9950-355

(NASA-CR-163037) DESIGN TRADEOFF STUDIES AND SENSITIVITY ANALYSIS, APPENDICES B1 - B4 (South Coast Technology, Inc.) 190 p HC A09/MF A01 CSCL 13F N80-27225 Unclas G3/85 27872



SOUTH COAST TECHNOLOGY, INC.
Santa Barbara, California

# APPENDICES B1 - B4

## DESIGN TRADEOFF STUDIES

## AND

## SENSITIVITY ANALYSIS

PREPARED FOR:

JET PROPULSION LABORATORIES

CONTRACT NUMBER 955189

PREPARED BY:

SOUTH COAST TECHNOLOGY, INC.

MAY 25, 1979

TABLE OF CONTENTS

## APPENDICES

# 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

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

### 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:

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

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

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

$$4.7 \quad P_{EO} = P_{mo} = P_{GO} = P_{BRK} = 0$$

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

$$4.8 \quad P_{mo} = P_{EO} = 0$$

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

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

* 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)

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

---

** $\mu_{RG}$ and $\mu_{RG2}$ represent average battery regeneration efficiencies on Modes 1 and 2, respectively. $\mu_{RG2}$ is assumed to be higher than $\mu_{RG}$ 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

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

## 7.2 AERODYNAMIC

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

## 7.3 FINAL DRIVE

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

## 7.4 TRANSMISSION

$$\mathcal{E}_T = \int_0^T \left| \mathcal{P}_{SO} - \mathcal{P}_T \right| dt = 10^{-3}\int_0^T \left| \mathcal{P}_{SO} - \frac{2\pi}{60{,}000} T_{TO}\,\omega_{TO} \right| dt \quad (mJ)$$

## 7.5 BRAKES

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

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

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

7.9 FUEL

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

# HYBRID.



| PARAMETERS: EQUATION | PARAMETERS: PROGRAM | UNITS | DESCRIPTION |
|---|---|---|---|
| | NPWR | — | PHEZ, [illegible] matrix size |
| | PHEZRO | KW | Heat engine power, nominal |
| | FCDL | g/hr | Fuel consumption at idle (unscaled) |
| | FUELSG | | Fuel specific gravity |
| | PHEU(20) | KW | Heat engine power (unscaled) |
| BSFC | BSFC(20) | | Brake specific fuel consumption |
| $\mu_T$ | EMUT | — | Transmission efficiency |
| | NDD[illegible] | — | (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 |
| $\mu_D$ | 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 |
| | NTI(3) | — | (TIME, SPEDE) matrix size |
| | NPRTI(3) | — | Output, printing [illegible] 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 |
| | TIME(3,200) | [illegible] | Time on driving cycles |
| | SPEDE(3,200) | KM/HR | Speed on driving cycles |
| | NCDIST | — | (DSUR, DNC, GAMMA) matrix size |
| | DSTAV | — | Average usage (Trip Distribution) |
| | DSUR(30) | KM | Max. distance on driving cycle (Trip Distribution) |
| | DNC(30) | — | Fraction of total distance (Trip Distribution) |
| | GAMMA(30,3) | — | Driving cycle weighting (Trip Distribution) |
| | NCASE | — | Number of cases |
| $P_{eomin}$ | PEOMIN | KW | Heat engine minimum power |
| | LEMPY | | Battery [illegible] |
| $P_{HEmax}$ | PHEMAX | KW | Heat engine power, maximum |
| $P_{mmax}$ | PMMAX | KW | Motor power, maximum |
| $P_{eomin}$ | PMMIN | KW | Motor power, minimum |
| $\mu_I$ | EM[illegible] | — | Motor efficiency |
| $\mu_G$ | EMUG | — | Generator efficiency (of motor) |
| $P_{NLD}$ | PINLD | KW | Motor no-load input |
| | WB | KG | Battery weight |
| | EGMAX | | Battery energy density |

HYBRID

| PARAMETERS | | UNITS | DESCRIPTION |
| --- | --- | --- | --- |
| EQUATION | PROGRAM | | |
| $\mu_{RG}$ | EMURG | — | Average [illegible] efficiency (of [illegible]) |
| $\mu_{RG2}$ | EMURG2 | — | Maximum generating efficiency (of motor) |
| $m_r$ | VMASS | KG | Vehicle mass |
| $I_{DL}$ | DLI | | Driveline inertia |
| $C_D A$ | CDA | | Drag coefficient * Area |

| VARIABLES | | UNITS | DESCRIPTION |
|---|---|---|---|
| EQUATION | PROGRAM | | |
| | 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 |
| $P_E$ | 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 dimensional interpolation |
| | INT2 | — | Function subroutine, 2 dimensional 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) |
| | TI | SEC | Final time for specified cycle |
| | TIME(200) | SEC | Times for specified driving cycle |
| | TTMP | SEC | Time holder |
| $V$ | Y(6) | m/sec | Velocities |
| $m_r$ | VMASS2 | | 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/h | 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 |
| $\omega_{DO}$ | RPMDO | RPM | Drive train output |
| $\omega_{TO}$ | RPMTO | RPM | Transmission output |
| $T_{DO}$ | TDO | NT·M | Drive train output torque |
| $T_{TO}$ | TTO | NT·M | Transmission output torque |
| | VMPS | m/sec | Velocity (meters/sec²) |
| | YDOT(2) | — | Variables of integration |

GRC
GENERAL RESEARCH CORPORATION

# FORTRAN CODING FORM

PROGRAM: HYBRI[illegible]

NAME:

ROUTINE: MAIN PROGRAM

DATE:

PAGE 1 OF 2

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

      TRANSMISSION DATA
      EMUT

      BATTERY DATA
      NCDSCH    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)TTC(NCYCLE
      TIMC(1,1) SPEDC(1,1). . .     TIMC(NCYCLE,NT)SPEDC(NCYCLE,NT)
```

FORM NO. GRC 103 REV. 1

**GRC**
**GENERAL RESEARCH CORPORATION**

# FORTRAN CODING FORM

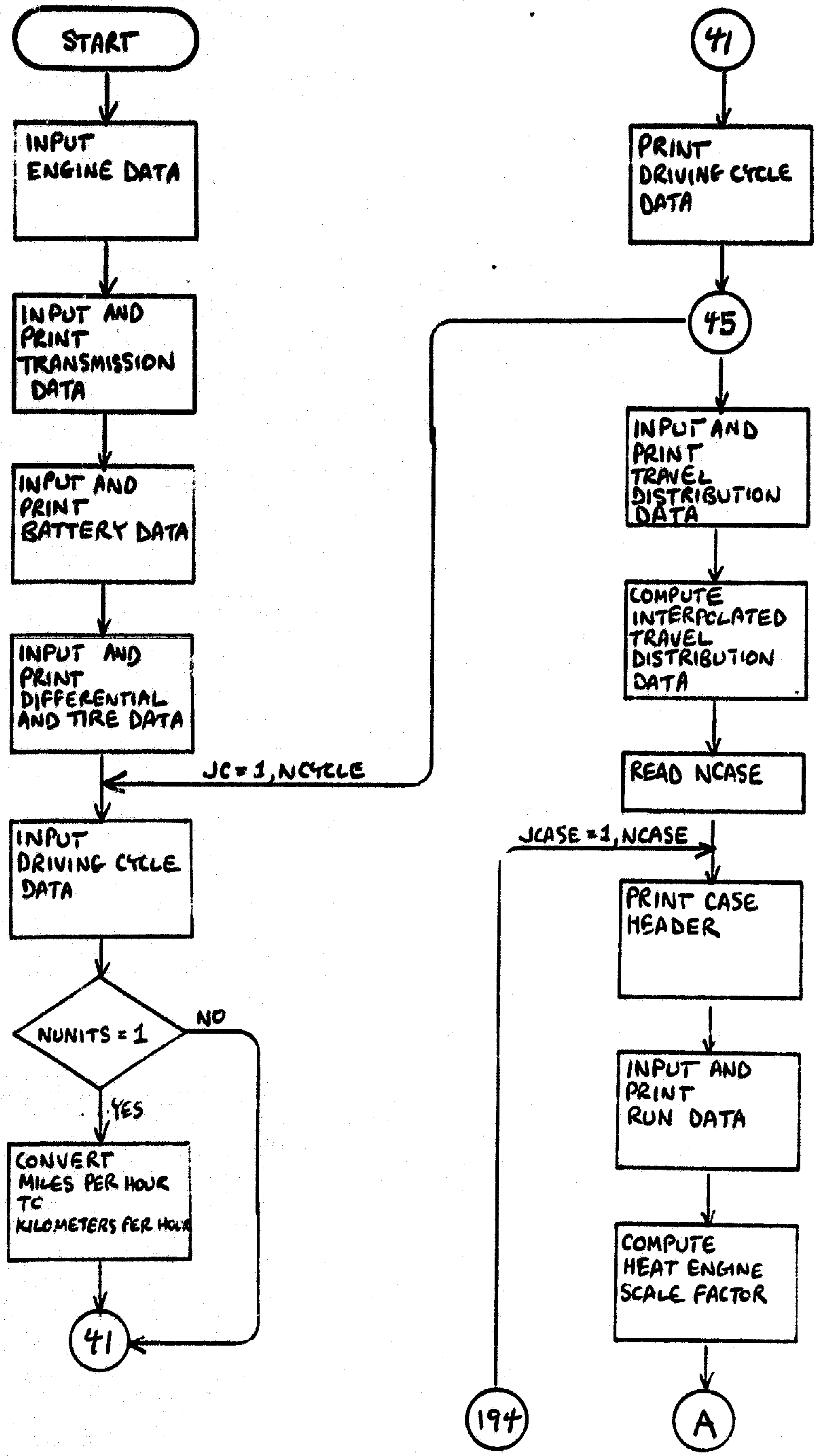
PROGRAM: HYBRID
ROUTINE: MAIN PROGRAM
NAME:
DATE:
PAGE 2 OF 2

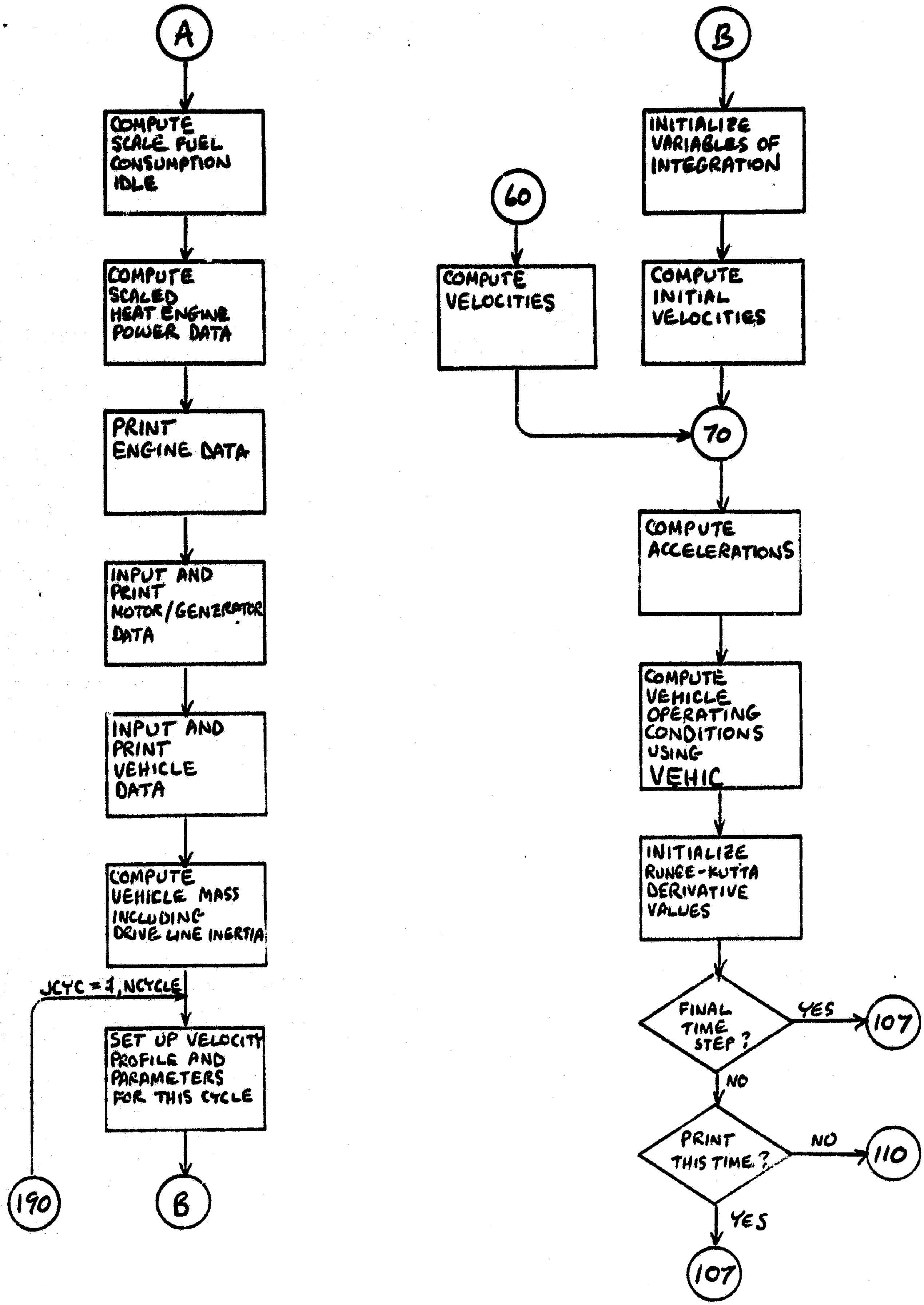
0 = ZERO, Ø = ALPHA O; 1 = ONE, I = ALPHA I; 2 = TWO, Z = ALPHA Z

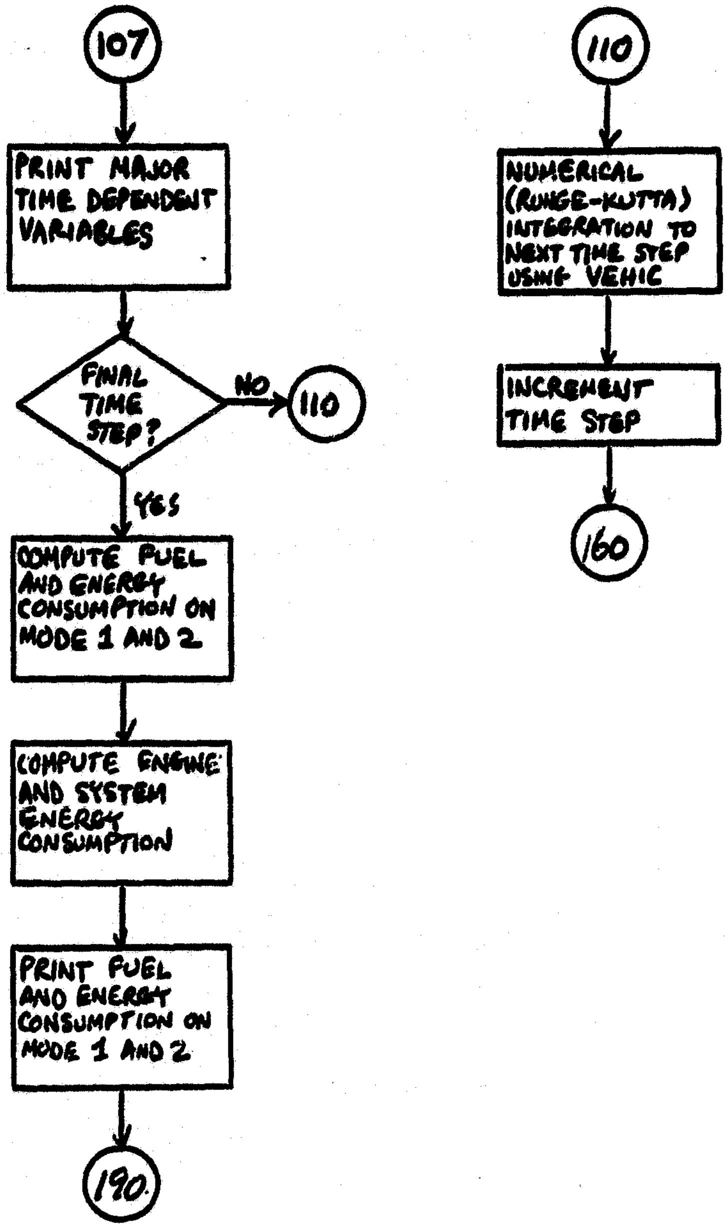
```
      TRAVEL DISTRIBUTION DATA
 NCOMP    DSTAV
DSUP(1)   DNC(1) GAMMA(1,1)   . . .   DSUP(NCOMP) DNC(NCOMP) GAMMA(NCOMP,NCYCLE)

      RUN DATA
 NCASE
TEOMIN    DBMAX     PEOMIN

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

      VEHICLE DATA
 VMASS    DLI       CDA
```

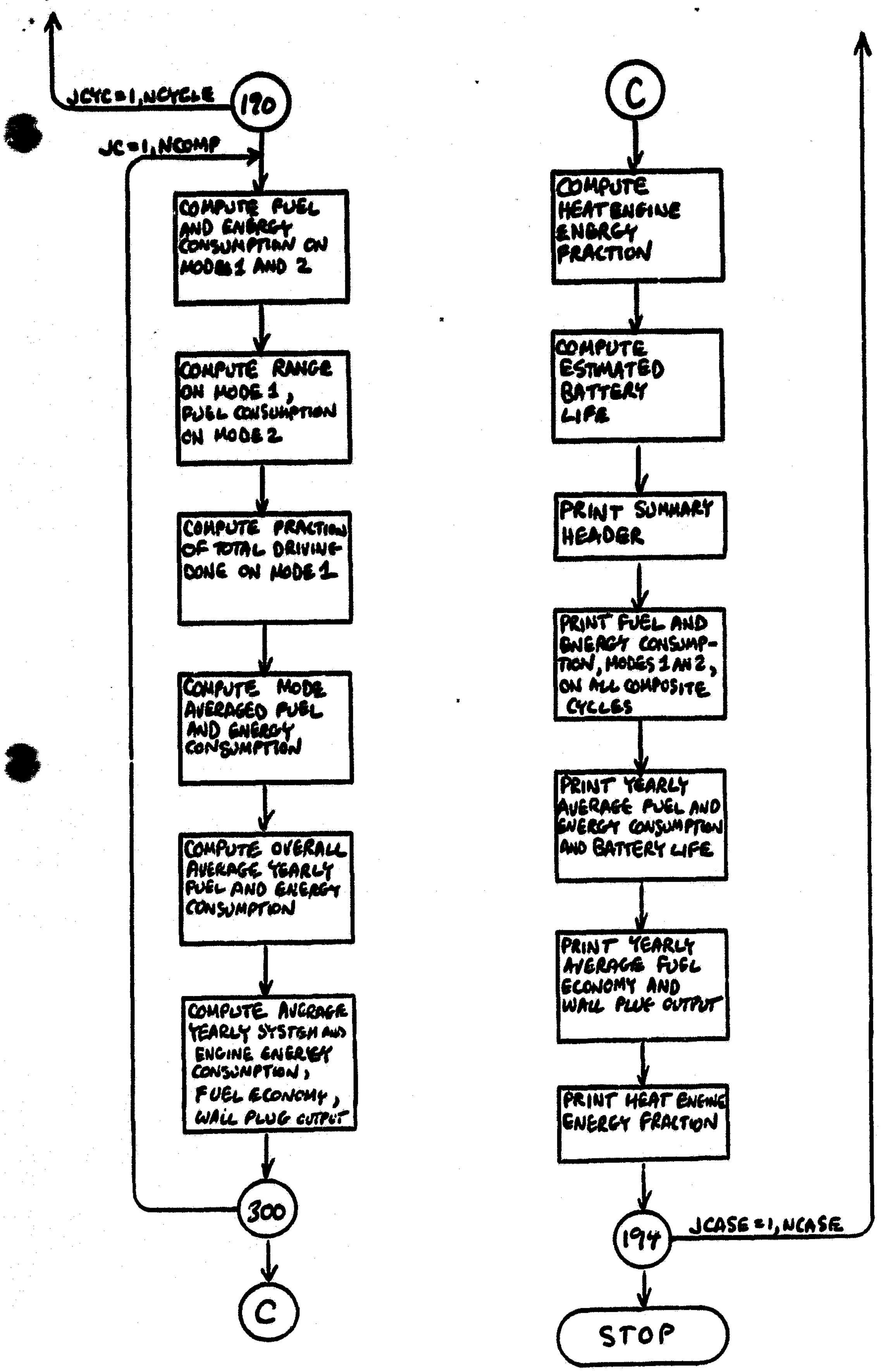
SERIAL NUMBER

# Hybrid Flowchart



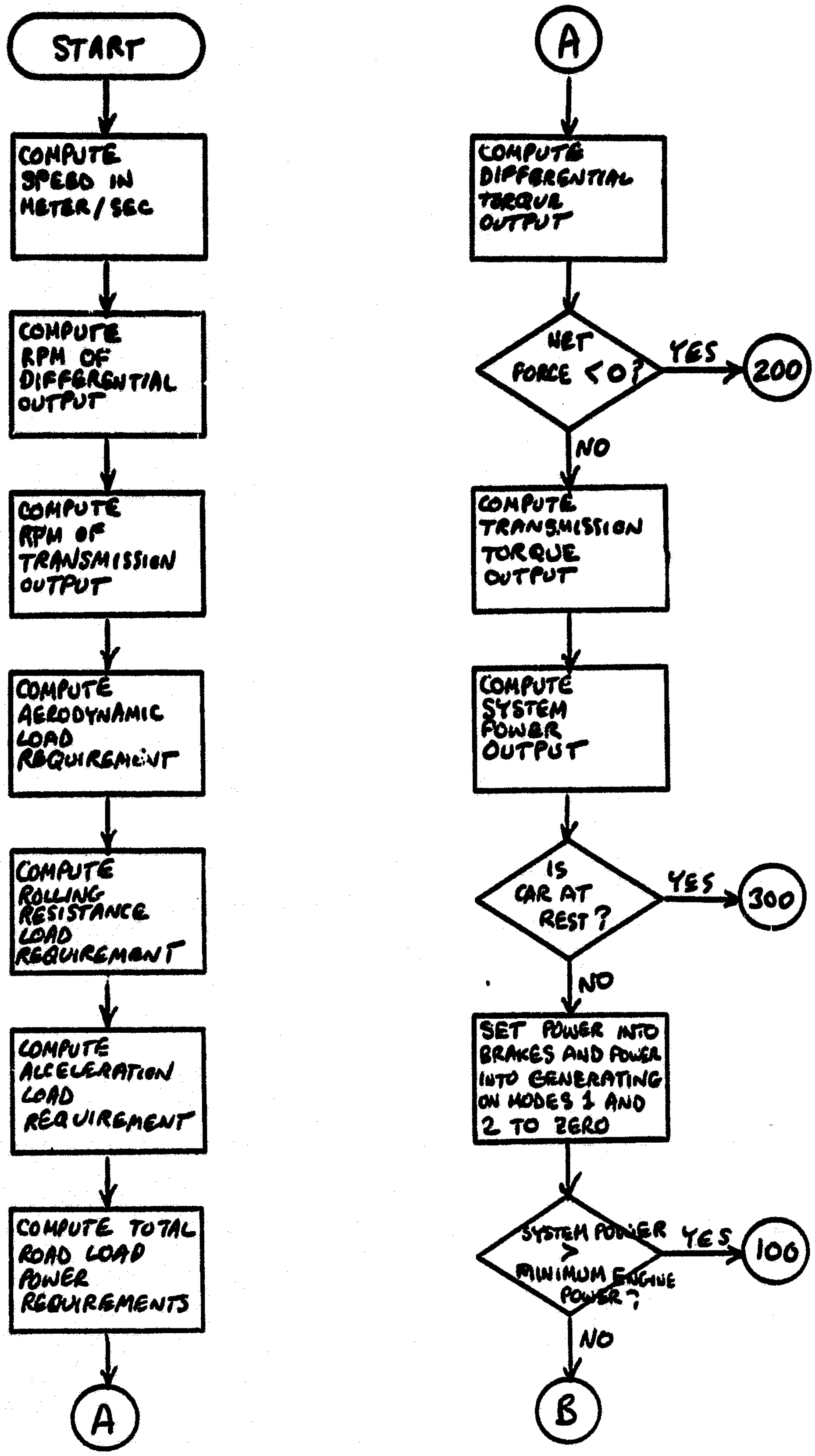

A
COMPUTE SCALE FUEL CONSUMPTION IDLE
COMPUTE SCALED HEAT ENGINE POWER DATA
PRINT ENGINE DATA
INPUT AND PRINT MOTOR/GENERATOR DATA
INPUT AND PRINT VEHICLE DATA
COMPUTE VEHICLE MASS INCLUDING DRIVE LINE INERTIA
JCYC = 1, NCYCLE
SET UP VELOCITY PROFILE AND PARAMETERS FOR THIS CYCLE
190
B
B
INITIALIZE VARIABLES 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

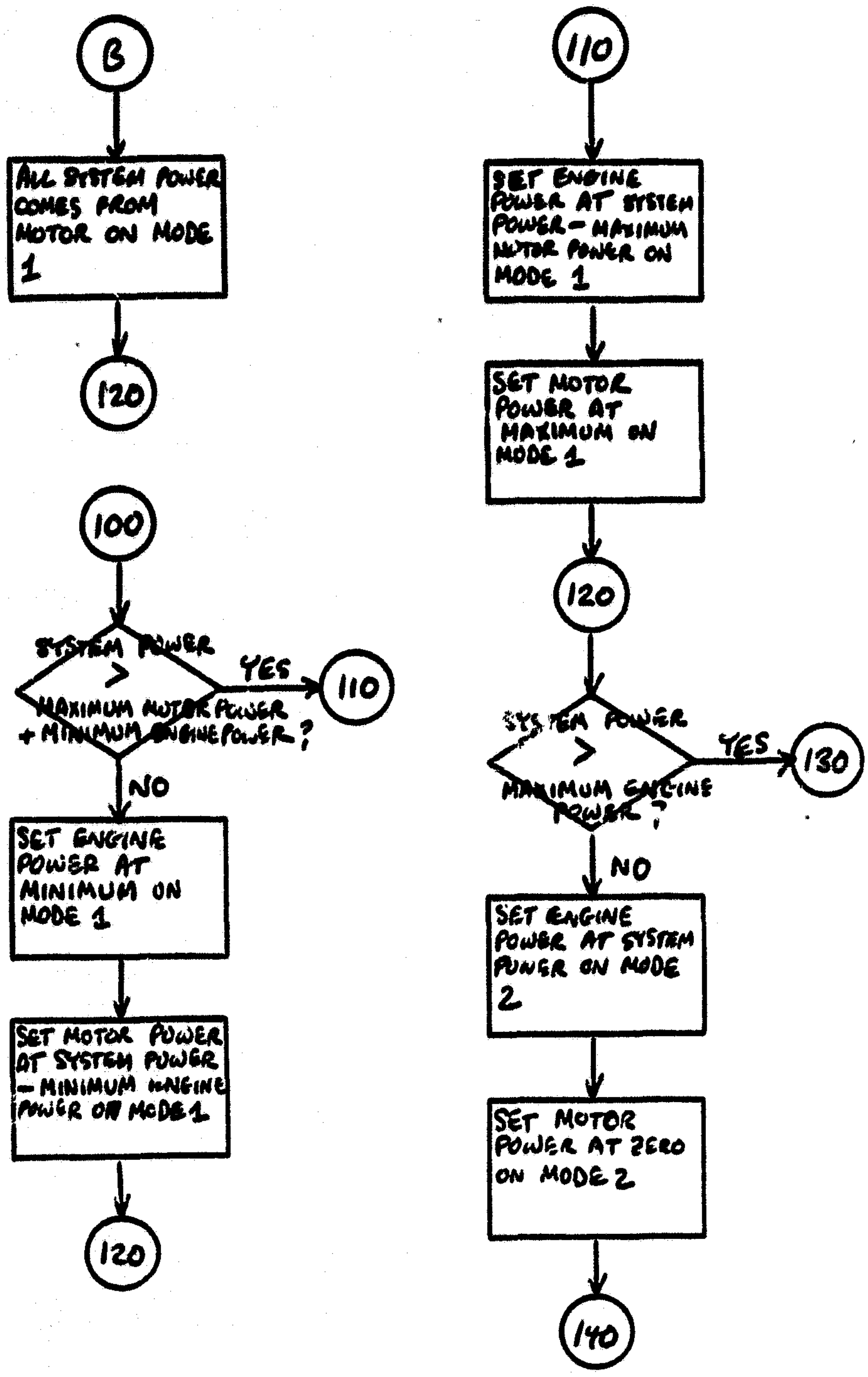

107
PRINT MAJOR TIME DEPENDENT VARIABLES
FINAL TIME STEP?
NO
110
YES
COMPUTE FUEL AND ENERGY CONSUMPTION ON MODE 1 AND 2
COMPUTE ENGINE AND SYSTEM ENERGY CONSUMPTION
PRINT FUEL AND ENERGY CONSUMPTION ON MODE 1 AND 2
190
110
NUMERICAL (RUNGE-KUTTA) INTEGRATION TO NEXT TIME STEP USING VEHIC
INCREMENT TIME STEP
160

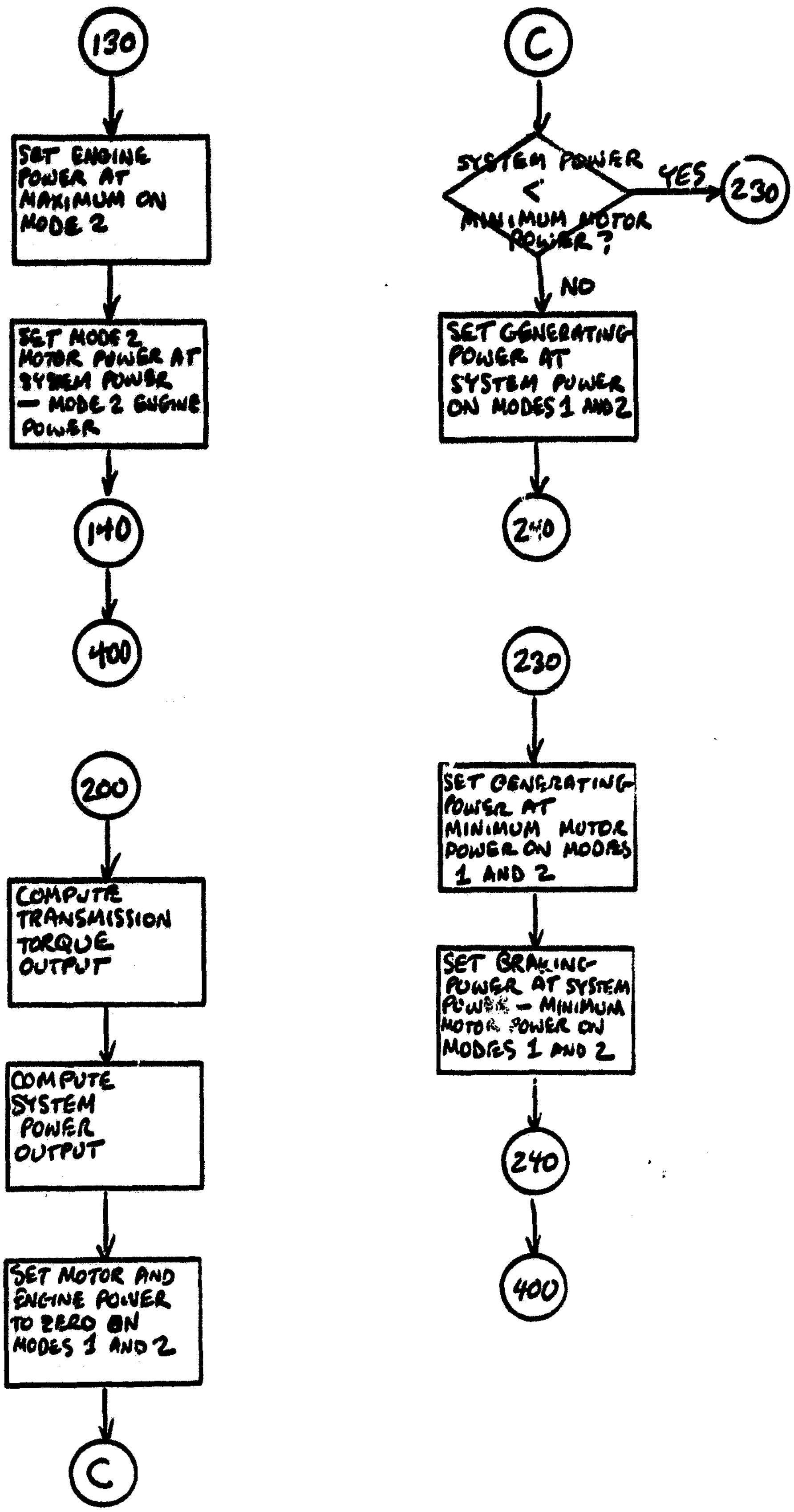


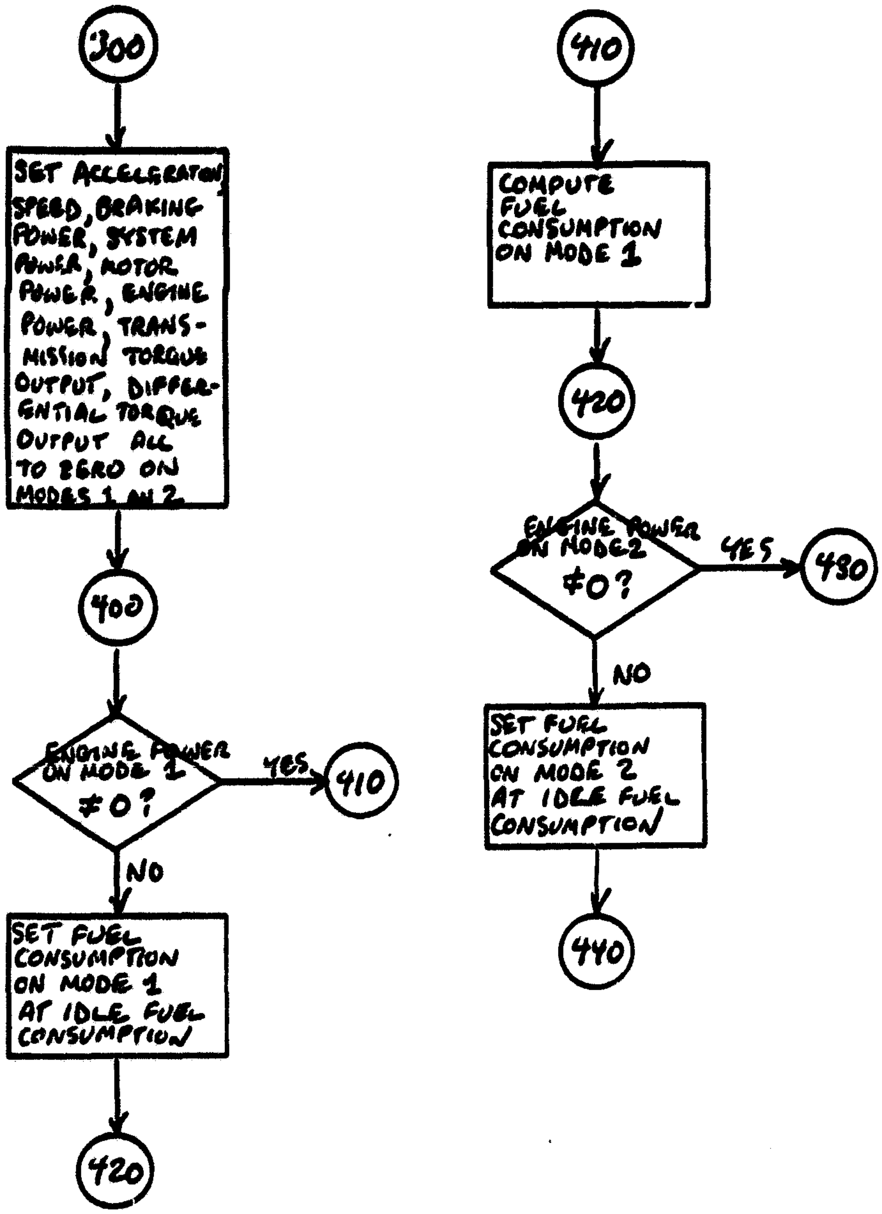
JCYC=1,NCYCLE
170
JC=1,NCOMP
COMPUTE FUEL AND ENERGY CONSUMPTION ON MODES 1 AND 2
COMPUTE RANGE ON MODE 1, FUEL CONSUMPTION ON MODE 2
COMPUTE FRACTION OF TOTAL DRIVING DONE ON MODE 1
COMPUTE MODE AVERAGED FUEL AND ENERGY CONSUMPTION
COMPUTE OVERALL AVERAGE YEARLY FUEL AND ENERGY CONSUMPTION
COMPUTE AVERAGE YEARLY SYSTEM AND ENGINE ENERGY CONSUMPTION, FUEL ECONOMY, WALL PLUG OUTPUT
300
C
C
COMPUTE HEAT ENGINE 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

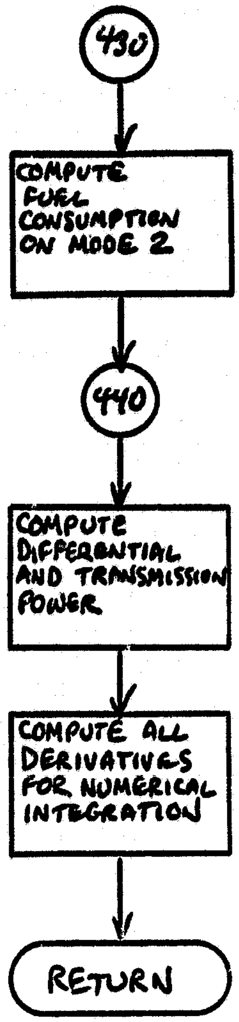
# VEHIC Subroutine Flowchart



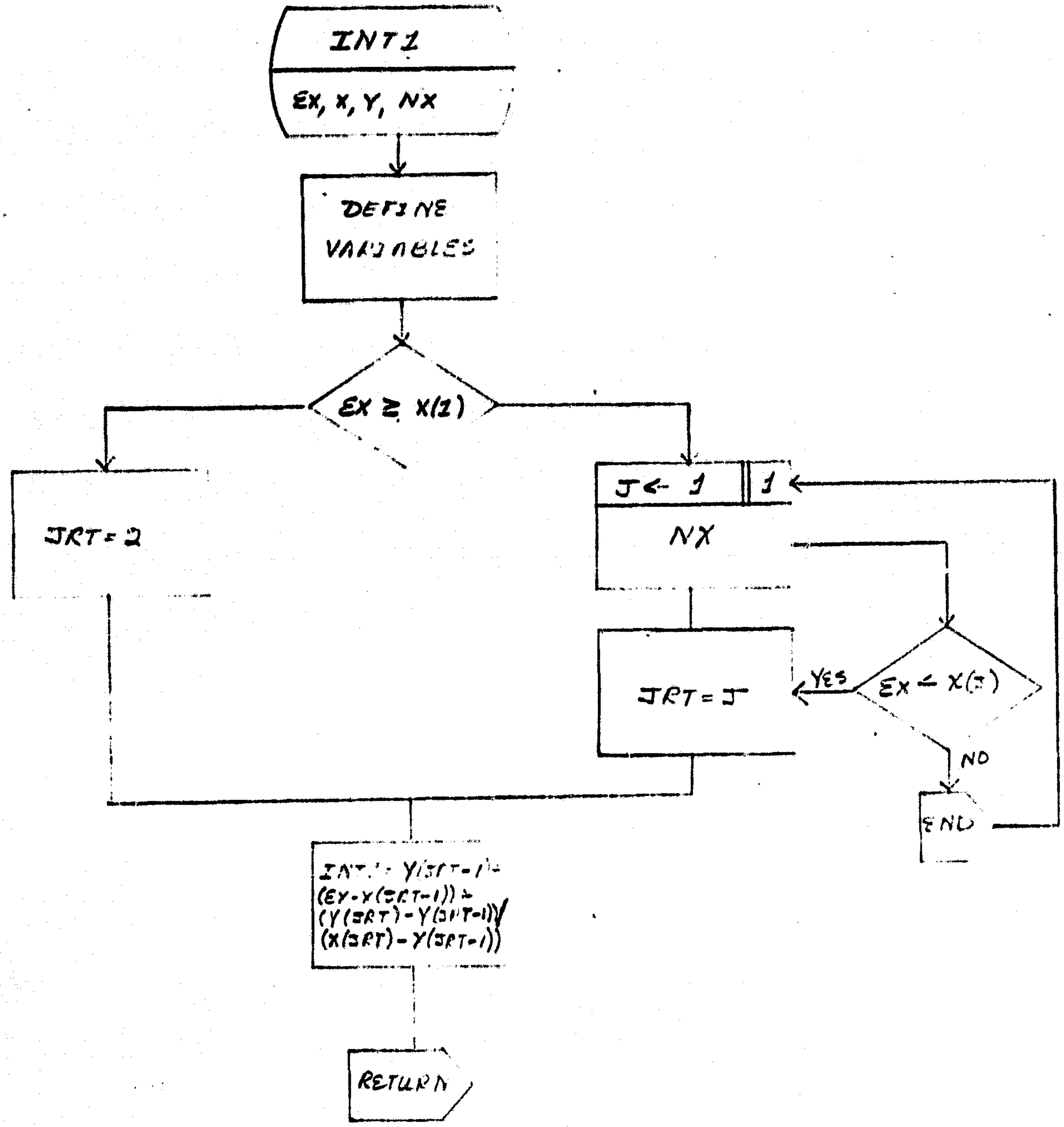

B
ALL SYSTEM POWER COMES FROM MOTOR ON MODE 1
120
100
SYSTEM POWER > MAXIMUM MOTOR POWER + MINIMUM ENGINE POWER ?
YES
110
NO
SET ENGINE POWER AT MINIMUM ON MODE 1
SET MOTOR POWER AT SYSTEM POWER – MINIMUM ENGINE POWER ON MODE 1
120
110
SET ENGINE POWER AT SYSTEM POWER – MAXIMUM MOTOR POWER ON MODE 1
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, TRANS-MISSION TORQUE OUTPUT, DIFFER-ENTIAL 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 MODE 2 ≠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

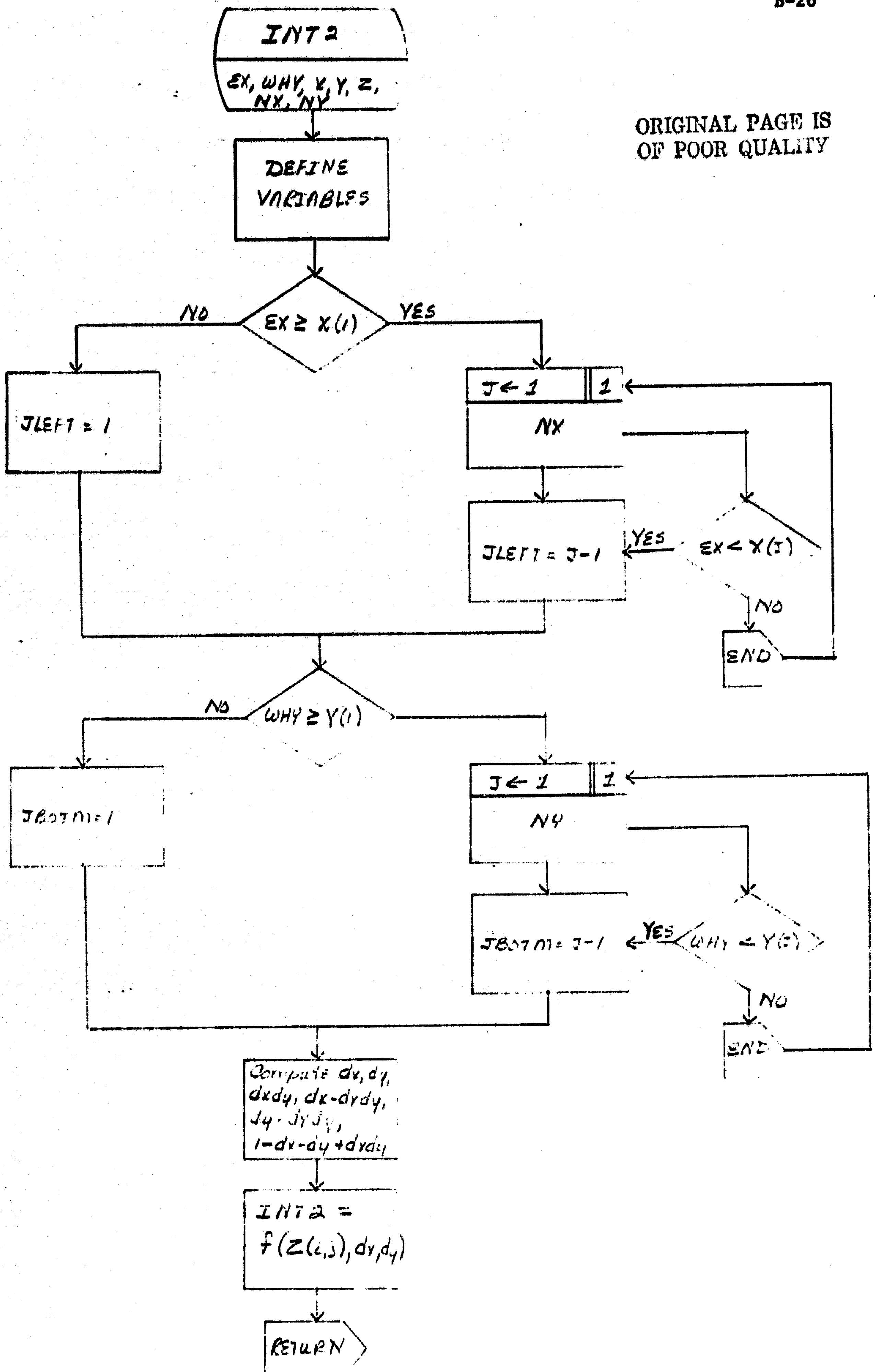
# SUBROUTINE INT1



SUBROUTINE INT2



ORIGINAL PAGE IS OF POOR QUALITY



```
                  PROGRAM HYBRID
            C
            C     HYBRID MODELS OPERATION OF A HYBRID VEHICLE OVER SPECIFIED DRIV
            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,EMUF
                 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 TRANSMISSION DATA
            C
000034            READ 610,EMUT
000042            PRINT 843
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)
```

```
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=FCOL*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
```

```
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(
```

```
                   2E92
001066             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)
```

```
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-ZI
          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 COMPOSITI
          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,NODSCH)
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
```

```
 001524       194 CONTINUE
 001527       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. OUT
 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.,E
                 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.)
 001531       875 FORMAT(1H0,18HAXLE AND TIRE DATA )
 001531       880 FORMAT(1H0,3X,11HDIFF. RATIO,5X,10HEFFICIENCY,4X 14HROLLING RAD
                 1,5X,25HROLL. RESIST. COEFFICIENTS)
 001531       885 FORMAT(1H ,5E16.6)
 001531       890 FORMAT(1H0,14HVEHICLE MASS =,E16.6,5X,19HDRIVELINE INERTIA =,E1
                 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. DIS
                 1 LIMIT =,E11.4)
 001531       950 FORMAT(1H0,47HFUEL AND ENERGY CONSUMPTION ON COMPOSITE CYCLES/1
                 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 =,E1
                 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)
 001531       990 FORMAT(1H0,24HTRAVEL DISTRIBUTION DATA/1X,11HAV. USAGE =,E12.4)
 001531       995 FORMAT(1H0,3X,10HMAX. DIST.,4X,15HFRACT. OF TOTAL,14X,21HDRIVI
                 1YCLE WEIGHTS)
 001531      1010 FORMAT(1H0,29HHEAT ENGINE ENERGY FRACTION =,E16.6)
```

```
                 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,EMUR
                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*0.00010471 97/EMUT
           C
           C     IS CAR AT REST AND IDLING -
```

```
              C
  100051            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 PEC2=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*0.000104719?*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
```

```
 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*7(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. | 5.000000E+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 | 9.690000E-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 |
| 3.730000E+01 | 3.215600E+01 |
| 3.970000E+01 | 2.365671E+01 |
| 4.3[illegible]0000E+01 | 2.542694E+01 |
| 4.690000E+01 | 3.653111E+01 |
| 5.070000E+01 | 3.653111E+01 |
| 5.460000E+01 | 2.413950E+01 |
| 5.960000E+01 | 3.942795E+01 |
| 9.070000E+01 | 4.135991E+01 |
| 8.720000E+01 | 4.908365E+01 |
| 1.085000E+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 | 3.620975E+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 |
| 1.946000E+02 | 3.713717E+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 | 9.529290E+01 |
| 6.400000E+02 | 7.402780E+01 |
| 6.437000E+02 | 7.402780E+01 |
| 6.546000E+02 | 8.491011E+01 |
| 6.585000E+02 | 8.207430E+01 |
| 6.610000E+02 | 8.207430E+01 |
| 6.670000E+02 | 8.513137E+01 |
| 6.710000E+02 | 8.416539E+01 |
| 6.750000E+02 | 9.481011E+01 |
| 6.827000E+02 | 7.956035E+01 |
| 6.870000E+02 | 7.956035E+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 | 9.143058E+01 |
| 7.430000E+02 | 7.354501E+01 |
| 7.450000E+02 | 6.839525E+01 |
| 7.500000E+02 | 4.194130E+01 |
| 7.600000E+02 | 4.827300E+01 |
| 7.625000E+02 | 0. |
| 9.000000E+02 | 0. |

TRAVEL DISTRIBUTION DATA
AV. USAGE = 5.5790E+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 | 9.269600E-02 | 1.954500E-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 | 1.889400E-01 | 8.004200E-01 |
| 2.200000E+02 | 2.259900E-02 | 9.714000E-03 | 1.709600E-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 | 1.329900E-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 |
|---|---|
| 9.753304E-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 | 2.890000E+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+12 | 5.000000E+11 | 6.000000E-01 | 9.500000E-01 |

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

| TIME | SPEED | SYS. PWR. | AERO. | TIRES | DIFF. | TRANS. | SYSTEM OUT | | |
|---|---|---|---|---|---|---|---|---|---|
| MOT. PWR. | ENG. PWR. | GEN. PWR. | BRK. PWR. | MOTOR OUT | ENGINE OUT | GEN. IN | 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 | 3.4052E-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 | 1.3603E-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 | 2.1264E+01 | 7.5150E+00 | 3.3453E-04 | 6.5950E-03 | 1.9507E-03 | 4.2407E-03 | 5.3009E-02 | | |
| 7.5150E+00 | 0. | 0. | 0. | 5.3009E-02 | 0. | 0. | 0. | 0. | 7.2930E-02 |
| 0. | 7.5150E+00 | 0. | 0. | 0. | 5.3009E-02 | 0. | 0. | 5.0729E+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. | 9.2403E-02 |
| 0. | 5.5756E+00 | 0. | 0. | 0. | 6.7410E-02 | 0. | 0. | 6.4050E+00 | 1.5000E-02 |
| 1.2000E+01 | 2.6167E+01 | 5.3847E+00 | 1.0601E-03 | 1.2098E-02 | 2.9037E-03 | 6.3125E-03 | 7.8906E-02 | | |
| 5.3847E+00 | 0. | 0. | 0. | 7.8906E-02 | 0. | 0. | 0. | 0. | 1.0870E-01 |
| 0. | 5.3847E+00 | 0. | 0. | 0. | 7.8906E-02 | 0. | 0. | 7.5074E+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 | 2.9599E+01 | 6.9166E+00 | 2.0510E-03 | 1.9388E-02 | 3.9455E-03 | 8.3598E-03 | 1.0450E-01 | | |
| 6.9166E+00 | 0. | 0. | 0. | 1.0450E-01 | 0. | 0. | 0. | 0. | 1.4411E-01 |
| 0. | 6.9166E+00 | 0. | 0. | 0. | 1.0450E-01 | 0. | 0. | 1.0046E+01 | 2.4000E-02 |
| 1.8000E+01 | 3.1167E+01 | 7.2426E+00 | 2.6905E-03 | 2.1816E-02 | 4.3629E-03 | 9.4945E-03 | 1.1856E-01 | | |

ORIGINAL PAGE IS
OF POOR QUALITY

# 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

# TABLE OF CONTENT

TABLE OF CONTENT ..... Cont'd

CONTENT | PAGE

26 MAR '79

ORIGINAL PAGE IS
OF POOR QUALITY

## 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.

L.S. [signature] 26 MAY '79



## 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 BENDING, (b) VEHICLE TORSION, (c) REAR-END BENDING, (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.

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.

21 MAR '94

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 DENOTE THE ORIGINAL AND NEW (SUBSTITUTE MATERIAL. THEN,

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

21 MAR '79

## 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,

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

THEREFORE,

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

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:

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

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),

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

WHERE,

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

* REFERENCE 1.

26 MAR '79

## 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 (E)

THE BUCKLING STRENGTH OF A CURVED PANEL IS GIVEN BY BRUNN (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 COEFFICIENT; 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

ORIGINAL PAGE IS OF POOR QUALITY

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 ($= RESIST_{OIL-CAN}$)

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

$\rho$ = MATERIAL DENSITY

$t$ = MATERIAL THICKNESS

5.0 THEORETICAL DEVELOPMENT . . . CONT'D

$\zeta$ = CONSTANT DEPENDING ON PANEL GEOMETRY AND VIBRATION MODE SHAPE.

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

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

FOR PRACTICAL AUTOMOTIVE DESIGNS $m \approx 2$. 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.

ORIGINAL PAGE IS OF POOR QUALITY

## 5.0 THEORETICAL DEVELOPMENT ..... CONT'D

### 5.2 THIN-WALL BEAM MEMBERS

ORIGINAL PAGE IS OF POOR QUALITY

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.,

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

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:

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

5.0 THEORETICAL DEVELOPMENT ..... CONT'D

WHERE,

ORIGINAL PAGE IS OF POOR QUALITY

$L$ = 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

$$\frac{STIFF_{BEND_N}}{STIFF_{BEND_0}} = \left(\frac{E_N}{E_0}\right) \cdot \left(\frac{t_{REF_N}}{t_{REF_0}}\right) \quad ...... (24)$$

FOR EQUAL STIFFNESS,

$$\frac{t_N}{t_0} = \frac{t_{REF_N}}{t_{REF_0}} = \left(\frac{E_0}{E_N}\right) \quad ..... (25)$$

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,

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

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),

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

OR

$$\frac{STIFF_{TORSION_N}}{STIFF_{TORSION_0}} = \frac{G_N}{G_0} \cdot \frac{t_N}{t_0} \sim \frac{E_N}{E_0} \cdot \frac{t_N}{t_0} \quad \ldots\ldots \quad (29)$$

FOR EQUAL STIFFNESS,

$$\frac{t_N}{t_0} = \frac{E_0}{E_N} \quad \ldots\ldots \quad (30)$$

CLOSED SECTION TORSIONAL STIFFNESS

## 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,

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

[signature] 26 MAR '79

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,

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

WHERE,

$L_j$ = LENGTH OF $j^{th}$ ELEMENT

$t_j$ = THICKNESS OF $j^{th}$ "

$a_j$ = SECTION SHAPE FACTOR

$c_j$ = " " "

FROM (35),

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

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

$$\frac{M_N}{M_0} = \left(\frac{STRESS_{YLD_N}}{STRESS_{YLD_0}}\right) \cdot \frac{t_N}{t_0} \quad \ldots\ldots (38)$$

FOR EQUAL STRENGTH (OF SECTION)

$$\frac{t_N}{t_0} = \frac{STRESS_{YLD_0}}{STRESS_{YLD_N}} \quad \ldots\ldots (39)$$

BENDING STRENGTH

26 Mar '79

## 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

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

## 5.0 THEORETICAL DEVELOPMENT ..... CONT'D

FOR EQUAL RESISTANCE TO BUCKLING,

$$\frac{t_N}{t_0} = \frac{E_0}{E_N} \quad \ldots\ldots (44)$$

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

$\nu$ = POISSONS' RATIO

$t$ = MATERIAL THICKNESS

FOR MATERIAL SUBSTITUTION WE HAVE,

$$\frac{RESIST_{BUCK_N}}{RESIST_{BUCK_0}} = \left(\frac{E_N}{E_0}\right)\left(\frac{1-\nu_0^2}{1-\nu_N^2}\right)\left(\frac{t_N}{t_0}\right)^3 \quad \ldots\ldots (46)$$

FOR EQUAL RESISTANCE TO BUCKLING,

$$\frac{t_N}{t_0} = \left[\frac{E_0}{E_N}\cdot\frac{1-\nu_N^2}{1-\nu_0^2}\right]^{1/3} \quad \ldots\ldots (47)$$

FLANGE BUCKLING

31 MAR '79

## 5.0 THEORETICAL DEVELOPMENT ..... CONT'D

CRIPPLING OF SECTION: THE CRIPLING 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 DEGREE 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,

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

### 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.

## 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,

$$K \sim Et \quad \ldots\ldots (55)$$

$$M = CONST$$

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

26 NOV '79

## 5.0 THEORETICAL DEVELOPMENT ..... CONT'D

NOW,

$$\frac{\omega_N}{\omega_o} = \left[\frac{E_N}{E_o} \cdot \frac{t_N}{t_o}\right]^{1/2} \quad \ldots\ldots (57)$$

FOR EQUAL FREQUENCY RESPONSE,

$$\frac{t_N}{t_o} = \frac{E_o}{E_N} \quad \ldots\ldots (58)$$

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,

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

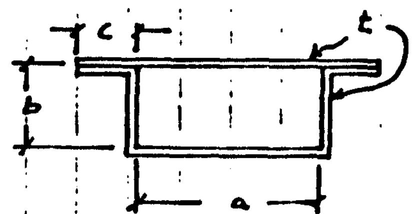



FIGURE 1

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,

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

$\therefore$

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

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,

$$\frac{EN_N}{EN_0} = \frac{P_{MS_N}}{P_{MS_0}} = \frac{t_n^2 S_{YLD}(\dot{\varepsilon})_N}{\left(\frac{b}{2} - 5t_n\right)} \cdot \frac{\left(\frac{b}{2} - 5t_0\right)}{t_0^2 S_{YLD}(\dot{\varepsilon})_0}$$

$$\frac{EN_N}{EN_0} = \left(\frac{t_n}{t_0}\right)^2 \cdot \left(\frac{S_{YLD}(\dot{\varepsilon})_N}{S_{YLD}(\dot{\varepsilon})_0}\right) \cdot \frac{\left(\frac{b}{2} - 5t_0\right)}{\left(\frac{b}{2} - 5t_n\right)} \quad \ldots .. (66)$$

FOR $\frac{b}{2} \gg t_0 ; \gg t_n$ AND FOR EQUAL ENERGY ABSORPTION,

$$\frac{t_n}{t_0} \simeq \sqrt{\frac{S_{YLD}(\dot{\varepsilon})_0}{S_{YLD}(\dot{\varepsilon})_N}} \quad \ldots . (67)$$

ENERGY ABSORPTION

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

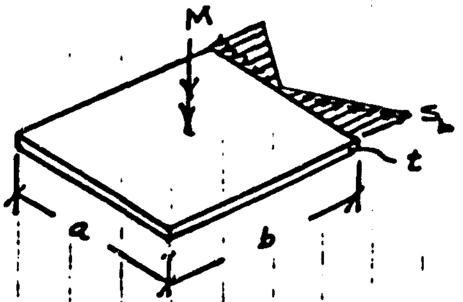
## 5.0 THEORETICAL DEVELOPMENT ... CONT'D

### 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,




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

HERE,

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

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),

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

26 MAR '79

## 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,

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

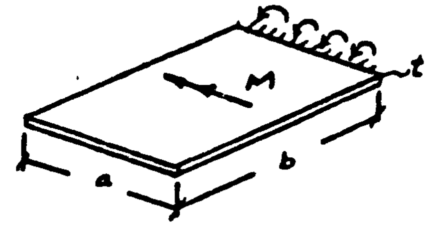



FIGURE 3

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,

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

26 Mar '79

## 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,

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

S. [signature] 26 MAR '79

## 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 PRIORITY 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 BEAMING OF THE SUSPENDED WEIGHT OF THE VEHICLE TO THE FORE AND AFT AXLES AND THE STIFFNESS REQUIREMENTS FOR RIDING AND HANDLING.

HYBRID VEHICLE | DATE:

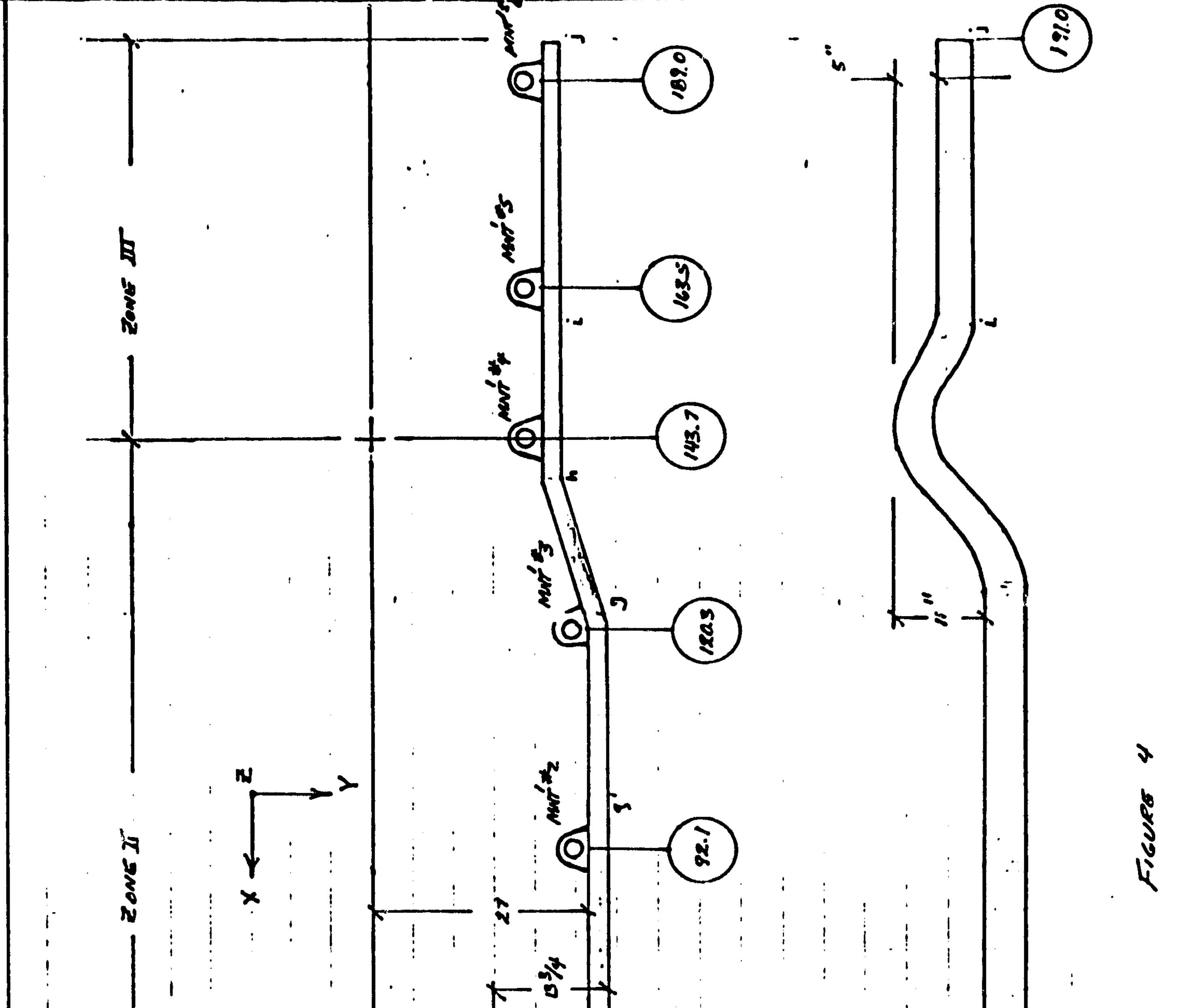



FIGURE 4

26 MAR '79

## 6.0 FORD LTD WEIGHT SAVING CALCULATION'S

### 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:

- $S_{EU} = 65{,}000$ psi (min)
- $S_{EYW} = 50{,}000$ 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):

- $S_{EU} = 40{,}000$ 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.

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

WHERE,

V = IMPACT SPEED (MPH)

PAGE IS

26 MAR '79

## 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: FLANGE | | BUCKLING: CRIPPLING | | IMPACT | |
|---|---|---|---|---|---|---|---|---|
| ALUMINUM ALLOY | $t_N/t_o$ | $\Delta W$ % | $t_N/t_o$ | $\Delta W$ % | $t_N/t_o$ | $\Delta W$ % | $t_N/t_o$ | $\Delta W$ % |
| 5182 | 1.72 | -39.1 | 1.41 | -50.2 | 1.60 | -43.5 | 1.52 | -46.9 |
| 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 | -42.9 | 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 | 23 | 24 | 25 | 26 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORIGINAL MATERIAL | | | | | SUBSTITUTE MATERIAL | | | | | MATERIAL PERFORMANCE - $t_N/t_o$ ; ΔW | | | | | | | | | | | | | | | |
| | | | | | | | | | | STIFFN. | | YIELDING | | BUCKLING: COLUMN | | BUCKLING: FLANGE | | BUCKLING: CRIPPL'G | | VIBRATION: ELE. MASS | VIBRATION: SYS. MASS | | IMPACT | | 1 |
| ALLOY | $S_{YLD}$ $\times 10^3$ [1] | ρ #/in³ | E $\times 10^6$ | ν | ALLOY | $S_{YLD}$ $\times 10^3$ | ρ #/in³ | E $\times 10^6$ | ν [3] | $t_N/t_o$ | ΔW/W₀ | $t_N/t_o$ | ΔW/W₀ | $t_N/t_o$ | ΔW/W₀ | $t_N/t_o$ | ΔW/W₀ | $t_N/t_o$ | ΔW/W₀ | $\omega_N/\omega_o$ | $t_N/t_o$ | ΔW/W₀ | $t_N/t_o$ | ΔW/W₀ | |
| 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.[illegible] (80) | 1.60 (50) | -49.5 (80) | .97 (53) | 3.0 (58) | +67% (80) | 1.52 (67) | -46.5 | 2 |
| " | 50 [1] | .283 | 30 | .25 | 2014-T4 | 37 [2] | .1 | 10 | .32 | 3.0 (25, 30,34) | +67% | 1.35 (39) | -52.[illegible] (80) | 3.0 (44) | +67% (80) | 1.41 (47) | -50.[illegible] (80) | 1.49 (50) | -47.3 (80) | .97 (53) | 3.0 (58) | +67% (80) | 1.39 (67) | -52.6 | 3 |
| " | 50 [1] | .283 | 30 | .25 | 6061-T6 | 40 [2] | .1 | 10 | .32 | 3.0 (25, 30,34) | +67% | 1.25 (39) | -55.[illegible] (80) | 3.0 (44) | +67% (80) | 1.41 (47) | -50.[illegible] (80) | 1.46 (50) | -48.5 (80) | .97 (53) | 3.0 (58) | +67% (80) | 1.29 (67) | -54.[illegible] | 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.[illegible] (80) | 1.31 (50) | -53.6 (80) | .97 (53) | 3.0 (58) | +67% (80) | 1.07 (67) | -62.[illegible] | 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.[illegible] (80) | 1.22 (50) | -52.[illegible] (80) | .97 (53) | 3.0 (58) | +67% (80) | .95 (67) | -66.[illegible] | 6 |
| " | 25 [1] | .283 | 30 | .25 | 6061-T6 | 40 [2] | .1 | 10 | .32 | 3.0 (25, 30,34) | +67% | .63 (39) | -71.7 (80) | 3.0 (44) | +67% (80) | 1.41 (47) | -50.[illegible] (80) | 1.20 (50) | -52.7 (80) | .97 (53) | 3.0 (58) | +67% (80) | .91 (67) | -62.7 | 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.[illegible] (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 | -57.9 | 9 |
| " | 36 [1] | .283 | 30 | .25 | 6061-T6 | 40 [2] | .1 | 10 | .32 | 3.0 (25, 30,34) | +67% | .90 (39) | -68.[illegible] (80) | 3.0 (44) | +67% (80) | 1.41 (47) | -50.2 (80) | 1.53 (50) | -53.1 (80) | .97 (53) | 3.0 (58) | +67% (80) | 1.10 | -66.2 | 10 |
| " | 36 [1] | .283 | 30 | .25 | PLASTIC PIPC (TABLE II) | 9.5 | .057 | 1.85 | .35 | 16.2 | +284 | 3.79 | -10.3 | 16.2 | +284 | 2.48 | -41.4 | 3.24 | -23.2 | .61 | 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

## 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 IMPORTANCE IN ZONE I 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

26 MAR '79

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 ASSUMED 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.

[signature] 26 MAR '79

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.

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

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 | 5182 | 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 (PLASTIC)[4] | 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 (PLASTIC) 290[5] | 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 290, HAS 20% GLASS REINFORCEMENT; BY ARCO / POLYMERS INC.
6. YIELD STRENGTHS UNAVAILABLE; HENCE, $S_{YLD}$ ≅ .7 $S_{ULT}$ ASSUMED.

[signature] 26 MAR '79

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

[signature] 26 MAR '79

## 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

## 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

...AL PAGE IS ...UALITY

## 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 |

## 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 | -66.6 |

# LIST OF REFERENCES


1. David C. Chang and J. W. Justusson. "Structural Requirements in Material Sugstitution for Car-Weight Reduction". SAE 760023.

2. J.A. DiCell and R.A. George. "Design Criteria for Dent Resistance of Auto Body Panels". SAE 740081.

3. T. E. Johnson, Jr., and W. O. Schaffnit. "Dent Resistance of Cold Rolled Low-Carbon Steel Sheet." SAE 730528.

4. E. F. Bruhn. "Analysis and Design of Flight Vehicle Structures". Tri-State Offset Company, Cincinnati, Ohio, 1965.

5. Y. Ohkubo, T. Akamatsu, and K. Shirasawa. "Mean Crushing Strength of Closed-Hat Section Members". SAE 740040.

6. Sheet Committees. "Cost-Effective Weight Reduction with Sheet Steel". American Iron and Steel Institute, Washington D.C., Report SG 631R-1177-10M-RP.

7. Committee of Sheet Steel Producers. "The Materials Decision". American Iron and Steel Institute, Washington D.C., Report SG 834-279-5M-DJ.

WHARTON EFA, INC. WEFA

APPENDIX B3

# THE MARKET POTENTIAL FOR HYBRID VEHICLES

by

Colin J. Loxley
Priscilla Luce
Kathleen Rodenrys

March 1979

A Report Prepared by

Wharton EFA, Inc.
3624 Science Center
Philadelphia, PA 19104

for

South Coast Technology, Inc.
Santa Barbara, CA

TABLE OF CONTENTS

WHARTON EFA, INC. WEFA

# 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.

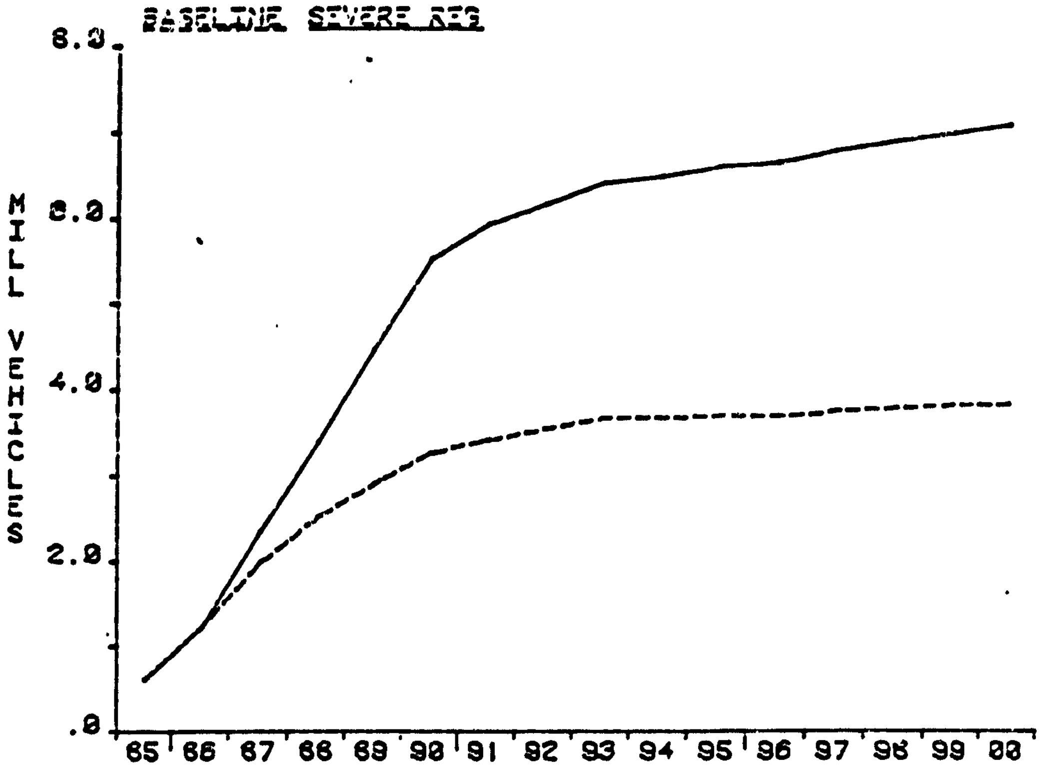
3. The real price of gasoline is critical: each 1% change produces almost a 1% change in hybrid sales; for real electricity prices, the effect is almost exactly half as important.

IS

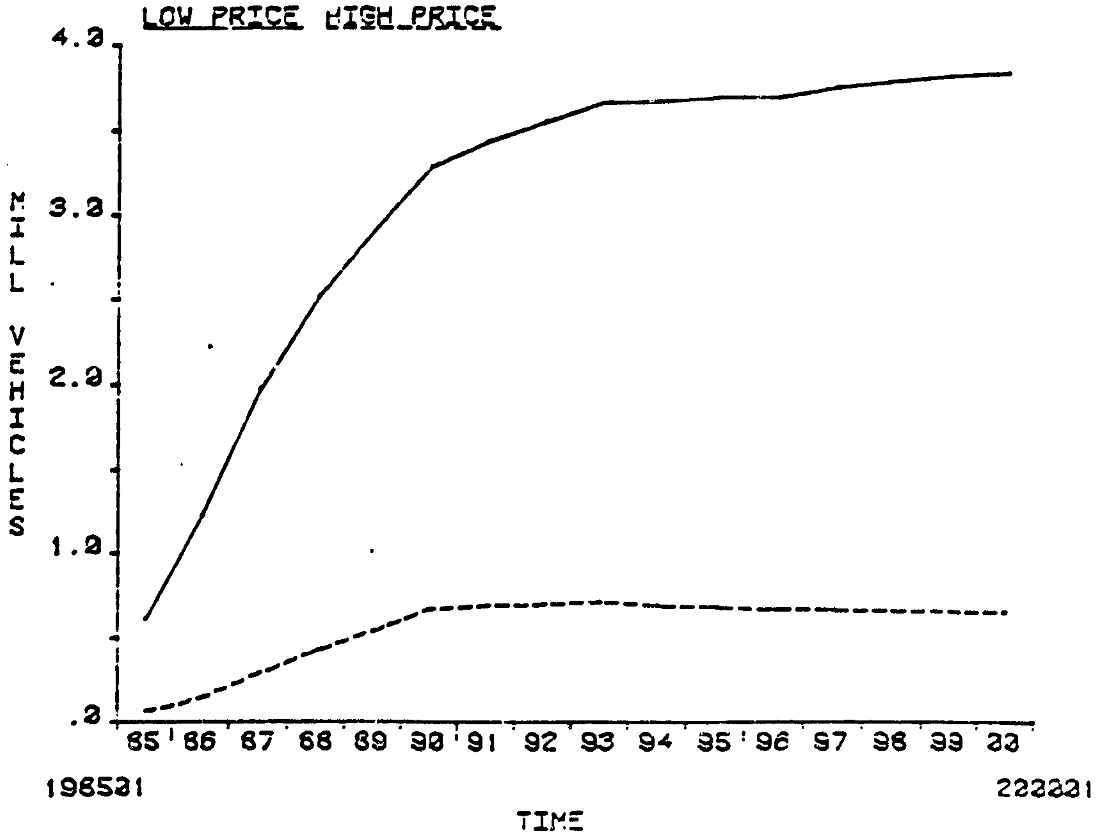
4. The most effective way to maximize hybrid sales is with models in each market segment: even though large cars benefit the most, the size of the mid-size/intermediate segment established in the U.S. market makes this a signifi.ant potential source of hybrid sales.

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.

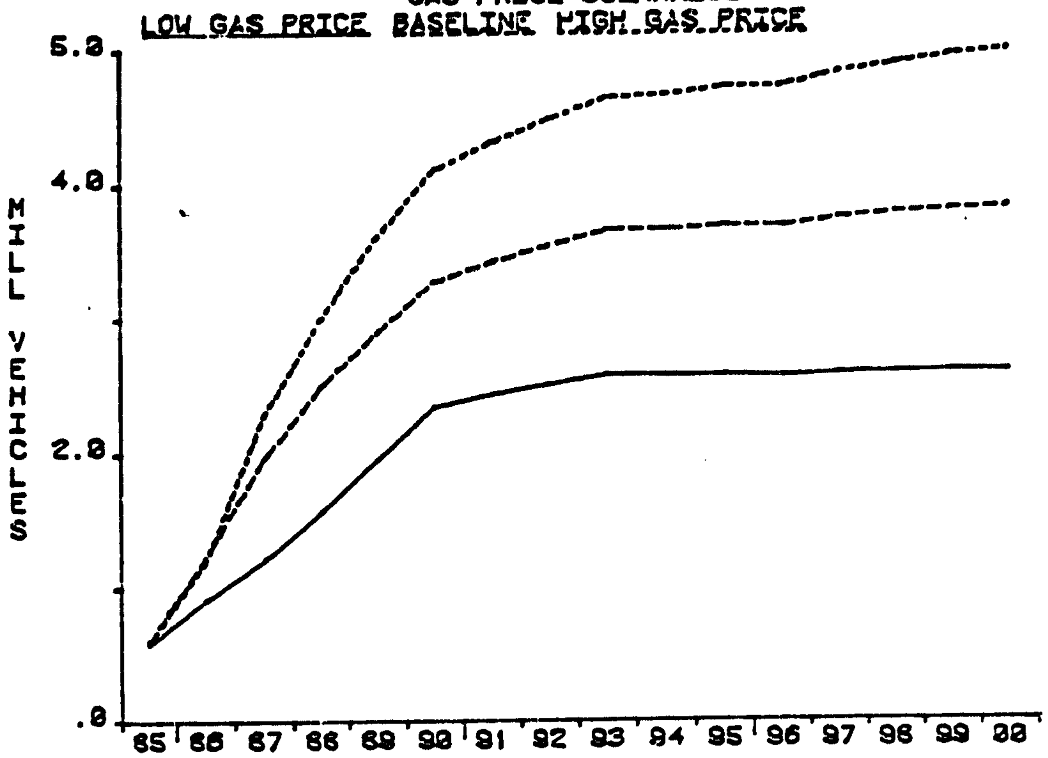
WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
REGULATION SCENARIOS



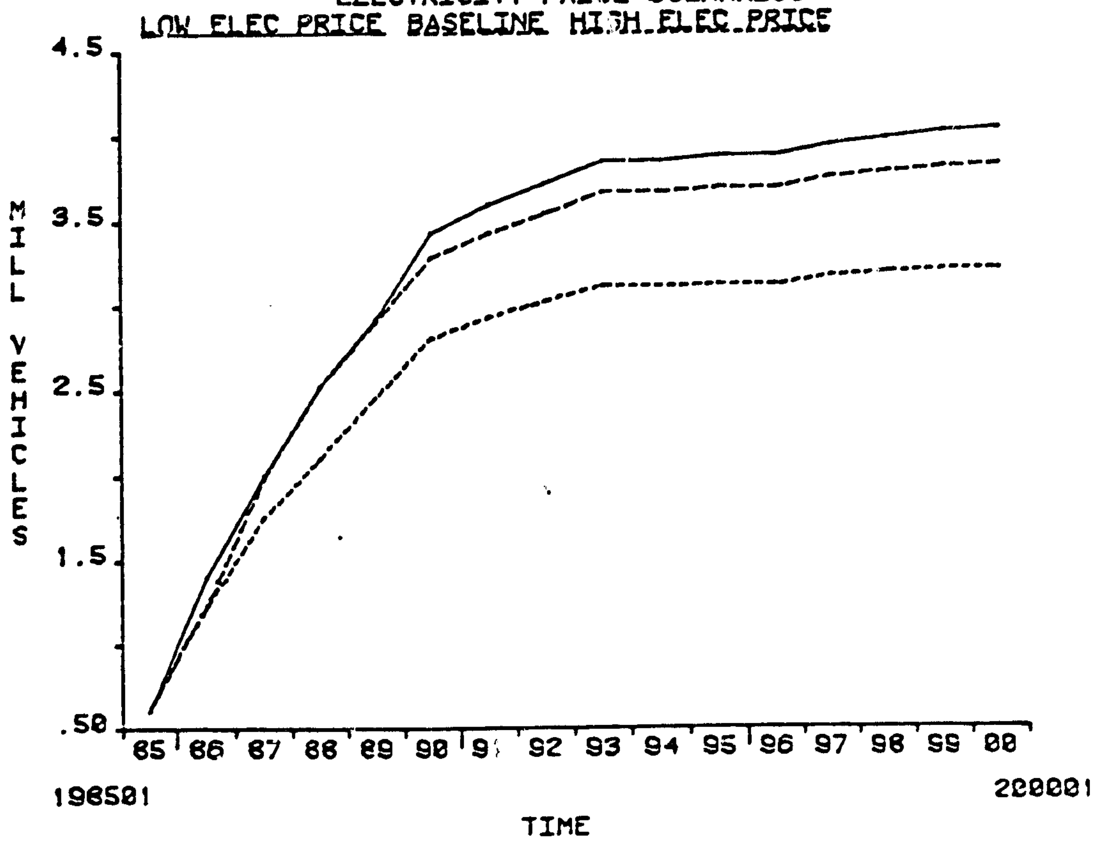

WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HYBRIDS NEW REGISTRATIONS
HYBRID PRICE SCENARIOS



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




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



## 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 <u>0.5 million units annually</u>. 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

---

[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:

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

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.

WHARTON EFA, INC. WEFA

# HYBRID STUDY CONTROL FORECAST SUMMARY TABLE

| | | 1970 | | 1975 | | 1978 | | 1980 | | 1985 | | 1990 | | 1995 | | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RETAIL SALES, TOTAL | (mills) | 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 | (mills) | 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 | (mills) | 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 | (mills) | 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 | (mills) | 204.9 | | 213.5 | | 218.5 | | 222.2 | | 233.0 | | 243.6 | | 252.9 | | 260.3 |
| average annual growth rate | | | 0.8 | | 0.8 | | 0.8 | | 1.0 | | 0.9 | | 0.8 | | 0.6 | |
| LICENSED DRIVERS | (mills) | 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 | (mills) | 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 | (bills) | 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] PRICE REGULAR | (¢) | 35.7 | [illegible] | 57.2 | [illegible] | 65.3 | 11.[illegible] | 80.7 | 11.6 | 138.2 | 8.0 | 202.8 | 4.6 | 254.3 | 4.4 | 316.0 |

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.

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

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 | 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 | 7.086 | 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 | 1.062 | 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 | 39.548 | 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.

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

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 | 3.583 | 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.[illegible]2 | 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.

ORIGINAL PAGE IS OF POOR QUALITY

T. WHARTON EFA MOTOR 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 | 22[illegible].384 |
| 32 | | | | | | | | | |
| 33 | TOTAL DOMESTIC NEW CAR MPG (EPA) | | 30.41 | 30.39 | 30.37 | 30.37 | 30.35 | 30.33 | 3[illegible].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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MO[illegible] VEHICLE DEMAND MODEL
HIGH PRICE HYBRIDS - HEDONIC SHARES

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 | [illegible] | 0.878 | 1.160 | 1.435 | 1.698 |
| 17 | LUXURY | | 0.011 | 0.032 | 0.077 | 0.145 | [illegible] | 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 | [illegible] | 77.233 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
HIGH PRICE HYBRIDS - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

| LINE | ITEM | UNIT | 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 (NEFA) | | 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.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - LOW ELEC PRICE - HEDONIC SHARES

TABLE 1.10 HYBRID CAPS

| 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 | [illegible] |
| 10 | | %SHARE | 1.8 | 4.9 | 6.2 | 7.3 | 8.2 | 9.1 | 9.0 | 8.9 | 8.8 |
| 11 | LUXURY | | 0.104 | 0.220 | 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 | | 15805. | 16309. | 17286. | 18199. | 19165. | 20188. | 21263. | 22400. | 23582. |
| 21 | FULL SIZE | | 16098. | 17038. | 18013. | 19005. | 20007. | 21068. | 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 | 118.028 | 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 MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - LOW ELEC 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 | 51.99 | 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 | 10.728 | 10.939 | 11.089 |
| 17 | LUXURY | | 4.887 | 5.442 | 5.935 | 6.371 | 6.747 | 7.070 | 7.300 |
| 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 | 24.65 | 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.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - HIGH ELEC PRICE - HEDONIC SHARES

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 | 0.950 | 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 | 6.697 | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - HIGH ELEC 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 | % | 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 | 29.180 |
| 15 | MID-SIZE | | 10.294 | 11.336 | 12.226 | 12.981 | 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. | 31650. | 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 | 238.778 | 252.984 | 265.413 |
| 30 | | | | | | | | | |
| 31 | ELECTRICITY CONSUMED | BILL KWH | 115.931 | 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 | 29.88 |
| 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 | MILL GAL | 71.488 | 72.396 | 73.329 | 74.525 | 76.097 | 77.943 | 79.958 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - LOW PRICE GAS - HEDONIC SHARES

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 | 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 | 1.230 |
| 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 | 4.646 | 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. | 30260. | 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 | 45.416 | 60.231 | 75.441 | 93.880 |
| 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 | 82.883 | 81.939 | 82.317 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - LOW 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 | % | 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 | | 1.236 | 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 | 17.098 | 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. | 28948. | 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 | 243.138 |
| 30 | | | | | | | | | |
| 31 | ELECTRICITY CONSUMED | BILL KWH | 106.047 | 120.220 | 132.871 | 144.113 | 154.122 | 162.885 | 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 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MO... VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - HIG PRICE GAS - HEDONIC SHARES

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 | 80.00 | 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 | 0.718 | 0.983 | 1.123 | 1.249 | 1.296 | 1.338 | 1.378 |
| 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 | 4.085 | 7.013 | 10.542 | 14.502 | 18.569 | 22.628 | 26.615 |
| 15 | MID-SIZE | | 0.292 | 0.879 | 2.087 | 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. | 22409. | 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 (MEFA) | | 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.

ORIGINAL PAGE IS
POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
LOW PRICE HYBRIDS - HIGH PRICE GAS - HEDONIC SHARES

TABLE 1.10 HYBRID CARS

| LINE | ITEM | UNIT | 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 | 66.68 |
| 2 | FULL SIZE | | 80.30 | 80.10 | 80.10 | 80.10 | 80.10 | 80.00 | 79.78 |
| 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 | 4.887 | 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. | 45065. | 47368. |
| 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 | 1.145 | 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 |

A PRODUCT OF WHARTON EFA, INC.

WHARTON EFA, INC. WEFA

## INDEX OF TABLES

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 113.984 | 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 | 2.075 | 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. | 3730. | 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 | 131,897 | 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 | 15,354 | 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 | 1572.46 | 1610.76 | 1651.46 | 1693.52 | 1732.91 | 1774.01 | 1818.51 | 1866.87 | 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. | 15200. | 16070. | 16918. | 17818. | 18749. | 19718. | 20737. | 21811. | 22922. | 24091. |
| 43 | | %GROWTH | 5.4 | 5.0 | 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 | 21,495 | 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 | 1,087 | 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 |

MARCH CONTROL FOR HYBRIDS

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 | 2,156 | 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 | 89.90 | 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 | 10.80 | 10.64 | 10.72 |



ORIGINAL PAGE IS
OF POOR QUALITY

# THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
## MARCH CONTROL FOR HYBRIDS

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 | | %SHARE | 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 | | %SHARE | 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 | 4,118 |
| 8 | | %SHARE | 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 | | %SHARE | 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 | | %SHARE | 10.54 | 10.63 | 10.72 | 10.78 | 10.84 | 10.91 | 10.99 | 11.11 | 11.19 | 11.27 | 11.31 |

MARCH CONTROL FOR HYBRIDS

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 | | %SHARE | 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 | | %SHARE | 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 | 4,118 |
| 8 | | %SHARE | 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 | | %SHARE | 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 | | %SHARE | 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 | | %SHARE | 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 | | %SHARE | 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 | | %SHARE | 6.28 | 6.30 | 6.40 | 6.16 | 5.88 | 5.69 | 5.58 | 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 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 |

MARCH CONTROL FOR HYBRIDS

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 |

MARCH CONTROL FOR HYBRIDS

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 |

A PRODUCT OF WHARTON EFA, INC.

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 | 9.3 | 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 |

A PRODUCT OF WHARTON EFA, INC.

# THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
## MARCH CONTROL FOR HYBRIDS

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 | 26,189 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 140,789 |
| 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 | 22,709 | 23,492 | 24,249 | 25,012 | 25,814 | 26,621 | 27,412 | 28,160 |
| 2 | | | | | | | | | | | | | |
| 3 | SUBCOMPACTS | | 18,877 | 19,463 | 20,087 | 20,709 | 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 | 1.8 |
| 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 | 1.6 |
| 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 | 2.0 | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS OF POOR QUALITY

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 |

MARCH CONTROL FOR HYBRIDS

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 |

MARCH CONTROL FOR HYBRIDS

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 |

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 | 100.148 | 101.815 | 103.605 | 105.317 | 107.196 | 109.157 | 111.088 | 112.948 | 114.775 | 116.573 | 118.212 |
| 2 | | | | | | | | | | | | |
| 3 | LESS THAN 1 YEAR OLD | 5.391 | 5.262 | 5.309 | 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 | 11.078 | 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 | 7.978 | 7.767 | 7.948 |
| 12 | AGE, 9 YEARS OLD | 5.383 | 6.321 | 6.789 | 7.360 | 5.627 | 5.382 | 6.287 | 6.916 | 7.027 | 6.894 | 6.708 |
| 13 | AGE, 10 YEARS OLD | 4.894 | 4.307 | 5.175 | 5.528 | 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 | 2.378 | 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 | 0.688 | 0.789 | 0.826 | 0.878 |
| 20 | AGE, 17 YEARS OLD | 0.405 | 0.458 | 0.502 | 0.572 | 0.537 | 0.493 | 0.556 | 0.561 | 0.408 | 0.568 | 0.590 |
| 21 | AGE, 18 YEARS OLD | 0.282 | 0.298 | 0.335 | 0.366 | 0.417 | 0.393 | 0.359 | 0.398 | 0.400 | 0.389 | 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 | 0.289 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 | 0.84 | 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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS



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 | 139,460 |
| 2 | | | | | | | | | | | | |
| 3 | LESS THAN 1 YEAR OLD | 6,332 | 6,539 | 6,784 | 7,037 | 7,114 | 7,247 | 7,323 | 7,521 | 7,660 | 7,790 | 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 | 15,260 | 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 | 11,782 | 11,823 | 11,725 | 11,897 | 12,030 | 12,415 | 12,874 | 13,309 | 13,408 | 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 | 8,986 | 9,211 | 9,532 |
| 12 | AGE: 9 YEARS OLD | 6,880 | 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 | 4,105 | 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 | 0,618 | 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 | 0,408 |
| 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 | 0,185 |
| 23 | AGE: 20 YEARS OLD | 0,177 | 0,202 | 0,207 | 0,213 | 0,153 | 0,136 | 0,151 | 0,150 | 0,151 | 0,140 | 0,120 |

MARCH CONTROL FOR HYBRIDS

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 | 5.85 | 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 | 1.40 | 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 | 0.28 | 0.25 | 0.19 | 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 | -1.5 | -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 | -3.1 | 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 | 6.8 | -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 | -10.8 | 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 | -0.1 | 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 | 6.9 | 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 | -20.7 | -6.6 | 16.1 | 8.8 | 0.5 | -3.2 | -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 | 2,6 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 9,015 | 8,563 | 9,188 | 9,562 | 9,555 | 9,627 | 10,158 | 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 | 2,289 |
| 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 | 2,384 |
| 10 | | | | | | | | | | | | |
| 11 | MID-SIZE | 2,212 | 1,989 | 2,112 | 2,206 | 2,280 | 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 | 0,958 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 | 6,6 |
| 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 | 6,3 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 | -3,0 | -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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 9.00 MISCELLANEOUS MARKET VARIABLES

| LINE | ITEM | | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LONG-RUN EQUILIBRIUM ('DESIRED') VALUES | | | | | | | | | | | | |
| 2 | DESIRED STOCK | MILL AUTOS | 101.306 | 103.668 | 105.598 | 107.860 | 110.297 | 112.536 | 114.812 | 117.070 | 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 | 2[illegible].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 | | 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 | 0.0 | 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 |

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 9.00 MISCELLANEOUS MARKET VARIABLES

| LINE | ITEM | UNIT | 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 |

MARCH CONTROL FOR HYBRIDS

TABLE 9.10 GROWTH RATES, MISCELLANEOUS MARKET VARIABLES

| LINE | ITEM | UNIT | 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 | -0.1 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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. | 20219. | 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. | 16056. | 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. |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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. | 20078. | 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. | [illegible] |
| 10 | COMPACT | 755. | 818. | 885. | 957. | 1036. | 1120. | 1210. | 1304. | 1407. | 1517. | [illegible] |
| 11 | MID-SIZE | 890. | 961. | 1038. | 1119. | 1209. | 1304. | 1405. | 1512. | 1628. | 1750. | [illegible] |
| 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. | 16524. | 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. | 2855. | 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. | 1587. | 1687. | 1791. | 1898. | 2017. | 2143. | 2278. | 2416. |
| 38 | COMPACT | 1880. | 1985. | 2093. | 2208. | 2329. | 2456. | 2589. | 2719. | 2856. | 3002. | 3149. |
| 39 | MID-SIZE | 2428. | 2508. | 2672. | 2801. | 2936. | 3074. | 3215. | 3356. | 3501. | 3650. | 3803. |
| 40 | FULL SIZE | 2600. | 2722. | 2849. | 2979. | 3115. | 3253. | 3393. | 3531. | 3677. | 3828. | 3974. |
| 41 | LUXURY | 2835. | 2956. | 3080. | 3206. | 3338. | 3471. | 3607. | 3742. | 3881. | 4022. | 4168. |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS



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. | 16718. | 17544. |
| 4 | LUXURY | 21033. | 22723. | 24684. | 26683. | 28799. | 30982. | 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. | 13587. | 14179. |
| 19 | LUXURY | 18179. | 19626. | 21325. | 23056. | 24885. | 26730. | 28461. | 30280. | 32156. | 34155. | 36252. |

MARCH CONTROL FOR HYBRIDS

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 | 7.5 | 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 | 11.5 | 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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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. | 9281. | 9651. | 10081. | 10531. | 11002. | 11486. | 11991. | 12520. | 13073. |
| 18 | COMPACT | 14884. | 15549. | 16290. | 17069. | 17888. | 18748. | 19651. | 20583. | 21561. | 22588. | 23666. |
| 19 | LUXURY | 38887. | 40890. | 43450. | 46176. | 49079. | 52171. | 55464. | 58905. | 62565. | 66459. | 70601. |

MARCH CONTROL FOR HYBRIDS

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 |

A PRODUCT OF WHARTON EFA, INC.

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 | 0.959 | 1.022 |

MARCH CONTROL FOR HYBRIDS

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 | 8.0 | 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 | 0.920 |
| 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 | 1.850 | 1.970 |

MARCH CONTROL FOR HYBRIDS

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 | 5.5 | 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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 19.28 |
| 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 | 12.80 | 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 |

MARCH CONTROL FOR HYBRIDS

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 |

A PRODUCT OF WHARTON EFA, INC.

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 | 19.65 | 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 | 15.58 | 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 | 18.27 | 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 |

MARCH CONTROL FOR HYBRIDS

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 | 1.76 | 3.83 | 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 | 4.8 | 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 | 9.0 | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

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 | 0.08 | -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 | -0.3 | -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 (%): | | | | | | | | | | | | |
| 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 | 69.61 | 69.73 | 70.09 | 70.18 |
| 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 | 63.08 |
| 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 | 5.88 |
| 2 | | | | | | | | | | | | | |
| 3 | PRICE OF 1 YR OLD CAR/NEW CAR (%): | | | | | | | | | | | | |
| 4 | SUBCOMPACT | | 0.37 | 1.20 | 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 | 1.20 | -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 | -1.58 | 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 | [illegible] | -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 | 2.91 |

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. | 10485. | 11080. | 11682. | 12347. | 13051. |
| 2 | | | | | | | | | | | | | |
| 3 | PRICE OF 1 YR OLD CAR/NEW CAR (%): | | | | | | | | | | | | |
| 4 | SUBCOMPACT | | 80.21 | 80.01 | 79.73 | 79.44 | 79.45 | 79.55 | 79.62 | 79.59 | 79.87 | 79.86 | 79.88 |
| 5 | COMPACT | | 70.01 | 69.77 | 69.39 | 69.06 | 69.13 | 69.22 | 69.31 | 69.18 | 69.08 | 69.06 | 69.15 |
| 6 | MID-SIZE | | 64.89 | 64.74 | 64.46 | 64.23 | 64.20 | 64.32 | 64.38 | 64.38 | 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 | 69.78 | 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 | 22,074 | 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 (%): | | | | | | | | | | | | |
| 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 | 1.71 | 2.13 | 0.86 | 1.81 | 1.99 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 VARIABLES

| 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 | -0.2 | -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 |

THE WHARTON EFA MO[illegible] VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 736.89 |
| 4 | TRANSFER PAYMENTS | BILL CURR $ | 250.51 | 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 | 25.20 | 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 | 328.8 | 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 | 617.4 | 666.8 |
| 20 | TIRES | | 154.7 | 160.0 | 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.[illegible] | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 5100.58 | 5513.24 | 5961.04 | 6431.28 | 6939.60 | 7482.02 | 8078.19 | 8712.26 | 9398.88 | 10132.54 |
| 3 | PERSONAL INCOME TAXES | BILL CURR $ | 804.43 | 875.39 | 955.03 | 1041.53 | 1131.39 | 1228.22 | 1334.31 | 1452.64 | 1578.08 | 1716.05 | 1865.88 |
| 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 | 34.20 | 35.76 | 37.37 | 38.90 | 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 | 1320.1 | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 9.0 |
| 4 | TRANSFER PAYMENTS | BILL CURR $ | 12.3 | 11.3 | 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 | 1.6 | 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 | 7.5 |
| 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | 4.4 |
| 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 | 4.8 | 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 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

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. | 2809. |
| 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 |

THE WHARTON EFA MOI[illegible] VEHICLE DEMAND MODEL
MARCH CONTR[illegible] FOR HYBRIDS

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 | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. |
| 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 |

ORIGINAL PAGE IS
OF POOR QUALITY

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

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 | -4.1 | -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 | -6.8 | -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 | -5.3 | -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 | -5.8 | -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.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS



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 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 |
| 13 | LUXURY | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 | 1,038 |
| 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 |

MARCH CONTROL FOR HYBRIDS

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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 28.00 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 | EPACFMPGC | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 | -0.90 |
| 5 | EPACFMPGH | -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 | EPALFMPGC | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 | -0.75 |
| 11 | EPALFMPGH | -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 | EPASFMPGC | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| 17 | EPASFMPGH | -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 | KFND*AY/LD | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 |
| 21 | OMVHANR | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 | -1.060 |
| 22 | OPMVHAC+LFYFND | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23 | PC4112-1701 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | PC4121-1000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | PC4122-1001 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26 | PC4122-1783 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | PDLFDAVN | 6.030 | 9.260 | 10.690 | 10.710 | 10.400 | 10.270 | 11.360 | 12.700 | 14.590 | 16.090 | 17.590 |
| 28 | PERIS* | 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 | PU/MCT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31 | PU/MFD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 32 | PU/MLT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 33 | PU/NMD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34 | PU/NGT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35 | PUCFDAVN | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 | 0.094 |
| 36 | PURMVUNA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 37 | PUSFNW | 90.000 | 90.000 | 90.006 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 |
| 38 | SANRRDAV | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 39 | SANRRDAVD-V | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 | 0.070 |
| 40 | SANRRDAVF-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 | 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 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SCMVUASP | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | SCMVUASF | 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 | SCMVUATF | 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 | -0.000 | -0.001 | -0.001 | -0.002 | -0.003 | -0.003 | -0.004 | -0.004 | -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 | 0.016 | 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 | SHRSF*A | -0.008 | -0.008 | -0.008 | -0.009 | -0.010 | -0.010 | -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 | USCDPOPTH | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 24 | USCDPURASF-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 | 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 | USCFPURASF-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 | USFDPOPTH | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 34 | USFDPURASF-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 | USLDPOPTH | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 40 | USLDPURASF-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 | 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 | USLFPURASF-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 | USMDPOPTH | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 50 | USMDPURASF-2 | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.00 CONSTANT ADJUSTMENTS

| ID. | VAR LABEL | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | USMDPUDPI-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 | USSDPOPTN | 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 | USSDPUDPI-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 | USTDPUPTCFW | 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/EM | 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 | VMTPVA-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 | 0.070 | 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 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.00 CONSTANT ADJUSTMENTS

| LINE | VAR LABEL T I L M | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AVAGEQ-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 | FRMCICR | 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 | KFUD*AV/LD | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 | -0.006 |
| 21 | ONVUAHR | -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 | PC4112-1701 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24 | PC4121-1000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | PC4122-1001 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26 | PC4122-1783 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 27 | PPCEDAVN | 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 | PU/NC? | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31 | PU/NED | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 32 | PU/MLT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 33 | PU/MMD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34 | PU/MST | 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 | PURMVUIA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 37 | PUSED4 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 | 90.000 |
| 38 | SAWRHDAV | 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 | SAWRHDAVF-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 | SCMVUAMD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.00 CONSTANT ADJUSTMENTS

| LINE | VAR LABEL | ITEM | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | SCMVUASF | | 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 | SCMVUATF | | 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 | SHRCDTHR | | 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 | SHRFDTHR | | -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 | SHRLDTHR | | -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 | SHRMDTHR | | 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 | SHRSDTHR | | 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 | SHRSFTHR | | 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 | USCDPOPTN | | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 24 | USCDPURASE-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 | USCFPURASE-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 | USFDPOPTN | | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 34 | USFDPURASE-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 | USLDPOPTN | | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 40 | USLDPURASE-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 | USLFPURASE-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 | USMDPOPTN | | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 50 | USMDPURASE-2 | | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. | 230. |

A PRODUCT OF WHARTON EFA, INC.

TABLE 24.00 CONSTANT ADJUSTMENTS

| LINE | VAR LABEL ITEM | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | USMDPUMPT-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 | USSDPURASE-2 | -190. | -190. | -190. | -190. | -190. | -190. | -190. | -190. | -190. | -190. | -190. |
| 7 | USSDPUMPT-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 | USSFPURASE-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 | USTDPURASEFW | 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 | VMTRA/K | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 | 0.020 |
| 19 | VMTUA/K | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

A PRODUCT OF WHARTON EFA, INC.

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 | EPMHPC | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| 39 | GNTWH/HER | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 |
| 40 | GRPUT/HER | 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 | 0.998 | 0.998 | 0.994 | 0.994 | 0.998 | 0.998 | 0.998 | 0.998 |
| 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 | UPMFT | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 |
| 45 | UPRENC/R | 0.193 | 0.193 | 0.194 | 0.195 | 0.195 | 0.196 | 0.197 | 0.197 | 0.198 | 0.198 | 0.199 |
| 46 | UPRESC/R | 0.061 | 0.060 | 0.059 | 0.059 | 0.058 | 0.057 | 0.057 | 0.056 | 0.055 | 0.055 | 0.054 |
| 47 | UPRHTN/R | 0.049 | 0.050 | 0.051 | 0.052 | 0.053 | 0.054 | 0.055 | 0.056 | 0.057 | 0.058 | 0.060 |
| 48 | UPRNEW/R | 0.057 | 0.056 | 0.056 | 0.056 | 0.056 | 0.056 | 0.056 | 0.056 | 0.055 | 0.055 | 0.055 |
| 49 | UPUPAC/R | 0.137 | 0.138 | 0.139 | 0.140 | 0.141 | 0.142 | 0.143 | 0.144 | 0.145 | 0.147 | 0.148 |
| 50 | UPRSA/R | 0.157 | 0.156 | 0.156 | 0.156 | 0.155 | 0.155 | 0.154 | 0.154 | 0.154 | 0.153 | 0.153 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.10 EXOGENOUS ASSUMPTIONS

| LINE | ITEM | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | UPRWHC/R | 0.077 | 0.077 | 0.076 | 0.076 | 0.076 | 0.076 | 0.075 | 0.075 | 0.075 | 0.074 | 0.074 |
| 2 | UPRWSC/R | 0.101 | 0.101 | 0.102 | 0.103 | 0.103 | 0.104 | 0.104 | 0.105 | 0.106 | 0.106 | 0.107 |
| 3 | UPR20.29 | 38.89 | 39.58 | 40.13 | 40.55 | 40.81 | 40.91 | 40.78 | 40.39 | 39.76 | 38.89 | 37.85 |
| 4 | UPVUACFUP | 0.093 | 0.089 | 0.088 | 0.080 | 0.076 | 0.072 | 0.069 | 0.065 | 0.062 | 0.059 | 0.056 |
| 5 | PC9113-1747 | 150.7 | 160.0 | 173.8 | 184.3 | 195.3 | 207.0 | 219.5 | 232.6 | 246.6 | 261.0 | 277.1 |
| 6 | PSCHAPAV | 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 | GNPPVT | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 | 82.663 |
| 13 | TXRDWN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | TXRDWNCT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | TXRDWNFD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | TXRDWNLT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | TXRDWNMD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | TXRDWNST | 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 | USCDCURR | 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 | 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 | 0.150 | 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 | USCDPUPTN/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 | USCFCURR | 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 | 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 | USFDCURR | 3800. | 3700. | 3600. | 3450. | 3300. | 3250. | 3200. | 3200. | 3200. | 3200. | 3200. |
| 39 | USFDDISP | 287.0 | 274.0 | 259.0 | 242.0 | 228.0 | 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 | 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 | 0.0 | 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 | USFDPUPTN/T | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 | 1.018 |
| 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 | USLDCURR | 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 | USLDFOD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.10 EXOGENOUS ASSUMPTIONS

| LINE | ITEM | 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 | USLDPOPTH/T | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 | 1.030 |
| 4 | USLDPURASF-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 | 168.0 | 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 | USLFFDD | 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 | USMDFDD | 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 | USMDPOPTH/T | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 |
| 18 | USMDPURASF-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 | USSDFDD | 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 | USSDPOPTH/T | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 |
| 26 | USSDPURASF-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 | USSFFDD | 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 |

A PRODUCT OF WHARTON EFA, INC.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.10 EXOGENOUS ASSUMPTIONS

| LINE | ITEM | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DUMHITOS | 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 | FRMHPC | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| 39 | GMIWOZ/HER | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 | 0.943 |
| 40 | GRPUT/HER | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 | 0.978 |
| 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 | NCEMS10/FM | 0.319 | 0.320 | 0.321 | 0.321 | 0.322 | 0.323 | 0.324 | 0.325 | 0.326 | 0.327 | 0.328 |
| 43 | NCEMS*/FM | 0.080 | 0.077 | 0.075 | 0.073 | 0.071 | 0.069 | 0.068 | 0.065 | 0.064 | 0.063 | 0.063 |
| 44 | HPMET | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 | 73.270 |
| 45 | HPRHMC/R | 0.200 | 0.200 | 0.201 | 0.202 | 0.202 | 0.203 | 0.204 | 0.204 | 0.205 | 0.206 | 0.206 |
| 46 | HPRESC/R | 0.054 | 0.053 | 0.052 | 0.052 | 0.051 | 0.050 | 0.050 | 0.049 | 0.049 | 0.048 | 0.048 |
| 47 | HPRMTN/R | 0.061 | 0.062 | 0.063 | 0.064 | 0.066 | 0.067 | 0.068 | 0.070 | 0.071 | 0.073 | 0.074 |
| 48 | HPRMEM/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 | HPRRA/R | 0.152 | 0.152 | 0.152 | 0.151 | 0.151 | 0.150 | 0.150 | 0.150 | 0.149 | 0.149 | 0.148 |

# THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
## MARCH CONTROL FOR HYBRIDS

### TABLE 24.10 EXOGENOUS ASSUMPTIONS

| LINE | I T E M | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | UPRWNC/R | 0.074 | 0.073 | 0.073 | 0.07[illegible] | [illegible] | 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 | 0.119 |
| 3 | UPR20.29 | 37.29 | 36.77 | 36.40 | 35.53 | 34.60 | 34.00 | 33.51 | 33.18 | 33.03 | 32.98 | 32.68 |
| 4 | DMVHACFNR | 0.053 | 0.051 | 0.048 | 0.046 | 0.043 | 0.041 | 0.039 | 0.037 | 0.035 | 0.034 | 0.032 |
| 5 | PC4113-1707 | 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 | RNMPVT | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 | 42.663 |
| 13 | TXRDWN | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | TXRDWNCT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | TXRDWNFD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | TXRDWNLT | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | TXRDWNMD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | TXRDWNST | 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 | TXRHYDAUTO | 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. | 2706. | 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 | USCDPUPTH/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 | 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 | USFDPUPTH/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 | 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 |

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
MARCH CONTROL FOR HYBRIDS

TABLE 24.10 EXOGENOUS ASSUMPTIONS

| LINE | I T E M | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | USLDE4CYL | 0.150 | 0.150 | 0.150 | [illegible] | 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 | USLDPORTM/T | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 | 1.034 |
| 4 | USLDPUHASE-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 | USLECURR | 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 | USLEFAUTO | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 | 0.450 |
| 8 | USLEFOD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | USLEF4CYL | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 | 0.600 |
| 10 | USLEF6CYL | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 |
| 11 | USMDCURR | 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 | USMDFAUTO | 0.725 | 0.725 | 0.725 | 0.725 | 0.725 | 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 | 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 | USMDPORTM/T | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 | 1.017 |
| 18 | USMDPUHASE-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 | 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 | USSDFAUTO | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 0.400 | 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 | 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 | USSDPORTM/T | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 | 0.922 |
| 26 | USSDPUHASE-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 | USSECURR | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. | 2098. |
| 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 | USSEFAUTO | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 | 0.250 |
| 30 | USSEFOD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31 | USSE4CYL | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 | 0.950 |
| 32 | USSE6CYL | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |

A PRODUCT OF WHARTON EFA, INC.

ORIGINAL PAGE IS
OF POOR QUALITY

# APPENDIX B4

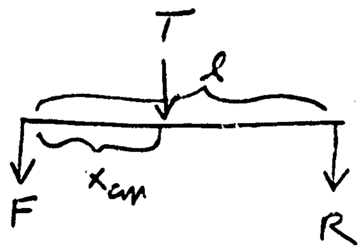
## BATTERY COMPARTMENT WEIGHT DISTRIBUTION AND VEHICLE HANDLING ANALYSIS

21 APR 17
(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 $l = 2.90$




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

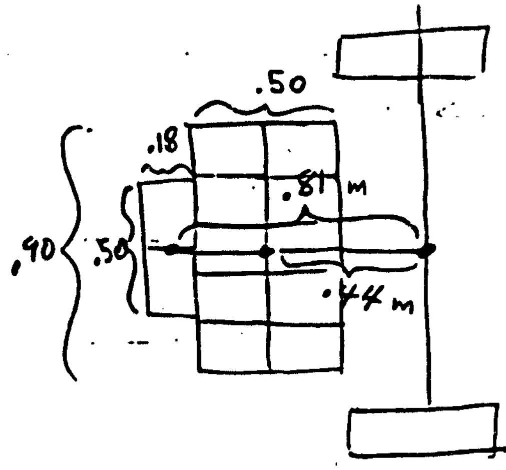
$$\frac{F}{T} = 1 - \frac{R}{T}$$

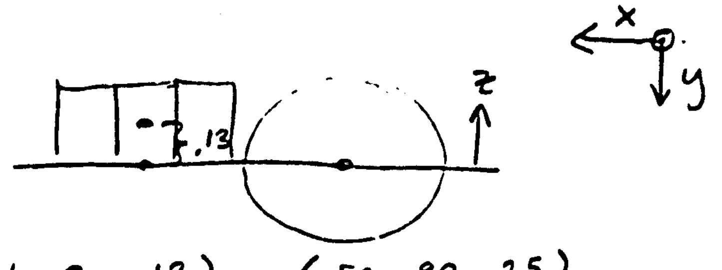
LTD Battery configurations : ~~27.67 kg/battery~~ 28 kg / battery

Wheelbase : 2.90 m , 10 3/8 in ,
Gerstenberger drawing scale : $\frac{2.90}{10.375}$ = .280 m/in

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

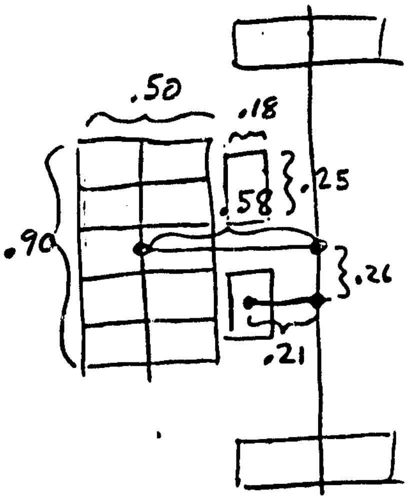
(A)

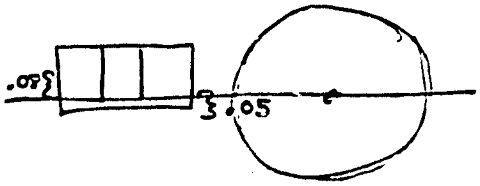



~~276.7~~ 280. (3.34 , 0 , .13) (.50, .90, .25)
~~55.3~~ 56. (3.71 , 0 , .13) (.18, .50, .25)

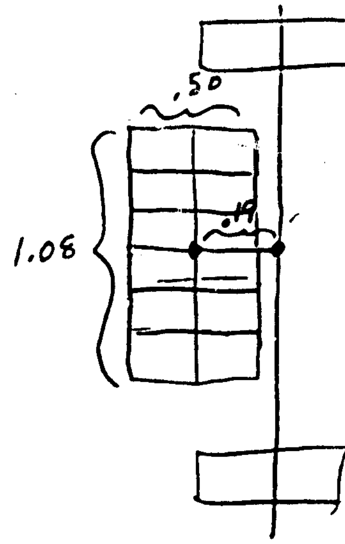
(B)

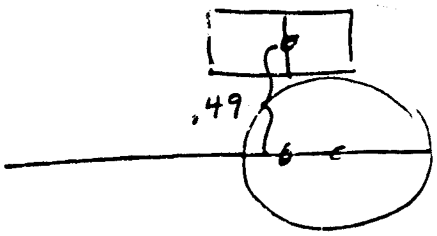


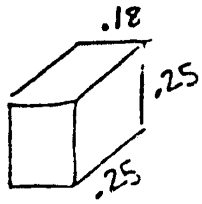




~~276.7~~ 280. (3.48, 0, .08) (.50, .90, .25)
~~27.7~~ 28.0 (3.11 , -.26 , .08) (.18, .25, .25)
~~27.7~~ 28.0 (3.11 , .26 , .08) (.18, .25, .25)

(C)



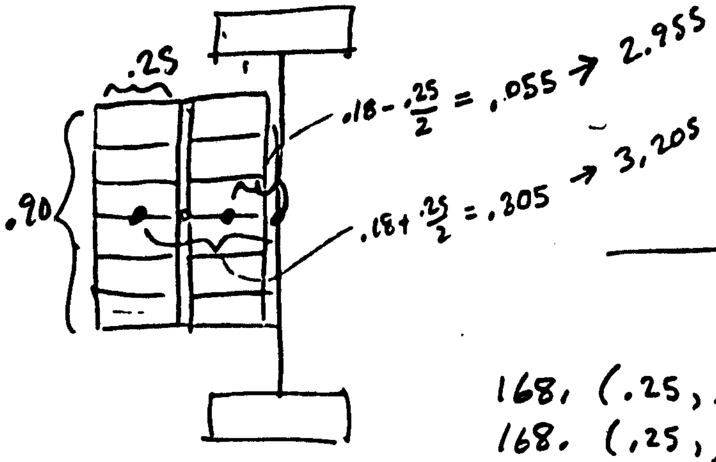



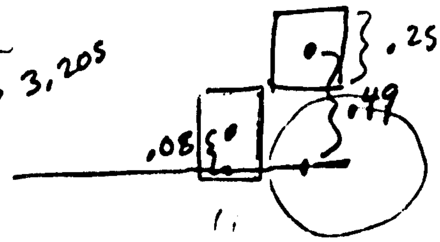

~~332.0~~ 336.0 (3.09, 0, .49) (.50, 1.08, .25)

LTD Battery configurations (cont'd):

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

(D)



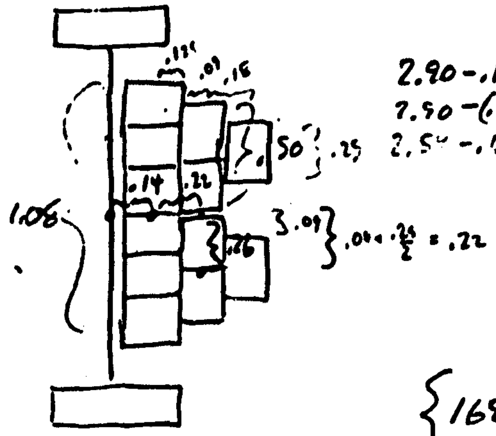

168. (.25, ~~.96~~ 1.08, .25) (2.955, 0., .49)

168. (.25, ~~.96~~ 1.08, .25) (3.205, 0., .08)

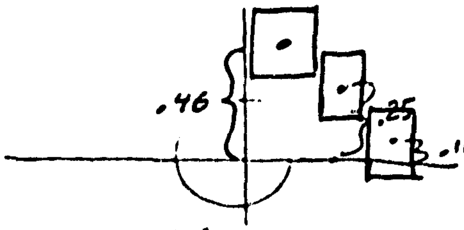
# LTD Battery Configurations (cont'd) .280 #/in

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

(E)

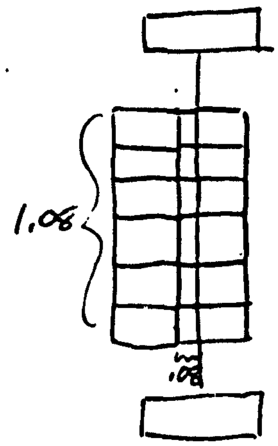


2.90 - .14 =
2.90 - (.14 + .22) = 2.90 - .36 = 2.54
2.54 - .18 = 2.36

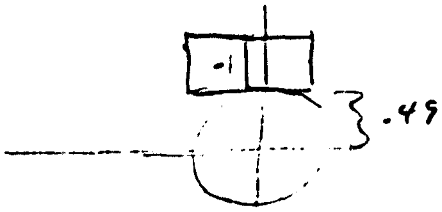


168. (.25, 1.08, .25)(2.76, 0., .46)
56. (.18, .50, .25)(2.54, .26, .25)
56. (.18, .50, .25)(2.54, -.26, .25)
28. (.18, .25, .25)(2.36, .22, .11)
28. (.18, .25, .25 (2.36, -.22, .11)

(F)

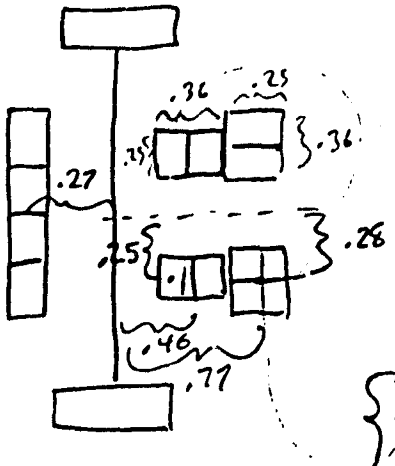


2.90 + .08 = 2.98

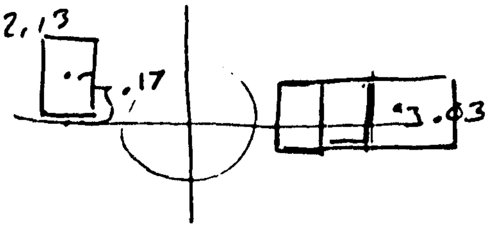


336. (.50, 1.08, .25) (2.98, 0., .49)

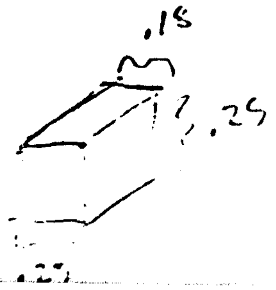
(G)



2,9 + .27 = 3,17
2,9 + .46 = 2,49
2,9 - .77 = 2,13

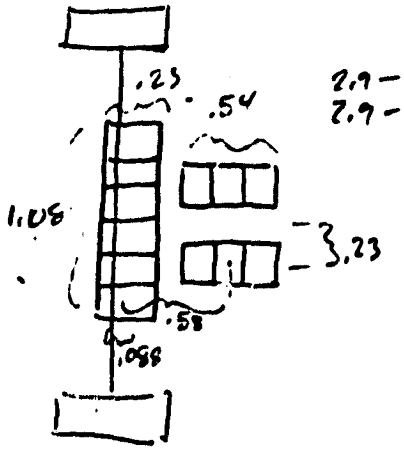


112. (.18, 1.0, .25) (3.17, 0., .17)
56. (.36, .25, .25) (2.44, +.25, .03)
56. (.36, .25, .25) (2.44, -.25, .03)
56. (.25, .36, .25) (2.13, +.28, .03)
56. (.25, .36, .25) (2.13, -.28, .03)

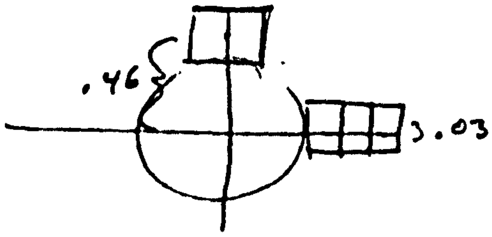


m (a, b, c) (x, y, z)

(H)

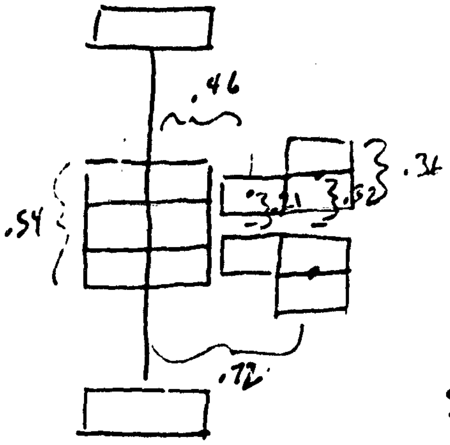



2.9 − .088 = 2.81
2.9 − .58 = 2.32

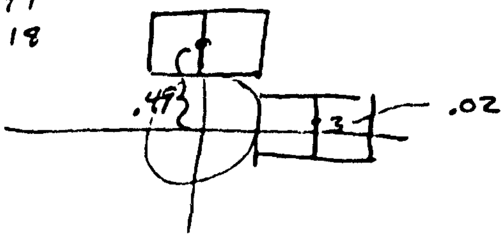



168, (.25, 1.08, .25) (2.81, 0, , .46)
84, (.54, .25, .25) (2.32, +.23, .03)
84, (.54, .25, .25) (2.32, −.23, .03)

(I)

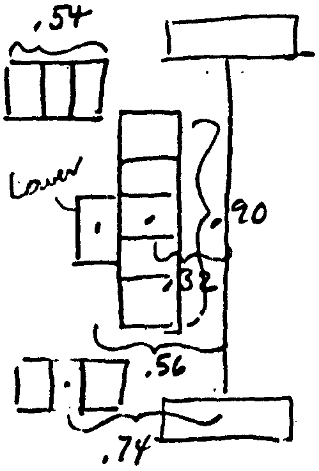



2.9 − .46 = 2.44
2.9 − .72 = 2.18

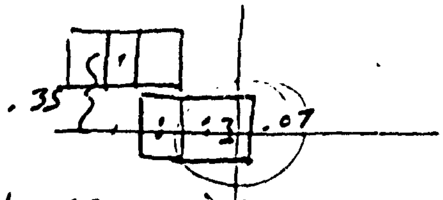



168, (.50, .54, .25)(2.90, 0, , .49)
28, (.25, .18, .25)(2.44, +.21, .02)
28, (.25, .18, .25)(2.44, −.21, .02)
56, (.25, .36, .25)(2.18, +.32, .02)
56, (.25, .36, .25)(2.18, −.32, .02)

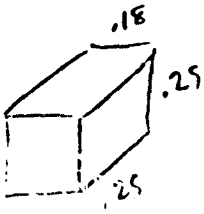
(J)




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

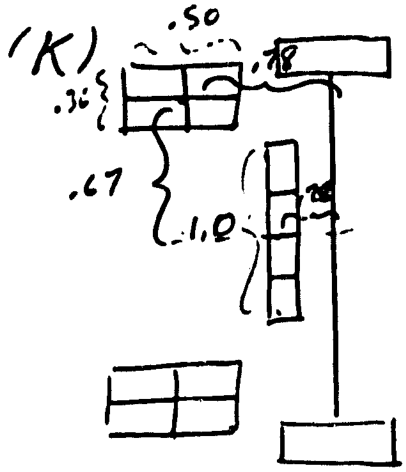



84, (.54, .25, .25)(3.64, .73, .35)
84, (.54, .25, .25)(3.64, −.73, .35)
28, (.18, .25, .25)(3.46, 0, , .07)
140, (.25, .90, .25)(3.22, 0, , .07)

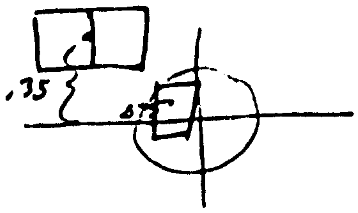


m ( a , b , c )( x , y , z )

(K)

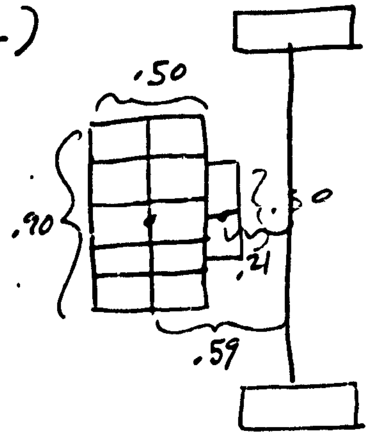



2.9+.78 = 3.68
2.9+.28 = 3.18

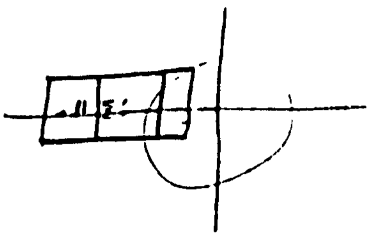



112.(.50, .36, .25)(3.68, .67, .35)
112.(.50, .36, .25)(3.68, -.67, .35)
112.(.18, 1.0, .25)(3.18, 0., .07)

(L)

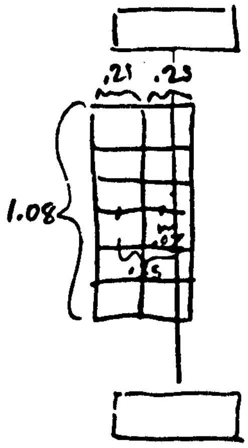



2.9+.21 = 3.11
2.9+.59 = 3.49

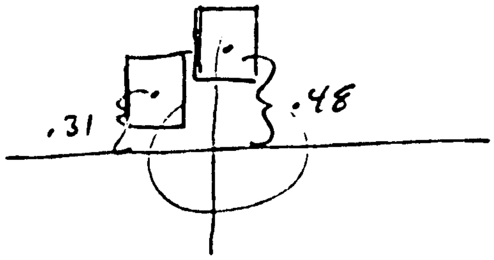


280.(.50, .90, .25)(3.49, 0., .11)
56.(.18, .50, .25)(3.11, 0., .11)

(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)