL TAXES:											
7	SUBCOMPACT	276.	302.	331.	361.	395.	429.	464.	500.	539.	578.	621.
8	COMPACT	469.	514.	564.	617.	673.	732.	790.	852.	917.	986.	1061.
9	LUXURY	992.	1103.	1234.	1372.	1522.	1681.	1837.	2006.	2184.	2378.	2589.
10												
11	TRANSPORTATION CHARGES:											
12	SUBCOMPACT	227.	252.	270.	287.	311.	338.	362.	392.	429.	470.	510.
13	COMPACT	289.	313.	329.	344.	364.	387.	407.	430.	460.	491.	521.
14	LUXURY	290.	313.	329.	344.	364.	387.	407.	430.	460.	491.	521.
15												
16	BASE PRICES:											
17	SUBCOMPACT	4950.	5230.	5551.	5871.	6202.	6528.	6828.	7137.	7451.	7779.	8118.
18	COMPACT	8382.	8883.	9461.	10039.	10640.	11235.	11786.	12356.	12937.	13547.	14179.
19	LUXURY	18179.	19626.	21325.	23056.	24885.	26730.	28461.	30280.	32156.	34155.	36252.

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TABLE 12.10 GROWTH RATES, FOREIGN AUTO PRICES

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	7.7	6.4	6.4	6.3	6.4	6.0	5.4	5.4	5.2	5.0	4.9
3	COMPACT	7.9	6.4	6.6	6.3	6.2	5.9	5.2	5.1	5.0	5.0	5.0
4	LUXURY	10.0	8.0	8.6	8.1	7.9	7.4	6.5	6.4	6.3	6.3	6.2
5												
6	STATE AND LOCAL TAXES:											
7	SUBCOMPACT	10.9	9.4	9.5	9.4	9.2	8.7	8.0	7.9	7.6	7.4	7.4
8	COMPACT	11.1	9.5	9.8	9.4	9.2	8.7	7.9	7.8	7.6	7.6	7.6
9	LUXURY	13.4	11.3	11.8	11.2	10.9	10.4	9.3	9.2	8.9	8.9	8.9
10												
11	TRANSPORTATION CHARGES:											
12	SUBCOMPACT	11.0	11.4	6.8	6.5	8.2	8.8	7.2	8.0	9.7	9.4	8.6
13	COMPACT	12.4	8.4	4.8	4.6	5.8	6.3	5.2	5.7	6.9	6.7	6.2
14	LUXURY	7.8	8.1	4.8	4.6	5.8	6.3	5.2	5.7	6.9	6.7	6.2
15												
16	BASE PRICES:											
17	SUBCOMPACT	7.1	5.7	6.1	5.8	5.6	5.3	4.6	4.5	4.4	4.4	4.4
18	COMPACT	7.5	6.0	6.5	6.1	6.0	5.6	4.9	4.8	4.7	4.7	4.7
19	LUXURY	10.0	8.0	8.7	8.1	7.9	7.4	6.5	6.4	6.2	6.2	6.1

TABLE 12.00 FOREIGN AUTO PRICES (DOLLARS)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	10996.	11544.	12124.	12736.	13375.	14047.	14752.	15489.	16269.	17093.	17956.
3	COMPACT	18417.	19350.	20332.	21368.	22465.	23621.	24839.	26095.	27420.	28820.	30291.
4	LUXURY	44693.	47507.	50504.	53699.	57110.	60744.	64619.	68674.	72998.	77605.	82516.
5												
6	STATE AND LOCAL TAXES:											
7	SUBCOMPACT	667.	718.	772.	831.	893.	961.	1033.	1110.	1194.	1283.	1380.
8	COMPACT	1141.	1229.	1323.	1425.	1535.	1653.	1781.	1916.	2062.	2219.	2389.
9	LUXURY	2820.	3073.	3349.	3650.	3979.	4338.	4730.	5152.	5612.	6113.	6660.
10												
11	TRANSPORTATION CHARGES:											
12	SUBCOMPACT	552.	587.	625.	666.	713.	764.	819.	876.	941.	1011.	1087.
13	COMPACT	552.	587.	625.	666.	713.	764.	819.	876.	941.	1011.	1087.
14	LUXURY	552.	587.	625.	666.	713.	764.	819.	876.	941.	1011.	1087.
15												
16	BASE PRICES:											
17	SUBCOMPACT	8473.	8848.	9241.	9651.	10081.	10531.	11002.	11486.	11991.	12520.	13073.
18	COMPACT	14844.	15549.	16290.	17069.	17888.	18748.	19651.	20583.	21561.	22588.	23666.
19	LUXURY	38487.	40890.	43450.	46176.	49079.	52171.	55464.	58909.	62565.	66459.	70601.

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TABLE 12.10 GROWTH RATES, FOREIGN AUTO PRICES

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL AUTO PRICES:											
2	SUBCOMPACT	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1
3	COMPACT	5.0	5.1	5.1	5.1	5.1	5.1	5.2	5.1	5.1	5.1	5.1
4	LUXURY	6.2	6.3	6.3	6.3	6.4	6.4	6.4	6.3	6.3	6.3	6.3
5												
6	STATE AND LOCAL TAXES:											
7	SUBCOMPACT	7.4	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5
8	COMPACT	7.6	7.7	7.7	7.7	7.7	7.7	7.7	7.6	7.6	7.6	7.6
9	LUXURY	8.9	9.0	9.0	9.0	9.0	9.0	9.0	8.9	8.9	8.9	8.9
10												
11	TRANSPORTATION CHARGES:											
12	SUBCOMPACT	8.2	6.5	6.4	6.6	7.1	7.0	7.2	7.0	7.4	7.5	7.5
13	COMPACT	5.9	6.5	6.4	6.6	7.1	7.0	7.2	7.0	7.4	7.5	7.5
14	LUXURY	5.9	6.5	6.4	6.6	7.1	7.0	7.2	7.0	7.4	7.5	7.5
15												
16	BASE PRICES:											
17	SUBCOMPACT	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.4	4.4	4.4	4.4
18	COMPACT	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.8	4.8	4.8
19	LUXURY	6.2	6.2	6.3	6.3	6.3	6.3	6.3	6.2	6.2	6.2	6.2

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TABLE 13.00 CAPITALIZED COSTS PER MILE (DOLLARS PER MILE)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	AVG NOMINAL CAP. COST PER MILE	0.273	0.293	0.317	0.341	0.364	0.389	0.416	0.445	0.475	0.506	0.537
2												
3	AVG REAL CAP. COST PER MILE	0.162	0.161	0.163	0.164	0.164	0.166	0.167	0.170	0.172	0.175	0.178
4												
5	CAPITALIZED COST PER MILE BY SIZE:											
6	SUBCOMPACTS	0.222	0.238	0.258	0.279	0.300	0.321	0.343	0.368	0.393	0.419	0.445
7	COMPACTS	0.251	0.269	0.292	0.313	0.334	0.357	0.382	0.410	0.438	0.467	0.497
8	MID-SIZE	0.279	0.298	0.322	0.346	0.368	0.394	0.422	0.451	0.482	0.513	0.546
9	FULL SIZE	0.295	0.316	0.342	0.368	0.393	0.421	0.449	0.481	0.513	0.547	0.581
10	LUXURY	0.383	0.411	0.447	0.482	0.515	0.552	0.589	0.629	0.669	0.713	0.757
11												
12	CAP. COST PER MILE BY FOR/DOM:											
13	TOTAL DOMESTIC	0.277	0.297	0.321	0.345	0.368	0.394	0.422	0.452	0.483	0.514	0.547
14	SUBCOMPACT	0.216	0.232	0.252	0.272	0.291	0.312	0.334	0.359	0.384	0.410	0.437
15	COMPACT	0.249	0.267	0.289	0.311	0.332	0.355	0.380	0.408	0.436	0.465	0.495
16	LUXURY	0.371	0.398	0.432	0.464	0.496	0.531	0.565	0.603	0.643	0.683	0.725
17												
18	TOTAL FOREIGN	0.244	0.262	0.284	0.308	0.331	0.355	0.381	0.406	0.432	0.459	0.488
19	SUBCOMPACT	0.226	0.242	0.263	0.284	0.305	0.327	0.349	0.373	0.398	0.423	0.450
20	COMPACT	0.304	0.325	0.352	0.380	0.407	0.434	0.462	0.492	0.523	0.556	0.589
21	LUXURY	0.502	0.542	0.591	0.641	0.690	0.741	0.791	0.845	0.900	0.949	1.022

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TABLE 13.10 GROWTH RATES, CAPITALIZED COSTS PER MILE

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	AVG NOMINAL CAP. COST PER MILE	8.6	7.0	8.3	7.5	6.8	7.0	6.9	7.0	6.7	6.5	6.3
2												
3	AVG REAL CAP. COST PER MILE	0.3	-0.4	1.0	0.5	0.2	0.8	1.0	1.5	1.5	1.6	1.5
4												
5	CAPITALIZED COST PER MILE BY SIZE:											
6	SUBCOMPACTS	9.3	7.4	8.5	8.0	7.3	7.2	6.9	7.1	6.9	6.6	6.4
7	COMPACTS	8.0	7.3	8.3	7.3	6.8	7.0	7.0	7.1	6.9	6.6	6.4
8	MID-SIZE	8.7	6.9	8.3	7.2	6.6	7.0	6.9	7.1	6.8	6.5	6.3
9	FULL SIZE	8.5	7.2	8.4	7.5	6.7	7.1	6.8	7.0	6.8	6.5	6.3
10	LUXURY	7.9	7.4	8.6	7.8	7.0	7.0	6.8	6.8	6.5	6.4	6.2
11												
12	CAP. COST PER MILE BY FOR/DOM:											
13	TOTAL DOMESTIC	8.7	7.1	8.4	7.4	6.7	7.0	6.9	7.2	6.8	6.5	6.3
14	SUBCOMPACT	9.1	7.4	8.5	7.9	7.2	7.2	7.0	7.4	7.1	6.8	6.5
15	COMPACT	8.0	7.3	8.4	7.4	6.8	7.0	7.1	7.2	6.9	6.7	6.5
16	LUXURY	8.4	7.2	8.4	7.5	6.9	6.9	6.5	6.7	6.5	6.3	6.1
17												
18	TOTAL FOREIGN	8.4	7.3	8.6	8.3	7.5	7.1	7.4	6.7	6.3	6.4	6.1
19	SUBCOMPACT	9.4	7.3	8.4	8.1	7.4	7.1	6.8	6.9	6.6	6.4	6.2
20	COMPACT	9.4	7.1	8.3	7.9	7.1	6.8	6.5	6.5	6.3	6.2	6.1
21	LUXURY	10.6	7.9	9.1	8.6	7.6	7.4	6.8	6.8	6.6	6.6	6.5

TABLE 13,00 CAPITALIZED COSTS PER MILE (DOLLARS PER MILE)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	AVG NOMINAL CAP. COST PER MILE	0,570	0,603	0,638	0,674	0,712	0,752	0,796	0,840	0,886	0,935	0,986
2												
3	AVG REAL CAP. COST PER MILE	0,180	0,182	0,184	0,186	0,188	0,189	0,192	0,194	0,196	0,198	0,200
4												
5	CAPITALIZED COST PER MILE BY SIZE:											
6	SUBCOMPACTS	0,473	0,500	0,530	0,560	0,593	0,626	0,663	0,700	0,739	0,781	0,825
7	COMPACTS	0,528	0,559	0,592	0,626	0,663	0,701	0,743	0,784	0,828	0,875	0,924
8	MID-SIZE	0,579	0,613	0,649	0,686	0,725	0,766	0,810	0,855	0,902	0,951	1,004
9	FULL SIZE	0,617	0,652	0,690	0,729	0,771	0,814	0,861	0,908	0,957	1,010	1,065
10	LUXURY	0,804	0,850	0,900	0,950	1,001	1,056	1,115	1,177	1,241	1,307	1,376
11												
12	CAP. COST PER MILE BY FOR/DOM:											
13	TOTAL DOMESTIC	0,580	0,614	0,650	0,688	0,728	0,769	0,814	0,858	0,906	0,956	1,009
14	SUBCOMPACT	0,465	0,493	0,523	0,554	0,587	0,621	0,659	0,696	0,736	0,778	0,822
15	COMPACT	0,526	0,557	0,590	0,625	0,661	0,700	0,741	0,783	0,827	0,874	0,923
16	LUXURY	0,768	0,811	0,857	0,905	0,955	1,008	1,065	1,121	1,181	1,245	1,312
17												
18	TOTAL FOREIGN	0,518	0,548	0,580	0,612	0,644	0,679	0,718	0,759	0,801	0,845	0,889
19	SUBCOMPACT	0,477	0,504	0,533	0,563	0,595	0,629	0,665	0,702	0,741	0,783	0,826
20	COMPACT	0,624	0,659	0,696	0,735	0,775	0,818	0,865	0,912	0,962	1,015	1,070
21	LUXURY	1,086	1,154	1,225	1,302	1,381	1,466	1,560	1,654	1,753	1,860	1,974

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TABLE 13,10 GROWTH RATES, CAPITALIZED COSTS PER MILE

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	AVG NOMINAL CAP. COST PER MILE	6,1	5,8	5,8	5,7	5,7	5,6	5,8	5,5	5,5	5,5	5,5
2												
3	AVG REAL CAP. COST PER MILE	1,3	1,0	1,1	1,1	1,0	1,0	1,1	1,1	1,1	1,0	1,1
4												
5	CAPITALIZED COST PER MILE BY SIZE:											
6	SUBCOMPACTS	6,2	5,9	5,9	5,8	5,7	5,7	5,9	5,6	5,6	5,6	5,6
7	COMPACTS	6,2	5,9	5,9	5,8	5,8	5,8	5,9	5,6	5,6	5,6	5,6
8	MID-SIZE	6,1	5,8	5,8	5,7	5,7	5,6	5,8	5,5	5,5	5,5	5,5
9	FULL SIZE	6,1	5,8	5,8	5,7	5,7	5,6	5,8	5,5	5,5	5,5	5,5
10	LUXURY	6,2	5,8	5,8	5,5	5,4	5,4	5,6	5,6	5,4	5,4	5,2
11												
12	CAP. COST PER MILE BY FOR/DOM:											
13	TOTAL DOMESTIC	6,1	5,9	5,8	5,8	5,8	5,7	5,8	5,5	5,5	5,5	5,6
14	SUBCOMPACT	6,3	6,1	6,0	6,0	5,9	5,8	6,0	5,7	5,7	5,7	5,7
15	COMPACT	6,3	6,0	5,9	5,8	5,9	5,8	5,9	5,6	5,6	5,6	5,6
16	LUXURY	5,9	5,7	5,6	5,6	5,6	5,5	5,7	5,3	5,3	5,4	5,4
17												
18	TOTAL FOREIGN	6,3	5,8	5,9	5,4	5,3	5,4	5,6	5,7	5,5	5,6	5,2
19	SUBCOMPACT	6,0	5,8	5,7	5,7	5,6	5,6	5,8	5,5	5,5	5,6	5,6
20	COMPACT	5,9	5,6	5,6	5,6	5,5	5,5	5,7	5,4	5,4	5,5	5,5
21	LUXURY	6,3	6,2	6,2	6,2	6,1	6,1	6,4	6,0	6,0	6,1	6,1

TABLE 14.00 MILES PER GALLON (WEFA)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	OVERALL FLEET MILES PER GALLON	13.93	14.22	14.59	15.07	15.63	16.25	16.92	17.56	18.16	18.72	19.24
2												
3	NEW AUTO MILES PER GALLON											
4	TOTAL DOMESTIC AND FOREIGN	14.52	15.18	16.12	17.26	18.43	19.21	19.49	19.45	19.43	19.42	19.41
5	SUBCOMPACT	19.83	20.45	21.27	22.11	23.01	23.78	24.16	24.10	24.05	24.00	23.96
6	COMPACT	15.32	15.85	16.80	18.01	19.21	20.02	20.30	20.25	20.21	20.17	20.13
7	MID-SIZE	13.18	13.96	14.91	16.23	17.54	18.31	18.53	18.48	18.44	18.40	18.37
8	FULL SIZE	12.40	13.02	13.96	15.09	16.31	17.09	17.38	17.33	17.29	17.25	17.22
9	LUXURY	11.87	12.37	13.24	14.16	15.03	15.70	15.99	15.94	15.90	15.87	15.84
10												
11	TOTAL DOMESTIC	13.73	14.38	15.34	16.54	17.76	18.56	18.86	18.80	18.76	18.73	18.70
12	SUBCOMPACT	18.46	19.15	20.20	21.34	22.63	23.62	24.30	24.24	24.19	24.14	24.10
13	COMPACT	15.23	15.77	16.74	17.98	19.20	20.02	20.31	20.25	20.21	20.17	20.13
14	LUXURY	11.58	12.07	12.94	13.88	14.76	15.43	15.71	15.67	15.63	15.60	15.57
15												
16	TOTAL FOREIGN	20.37	20.89	21.50	22.11	22.72	23.33	23.49	23.45	23.43	23.39	23.37
17	SUBCOMPACT	20.87	21.40	22.02	22.65	23.27	23.88	24.07	24.02	23.97	23.92	23.88
18	COMPACT	17.78	18.16	18.63	19.10	19.56	20.01	20.10	20.05	20.00	19.96	19.93
19	LUXURY	15.96	16.41	16.94	17.48	18.03	18.55	18.75	18.70	18.66	18.62	18.58

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TABLE 14.10 NEW AUTO MILES PER GALLON (EPA)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL DOMESTIC AND FOREIGN	20.38	21.46	22.83	24.68	26.60	27.67	28.09	28.09	28.11	28.15	28.17
2	SUBCOMPACT	25.63	26.67	28.04	29.56	30.98	32.26	32.85	32.82	32.79	32.76	32.74
3	COMPACT	21.19	22.22	23.62	25.61	27.72	28.87	29.32	29.32	29.33	29.33	29.34
4	MID-SIZE	19.04	20.20	21.47	23.48	25.66	26.68	27.06	27.06	27.06	27.06	27.06
5	FULL SIZE	18.03	19.06	20.42	22.27	24.27	25.21	25.54	25.54	25.54	25.54	25.54
6	LUXURY	17.17	18.09	19.48	21.13	22.65	23.51	23.82	23.82	23.81	23.82	23.82
7												
8	TOTAL DOMESTIC	19.57	20.66	22.05	24.00	26.07	27.12	27.55	27.53	27.53	27.55	27.56
9	SUBCOMPACT	24.68	25.97	27.64	29.71	31.97	33.37	34.32	34.32	34.32	34.32	34.32
10	COMPACT	21.15	22.20	23.62	25.64	27.80	28.96	29.40	29.40	29.40	29.40	29.40
11	LUXURY	16.91	17.84	19.25	20.94	22.52	23.37	23.65	23.65	23.65	23.65	23.65
12												
13	TOTAL FOREIGN	25.68	26.51	27.63	28.78	29.67	30.87	31.20	31.22	31.25	31.26	31.28
14	SUBCOMPACT	26.31	27.15	28.30	29.46	30.37	31.58	31.94	31.94	31.94	31.94	31.94
15	COMPACT	22.21	22.84	23.73	24.62	25.29	26.21	26.41	26.41	26.41	26.41	26.41
16	LUXURY	20.35	21.08	22.05	23.06	23.87	24.91	25.28	25.28	25.28	25.28	25.28

TABLE 14.00 MILES PER GALLON (WEFA)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	OVERALL FLEET MILES PER GALLON	19.66	20.02	20.27	20.41	20.47	20.51	20.53	20.53	20.51	20.48	20.45
2												
3	NEW AUTO MILES PER GALLON:											
4	TOTAL DOMESTIC AND FOREIGN	19.41	19.38	19.35	19.31	19.27	19.23	19.21	19.18	19.14	19.09	19.04
5	SUBCOMPACT	23.92	23.87	23.82	23.77	23.72	23.66	23.61	23.56	23.51	23.45	23.39
6	COMPACT	20.10	20.06	20.01	19.97	19.92	19.87	19.83	19.78	19.73	19.68	19.63
7	MID-SIZE	18.33	18.30	18.25	18.21	18.17	18.12	18.08	18.04	17.99	17.94	17.89
8	FULL SIZE	17.19	17.15	17.11	17.07	17.03	16.99	16.95	16.91	16.86	16.81	16.77
9	LUXURY	15.83	15.80	15.77	15.72	15.67	15.62	15.57	15.54	15.49	15.44	15.39
10												
11	TOTAL DOMESTIC	18.68	18.64	18.59	18.54	18.49	18.45	18.41	18.38	18.33	18.29	18.23
12	SUBCOMPACT	24.06	24.02	23.96	23.91	23.86	23.81	23.75	23.70	23.64	23.58	23.52
13	COMPACT	20.10	20.06	20.02	19.97	19.92	19.88	19.83	19.79	19.74	19.68	19.63
14	LUXURY	15.54	15.51	15.47	15.43	15.39	15.35	15.31	15.27	15.23	15.19	15.14
15												
16	TOTAL FOREIGN	23.32	23.29	23.24	23.22	23.19	23.16	23.12	23.07	23.02	22.97	22.93
17	SUBCOMPACT	23.84	23.80	23.75	23.70	23.65	23.60	23.55	23.50	23.44	23.39	23.33
18	COMPACT	19.89	19.85	19.81	19.76	19.72	19.67	19.62	19.58	19.53	19.48	19.42
19	LUXURY	18.55	18.51	18.47	18.43	18.38	18.34	18.29	18.25	18.20	18.15	18.10

TABLE 14.10 NEW AUTO MILES PER GALLON (EPA)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL DOMESTIC AND FOREIGN	28.20	28.21	28.22	28.22	28.24	28.25	28.27	28.29	28.30	28.30	28.31
2	SUBCOMPACT	32.72	32.71	32.70	32.68	32.66	32.66	32.65	32.65	32.65	32.65	32.64
3	COMPACT	29.34	29.35	29.35	29.36	29.36	29.36	29.37	29.37	29.37	29.37	29.38
4	MID-SIZE	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06
5	FULL SIZE	25.54	25.54	25.54	25.54	25.54	25.54	25.54	25.54	25.54	25.54	25.54
6	LUXURY	23.83	23.83	23.83	23.83	23.82	23.81	23.81	23.82	23.81	23.81	23.80
7												
8	TOTAL DOMESTIC	27.57	27.57	27.57	27.56	27.55	27.56	27.57	27.58	27.59	27.59	27.59
9	SUBCOMPACT	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32
10	COMPACT	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40	29.40
11	LUXURY	23.65	23.65	23.65	23.65	23.65	23.65	23.65	23.65	23.65	23.65	23.65
12												
13	TOTAL FOREIGN	31.28	31.29	31.29	31.32	31.35	31.38	31.39	31.39	31.40	31.41	31.44
14	SUBCOMPACT	31.94	31.94	31.94	31.94	31.94	31.94	31.94	31.94	31.94	31.94	31.94
15	COMPACT	26.41	26.41	26.41	26.41	26.41	26.41	26.41	26.41	26.41	26.41	26.41
16	LUXURY	25.28	25.28	25.28	25.28	25.28	25.28	25.28	25.28	25.28	25.28	25.28

TABLE 15.00 GROWTH RATES, MILES PER GALLON (WEFA)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	OVERALL FLEET MILES PER GALLON	1.31	2.04	2.61	3.29	3.71	3.99	4.15	3.76	3.43	3.07	2.77
2												
3	NEW AUTO MILES PER GALLON:											
4	TOTAL DOMESTIC AND FOREIGN	5.5	4.5	6.2	7.1	6.7	4.2	1.5	-0.2	-0.1	-0.0	-0.1
5	SUBCOMPACT	2.2	3.1	4.0	4.0	4.1	3.3	1.6	-0.3	-0.2	-0.2	-0.2
6	COMPACT	9.2	3.5	6.0	7.2	6.7	4.2	1.4	-0.3	-0.2	-0.2	-0.2
7	MID-SIZE	5.4	5.9	6.8	8.9	8.1	4.4	1.2	-0.3	-0.2	-0.2	-0.2
8	FULL SIZE	7.2	5.0	7.2	8.1	8.1	4.8	1.7	-0.3	-0.2	-0.2	-0.2
9	LUXURY	6.5	4.2	7.0	7.0	6.2	4.4	1.8	-0.3	-0.3	-0.2	-0.2
10												
11	TOTAL DOMESTIC	6.5	4.7	6.7	7.8	7.4	4.5	1.6	-0.3	-0.2	-0.2	-0.2
12	SUBCOMPACT	3.1	3.7	5.5	5.6	6.1	4.4	2.9	-0.2	-0.2	-0.2	-0.2
13	COMPACT	9.6	3.5	6.1	7.4	6.8	4.3	1.4	-0.3	-0.2	-0.2	-0.2
14	LUXURY	7.6	4.2	7.2	7.3	6.4	4.5	1.8	-0.3	-0.2	-0.2	-0.2
15												
16	TOTAL FOREIGN	1.7	2.5	2.9	2.9	2.8	2.7	0.7	-0.2	-0.1	-0.2	-0.1
17	SUBCOMPACT	1.4	2.5	2.9	2.8	2.7	2.6	0.8	-0.2	-0.2	-0.2	-0.2
18	COMPACT	1.3	2.2	2.6	2.5	2.4	2.3	0.5	-0.3	-0.2	-0.2	-0.2
19	LUXURY	2.1	2.8	3.2	3.2	3.1	2.9	1.0	-0.3	-0.2	-0.2	-0.2

MARCH CONTROL FOR HYBRIDS

TABLE 15.10 GROWTH RATES, NEW AUTO MILES PER GALLON (EPA)

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	TOTAL DOMESTIC AND FOREIGN	5.7	5.3	6.4	8.1	7.8	4.0	1.5	0.0	0.1	0.1	0.1
2	SUBCOMPACT	2.5	4.1	5.1	5.4	4.8	4.1	1.8	-0.1	-0.1	-0.1	-0.1
3	COMPACT	8.7	4.9	6.3	8.4	8.2	4.2	1.5	0.0	0.0	0.0	0.0
4	MID-SIZE	5.3	6.1	6.3	9.4	9.3	4.0	1.4	0.0	0.0	0.0	0.0
5	FULL SIZE	7.6	5.7	7.2	9.1	9.0	3.9	1.3	0.0	0.0	0.0	0.0
6	LUXURY	7.1	5.4	7.7	8.4	7.2	3.8	1.3	0.0	-0.0	0.0	0.0
7												
8	TOTAL DOMESTIC	6.5	5.6	6.7	8.8	8.6	4.0	1.6	-0.1	0.0	0.1	0.0
9	SUBCOMPACT	3.3	5.2	6.4	7.5	7.6	4.4	2.8	0.0	0.0	0.0	0.0
10	COMPACT	9.0	5.0	6.4	8.6	8.4	4.2	1.5	0.0	0.0	0.0	0.0
11	LUXURY	8.0	5.5	7.9	8.8	7.5	3.8	1.2	0.0	0.0	0.0	0.0
12												
13	TOTAL FOREIGN	2.2	3.2	4.2	4.2	3.1	4.0	1.1	0.1	0.1	0.0	0.1
14	SUBCOMPACT	1.9	3.2	4.2	4.1	3.1	4.0	1.1	0.0	0.0	0.0	0.0
15	COMPACT	1.8	2.8	3.9	3.8	2.7	3.6	0.8	0.0	0.0	0.0	0.0
16	LUXURY	2.5	3.5	4.6	4.6	3.5	4.3	1.5	0.0	0.0	0.0	0.0

TABLE 15.00 GROWTH RATES, MILES PER GALLON (WEFA)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	OVERALL FLEET MILES PER GALLON	2.20	1.80	1.26	0.72	0.29	0.19	0.07	0.04	-0.12	-0.14	-0.15
2												
3	NEW AUTO MILES PER GALLON											
4	TOTAL DOMESTIC AND FOREIGN	-0.0	-0.1	-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2	-0.3
5	SUBCOMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3
6	COMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3
7	MID-SIZE	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3
8	FULL SIZE	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.2	-0.2	-0.3	-0.3	-0.3
9	LUXURY	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.3	-0.4
10												
11	TOTAL DOMESTIC	-0.1	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3
12	SUBCOMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3
13	COMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3
14	LUXURY	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3
15												
16	TOTAL FOREIGN	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2
17	SUBCOMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.2
18	COMPACT	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3
19	LUXURY	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3

MARCH CONTROL FOR HYBRIDS

TABLE 15.10 GROWTH RATES, NEW AUTO MILES PER GALLON (EPA)

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	TOTAL DOMESTIC AND FOREIGN	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
2	SUBCOMPACT	-0.0	-0.1	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0
3	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	LUXURY	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0
7												
8	TOTAL DOMESTIC	0.1	-0.0	-0.0	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0	-0.0
9	SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12												
13	TOTAL FOREIGN	-0.0	0.0	0.0	0.1	0.1	0.1	0.1	-0.0	0.0	0.0	0.1
14	SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 16,00 USED CAR MARKET

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	AVERAGE WHOLESALE PRICE	DOLLARS	3436,	3734,	4050,	4371,	4709,	5054,	5398,	5758,	6134,	6516,	6896,
2													
3	PRICE OF 1 YR OLD CAR/NEW CAR (X)												
4	SUBCOMPACT		79,41	80,39	80,50	79,98	79,75	80,00	79,98	79,80	79,89	80,18	80,27
5	COMPACT		70,23	70,70	70,98	70,14	69,84	70,08	69,94	69,63	69,73	70,09	70,14
6	MID-SIZE		64,14	64,93	64,92	64,67	64,40	64,58	64,66	64,45	64,54	64,85	64,98
7	FULL SIZE		58,66	61,76	61,66	60,72	59,78	60,78	61,55	60,87	61,19	62,41	63,00
8	LUXURY		69,57	70,80	70,65	70,05	69,50	70,15	70,34	70,07	70,32	70,90	71,29
9													
10	TOTAL USED CARS PURCHASED	MILL AUTOS	15,663	16,641	17,288	17,233	16,971	17,463	18,156	18,072	18,339	18,818	19,370

TABLE 16,10 GROWTH RATES, USED CAR MARKET

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	AVERAGE WHOLESALE PRICE	DOLLARS	10,74	8,66	8,46	7,94	7,72	7,34	6,81	6,66	6,53	6,23	5,84
2													
3	PRICE OF 1 YR OLD CAR/NEW CAR (X)												
4	SUBCOMPACT		0,37	1,24	0,14	-0,65	-0,28	0,31	-0,03	-0,22	0,11	0,36	0,11
5	COMPACT		1,23	0,67	0,39	-1,18	-0,43	0,35	-0,20	-0,45	0,15	0,52	0,07
6	MID-SIZE		1,80	1,24	-0,02	-0,39	-0,42	0,28	0,13	-0,33	0,14	0,47	0,21
7	FULL SIZE		5,81	5,28	-0,16	-1,53	-1,54	1,67	1,27	-1,11	0,53	1,99	0,95
8	LUXURY		5,45	1,76	-0,20	-0,85	-0,79	0,93	0,28	-0,38	0,35	0,83	0,54
9													
10	TOTAL USED CARS PURCHASED	MILL AUTOS	7,07	6,24	3,89	-0,32	-1,52	2,90	3,97	-0,46	1,47	2,62	2,93

TABLE 16.00 USED CAR MARKET

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	AVERAGE WHOLESALE PRICE	DOLLARS	7301.	7738.	8220.	8741.	9295.	9860.	10445.	11040.	11682.	12347.	13051.
2													
3	PRICE OF 1 YR OLD CAR/NEW CAR (X)												
4	SUBCOMPACT		80.21	80.01	79.73	79.44	79.45	79.55	79.62	79.59	79.47	79.46	79.48
5	COMPACT		70.01	69.77	69.39	69.06	69.13	69.22	69.31	69.14	69.08	69.06	69.15
6	MID-SIZE		64.89	64.74	64.46	64.23	64.20	64.32	64.38	64.34	64.27	64.29	64.32
7	FULL SIZE		62.71	62.09	61.05	60.12	59.97	60.51	60.76	60.69	60.35	60.47	60.50
8	LUXURY		70.93	70.69	70.00	69.65	69.61	69.87	69.99	69.70	69.66	69.75	69.94
9													
10	TOTAL USED CARS PURCHASED	MILL AUTOS	19,424	19,673	19,754	19,857	20,059	20,689	21,047	21,495	21,680	22,072	22,510

TABLE 16.10 GROWTH RATES, USED CAR MARKET

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	AVERAGE WHOLESALE PRICE	DOLLARS	5.87	5.99	6.22	6.34	6.34	6.08	5.93	5.70	5.81	5.69	5.71
2													
3	PRICE OF 1 YR OLD CAR/NEW CAR (X)												
4	SUBCOMPACT		-0.08	-0.25	-0.34	-0.37	0.01	0.13	0.08	-0.03	-0.15	-0.01	0.02
5	COMPACT		-0.18	-0.35	-0.54	-0.49	0.11	0.12	0.13	-0.25	-0.09	-0.02	0.13
6	MID-SIZE		-0.15	-0.23	-0.43	-0.36	-0.04	0.19	0.09	-0.06	-0.12	0.04	0.04
7	FULL SIZE		-0.47	-0.99	-1.67	-1.53	-0.24	0.89	0.41	-0.10	-0.57	0.20	0.05
8	LUXURY		-0.50	-0.34	-0.98	-0.50	-0.05	0.37	0.17	-0.41	-0.06	0.14	0.27
9													
10	TOTAL USED CARS PURCHASED	MILL AUTOS	0.28	1.28	0.41	0.52	1.02	3.14	1.73	2.13	0.86	1.81	1.99

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TABLE 17.00 DEMOGRAPHIC VARIABLES

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	NUMBER OF FAMILIES MILL FAMILIES	59.268	60.260	61.275	62.312	63.316	64.287	65.201	66.099	66.970	67.817	68.668
2	NUMBER OF UNREL. INDIVIDUALS MILL PERS	22.122	22.682	23.244	23.782	24.323	24.861	25.404	25.901	26.391	26.876	27.372
3												
4	PERCENT OF FAMILIES WITH 3 OR 4 PERS.	30.94	31.18	31.32	31.47	31.61	31.65	31.79	31.79	31.83	31.87	31.91
5	PERCENT OF FAMILIES WITH 5+ PERSONS	13.01	12.24	11.68	11.12	10.56	10.21	9.65	9.37	9.02	8.67	8.32
6												
7	PERSONS 20 TO 29 PER FAMILY	0.478	0.477	0.475	0.471	0.466	0.459	0.450	0.439	0.426	0.411	0.394
8	NUMBER OF LICENSED DRIVERS MILL PERS	144.31	147.20	149.95	152.48	154.88	157.17	159.45	161.76	164.11	166.16	167.97
9												
10	PERCENT OF POPULATION:											
11	IN METROPOLITAN AREAS	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27
12	IN NEW ENGLAND REGION	5.66	5.64	5.63	5.62	5.60	5.59	5.57	5.56	5.55	5.53	5.52
13	IN SOUTH ATLANTIC REGION	15.68	15.64	15.60	15.56	15.52	15.48	15.44	15.40	15.36	15.32	15.28
14	IN EAST NORTH CENTRAL REGION	19.28	19.34	19.41	19.47	19.53	19.59	19.66	19.72	19.78	19.84	19.91
15	IN EAST SOUTH CENTRAL REGION	6.08	6.01	5.94	5.87	5.81	5.74	5.67	5.61	5.54	5.48	5.41
16	IN MOUNTAIN REGION	4.88	4.98	5.08	5.18	5.28	5.39	5.50	5.61	5.72	5.83	5.95
17	IN PACIFIC REGION	13.70	13.81	13.91	14.01	14.12	14.23	14.33	14.44	14.55	14.66	14.77
18	IN WEST NORTH CENTRAL REGION	7.71	7.67	7.64	7.61	7.58	7.55	7.52	7.49	7.46	7.43	7.40
19	IN WEST SOUTH CENTRAL REGION	10.08	10.14	10.20	10.26	10.32	10.39	10.45	10.51	10.57	10.64	10.70
20												
21	GROWTH RATES:											
22	PASSENGERS / EMPLOYMENT	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
23	PASS / PUBLIC TRANSIT M.T.W.	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
24	OTHER M.T.W. / EMPLOYMENT	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94

MARCH CONTROL FOR HYBRIDS

TABLE 17.10 GROWTH RATES, DEMOGRAPHIC VARIBLES

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	NUMBER OF FAMILIES MILL FAMILIES	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.4	1.3	1.3	1.3
2	NUMBER OF UNREL. INDIVIDUALS MILL PERS	2.6	2.5	2.5	2.3	2.3	2.2	2.2	2.0	1.9	1.8	1.8
3												
4	PERCENT OF FAMILIES WITH 3 OR 4 PERS.	0.4	0.8	0.4	0.5	0.4	0.1	0.4	0.0	0.1	0.1	0.1
5	PERCENT OF FAMILIES WITH 5+ PERSONS	-4.1	-5.9	-4.6	-4.8	-5.0	-3.3	-5.5	-2.9	-3.7	-3.9	-4.0
6												
7	PERSONS 20 TO 29 PER FAMILY	-0.2	-0.2	-0.4	-0.8	-1.1	-1.4	-1.9	-2.5	-3.0	-3.6	-4.0
8	NUMBER OF LICENSED DRIVERS MILL PERS	2.20	2.00	1.87	1.69	1.58	1.48	1.45	1.45	1.45	1.24	1.10
9												
10	PERCENT OF POPULATION:											
11	IN METROPOLITAN AREAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	IN NEW ENGLAND REGION	-0.3	-0.2	-0.2	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2
13	IN SOUTH ATLANTIC REGION	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
14	IN EAST NORTH CENTRAL REGION	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
15	IN EAST SOUTH CENTRAL REGION	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
16	IN MOUNTAIN REGION	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
17	IN PACIFIC REGION	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
18	IN WEST NORTH CENTRAL REGION	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
19	IN WEST SOUTH CENTRAL REGION	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

TABLE 17.00 DEMOGRAPHIC VARIABLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	NUMBER OF FAMILIES	MILL FAMILIES	69.483	70.310	71.147	71.993	72.850	73.717	74.594	75.482	76.380	77.289	78.209
2	NUMBER OF UNREL. INDIVIDUALS	MILL PERS	27.870	28.355	28.848	29.350	29.861	30.381	30.909	31.447	31.994	32.551	33.117
3													
4	PERCENT OF FAMILIES WITH 3 OR 4 PERS.		31.94	32.02	32.08	32.14	32.21	32.29	32.37	32.46	32.56	32.66	32.77
5	PERCENT OF FAMILIES WITH 5+ PERSONS		7.97	7.73	7.50	7.30	7.11	6.94	6.78	6.50	6.38	6.30	6.26
6													
7	PERSONS 20 TO 29 PER FAMILY		0.383	0.373	0.364	0.351	0.337	0.327	0.318	0.310	0.305	0.300	0.293
8	NUMBER OF LICENSED DRIVERS	MILL PERS	169.68	171.42	173.05	174.66	176.39	178.16	180.03	182.02	184.06	186.13	188.19
9													
10	PERCENT OF POPULATION:												
11	IN METROPOLITAN AREAS		73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27	73.27
12	IN NEW ENGLAND REGION		5.50	5.49	5.48	5.46	5.45	5.44	5.42	5.41	5.39	5.38	5.37
13	IN SOUTH ATLANTIC REGION		15.24	15.20	15.16	15.12	15.08	15.04	15.00	14.96	14.92	14.89	14.85
14	IN EAST NORTH CENTRAL REGION		19.97	20.03	20.10	20.16	20.23	20.29	20.36	20.42	20.49	20.55	20.62
15	IN EAST SOUTH CENTRAL REGION		5.35	5.29	5.23	5.17	5.11	5.05	4.99	4.93	4.87	4.82	4.76
16	IN MOUNTAIN REGION		6.07	6.19	6.31	6.44	6.57	6.70	6.84	6.97	7.11	7.25	7.40
17	IN PACIFIC REGION		14.88	14.99	15.10	15.21	15.33	15.44	15.56	15.68	15.79	15.91	16.03
18	IN WEST NORTH CENTRAL REGION		7.37	7.34	7.31	7.28	7.25	7.22	7.19	7.16	7.13	7.10	7.07
19	IN WEST SOUTH CENTRAL REGION		10.76	10.83	10.89	10.96	11.03	11.09	11.16	11.23	11.29	11.36	11.43
20													
21	GROWTH RATES:												
22	PASSENGERS / EMPLOYMENT		0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
23	PASS / PUBLIC TRANSIT M.T.W.		0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
24	OTHER M.T.W. / EMPLOYMENT		0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94

MARCH CONTROL FOR HYBRIDS

TABLE 17.10 GROWTH RATES, DEMOGRAPHIC VARIBLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	NUMBER OF FAMILIES	MILL FAMILIES	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2	NUMBER OF UNREL. INDIVIDUALS	MILL PERS	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
3													
4	PERCENT OF FAMILIES WITH 3 OR 4 PERS.		0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
5	PERCENT OF FAMILIES WITH 5+ PERSONS		-4.2	-3.0	-3.0	-2.7	-2.6	-2.4	-2.3	-4.1	-1.8	-1.3	-0.6
6													
7	PERSONS 20 TO 29 PER FAMILY		-2.8	-2.7	-2.3	-3.7	-3.8	-3.1	-2.8	-2.3	-1.8	-1.5	-2.4
8	NUMBER OF LICENSED DRIVERS	MILL PERS	1.02	1.02	0.95	0.94	0.99	1.00	1.05	1.10	1.12	1.12	1.11
9													
10	PERCENT OF POPULATION:												
11	IN METROPOLITAN AREAS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	IN NEW ENGLAND REGION		-0.3	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2
13	IN SOUTH ATLANTIC REGION		-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
14	IN EAST NORTH CENTRAL REGION		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
15	IN EAST SOUTH CENTRAL REGION		-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
16	IN MOUNTAIN REGION		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
17	IN PACIFIC REGION		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
18	IN WEST NORTH CENTRAL REGION		-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
19	IN WEST SOUTH CENTRAL REGION		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

TABLE 18.00 ECONOMIC VARIABLES

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	GENERAL:												
2	PERSONAL INCOME	BILL CURR $	1881.01	2052.79	2263.40	2490.86	2723.59	2963.39	3230.52	3506.39	3789.11	4076.06	4391.82
3	PERSONAL INCOME TAXES	BILL CURR $	279.53	302.97	343.37	385.13	427.59	471.83	518.21	567.14	617.99	673.25	736.49
4	TRANSFER PAYMENTS	BILL CURR $	254.51	288.25	317.46	349.79	384.98	422.09	460.49	500.39	543.09	588.34	635.91
5													
6	REAL DISP. INCOME/FAMILY	THOU 72 $	9.81	9.72	9.76	9.82	9.85	9.88	10.00	10.12	10.22	10.29	10.40
7	FAMILIES WITH INCOME OVER $15,000												
8	IN 1970 $	PERCENT	25.09	25.24	25.63	25.74	25.74	25.91	26.29	26.77	27.41	28.20	29.06
9													
10	EMPLOYMENT	MILL PERSONS	96.38	97.73	99.67	101.42	102.94	104.33	105.89	107.51	109.10	110.48	111.96
11	UNEMPLOYMENT RATE		6.19	6.78	6.38	6.08	5.99	5.91	5.69	5.43	5.28	5.20	4.99
12													
13	CONSUMER INSTALL. CREDIT RATE,												
14	NEW AUTOS	PERCENT	12.44	12.33	12.41	12.52	12.12	11.94	11.76	11.62	11.48	11.44	11.52
15													
16	CONSUMER PRICE INDICES (1967=100):												
17	TOTAL		211.4	227.2	243.5	260.2	277.3	294.4	311.6	328.4	345.2	361.8	378.9
18	AUTO REPAIRS		267.7	291.3	317.0	344.6	373.1	402.2	431.6	461.0	490.7	520.7	551.3
19	AUTO INSURANCE PREMIUMS		263.5	291.2	325.6	361.5	400.3	440.6	481.3	523.8	570.1	617.46	666.8
20	TIRES		154.7	164.0	173.8	184.3	195.3	207.0	219.5	232.6	246.6	261.4	277.1
21	MOTOR OIL		192.7	206.6	222.1	237.8	253.9	269.9	285.8	301.5	317.3	332.9	348.9
22	PARKING FEES		261.6	284.0	309.0	336.8	366.3	397.1	428.5	460.0	492.8	526.8	561.6
23													
24	OTHER COSTS AND PRICES:												
25	NEW AUTO UNIT PRICE	THOU 72 $	4.70	4.73	4.81	4.94	5.08	5.21	5.30	5.38	5.45	5.53	5.61
26	NEW AUTOS PRICE INDEX	1972=100	148.2	158.0	167.3	174.6	181.8	189.2	197.6	206.2	215.2	223.9	232.5
27	DOM. AUTO INPUT PRICE INDEX	1972=100	158.3	168.7	181.2	193.3	205.9	218.9	231.5	244.2	257.2	270.5	283.8
28	IMPORTED GOODS PRICE INDEX	1972=100	213.1	227.6	244.3	261.1	278.6	296.0	312.1	328.9	345.9	363.9	382.6
29	TRANSPORTATION PRICE INDEX	1972=100	154.4	163.2	168.7	174.2	181.3	189.3	196.2	204.1	213.9	224.0	233.6
30													
31	AVG RETAIL PRICE OF GASOLINE	CENTS	74.20	80.70	92.20	103.70	115.20	126.70	138.20	151.10	164.00	176.90	189.80
32	EXCLUDING TAXES	CENTS	61.40	67.70	79.02	90.34	101.67	112.98	124.28	136.98	149.69	162.39	175.09
33	FEDERAL TAX	CENTS	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
34	STATE AND LOCAL TAX	CENTS	8.80	9.00	9.18	9.36	9.53	9.72	9.92	10.12	10.31	10.51	10.71
35													
36	STEEL SCRAP PRICE	$/GROSS TON	85.22	89.49	93.96	98.66	103.59	108.77	114.21	119.92	125.91	132.21	138.82

TABLE 18.00 ECONOMIC VARIABLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	GENERAL:												
2	PERSONAL INCOME	BILL CURR $	4726.33	5100.54	5513.24	5961.04	6431.28	6939.60	7482.02	8078.19	8712.26	9398.84	10132.54
3	PERSONAL INCOME TAXES	BILL CURR $	804.43	875.39	955.03	1041.53	1131.39	1228.22	1334.31	1452.64	1578.84	1716.45	1863.88
4	TRANSFER PAYMENTS	BILL CURR $	687.70	745.68	806.10	870.44	943.36	1020.87	1105.87	1195.05	1292.13	1398.33	1511.61
5													
6	REAL DISP. INCOME/FAMILY	THOU 72 $	10.49	10.63	10.81	11.01	11.17	11.34	11.50	11.72	11.91	12.10	12.30
7	FAMILIES WITH INCOME OVER $15,000												
8	IN 1970 $	PERCENT	29.88	30.71	31.66	32.84	34.24	35.76	37.37	38.94	40.55	42.25	44.01
9													
10	EMPLOYMENT	MILL PERSONS	113.40	114.72	116.27	117.90	119.24	120.81	122.35	124.00	125.65	127.35	129.08
11	UNEMPLOYMENT RATE		4.81	4.82	4.59	4.30	4.33	4.22	4.22	4.21	4.22	4.23	4.19
12													
13	CONSUMER INSTALL. CREDIT RATE,												
14	NEW AUTOS	PERCENT	11.44	11.37	11.33	11.34	11.25	11.18	11.23	11.12	11.02	10.96	10.95
15													
16	CONSUMER PRICE INDICES (1967=100):												
17	TOTAL		396.8	415.6	434.8	454.5	475.7	497.7	520.6	543.2	566.9	592.3	618.4
18	AUTO REPAIRS		583.4	617.7	653.5	690.4	729.9	771.7	815.8	860.8	907.2	957.0	1009.3
19	AUTO INSURANCE PREMIUMS		720.5	779.8	841.5	907.6	981.2	1060.1	1143.6	1229.4	1324.1	1427.5	1535.1
20	TIRES		293.7	311.3	330.0	349.8	370.8	393.0	416.6	441.6	468.1	496.2	526.0
21	MOTOR OIL		365.6	383.3	401.4	419.9	439.8	460.3	481.9	503.1	525.3	549.0	573.4
22	PARKING FEES		598.0	636.7	677.8	720.8	766.6	815.9	867.8	921.6	977.9	1038.2	1101.9
23													
24	OTHER COSTS AND PRICES:												
25	NEW AUTO UNIT PRICE	THOU 72 $	5.69	5.78	5.87	5.97	6.06	6.15	6.26	6.36	6.46	6.56	6.67
26	NEW AUTOS PRICE INDEX	1972=100	241.5	250.7	260.2	269.7	280.0	290.5	300.1	311.0	322.1	333.3	344.8
27	DOM. AUTO INPUT PRICE INDEX	1972=100	297.6	312.2	327.4	343.2	360.1	377.3	395.2	413.4	432.4	451.9	472.7
28	IMPORTED GOODS PRICE INDEX	1972=100	402.3	423.2	445.2	468.4	492.8	518.5	545.6	573.5	603.0	633.9	666.5
29	TRANSPORTATION PRICE INDEX	1972=100	243.2	254.1	265.5	277.6	291.2	305.4	320.7	336.3	353.4	371.7	391.0
30													
31	AVG RETAIL PRICE OF GASOLINE	CENTS	202.80	213.10	223.40	233.70	244.00	254.30	266.60	278.90	291.20	303.60	316.00
32	EXCLUDING TAXES	CENTS	187.89	197.98	208.07	218.16	228.24	238.31	250.39	262.45	274.52	286.68	298.83
33	FEDERAL TAX	CENTS	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
34	STATE AND LOCAL TAX	CENTS	10.91	11.12	11.33	11.54	11.76	11.99	12.21	12.45	12.68	12.92	13.17
35													
36	STEEL SCRAP PRICE	$/GROSS TON	145.76	153.05	160.70	168.74	177.17	186.03	195.33	205.10	215.35	226.12	237.43

TABLE 19.00 GROWTH RATES, ECONOMIC VARIABLES

LINE	ITEM		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	GENERAL:												
2	PERSONAL INCOME	BILL CURR $	10.3	9.1	10.3	10.0	9.3	8.8	9.0	8.5	8.1	7.6	7.7
3	PERSONAL INCOME TAXES	BILL CURR $	9.5	8.4	13.3	12.2	11.0	10.3	9.8	9.4	9.0	8.9	9.4
4	TRANSFER PAYMENTS	BILL CURR $	12.3	13.3	10.1	10.2	10.1	9.6	9.1	8.7	8.5	8.3	8.1
5													
6	REAL DISP. INCOME/FAMILY	THOU 72 $	-0.2	-0.9	0.4	0.6	0.3	0.3	1.2	1.2	1.0	0.7	1.0
7	FAMILIES WITH INCOME OVER $15,000												
8	IN 1970 $	PERCENT	1.5	0.6	1.5	0.4	0.0	0.7	1.4	1.9	2.4	2.9	3.1
9													
10	EMPLOYMENT	MILL PERSONS	2.3	1.4	2.0	1.8	1.5	1.4	1.9	1.5	1.5	1.3	1.3
11	UNEMPLOYMENT RATE		2.3	9.6	-6.0	-4.6	-1.6	-1.2	-3.8	-4.4	-2.9	-1.4	-4.2
12													
13	CONSUMER INSTALL. CREDIT RATE,												
14	NEW AUTOS	PERCENT	4.1	-0.8	0.6	0.9	-3.2	-1.5	-1.9	-1.2	-1.2	-0.3	0.6
15													
16	CONSUMER PRICE INDICES (1967=100):												
17	TOTAL		8.2	7.5	7.2	6.9	6.6	6.2	5.8	5.4	5.1	4.8	4.7
18	AUTO REPAIRS		9.2	8.8	8.8	8.7	8.3	7.8	7.3	6.8	6.4	6.1	5.9
19	AUTO INSURANCE PREMIUMS		10.6	10.5	11.8	11.0	10.7	10.1	9.2	8.8	8.8	8.3	8.0
20	TIRES		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
21	MOTOR OIL		7.7	7.2	7.5	7.1	6.8	6.3	5.9	5.5	5.2	4.9	4.8
22	PARKING FEES		9.0	8.6	8.8	9.0	8.8	8.4	7.9	7.4	7.1	6.9	6.6
23													
24	OTHER COSTS AND PRICES:												
25	NEW AUTO UNIT PRICE	THOU 72 $	0.8	0.5	1.8	2.6	2.8	2.6	1.8	1.6	1.3	1.4	1.4
26	NEW AUTOS PRICE INDEX	1972=100	7.0	6.6	5.9	4.4	4.1	4.1	4.4	4.3	4.4	4.0	3.8
27	DOM. AUTO INPUT PRICE INDEX	1972=100	7.1	6.6	7.4	6.7	6.5	6.3	5.8	5.5	5.3	5.1	4.9
28	IMPORTED GOODS PRICE INDEX	1972=100	8.6	6.8	7.4	6.9	6.7	6.2	5.4	5.4	5.2	5.2	5.1
29	TRANSPORTATION PRICE INDEX	1972=100	5.5	5.7	3.4	3.2	4.1	4.4	3.6	4.0	4.8	4.7	4.3
30													
31	AVG RETAIL PRICE OF GASOLINE	CENTS	13.6	8.8	14.3	12.5	11.1	10.0	9.1	9.3	8.5	7.9	7.3
32	EXCLUDING TAXES	CENTS	16.5	10.3	16.7	14.3	12.5	11.1	10.0	10.2	9.3	8.5	7.8
33	FEDERAL TAX	CENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	STATE AND LOCAL TAX	CENTS	2.3	2.3	2.0	1.9	1.9	1.9	2.1	2.0	1.9	1.9	1.9
35													
36	STEEL SCRAP PRICE	$/GROSS TON	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

TABLE 19.00 GROWTH RATES, ECONOMIC VARIABLES

LINE	ITEM		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	GENERAL:												
2	PERSONAL INCOME	BILL CURR $	7,6	7,9	8,1	8,1	7,9	7,9	7,8	8,0	7,8	7,9	7,8
3	PERSONAL INCOME TAXES	BILL CURR $	9,2	8,8	9,1	9,1	8,6	8,6	8,6	8,9	8,7	8,7	8,6
4	TRANSFER PAYMENTS	BILL CURR $	8,1	8,4	8,1	8,0	8,4	8,2	8,3	8,1	8,1	8,2	8,1
5													
6	REAL DISP. INCOME/FAMILY	THOU 72 $	0,9	1,4	1,7	1,8	1,4	1,6	1,4	1,9	1,7	1,6	1,6
7	FAMILIES WITH INCOME OVER $15,000												
8	IN 1970 $	PERCENT	2,8	2,8	3,1	3,7	4,2	4,4	4,5	4,2	4,1	4,2	4,2
9													
10	EMPLOYMENT	MILL PERSONS	1,3	1,2	1,3	1,4	1,1	1,3	1,3	1,3	1,3	1,3	1,4
11	UNEMPLOYMENT RATE		-3,5	0,2	-4,8	-6,4	0,7	-2,6	-0,0	-0,2	0,4	0,1	-1,0
12													
13	CONSUMER INSTALL. CREDIT RATE,												
14	NEW AUTOS	PERCENT	-0,6	-0,6	-0,4	0,1	-0,8	-0,7	0,5	-1,0	-1,0	-0,5	-0,1
15													
16	CONSUMER PRICE INDICES (1967=100):												
17	TOTAL		4,7	4,7	4,6	4,5	4,7	4,6	4,6	4,3	4,4	4,5	4,4
18	AUTO REPAIRS		5,8	5,9	5,8	5,6	5,7	5,7	5,7	5,5	5,4	5,5	5,5
19	AUTO INSURANCE PREMIUMS		8,1	8,2	7,9	7,9	8,1	8,0	7,9	7,5	7,7	7,8	7,5
20	TIRES		6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0	6,0
21	MOTOR OIL		4,8	4,8	4,7	4,6	4,7	4,7	4,7	4,4	4,4	4,5	4,0
22	PARKING FEES		6,5	6,5	6,5	6,3	6,4	6,4	6,4	6,2	6,1	6,2	6,1
23													
24	OTHER COSTS AND PRICES:												
25	NEW AUTO UNIT PRICE	THOU 72 $	1,5	1,6	1,6	1,6	1,5	1,5	1,9	1,5	1,6	1,6	1,6
26	NEW AUTOS PRICE INDEX	1972=100	3,9	3,8	3,8	3,6	3,8	3,7	3,3	3,6	3,6	3,5	3,5
27	DOM. AUTO INPUT PRICE INDEX	1972=100	4,9	4,9	4,9	4,8	4,9	4,8	4,7	4,6	4,6	4,5	4,6
28	IMPORTED GOODS PRICE INDEX	1972=100	5,1	5,2	5,2	5,2	5,2	5,2	5,2	5,1	5,1	5,1	5,1
29	TRANSPORTATION PRICE INDEX	1972=100	4,1	4,5	4,5	4,6	4,9	4,9	5,0	4,9	5,1	5,2	5,2
30													
31	AVG RETAIL PRICE OF GASOLINE	CENTS	6,8	5,1	4,8	4,6	4,4	4,2	4,8	4,6	4,4	4,3	4,1
32	EXCLUDING TAXES	CENTS	7,3	5,4	5,1	4,8	4,6	4,4	5,1	4,0	4,6	4,4	4,2
33	FEDERAL TAX	CENTS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
34	STATE AND LOCAL TAX	CENTS	1,9	1,9	1,9	1,9	1,9	1,9	1,9	1,9	1,9	1,9	1,9
35													
36	STEEL SCRAP PRICE	$/GROSS TON	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0

TABLE 20.00 AUTO CHARACTERISTICS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CURB WEIGHT (POUNDS):											
2	DOMESTIC SUBCOMPACT	2600.	2550.	2500.	2440.	2380.	2330.	2300.	2300.	2300.	2300.	2300.
3	FOREIGN SUBCOMPACT	2293.	2258.	2224.	2191.	2158.	2126.	2094.	2094.	2094.	2094.	2094.
4	DOMESTIC COMPACT	3100.	3050.	3000.	2900.	2800.	2750.	2700.	2700.	2700.	2700.	2700.
5	FOREIGN COMPACT	2865.	2837.	2808.	2780.	2752.	2725.	2698.	2698.	2698.	2698.	2698.
6	MID-SIZE	3550.	3450.	3400.	3250.	3100.	3050.	3000.	3000.	3000.	3000.	3000.
7	FULL SIZE	3800.	3700.	3600.	3450.	3300.	3250.	3200.	3200.	3200.	3200.	3200.
8	DOMESTIC LUXURY	4100.	4000.	3850.	3700.	3600.	3550.	3500.	3500.	3500.	3500.	3500.
9	FOREIGN LUXURY	3169.	3106.	3044.	2983.	2923.	2865.	2808.	2808.	2808.	2808.	2808.
10												
11	ENGINE DISPLACEMENT (CUBIC INCHES):											
12	DOMESTIC SUBCOMPACT	143.0	135.0	130.0	125.0	115.0	110.0	105.0	105.0	105.0	105.0	105.0
13	FOREIGN SUBCOMPACT	93.9	92.1	90.2	88.4	86.6	84.9	83.2	83.2	83.2	83.2	83.2
14	DOMESTIC COMPACT	217.0	207.0	198.0	183.0	168.0	158.0	150.0	150.0	150.0	150.0	150.0
15	FOREIGN COMPACT	114.5	112.8	111.1	109.4	107.8	106.2	104.6	104.6	104.6	104.6	104.6
16	MID-SIZE	263.0	248.0	238.0	218.0	198.0	189.0	180.0	180.0	180.0	180.0	180.0
17	FULL SIZE	287.0	274.0	259.0	242.0	224.0	216.0	210.0	210.0	210.0	210.0	210.0
18	DOMESTIC LUXURY	351.0	336.0	318.0	298.0	283.0	272.0	265.0	265.0	265.0	265.0	265.0
19	FOREIGN LUXURY	171.0	168.4	165.9	163.4	160.9	158.5	156.1	156.1	156.1	156.1	156.1
20												
21	PERCENT WITH AUTOMATIC TRANSMISSION:											
22	DOMESTIC SUBCOMPACT	60.00	57.50	55.00	52.50	47.50	42.50	40.00	40.00	40.00	40.00	40.00
23	FOREIGN SUBCOMPACT	35.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
24	DOMESTIC COMPACT	87.50	85.00	80.00	75.00	70.00	67.50	67.50	67.50	67.50	67.50	67.50
25	FOREIGN COMPACT	55.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
26	MID-SIZE	90.00	85.00	80.00	77.50	75.00	72.50	72.50	72.50	72.50	72.50	72.50
27	FULL SIZE	98.00	97.00	95.00	92.50	90.00	87.50	85.00	85.00	85.00	85.00	85.00
28	DOMESTIC LUXURY	97.00	96.00	95.00	94.00	92.00	90.00	88.00	88.00	88.00	88.00	88.00
29	FOREIGN LUXURY	60.00	50.00	49.00	47.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
30												
31	PERCENT WITH 4 CYLINDERS:											
32	DOMESTIC SUBCOMPACT	75.00	77.50	80.00	82.50	85.00	87.50	90.00	90.00	90.00	90.00	90.00
33	FOREIGN SUBCOMPACT	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00
34	DOMESTIC COMPACT	15.00	20.00	30.00	40.00	45.00	50.00	55.00	55.00	55.00	55.00	55.00
35	FOREIGN COMPACT	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
36	MID-SIZE	0.0	2.50	5.00	7.50	10.00	15.00	15.00	15.00	15.00	15.00	15.00
37	FULL SIZE	0.0	2.50	5.00	7.50	10.00	12.50	15.00	15.00	15.00	15.00	15.00
38	DOMESTIC LUXURY	0.10	0.50	1.00	2.00	5.00	10.00	15.00	15.00	15.00	15.00	15.00
39	FOREIGN LUXURY	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
40												
41	PERCENT WITH 6 CYLINDERS:											
42	DOMESTIC SUBCOMPACT	25.00	22.50	20.00	17.50	15.00	12.50	10.00	10.00	10.00	10.00	10.00
43	FOREIGN SUBCOMPACT	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
44	DOMESTIC COMPACT	60.00	55.00	50.00	45.00	40.00	35.00	30.00	30.00	30.00	30.00	30.00
45	FOREIGN COMPACT	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
46	MID-SIZE	20.00	35.00	50.00	65.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
47	FULL SIZE	10.00	20.00	30.00	40.00	50.00	60.00	65.00	65.00	65.00	65.00	65.00
48	DOMESTIC LUXURY	5.00	10.00	15.00	20.00	25.00	30.00	35.00	35.00	35.00	35.00	35.00
49	FOREIGN LUXURY	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00

TABLE 20.00 AUTO CHARACTERISTICS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CURB WEIGHT (POUNDS)											
2	DOMESTIC SUBCOMPACT	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.
3	FOREIGN SUBCOMPACT	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.
4	DOMESTIC COMPACT	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.
5	FOREIGN COMPACT	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.
6	MID-SIZE	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
7	FULL SIZE	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.
8	DOMESTIC LUXURY	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.
9	FOREIGN LUXURY	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.
10												
11	ENGINE DISPLACEMENT (CUBIC INCHES)											
12	DOMESTIC SUBCOMPACT	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0
13	FOREIGN SUBCOMPACT	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2
14	DOMESTIC COMPACT	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
15	FOREIGN COMPACT	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6
16	MID-SIZE	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
17	FULL SIZE	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0
18	DOMESTIC LUXURY	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0
19	FOREIGN LUXURY	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1
20												
21	PERCENT WITH AUTOMATIC TRANSMISSION											
22	DOMESTIC SUBCOMPACT	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
23	FOREIGN SUBCOMPACT	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
24	DOMESTIC COMPACT	67.50	67.50	67.50	67.50	67.50	67.50	67.50	67.50	67.50	67.50	67.50
25	FOREIGN COMPACT	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
26	MID-SIZE	72.50	72.50	72.50	72.50	72.50	72.50	72.50	72.50	72.50	72.50	72.50
27	FULL SIZE	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
28	DOMESTIC LUXURY	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00	88.00
29	FOREIGN LUXURY	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
30												
31	PERCENT WITH 4 CYLINDERS											
32	DOMESTIC SUBCOMPACT	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
33	FOREIGN SUBCOMPACT	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00	95.00
34	DOMESTIC COMPACT	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00	55.00
35	FOREIGN COMPACT	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00	85.00
36	MID-SIZE	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
37	FULL SIZE	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
38	DOMESTIC LUXURY	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
39	FOREIGN LUXURY	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
40												
41	PERCENT WITH 6 CYLINDERS											
42	DOMESTIC SUBCOMPACT	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
43	FOREIGN SUBCOMPACT	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
44	DOMESTIC COMPACT	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
45	FOREIGN COMPACT	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
46	MID-SIZE	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
47	FULL SIZE	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00
48	DOMESTIC LUXURY	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
49	FOREIGN LUXURY	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00

TABLE 21.00 GROWTH RATES, AUTO CHARACTERISTICS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CURB WEIGHT (POUNDS)											
2	DOMESTIC SUBCOMPACT	-1.9	-1.9	-2.0	-2.4	-2.5	-2.1	-1.3	0.0	0.0	0.0	0.0
3	FOREIGN SUBCOMPACT	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0	0.0	0.0
4	DOMESTIC COMPACT	-8.8	-1.6	-1.6	-3.3	-3.4	-1.8	-1.8	0.0	0.0	0.0	0.0
5	FOREIGN COMPACT	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0
6	MID-SIZE	-4.3	-2.8	-1.4	-4.4	-4.6	-1.6	-1.6	0.0	0.0	0.0	0.0
7	FULL SIZE	-7.3	-2.6	-2.7	-4.2	-4.3	-1.5	-1.5	0.0	0.0	0.0	0.0
8	DOMESTIC LUXURY	-7.9	-2.4	-3.8	-3.9	-2.7	-1.4	-1.4	0.0	0.0	0.0	0.0
9	FOREIGN LUXURY	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	0.0	0.0	0.0	0.0
10												
11	ENGINE DISPLACEMENT (CUBIC INCHES)											
12	DOMESTIC SUBCOMPACT	-5.9	-5.6	-3.7	-3.8	-8.0	-4.3	-4.5	0.0	0.0	0.0	0.0
13	FOREIGN SUBCOMPACT	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	0.0	0.0	0.0	0.0
14	DOMESTIC COMPACT	-12.5	-4.6	-4.3	-7.6	-8.2	-6.0	-5.1	0.0	0.0	0.0	0.0
15	FOREIGN COMPACT	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0	0.0	0.0
16	MID-SIZE	-6.7	-5.7	-4.0	-8.4	-9.2	-4.5	-4.8	0.0	0.0	0.0	0.0
17	FULL SIZE	-9.2	-4.5	-5.5	-6.6	-7.4	-3.6	-2.8	0.0	0.0	0.0	0.0
18	DOMESTIC LUXURY	-9.3	-4.3	-5.4	-6.3	-5.0	-3.9	-2.6	0.0	0.0	0.0	0.0
19	FOREIGN LUXURY	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0	0.0	0.0
20												
21	PERCENT WITH AUTOMATIC TRANSMISSION											
22	DOMESTIC SUBCOMPACT	-4.00	-4.17	-4.35	-4.55	-9.52	-10.53	-5.88	0.0	0.0	0.0	0.0
23	FOREIGN SUBCOMPACT	-12.50	-28.57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	DOMESTIC COMPACT	-2.78	-2.86	-5.88	-6.25	-6.67	-3.57	0.0	0.0	0.0	0.0	0.0
25	FOREIGN COMPACT	-15.38	-18.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	MID-SIZE	-5.26	-5.56	-5.88	-3.13	-3.23	-3.33	0.0	0.0	0.0	0.0	0.0
27	FULL SIZE	-1.01	-1.02	-2.06	-2.63	-2.70	-2.78	-2.86	0.0	0.0	0.0	0.0
28	DOMESTIC LUXURY	-1.02	-1.03	-1.04	-1.05	-2.13	-2.17	-2.22	0.0	0.0	0.0	0.0
29	FOREIGN LUXURY	-14.29	-16.67	-2.00	-4.08	-4.26	0.0	0.0	0.0	0.0	0.0	0.0
30												
31	PERCENT WITH 4 CYLINDERS											
32	DOMESTIC SUBCOMPACT	3.45	3.33	3.23	3.13	3.03	2.94	2.86	0.0	0.0	0.0	0.0
33	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	DOMESTIC COMPACT	50.00	33.33	50.00	33.33	12.50	11.11	10.00	0.0	0.0	0.0	0.0
35	FOREIGN COMPACT	-5.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	MID-SIZE			100.00	50.00	33.33	50.00	0.0	0.0	0.0	0.0	0.0
37	FULL SIZE			100.00	50.00	33.33	25.00	20.00	0.0	0.0	0.0	0.0
38	DOMESTIC LUXURY		400.00	100.00	100.00	150.00	100.00	50.00	0.0	0.0	0.0	0.0
39	FOREIGN LUXURY	9.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40												
41	PERCENT WITH 6 CYLINDERS											
42	DOMESTIC SUBCOMPACT	-1.96	-10.00	-11.11	-12.50	-14.29	-16.67	-20.00	0.0	0.0	0.0	0.0
43	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	DOMESTIC COMPACT	20.00	-8.33	-9.09	-10.00	-11.11	-12.50	-14.29	0.0	0.0	0.0	0.0
45	FOREIGN COMPACT	50.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	MID-SIZE	73.91	75.00	42.86	30.00	7.69	0.0	0.0	0.0	0.0	0.0	0.0
47	FULL SIZE	100.00	100.00	50.00	33.33	25.00	20.00	8.33	0.0	0.0	0.0	0.0
48	DOMESTIC LUXURY		100.00	50.00	33.33	25.00	20.00	16.67	0.0	0.0	0.0	0.0
49	FOREIGN LUXURY	-11.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 21.00 GROWTH RATES, AUTO CHARACTERISTICS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CURB WEIGHT (POUNDS)											
2	DOMESTIC SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	DOMESTIC COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	FOREIGN COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	DOMESTIC LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	FOREIGN LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10												
11	ENGINE DISPLACEMENT (CUBIC INCHES)											
12	DOMESTIC SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	DOMESTIC COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	FOREIGN COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	DOMESTIC LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	FOREIGN LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20												
21	PERCENT WITH AUTOMATIC TRANSMISSION											
22	DOMESTIC SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	DOMESTIC COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	FOREIGN COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	DOMESTIC LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	FOREIGN LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30												
31	PERCENT WITH 4 CYLINDERS											
32	DOMESTIC SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	DOMESTIC COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	FOREIGN COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	DOMESTIC LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	FOREIGN LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40												
41	PERCENT WITH 6 CYLINDERS											
42	DOMESTIC SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	FOREIGN SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	DOMESTIC COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	FOREIGN COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	DOMESTIC LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	FOREIGN LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL

TABLE 22.00 FUEL CONSUMPTION EFFICIENCY FACTORS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CITY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	DOMESTIC SUBCOMPACT	2.00	4.00	8.00	12.00	16.00	19.00	21.00	21.00	21.00	21.00	21.00
3	FOREIGN SUBCOMPACT	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
4	DOMESTIC COMPACT	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
5	FOREIGN COMPACT	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
6	MID-SIZE	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
7	FULL SIZE	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
8	DOMESTIC LUXURY	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
9	FOREIGN LUXURY	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
10												
11	HIGHWAY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	DOMESTIC SUBCOMPACT	2.00	4.00	8.00	12.00	16.00	19.00	21.00	21.00	21.00	21.00	21.00
13	FOREIGN SUBCOMPACT	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
14	DOMESTIC COMPACT	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
15	FOREIGN COMPACT	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00
16	MID-SIZE	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
17	FULL SIZE	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
18	DOMESTIC LUXURY	2.00	4.00	8.00	12.00	16.00	19.00	19.00	19.00	19.00	19.00	19.00
19	FOREIGN LUXURY	1.00	2.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL

TABLE 22.00 FUEL CONSUMPTION EFFICIENCY FACTORS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	CITY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	DOMESTIC SUBCOMPACT	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
3	FOREIGN SUBCOMPACT	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
4	DOMESTIC COMPACT	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
5	FOREIGN COMPACT	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
6	MID-SIZE	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
7	FULL SIZE	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
8	DOMESTIC LUXURY	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
9	FOREIGN LUXURY	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
10												
11	HIGHWAY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	DOMESTIC SUBCOMPACT	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
13	FOREIGN SUBCOMPACT	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
14	DOMESTIC COMPACT	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
15	FOREIGN COMPACT	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
16	MID-SIZE	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
17	FULL SIZE	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
18	DOMESTIC LUXURY	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
19	FOREIGN LUXURY	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00

A PRODUCT OF WHARTON EFA, INC.

TABLE 23.00 MISCELLANEOUS ASSUMPTIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	DOMESTIC CLASS BASE PRICE/AVG (RATIO)											
2	SUBCOMPACT	0.729	0.728	0.727	0.726	0.725	0.724	0.723	0.722	0.721	0.720	0.719
3	COMPACT	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833
4	MID-SIZE	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929
5	FULL SIZE	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019
6	LUXURY	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621
7												
8	DOM CLASS MAX OPT PRICE/AVG (RATIO)											
9	SUBCOMPACT	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922
10	COMPACT	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969
11	MID-SIZE	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017
12	FULL SIZE	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014
13	LUXURY	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034
14												
15	CITY DRIVING, URBAN MILES / TOTAL	0.575	0.578	0.580	0.584	0.588	0.594	0.599	0.604	0.608	0.612	0.616
16												
17	EXPONENTIAL DECAY RATE, USED CAR PRICES											
18	SUBCOMPACT	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192
19	COMPACT	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
20	MID-SIZE	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
21	FULL SIZE	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
22	LUXURY	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229

TABLE 23.10 GROWTH RATES, MISCELLANEOUS ASSUMPTIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	DOMESTIC CLASS BASE PRICE/AVG (RATIO)											
2	SUBCOMPACT	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
3	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7												
8	DOM CLASS MAX OPT PRICE/AVG (RATIO)											
9	SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	FULL-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	LUXURY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14												
15	CITY DRIVING, URBAN MILES / TOTAL	-0.2	0.5	0.4	0.5	0.7	1.0	0.9	0.8	0.7	0.7	0.6
16												
17	EXPONENTIAL DECAY RATE, USED CAR PRICES											
18	SUBCOMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	COMPACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	MID-SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	FULL SIZE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 23,00 MISCELLANEOUS ASSUMPTIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	DOMESTIC CLASS BASE PRICE/AVG (RATIO)											
2	SUBCOMPACT	0,718	0,717	0,716	0,715	0,714	0,713	0,712	0,711	0,710	0,709	0,708
3	COMPACT	0,833	0,833	0,833	0,833	0,833	0,833	0,833	0,833	0,833	0,833	0,833
4	MID-SIZE	0,929	0,929	0,929	0,929	0,929	0,929	0,929	0,929	0,929	0,929	0,929
5	FULL SIZE	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019
6	LUXURY	1,621	1,621	1,621	1,621	1,621	1,621	1,621	1,621	1,621	1,621	1,621
7												
8	DOM CLASS MAX OPT PRICE/AVG (RATIO)											
9	SUBCOMPACT	0,922	0,922	0,922	0,922	0,922	0,922	0,922	0,922	0,922	0,922	0,922
10	COMPACT	0,969	0,969	0,969	0,969	0,969	0,969	0,969	0,969	0,969	0,969	0,969
11	MID-SIZE	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017	1,017
12	FULL SIZE	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014	1,014
13	LUXURY	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034	1,034
14												
15	CITY DRIVING, URBAN MILES / TOTAL	0,619	0,623	0,627	0,632	0,636	0,641	0,646	0,650	0,655	0,661	0,666
16												
17	EXPONENTIAL DECAY RATE, USED CAR PRICES											
18	SUBCOMPACT	0,192	0,192	0,192	0,192	0,192	0,192	0,192	0,192	0,192	0,192	0,192
19	COMPACT	0,163	0,163	0,163	0,163	0,163	0,163	0,163	0,163	0,163	0,163	0,163
20	MID-SIZE	0,189	0,189	0,189	0,189	0,189	0,189	0,189	0,189	0,189	0,189	0,189
21	FULL SIZE	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265	0,265
22	LUXURY	0,229	0,229	0,229	0,229	0,229	0,229	0,229	0,229	0,229	0,229	0,229

MARCH CONTROL FOR HYBRIDS

TABLE 23,10 GROWTH RATES, MISCELLANEOUS ASSUMPTIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	DOMESTIC CLASS BASE PRICE/AVG (RATIO)											
2	SUBCOMPACT	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1
3	COMPACT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
4	MID-SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	FULL SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
6	LUXURY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
7												
8	DOM CLASS MAX OPT PRICE/AVG (RATIO)											
9	SUBCOMPACT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
10	COMPACT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
11	MID-SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
12	FULL-SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
13	LUXURY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
14												
15	CITY DRIVING, URBAN MILES / TOTAL	0,6	0,6	0,7	0,7	0,7	0,7	0,7	0,7	0,8	0,8	0,8
16												
17	EXPONENTIAL DECAY RATE, USED CAR PRICES											
18	SUBCOMPACT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
19	COMPACT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
20	MID-SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
21	FULL SIZE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
22	LUXURY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	AVAGE0-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EPACDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	EPACDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	EPACEMPGC	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90
5	EPACEMPGH	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40
6	EPAEDMPGC	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
7	EPAEDMPGH	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
8	EPALDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	EPALDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	EPALEMPGC	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75
11	EPALEMPGH	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
12	EPAMDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	EPAMDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	EPASDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	EPASDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	EPASEMPGC	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
17	EPASEMPGH	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60
18	FRMCICP	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
19	GASAUTOADJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	KEND+AYZLD	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006
21	OMVUANR	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060
22	OPMVUAC+LFYEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	PC#112-1741	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	PC#121-1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	PC#122-1001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	PC#122-1783	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	PDCEDAVH	6.030	9.260	10.690	10.710	10.400	10.270	11.360	12.700	14.590	16.090	17.590
28	PER15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	PINPUTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	PUZMCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	PUZMED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	PUZMLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	PUZNMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	PUZNST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	PUCEDAVN	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
36	PURMVUUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	PUSEDW	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000
38	SAWRPDAV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	SAWRPDAVD-V	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
40	SAWRPDAVF-V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	SCMVUA	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420
42	SCMVUAC+LF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	SCMVUACD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	SCMVUACF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	SCMVUACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	SCMVUAFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	SCMVUALD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	SCMVUALF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	SCMVUALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	SCMVUAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	SCMVUASD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	SCMVUASE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	SCMVUAST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	SCMVUATD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	SCMVUATE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	SHRC+LETNR	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
7	SHRCD*A	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
8	SHRCDTNR	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037
9	SHRCE*A	-0.000	-0.001	-0.001	-0.002	-0.003	-0.003	-0.004	-0.004	-0.005	-0.005	-0.005
10	SHRED*A	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050
11	SHREDTNR	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260
12	SHRLD*A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	SHRLDTNR	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
14	SHRLE*A	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
15	SHRMD*A	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
16	SHRMDTNR	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
17	SHRSD*A	0.016	0.017	0.017	0.018	0.019	0.019	0.019	0.019	0.019	0.019	0.019
18	SHRSDTNR	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
19	SHRSE*A	-0.008	-0.008	-0.008	-0.009	-0.010	-0.010	-0.015	-0.015	-0.015	-0.015	-0.015
20	SHRSETNR	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253
21	USCDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	USCDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	USCDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	USCDPUBASE-2	13.	-12.	-37.	-67.	-97.	-127.	-127.	-127.	-127.	-127.	-127.
25	USCDPUOPT-2	57.	51.	45.	39.	33.	27.	21.	15.	9.	9.	9.
26	USCDPUTRN	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.
27	USCEMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	USCEMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	USCEPUBASE-2	686.	686.	686.	686.	686.	686.	686.	686.	686.	686.	686.
30	USCEPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	USFDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	USFDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	USFDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	USFDPUBASE-2	34.	69.	104.	144.	184.	224.	224.	224.	224.	224.	224.
35	USFDPUOPT-2	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
36	USFDPUTRN	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
37	USLDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	USLDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	USLDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	USLDPUBASE-2	285.	335.	390.	445.	500.	555.	555.	555.	555.	555.	555.
41	USLDPUOPT-2	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
42	USLDPUTRN	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.
43	USLEMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	USLEMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	USLEPUBASE-2	902.	902.	902.	902.	902.	902.	902.	902.	902.	902.	902.
46	USLEPUTRN	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
47	USMDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	USMDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	USMDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
50	USMDPUBASE-2	230.	230.	230.	230.	230.	230.	230.	230.	230.	230.	230.

TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	USMDPUOPT-2	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.
2	USMDPUTRN	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.
3	USSDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	USSDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	USSDPUPTN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	USSDPUBASE-2	-45.	-70.	-100.	-130.	-160.	-190.	-190.	-190.	-190.	-190.	-190.
7	USSDPUOPT-2	14.	10.	6.	2.	-2.	-6.	-10.	-10.	-10.	-10.	-10.
8	USSDPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	USSFMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	USSFMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	USSFPUBASE-2	242.	242.	242.	242.	242.	242.	242.	242.	242.	242.	242.
12	USSFPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	USTDPUPTGFM	103.	138.	173.	208.	243.	278.	313.	348.	383.	418.	453.
14	USTDPUBASEFW	103.	103.	103.	103.	103.	103.	103.	103.	103.	103.	103.
15	VMT/FM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	VMT/K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	VMTHVA-HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	VMTR+/K	0.070	0.075	0.070	0.060	0.050	0.040	0.030	0.020	0.020	0.020	0.020
19	VMTU+/K	0.090	0.090	0.070	0.040	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL T I T L E	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	AVAGE0-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EPACDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	EPACDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	EPACEMPGC	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90
5	EPACEMPGH	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40
6	EPAFDMPGC	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
7	EPAFDMPGH	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
8	EPALDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	EPALDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	EPALEMPGC	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75
11	EPALEMPGH	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
12	EPAMDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	EPAMDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	EPASDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	EPASDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	EPASEMPGC	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
17	EPASEMPGH	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60	-1.60
18	FRMCTCR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
19	GASAUTOADJ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	KEUD+AYZLD	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006
21	OMVUAHR	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060	-1.060
22	OMVUAC+LEYEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	PC#112-1701	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	PC#121-1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	PC#122-1001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	PC#122-1783	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	PCCEDAVN	19.090	20.590	22.090	23.590	25.590	27.590	28.590	30.590	32.590	34.590	36.590
28	PER15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	PINPUTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	PUZNCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	PUZNED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	PUZNLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	PUZNMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	PUZNST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	PUCEDAVN	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
36	PURMVUUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	PUSEDW	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000
38	SAWRRDAV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	SAWRRDAVD-V	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
40	SAWRRDAVE-V	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	SCMVUA	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420	1.420
42	SCMVUAC+LF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	SCMVUACD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	SCMVUACE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	SCMVUACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	SCMVUAED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	SCMVUALD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	SCMVUALE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	SCMVUALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	SCMVUAMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL I T E M	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	SCMVHASD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	SCMVHASF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	SCMVHAST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	SCMVHATD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	SCMVHATF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	SHRC+LFTNR	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
7	SHRCD*A	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
8	SHRCDTNR	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037
9	SHRCF*A	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
10	SHRFD*A	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050
11	SHRFDTNR	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260	-0.0260
12	SHRLD*A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	SHRLDTNR	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
14	SHRLF*A	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
15	SHRMD*A	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
16	SHRMDTNR	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046
17	SHRSD*A	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
18	SHRSDTNR	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071	0.0071
19	SHRSF*A	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015	-0.015
20	SHRSFTNR	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253	0.0253
21	USCDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	USCDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	USCDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
24	USCDPUBASE-2	-127.	-127.	-127.	-127.	-127.	-127.	-127.	-127.	-127.	-127.	-127.
25	USCDPUOPT-2	9.	9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
26	USCDPUTRN	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.	-7.
27	USCFMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	USCFMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	USCFPUBASE-2	686.	686.	686.	686.	686.	686.	686.	686.	686.	686.	686.
30	USCFPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
31	USFDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	USFDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	USFDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
34	USFDPUBASE-2	224.	224.	224.	224.	224.	224.	224.	224.	224.	224.	224.
35	USFDPUOPT-2	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
36	USFDPUTRN	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
37	USLDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	USLDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	USLDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
40	USLDPUBASE-2	555.	555.	555.	555.	555.	555.	555.	555.	555.	555.	555.
41	USLDPUOPT-2	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
42	USLDPUTRN	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.	17.
43	USLFMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	USLFMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	USLFPUBASE-2	902.	902.	902.	902.	902.	902.	902.	902.	902.	902.	902.
46	USLFPUTRN	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
47	USMDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	USMDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	USMDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
50	USMDPUBASE-2	230.	230.	230.	230.	230.	230.	230.	230.	230.	230.	230.

TABLE 24.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL I T E M	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	USMDPUOPT-2	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.	-35.
2	USMDPUTRN	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.
3	USSDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	USSDMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	USSDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	USSDPUBASE-2	-190.	-190.	-190.	-190.	-190.	-190.	-190.	-190.	-190.	-190.	-190.
7	USSDPUOPT-2	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.	-10.
8	USSDPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9	USSFMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	USSFMPGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	USSFPUBASE-2	242.	242.	242.	242.	242.	242.	242.	242.	242.	242.	242.
12	USSFPUTRN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13	USTDPOPTMFW	488.	523.	558.	593.	628.	663.	698.	733.	768.	803.	838.
14	USTDPUBASEFW	103.	103.	103.	103.	103.	103.	103.	103.	103.	103.	103.
15	VMT/FM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	VMT/K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	VMTMVA-MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	VMTR*/K	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
19	VMTU*/K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	DUMAUTOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EFFC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	EFFC*	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	EFFCCD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
5	EFFCCD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
6	EFFCCF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
7	EFFCCF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
8	EFFCFD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
9	EFFCFD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
10	EFFCLD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
11	EFFCLD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
12	EFFCLF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
13	EFFCLF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
14	EFFCMD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
15	EFFCMD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
16	EFFCSD	2.	4.	8.	12.	16.	19.	21.	21.	21.	21.	21.
17	EFFCSD*	3.	6.	11.	17.	23.	26.	28.	28.	28.	28.	28.
18	EFFCSF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
19	EFFCSF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
20	EFFH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	EFFH*	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	EFFHCD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
23	EFFHCD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
24	EFFHCF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
25	EFFHCF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
26	EFFHFD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
27	EFFHFD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
28	EFFHLD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
29	EFFHLD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
30	EFFHLF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
31	EFFHLF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
32	EFFHMD	2.	4.	8.	12.	16.	19.	19.	19.	19.	19.	19.
33	EFFHMD*	3.	6.	11.	17.	23.	26.	26.	26.	26.	26.	26.
34	EFFHSD	2.	4.	8.	12.	16.	19.	21.	21.	21.	21.	21.
35	EFFHSD*	3.	6.	11.	17.	23.	26.	28.	28.	28.	28.	28.
36	EFFHSF	1.	2.	4.	6.	8.	10.	10.	10.	10.	10.	10.
37	EFFHSF*	2.	3.	6.	9.	11.	14.	14.	14.	14.	14.	14.
38	FPMHPC	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
39	GMTWO/NER	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943
40	GRPUT/NER	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974
41	GRPUT/PTR	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994
42	UCFM3+4/FM	0.309	0.312	0.313	0.315	0.316	0.317	0.318	0.318	0.318	0.319	0.319
43	UCFM5+/FM	0.130	0.122	0.117	0.111	0.106	0.102	0.096	0.094	0.090	0.087	0.083
44	NPMET	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270
45	NPRENC/R	0.193	0.193	0.194	0.195	0.195	0.196	0.197	0.197	0.198	0.198	0.199
46	NPRESC/R	0.061	0.060	0.059	0.059	0.058	0.057	0.057	0.056	0.055	0.055	0.054
47	NPRMTN/R	0.049	0.050	0.051	0.052	0.053	0.054	0.055	0.056	0.057	0.058	0.060
48	NPRNEW/R	0.057	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.055	0.055	0.055
49	NPRPAC/R	0.137	0.138	0.139	0.140	0.141	0.142	0.143	0.144	0.145	0.147	0.148
50	NPRSA/R	0.157	0.156	0.156	0.156	0.155	0.155	0.154	0.154	0.154	0.153	0.153

TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	NPRWHC/R	0.077	0.077	0.076	0.076	0.076	0.076	0.075	0.075	0.075	0.074	0.074
2	NPRWSC/R	0.101	0.101	0.102	0.103	0.103	0.104	0.104	0.105	0.106	0.106	0.107
3	NPR20.29	38.89	39.54	40.13	40.55	40.81	40.91	40.78	40.39	39.76	38.89	37.85
4	UMVHACFNR	0.093	0.089	0.084	0.080	0.076	0.072	0.069	0.065	0.062	0.059	0.056
5	PC4113-1747	154.7	164.0	173.8	184.3	195.3	207.0	219.5	232.6	246.6	261.4	277.1
6	PSCRAPAV	85.22	89.49	93.96	98.66	103.59	108.77	114.21	119.92	125.91	132.21	138.82
7	PU/HADJCT	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
8	PU/HADJFD	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
9	PU/HADJLT	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229
10	PU/HADJMD	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
11	PU/HADJST	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192
12	RWHMVI	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663
13	TXROWN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	TXROWNCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	TXROWNFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	TXROWNLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	TXROWNMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	TXROWNST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	TXRPUCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	TXRPUFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	TXRPUMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	TXRPUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	TXRWTDAUTO	5.02	5.18	5.34	5.50	5.66	5.82	5.98	6.14	6.30	6.47	6.64
24	USCDCURB	3100.	3050.	3000.	2900.	2800.	2750.	2700.	2700.	2700.	2700.	2700.
25	USCDDISP	217.0	207.0	198.0	183.0	168.0	158.0	150.0	150.0	150.0	150.0	150.0
26	USCDFAUTO	0.875	0.850	0.800	0.750	0.700	0.675	0.675	0.675	0.675	0.675	0.675
27	USCDFDD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	USCDF4CYL	0.150	0.200	0.300	0.400	0.450	0.500	0.550	0.550	0.550	0.550	0.550
29	USCDF6CYL	0.600	0.550	0.500	0.450	0.400	0.350	0.300	0.300	0.300	0.300	0.300
30	USCDPOPTH/T	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969
31	USCDPURASE-2/T	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833
32	USCFCURB	2865.	2837.	2808.	2780.	2752.	2725.	2698.	2698.	2698.	2698.	2698.
33	USCFDISP	114.5	112.8	111.1	109.4	107.8	106.2	104.6	104.6	104.6	104.6	104.6
34	USCFFAUTO	0.550	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
35	USCFFDD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	USCFF4CYL	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
37	USCFF6CYL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
38	USFDCURB	3800.	3700.	3600.	3450.	3300.	3250.	3200.	3200.	3200.	3200.	3200.
39	USFDDISP	287.0	274.0	259.0	242.0	224.0	216.0	210.0	210.0	210.0	210.0	210.0
40	USFDFAUTO	0.980	0.970	0.950	0.925	0.900	0.875	0.850	0.850	0.850	0.850	0.850
41	USFDFDD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	USFDF4CYL	0.0	0.025	0.050	0.075	0.100	0.125	0.150	0.150	0.150	0.150	0.150
43	USFDF6CYL	0.100	0.200	0.300	0.400	0.500	0.600	0.650	0.650	0.650	0.650	0.650
44	USFDPOPTH/T	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014
45	USFDPURASE-2/T	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019
46	USLDCURB	4100.	4000.	3850.	3700.	3600.	3550.	3500.	3500.	3500.	3500.	3500.
47	USLDDISP	351.0	336.0	318.0	298.0	283.0	272.0	265.0	265.0	265.0	265.0	265.0
48	USLDFAUTO	0.970	0.960	0.950	0.940	0.920	0.900	0.880	0.880	0.880	0.880	0.880
49	USLDFDD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	I T E M	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	USLDF4CYL	0.001	0.005	0.010	0.020	0.050	0.100	0.150	0.150	0.150	0.150	0.150
2	USLDF6CYL	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.350	0.350	0.350	0.350
3	USLDPOPTM/T	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034
4	USLDPURASE-2/T	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621
5	USLFCURR	3169.	3106.	3044.	2983.	2923.	2865.	2808.	2808.	2808.	2808.	2808.
6	USLFDISP	171.0	168.4	165.9	163.4	160.9	158.5	156.1	156.1	156.1	156.1	156.1
7	USLFFAUTO	0.600	0.500	0.490	0.470	0.450	0.450	0.450	0.450	0.450	0.450	0.450
8	USLFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	USLFF4CYL	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
10	USLFF6CYL	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
11	USMDCURR	3550.	3450.	3400.	3250.	3100.	3050.	3000.	3000.	3000.	3000.	3000.
12	USMDDISP	263.0	248.0	238.0	218.0	198.0	189.0	180.0	180.0	180.0	180.0	180.0
13	USMDFAUTO	0.900	0.850	0.800	0.775	0.750	0.725	0.725	0.725	0.725	0.725	0.725
14	USMDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	USMDF4CYL	0.0	0.025	0.050	0.075	0.100	0.150	0.150	0.150	0.150	0.150	0.150
16	USMDF6CYL	0.200	0.350	0.500	0.650	0.700	0.700	0.700	0.700	0.700	0.700	0.700
17	USMDPOPTM/T	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017
18	USMDPURASE-2/T	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929
19	USSDCURR	2600.	2550.	2500.	2440.	2380.	2330.	2300.	2300.	2300.	2300.	2300.
20	USSDDISP	143.0	135.0	130.0	125.0	115.0	110.0	105.0	105.0	105.0	105.0	105.0
21	USSDFAUTO	0.600	0.575	0.550	0.525	0.475	0.425	0.400	0.400	0.400	0.400	0.400
22	USSDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	USSDF4CYL	0.750	0.775	0.800	0.825	0.850	0.875	0.900	0.900	0.900	0.900	0.900
24	USSDF6CYL	0.250	0.225	0.200	0.175	0.150	0.125	0.100	0.100	0.100	0.100	0.100
25	USSDPOPTM/T	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922
26	USSDPURASE-2/T	0.729	0.728	0.727	0.726	0.725	0.724	0.723	0.722	0.721	0.720	0.719
27	USSFCURR	2293.	2258.	2224.	2191.	2158.	2126.	2094.	2094.	2094.	2094.	2094.
28	USSFDISP	93.9	92.1	90.2	88.4	86.6	84.9	83.2	83.2	83.2	83.2	83.2
29	USSFFAUTO	0.350	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
30	USSFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	USSFF4CYL	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
32	USSFF6CYL	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050

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TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	DUMAUTOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EFFC	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	EFFC*	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	EFFCCD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
5	EFFCCD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
6	EFFCCF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
7	EFFCCF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
8	EFFCFD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
9	EFFCFD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
10	EFFCLD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
11	EFFCLD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
12	EFFCLF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
13	EFFCLF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14	EFFCMD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
15	EFFCMD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
16	EFFCSD	21.	21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
17	EFFCSD*	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
18	EFFCSF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
19	EFFCSF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
20	EFFH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	EFFH*	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22	EFFHCD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
23	EFFHCD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
24	EFFHCF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
25	EFFHCF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
26	EFFHFD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
27	EFFHFD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
28	EFFHLD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
29	EFFHLD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
30	EFFHLF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
31	EFFHLF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
32	EFFHMD	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
33	EFFHMD*	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.	26.
34	EFFHSD	21.	21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
35	EFFHSD*	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.	28.
36	EFFHSF	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
37	EFFHSF*	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
38	FRMPRC	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
39	GMTWO/NER	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943
40	GRPUT/NER	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974
41	GRPUT/PTR	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994
42	HCFM3+4/FM	0.319	0.320	0.321	0.321	0.322	0.323	0.324	0.325	0.326	0.327	0.328
43	HCFM5+/FM	0.080	0.077	0.075	0.073	0.071	0.069	0.068	0.065	0.064	0.063	0.063
44	HPMFT	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270
45	HPRENC/R	0.200	0.200	0.201	0.202	0.202	0.203	0.204	0.204	0.205	0.206	0.206
46	HPRFSC/R	0.054	0.053	0.052	0.052	0.051	0.050	0.050	0.049	0.049	0.048	0.048
47	HPRMIN/R	0.061	0.062	0.063	0.064	0.066	0.067	0.068	0.070	0.071	0.073	0.074
48	HPRNEW/R	0.055	0.055	0.055	0.055	0.054	0.054	0.054	0.054	0.054	0.054	0.054
49	HPRPAC/R	0.149	0.150	0.151	0.152	0.153	0.154	0.156	0.157	0.158	0.159	0.160
50	HPRSA/R	0.152	0.152	0.152	0.151	0.151	0.150	0.150	0.150	0.149	0.149	0.148

TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	UPRWNC/R	0.074	0.073	0.073	0.073	0.072	0.072	0.072	0.072	0.071	0.071	0.071
2	UPRWSC/R	0.108	0.108	0.109	0.110	0.110	0.111	0.112	0.112	0.113	0.114	0.114
3	UPR20.29	37.29	36.77	36.40	35.53	34.64	34.00	33.51	33.18	33.03	32.98	32.64
4	OMVHACFNR	0.053	0.051	0.048	0.046	0.043	0.041	0.039	0.037	0.035	0.034	0.032
5	PC4113-1747	293.7	311.3	330.0	349.8	370.8	393.0	416.6	441.6	468.1	496.2	526.0
6	PSCRAPAV	145.76	153.05	160.70	168.74	177.17	186.03	195.33	205.10	215.35	226.12	237.43
7	PU/NADJCT	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
8	PU/NADJFD	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
9	PU/NADJLT	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229
10	PU/NADJMD	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
11	PU/NADJST	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192
12	RNOMVI	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663
13	TXROWN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	TXROWNCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	TXROWNFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	TXROWNLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	TXROWNMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	TXROWNST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	TXRPUCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	TXRPUFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	TXRPUMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	TXRPUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	TXRWIDAUTO	6.82	7.01	7.20	7.39	7.59	7.80	8.01	8.22	8.45	8.67	8.91
24	USCDCURB	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.	2700.
25	USCDDISP	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
26	USCDFAUTO	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675
27	USCDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	USCDF4CYL	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550
29	USCDF6CYL	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
30	USCDPUPTM/T	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969
31	USCDPUBASE-2/T	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833
32	USCFCURB	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.	2698.
33	USCFDISP	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6
34	USCFFAUTO	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
35	USCFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	USCFF4CYL	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
37	USCFF6CYL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
38	USFDCURB	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.	3200.
39	USFDDISP	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0	210.0
40	USFDFAUTO	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
41	USFDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	USFDF4CYL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
43	USFDF6CYL	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650
44	USFDPUPTM/T	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014	1.014
45	USFDPUBASE-2/T	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019
46	USLDCURB	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.	3500.
47	USLDDISP	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0	265.0
48	USLDFAUTO	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880
49	USLDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 24.10 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	USLDE4CYL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
2	USLDE6CYL	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350
3	USLDPOPTM/T	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034	1.034
4	USLDPUBASE-2/T	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621	1.621
5	USLECURB	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.	2808.
6	USLEDISP	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1	156.1
7	USLEEAUTO	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
8	USLEEOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	USLEE4CYL	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
10	USLEE6CYL	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
11	USMDCURB	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.
12	USMDDISP	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0
13	USMDEAUTO	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725
14	USMDEOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	USMDE4CYL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
16	USMDE6CYL	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
17	USMDPOPTM/T	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017	1.017
18	USMDPUBASE-2/T	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929	0.929
19	USSDCURB	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.	2300.
20	USSDDISP	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0
21	USSDEAUTO	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
22	USSDEOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	USSDE4CYL	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
24	USSDE6CYL	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
25	USSDPOPTM/T	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922	0.922
26	USSDPUBASE-2/T	0.718	0.717	0.716	0.715	0.714	0.713	0.712	0.711	0.710	0.709	0.708
27	USSECURB	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.	2094.
28	USSEDISP	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2	83.2
29	USSEEAUTO	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
30	USSEEOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	USSEE4CYL	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
32	USSEE6CYL	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050

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APPENDIX B4

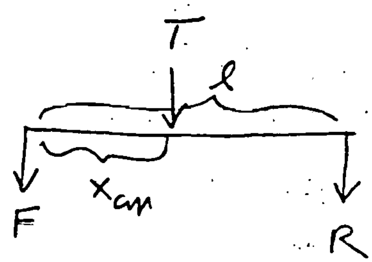
BATTERY COMPARTMENT WEIGHT DISTRIBUTION AND VEHICLE HANDLING ANALYSIS

(on-going)

Battery configuration summary for LTD :

Configuration	X_{cm} (m)	weight distribution front F/T	rear R/T	yaw moment I_{zz}	Z_{cm} (m
Baseline	1.280	.559	.441	4837.	.286
(A)	1.628	.439	.561	6134.	.260
(B)	1.631	.438	.562	6157.	.252
(C)	1.577	.456	.544	5797.	.319
(D)	1.576	.457	.543	5777.	.286
(E)	1.500	.483	.517	5380.	.293
(F)	1.559	.462	.538	5689.	.319
(G)	1.493	.485	.515	5405.	.251
(H)	1.491	.486	.514	5352.	.279
(I)	1.494	.485	.515	5374.	.281
(J)	1.636	.436	.564	6278.	.273
(K)	1.647	.432	.568	6374.	.281
(L)	1.632	.437	.563	6164.	.257
(M)	1.580	.455	.545	5819.	.304

wheelbase $l = 2.90$



$$T = F + R, \quad R = T\frac{X_{cm}}{l} \quad \Bigg\} \quad \frac{R}{T} = \frac{X_{cm}}{L}$$

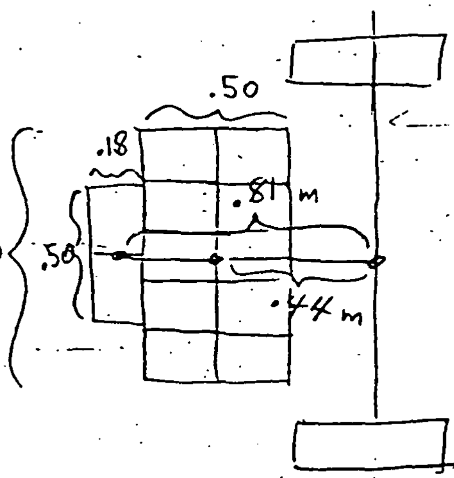
$$\frac{F}{T} = 1 - \frac{R}{T}$$

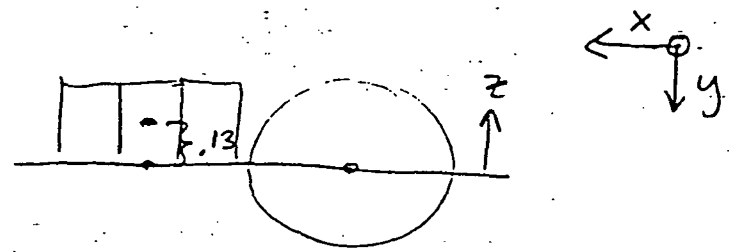
LTD Battery configurations : ~~27.62 kg / battery~~ 28 kg / battery

Wheelbase : 2.90 m , 10 3/8 in ,

Gerstenberger drawing scale : $\frac{2.90}{10.375}$ = .280 m/in

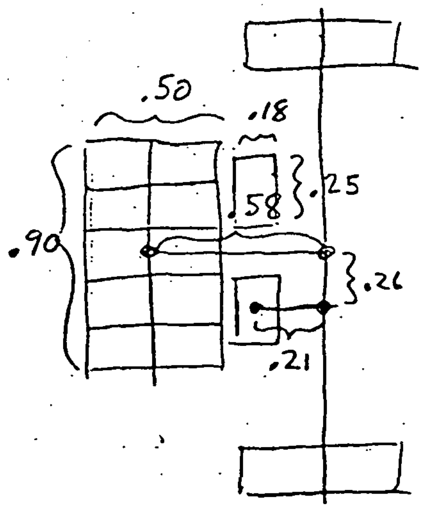
(A) m (x , y , z) (a , b , c)

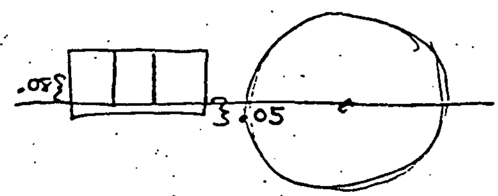




280.
~~276.7~~ (3.34 , 0 , .13) (.50 , .90 , .25)
~~55.3~~ (3.71 , 0 , .13) (.18 , .50 , .25)
56.

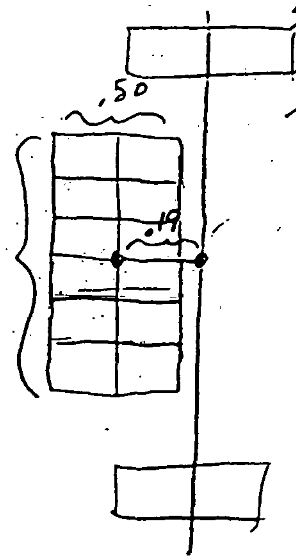
(B)

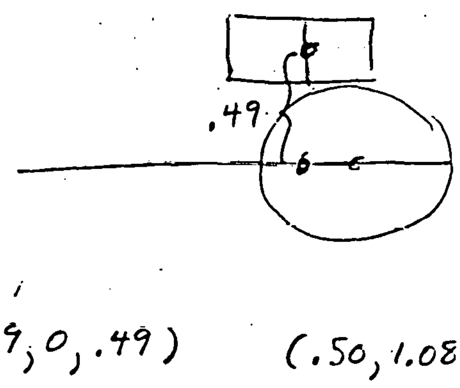


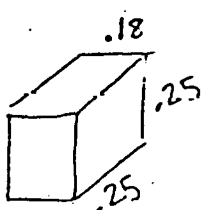


280.
~~276.7~~ (3.48 , 0 , .08) (.50 , .90 , .25)
~~27.7~~ (3.11 , -.26 , .08) (.18 , .25 , .25)
~~27.7~~ (3.11 , .26 , .08) (.18 , .25 , .25)
28.0
28.0

(C)





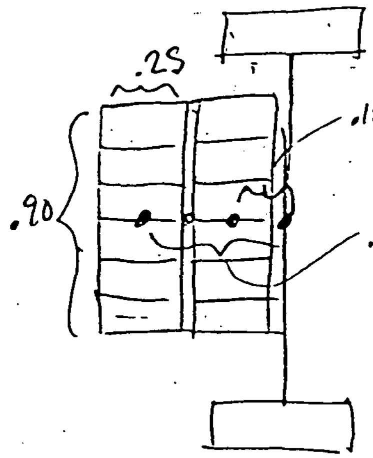


336.0
~~332.0~~ (3.09 , 0 , .49) (.50 , 1.08 , .25)

LTD Battery configurations (con'td):

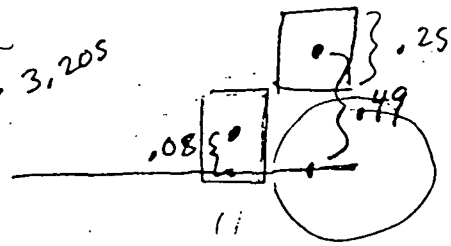
m (a, b, c) (x, y, z)

(D)



$.18 - \frac{.25}{2} = .055 \rightarrow 2.955$

$.18 + \frac{.25}{2} = .305 \rightarrow 3.205$



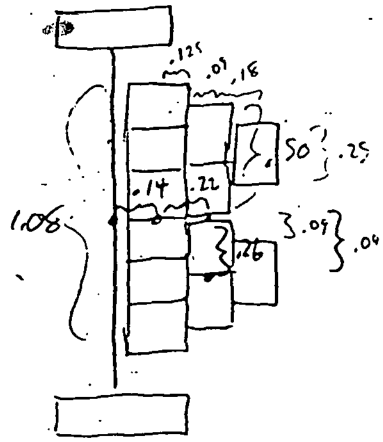
168. (.25, ~~.90~~ 1.08, .25) (2.955, 0., .49)

168. (.25, ~~.90~~ 1.08, .25) (3.205, 0., .08)

LTD Battery Configurations (cont'd) .280 m/in

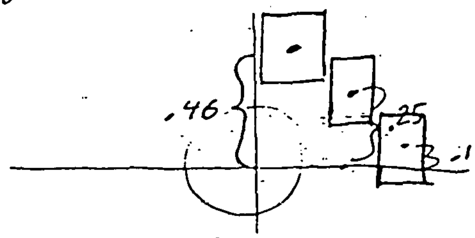
m (a, b, c)(x, y, z)

(E)



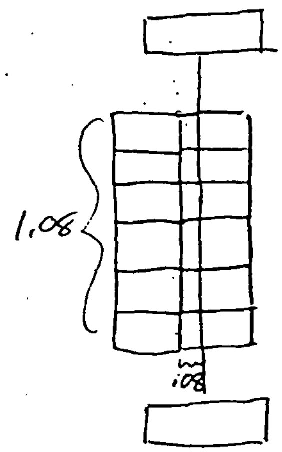
2.90 − .14 =
2.90 − (.14 + .22) = 2.90 − .36 = 2.54
2.54 − .18 = 2.36

$.09 + \frac{.25}{2} = .22$

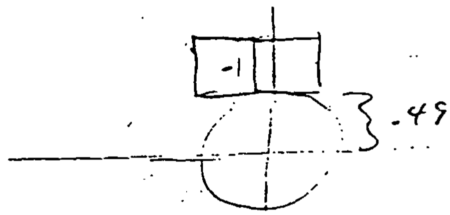


168. (.25, 1.08, .25)(2.76, 0., .46)
56. (.18, .50, .25)(2.54, .26, .25)
56. (.18, .50, .25)(2.54, −.26, .25)
28. (.18, .25, .25)(2.36, .22, .11)
28. (.18, .25, .25 (2.36, −.22, .11)

(F)

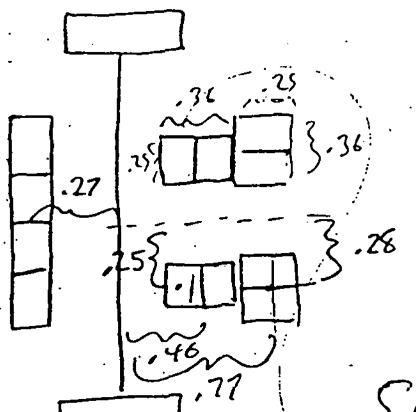


2.90 + .09 = 2.98

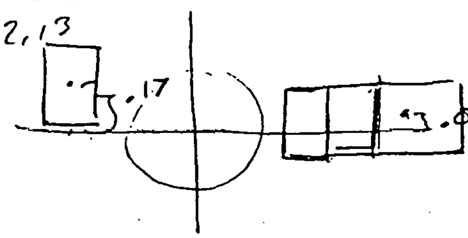


336. (.50, 1.08, .25) (2.98, 0., .49)

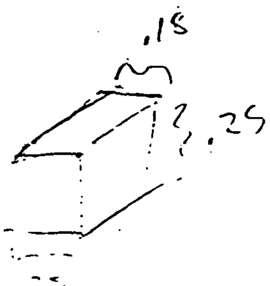
(G)



2.9 + .27 = 3.17
2.9 + .46 = 2.49
2.9 − .77 = 2.13

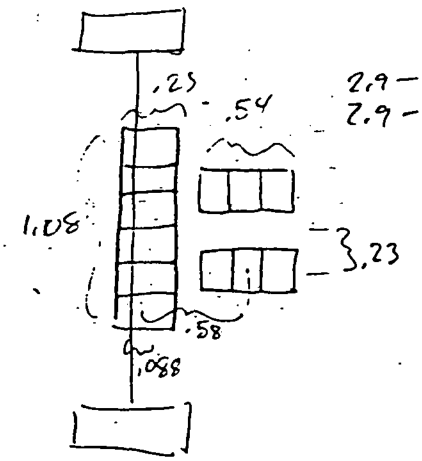


112. (.18, 1.0, .25) (3.17, 0., .17)
56. (.36, .25, .25) (2.44, +.25, .03)
56. (.36, .25, .25) (2.44, −.25, .03)
56. (.25, .36, .25) (2.13, +.28, .03)
56. (.25, .36, .25) (2.13, −.28, .03)

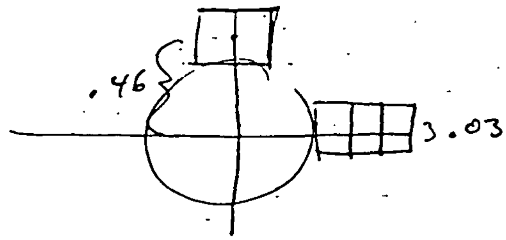


m (a, b, c) (x, y, z)

(H)

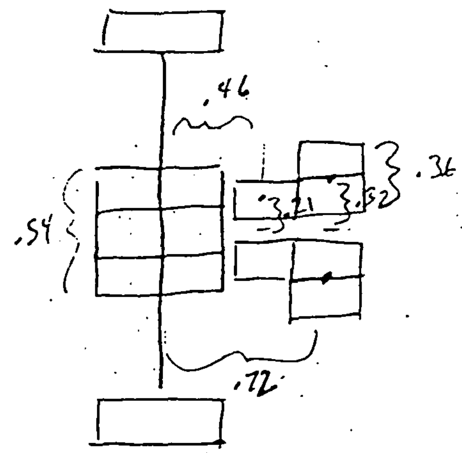


2.9 − .088 = 2.81
2.9 − .58 = 2.32

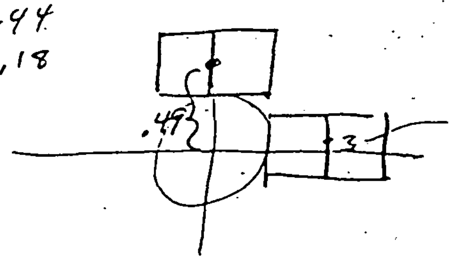


168, (.25, 1.08, .25) (2.81, 0, .46)
84, (.54, .25, .25) (2.32, +.23, .03)
84, (.54, .25, .25) (2.32, −.23, .03)

(I)

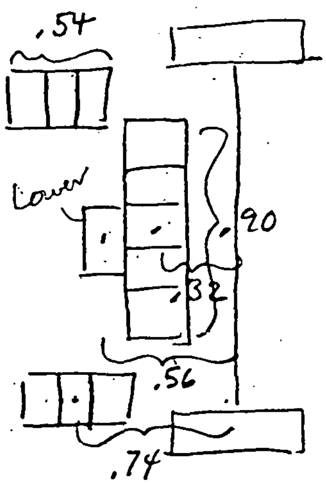


2.9 − .46 = 2.44
2.9 − .72 = 2.18

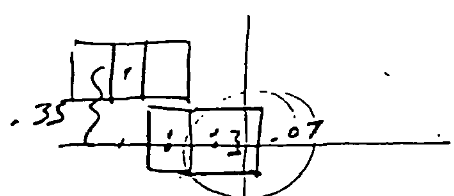


168, (.50, .54, .25) (2.90, 0, .49)
28, (.25, .18, .25) (2.44, +.21, .02)
28, (.25, .18, .25) (2.44, −.21, .02)
56, (.25, .36, .25) (2.18, +.32, .02)
56, (.25, .36, .25) (2.18, −.32, .02)

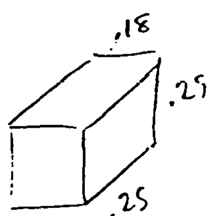
(J)



2.9 + .32 = 3.22
2.9 + .56 = 3.46
2.9 + .74 = 3.64

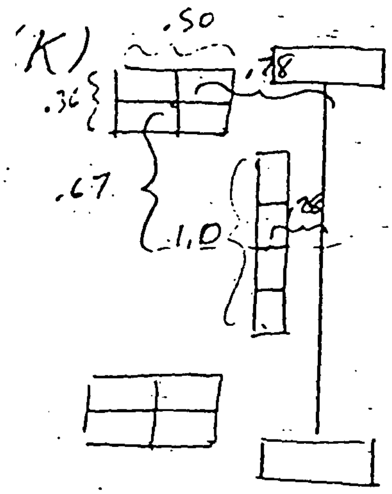


84, (.54, .25, .25) (3.64, .73, .35)
84, (.54, .25, .25) (3.64, −.73, .35)
28, (.18, .25, .25) (3.46, 0, .07)
140, (.25, .90, .25) (3.22, 0, .07)

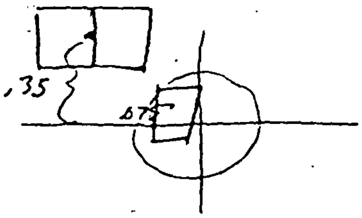


m (a , b , c)(x , y , z)

(K)

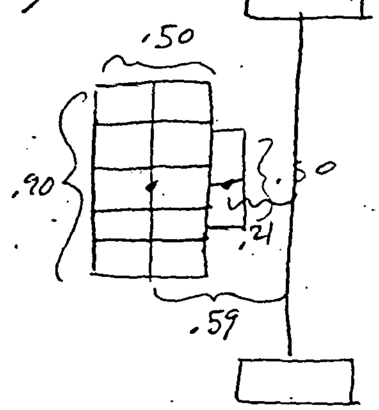


2,9+,78 = 3,68
2,9+,28 = 3,18

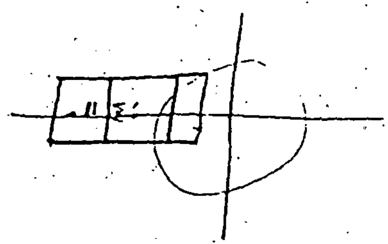


112,(.50, .36, .25)(3,68, .67, .35)
112,(.50, .36, .25)(3.68, .67, .35)
112,(.18, 1,0, .25)(3,18, 0., .07)

(L)

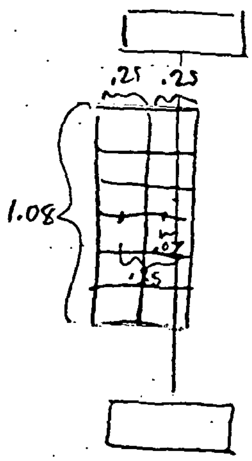


2,9+,21 = 3,11
2,9+,59 = 3,49

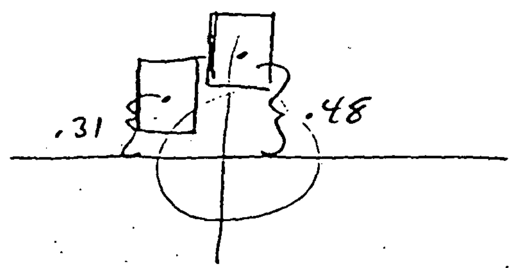


280,(.50, .90, .25)(3,49, 0., .11)
56,(.18, .50, .25)(3,11, 0., .11)

(M)



2,9+,07 = 2,97
2,9+,35 = 3,25



168,(.25, 1,08, .25)(3,25, 0., .31)
168,(.25, 1,08, .25)(2,97, 0., .48)