

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

This document summarizes the process followed to utilize laboratory engine dyno test data and generate a full engine fuel consumption map which can be used by EPA's ALPHA vehicle simulations. The map generated defines the complete operating boundaries of the engine needed for ALPHA modeling, including idle, WOT, minimum torque, and maximum speed.

Gather Engine Physical Characteristics

Source: <http://gmauthority.com/blog/gm/gm-engines/lcv/>

```
engine.name = 'Chevy Malibu 2.5L I4 Tier 3';  
engine.combustion_type = enum_engine_combustion_type.spark_ignition;  
engine.displacement_L = 2.5;  
engine.num_cylinders = 4;
```

Source: Inertia based on COMBINED 0.2 kgm² for total engine + torque converter + flex plate + accessories

```
engine.inertia_kgm2 = 0.146;
```

Load Fuel Map Test Data from Core Test Dataset

Source: Chevrolet Malibu Engine Data.xlsx

```
fuel_data.speed_rpm = xlsread('Chevrolet Malibu Engine Data.xlsx', 'FEV - Steady State & WOT  
Data', 'D3:D148');  
fuel_data.torque_Nm = xlsread('Chevrolet Malibu Engine Data.xlsx', 'FEV - Steady State & WOT  
Data', 'G3:G148');  
fuel_data.fuel_gps = xlsread('Chevrolet Malibu Engine Data.xlsx', 'FEV - Steady State & WOT  
Data', 'J3:J148');  
disp(struct2table(fuel_data))
```

Obtain Maximum Torque (WOT) Curve Data

Source: Chevrolet Malibu Engine Data.xlsx

Note: The original WOT test data was modified using data from vehicle testing. The higher available torque observed during chassis test data was eventually measured during engine dyno testing.

```
WOT_data.speed_rpm = xlsread('Chevrolet Malibu Engine Data.xlsx', 'EPA - WOT Data', 'D3:D24');  
WOT_data.torque_Nm = xlsread('Chevrolet Malibu Engine Data.xlsx', 'EPA - WOT Data', 'E3:E24');  
  
disp(struct2table(WOT_data))
```

Obtain Minimum Torque (Motoring) Curve Data

Source: P310798 Motored Friction vs. Temperature Map.xlsx

Note: Data points were removed where oil temperature < 90 degrees C.

```
CT_data.speed_rpm = xlsread('P310798 Motored Friction vs. Temperature Map.xlsx','P310798 Malibu Motored Friction','D3:D18451');
CT_data.torque_Nm = xlsread('P310798 Motored Friction vs. Temperature Map.xlsx','P310798 Malibu Motored Friction','H3:H18451');
CT_data.oil_temp_degC = xlsread('P310798 Motored Friction vs. Temperature Map.xlsx','P310798 Malibu Motored Friction','O3:O18451');

CT_data.speed_rpm( CT_data.oil_temp_degC < 90 ) = [];
CT_data.torque_Nm( CT_data.oil_temp_degC < 90 ) = [];
CT_data.oil_temp_degC( CT_data.oil_temp_degC < 90 ) = [];

% Only print summary statistics, data set is large
summary(struct2table(CT_data))
```

Obtain Properties of the Fuel Used When Mapping the Engine

Source: p310798_Mapping_8_wot.xls

Note: When using ALPHA to conduct specific technology assessments, the fuel properties and associated fuel consumption map for this engine definition are adjusted to suit the standard fuel being used during the specific assessment. For example, fuel rate is adjusted for LD GHG assessments to represent a suitable fuel rate with Tier 2 Certification fuel.

```
%Load from fuel database
engine.fuel = class_REVS_fuel('FEV Malibu');
disp(engine.fuel);
```

```
class_REVS_fuel with properties:
    id: 'FEV Malibu'
    description: 'FEV Malibu'
    density_kgpL_15C: 0.757
    energy_density_MJpkg: 41.047
    carbon_weight_fraction: 0.8272
    anti_knock_index: []
    research_octane_number: 93.3
    motor_octane_number: []
    cetane_number: []
    alcohol_pct_vol: 10
    gCO2pgal: 8685.6
    energy_density_BTUplbm: 17647
    specific_gravity: 0.75773
```

Calibrate Idle Fuel Consumption and Define Idle Speed

Fuel consumption in the idle region of the map is calibrated using vehicle benchmarking data collected on a vehicle chassis dyno. Actual idle fuel consumption during an ALPHA vehicle simulation would depend on the transmission drag and accessory loads.

Source: P310798_Malibu_1-20-13_FTP75_ph_1+2.xls

Note: Idle speed is determined from chassis test data.

```
engine.idle_speed_radps = 650 * convert.rpm2radps ;
```

Set Model Calibration Options

Note: These parameters influence particular behaviors within the ALPHA model. They often do not have a corresponding value with test data, but are calibrated to match observed behavior.

```
engine.pedal_map_type = enum_engine_pedal_map_type.max_engine_power;
```

```
%Post DFCO fuel adjustment – calibrated from time series test data
```

```
engine.refuel_profile_mult = [1 2 1];
```

```
engine.refuel_profile_time_secs = [0 0.1 4];
```

```
engine.refuel_limit_gps = 3;
```

```
engine.refuel_min_defuel_duration_secs = 0.5;
```

```
%Acceleration based fuel adjustment – calibrated from time series test data
```

```
engine.acceleration_penalty_gpradps2 = 0.01;
```

```
engine.acceleration_penalty_squelch_gps = 0.1;
```

```
%Transient Response Time Constants
```

```
engine.throttle_duration_secs = 0.2;
```

```
engine.boost_time_constant_secs = 0.2;
```

Build Fuel Consumption Map

Note: Generate fuel map and WOT curves using REVS_build_engine with default settings. This map defines the complete operating boundaries of the engine needed for ALPHA modeling, including idle, WOT, minimum torque, and maximum speed.

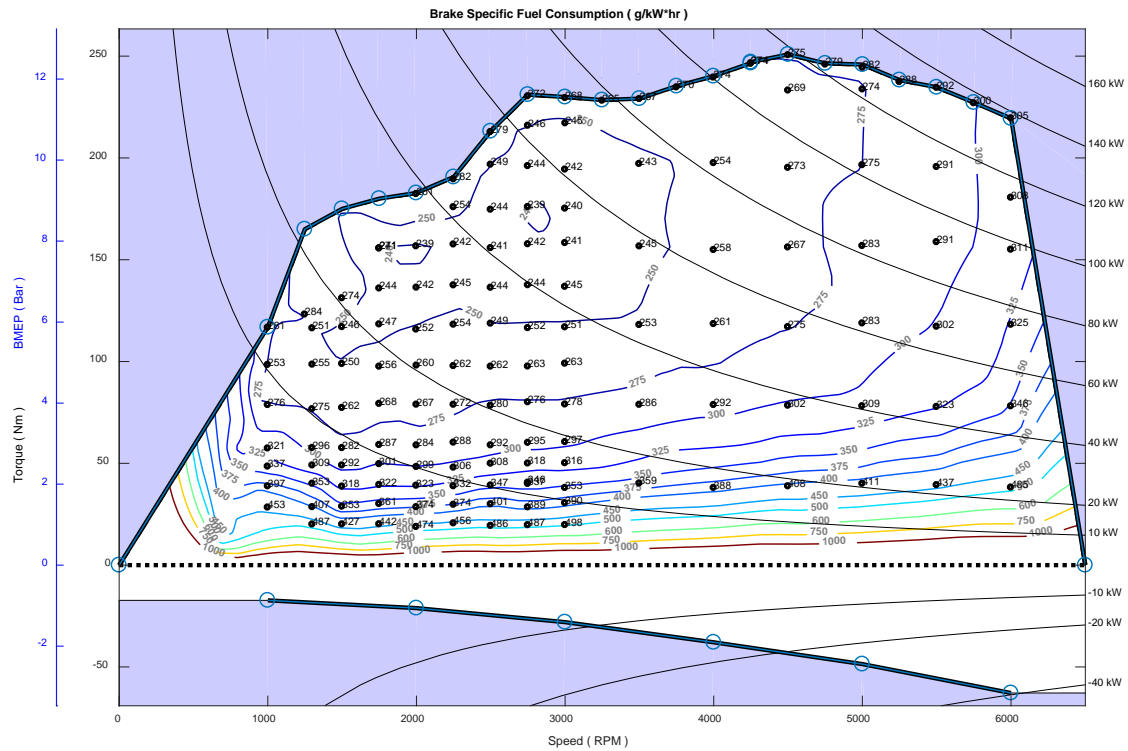
```
engine = REVS_build_engine(engine, fuel_data, WOT_data, CT_data);
```

NOTE: Individual data points from steady state mapping (shown numerically on map), data points from the WOT sweep (shown as the line on top of map) and data points from the minimum torque sweep (shown as the hollow circles on bottom of map) are shown as reference for comparison to the generated contours on the below BSFC map.

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016



Save Engine Fuel Consumption Map

```
write_REVS_engine('engine_2013_chevy_malibu_ecotec_2L5_tier3.m', engine);
```

Display Summary of Engine Fuel Consumption Map Information

Note: The listing below shows only the engine's fuel consumption map related information contained in the ALPHA Engine Definition .m file for this engine. This information is a subset of the full engine definition .m file that adds vehicle level information related to dynamic fuel use, accessories, etc.

```
% ALPHA ENGINE DEFINITION
% Generated 8-Nov-2016 11:10:27
% Chevy Malibu 2.5L I4 Tier 3

% Constructor
engine = class_REVS_engine_legacy;
engine.name = mfilename;
engine.matrix_vintage = enum_matrix_vintage.present;

% Physical Description
engine.combustion_type = enum_engine_combustion_type.spark_ignition;
```

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```
engine.displacement_L = 2.5;
engine.num_cylinders = 4;
engine.inertia_kgm2 = 0.146;

% Fuel Properties
engine.fuel = class_REVS_fuel('FEV Malibu');

% Pedal Calibration
engine.pedal_map_type = enum_engine_pedal_map_type.max_engine_power;

% Idle Speed
engine.idle_speed_radps.axis_1.signal = 'veh_spd_mps';
engine.idle_speed_radps.axis_1.breakpoints = [0, 1];
engine.idle_speed_radps.table = [68.0678408277789, 68.0678408277789];

% Maximum Torque Curve
engine.full_throttle_speed_radps = [0 104.720592458822 130.83130394078 157.087392099185
183.273620138153 209.33477770839 235.660713105701 261.706684217051 287.981908758786
314.234660545793 340.319901565312 366.58466942062 392.7319089334 418.751009793344
445.071998124704 445.072049227944 471.322960146375 497.551423861698 523.818595035385
549.785719606233 575.969033084976 602.139819148854 628.361124221716 680.678408277788];

engine.full_throttle_torque_Nm = [0 116.856 165 175 180 182.793 190.638 213.123 231.11 229.904
228.433 229.142 235.288 240.172 246.61 247.075 250.826 246.437 245.869 238.248 234.717 227.232
219.41 0];

% Minimum Torque Curve
engine.closed_throttle_speed_radps = [104.71975511966 209.43951023932 314.159265358979
418.879020478639 523.598775598299 628.318530717959];

engine.closed_throttle_torque_Nm = [-17.3 -21.1 -28 -37.9 -48.6 -62.8];

% Fuel Map
engine.fuel_map_speed_radps =
[0; 14.1060660539569; 28.2121321079138; 42.3181981618707; 56.4242642158276; 70.5303302697845; 84.636396
3237414; 98.7424623776983; 112.848528431655; 126.954594485612; 141.060660539569; 155.166726593526; 169.
272792647483; 183.37885870144; 197.484924755397; 211.590990809353; 225.69705686331; 239.803122917267; 2
53.909188971224; 268.015255025181; 282.121321079138; 296.227387133095; 310.333453187052; 324.439519241
009; 338.545585294966; 352.651651348922; 366.757717402879; 380.863783456836; 394.969849510793; 409.0759
1556475; 423.181981618707; 437.288047672664; 451.394113726621; 465.500179780578; 479.606245834535; 493.
712311888492; 507.818377942448; 521.924443996405; 536.030510050362; 550.136576104319; 564.242642158276
; 578.348708212233; 592.45477426619; 606.560840320147; 620.666906374104; 634.77297242806; 648.879038482
017; 662.985104535974; 677.091170589931; 691.197236643888];

engine.fuel_map_torque_Nm = [-69.08; -62.0394163265306; -54.9988326530612; -47.9582489795918; -
40.9176653061224; -33.8770816326531; -26.8364979591837; -19.7959142857143; -12.7553306122449; -
5.71474693877551; 1.32583673469389; 8.36642040816326; 15.4070040816327; 22.447587755102; 29.4881714285
714; 36.5287551020408; 43.5693387755102; 50.6099224489796; 57.650506122449; 64.6910897959184; 71.731673
4693878; 78.7722571428572; 85.8128408163265; 92.8534244897959; 99.8940081632653; 106.934591836735; 113.
975175510204; 121.015759183674; 128.056342857143; 135.096926530612; 142.137510204082; 149.178093877551
; 156.21867755102; 163.25926122449; 170.299844897959; 177.340428571429; 184.381012244898; 191.421595918
367; 198.462179591837; 205.502763265306; 212.543346938776; 219.583930612245; 226.624514285714; 233.6650
```


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(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

0. 18834203159374 0. 212240872511792 0. 236139713429844 0. 260038554347895 0. 307162682793718
0. 367465023595525 0. 436585400931746 0. 503094227631781 0. 539377350143701 0. 575660472655622
0. 611943595167542 0. 648226717679463 0. 688943796992208 0. 767848948886582 0. 865071664200079
0. 990637136350575 1. 09692361575199 1. 15806750082054 1. 21921138588908 1. 28035527095763
1. 34149915602617 1. 39687171534643 1. 44542211168389 1. 49998592680007 1. 8579299055495
2. 35799945568459;
0. 267950455691751 0. 215761599588862 0. 163572743485973 0. 100329042004372 0. 0603893559708168
0. 045571016606712 0. 0307526772426072 0. 0159343378785024 0. 0460435842368046 0. 0509134487904234
0. 0557833133440422 0. 060653177897661 0. 0655230424512799 0. 0703929070048987 0. 0752627715585175
0. 114210476767575 0. 146194845427909 0. 160625879810861 0. 175056914193814 0. 189487948576766
0. 203918982959718 0. 21835001734267 0. 260113954267292 0. 290618103343395 0. 314516944261447
0. 338415785179498 0. 36231462609755 0. 406063168162371 0. 466365508964178 0. 526667849765985
0. 595788450967609 0. 680330352743714 0. 716613475255634 0. 752896597767554 0. 789179720279475
0. 825462842791395 0. 878918404243832 0. 957823556138207 1. 05504384909208 1. 16910187261835
1. 30757554018961 1. 38312632982078 1. 44427021488932 1. 50541409995787 1. 56655798502641
1. 62192907309656 1. 67047946943402 1. 76028237688452 2. 19254814258367 2. 69261769271876;
0. 30144426265322 0. 249255406550331 0. 197066550447442 0. 144877694344553 0. 0753471951492213
0. 0605288557851165 0. 0457105164210117 0. 063411317717489 0. 109038813499042 0. 117896458056187
0. 122766322609806 0. 127636187163425 0. 132506051717043 0. 137375916270662 0. 162531442395674
0. 205409471525583 0. 247673705946963 0. 269940874924548 0. 2843719093075 0. 298802943690452
0. 313233978073404 0. 340667551601685 0. 386282209222736 0. 416793016011101 0. 440691856929153
0. 464590697847204 0. 504963653531024 0. 56526599433283 0. 625568335134637 0. 685870675936444
0. 754991501003471 0. 844199444640686 0. 893849600367567 0. 930132722879487 0. 966415845391408
1. 00269896790333 1. 06889301149546 1. 14779816338983 1. 24501603398407 1. 34756660888612
1. 48604027645739 1. 60818515882101 1. 66932904388956 1. 73047292895811 1. 79161681402665
1. 84698643084669 1. 89553682718415 2. 02057882696898 2. 52716637961784 3. 02723592975293;
0. 334938069614688 0. 282749213511799 0. 23056035740891 0. 178371501306021 0. 098569137638483
0. 0754866949635211 0. 0680698568703634 0. 113697352651916 0. 159324848433469 0. 185297079666614
0. 18974933187557 0. 194619196429188 0. 199489060982807 0. 211060104320042 0. 253518049272538
0. 296608466283592 0. 337426435529022 0. 379255870038235 0. 393686904421187 0. 408117938804139
0. 423309769478246 0. 465063787206249 0. 512450464178179 0. 542967928678808 0. 566866769596859
0. 603864138899677 0. 664166479701484 0. 724468820503291 0. 784771161305097 0. 845073502106904
0. 914194551039333 1. 00340249467655 1. 0710857254795 1. 10736884799142 1. 14365197050334
1. 17996246685271 1. 25886761874708 1. 33777277064146 1. 43498821887607 1. 53468922632828
1. 66450501272516 1. 80297868029643 1. 8943878728898 1. 95553175795835 2. 01667564302689
2. 07204378859681 2. 12059418493427 2. 33407815286759 2. 86178461665201 3. 3618541667871;
0. 368431876576157 0. 316243020473268 0. 264054164370379 0. 21186530826749 0. 151373515189503
0. 0904445341419255 0. 11835589180479 0. 163983387586343 0. 209610883367896 0. 253326451864521
0. 256732341141333 0. 261602205694952 0. 266472070248571 0. 301813113652591 0. 344720764754415
0. 387807461041601 0. 427927868717675 0. 471901863961166 0. 503001899534873 0. 517432933917825
0. 547706005082809 0. 590418746630858 0. 638618719133623 0. 669142841346513 0. 702764624268329
0. 763066965070136 0. 823369305871943 0. 88367164667375 0. 943973987475557 1. 00427632827736
1. 07339760107519 1. 16260554471241 1. 24832185059143 1. 28460497310335 1. 32088809561527
1. 36993707410433 1. 4488422259987 1. 52774737789308 1. 62496040376807 1. 72466141122027
1. 84296974899293 1. 9814434165642 2. 11944670189004 2. 18059058695859 2. 24173447202713
2. 29710114634694 2. 37229121701964 2. 68289892721314 3. 19640285368618 3. 69647240382127;
0. 401925683537626 0. 349736827434737 0. 297547971331848 0. 245359115228959 0. 19317025912607
0. 126325928778474 0. 168641926739217 0. 21426942252077 0. 259896918302323 0. 305524414083875
0. 324734478099666 0. 328585214960715 0. 350341775576958 0. 392566122985139 0. 435923480236293
0. 479006455799609 0. 519126863475684 0. 561654593543225 0. 606377292393311 0. 630348222959369
0. 672102240687372 0. 716587001586302 0. 764786974089066 0. 801665109636982 0. 861967450438789
0. 922269791240596 0. 982572132042403 1. 04287447284421 1. 10317681364602 1. 16347915444782

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(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

1. 23260065111106 1. 32180859474827 1. 41101653838549 1. 46184109821529 1. 49812422072721
1. 55991168135595 1. 63881683325033 1. 7177219851447 1. 81493258866006 1. 91463359611227
2. 02143448526071 2. 15990815283197 2. 29838182040324 2. 40564941595883 2. 46679330102737
2. 52215850409706 2. 63258766710409 3. 03095154058527 3. 53102109072035 4. 03109064085544;
0. 435419490499095 0. 383230634396206 0. 331041778293317 0. 278852922190428 0. 226664066087539
0. 179130306329495 0. 240844384597636 0. 288734403879839 0. 329105069590935 0. 36947573530203
0. 389469233089645 0. 392241438403491 0. 42906536984165 0. 476130391512004 0. 520357131682589
0. 562554378456467 0. 604650778347986 0. 659744233548111 0. 709774173946541 0. 746425596717626
0. 784914959050437 0. 830789603628122 0. 883699476309329 0. 954537790513273 1. 02117027660925
1. 08147261741106 1. 14177495821286 1. 20207729901467 1. 26237963981648 1. 32268198061828
1. 39180370114692 1. 48101164478413 1. 57021958842135 1. 63907722332722 1. 67536034583914
1. 74988628860758 1. 82879144050195 1. 90769659239633 2. 00490477355206 2. 10460578100427
2. 20430678845647 2. 33837288909975 2. 47684655667101 2. 61532022424228 2. 69185213002761
2. 74721586184719 2. 89288411718854 3. 36556977761944 3. 86563932775452 4. 36570887788961;
0. 468913297460564 0. 416724441357675 0. 364535585254786 0. 312346729151897 0. 260157873049008
0. 228565073485188 0. 293021387966834 0. 354803329546234 0. 397679387797437 0. 426683766248058
0. 448507245864164 0. 449649257549562 0. 494478236060022 0. 545876889274341 0. 592099289931457
0. 6392492410613 0. 689365399565849 0. 746685305800132 0. 822233476904619 0. 871197287732138
0. 89302334526545 0. 939385080351887 1. 00147958419168 1. 07152791196934 1. 14430215095903
1. 22040298099605 1. 29669357786892 1. 36128012518513 1. 42158246598694 1. 48188480678874
1. 55100675118278 1. 64021469482 1. 72942263845721 1. 81631334843915 1. 86095574396483 1. 9398608958592
2. 01876604775358 2. 09767119964795 2. 19487695844406 2. 29457796589627 2. 39427897334847
2. 51683762536752 2. 65531129293878 2. 79378496051005 2. 91691095902785 2. 98430005715475
3. 153180567273 3. 70018801465361 4. 20025756478869 4. 70032711492378;
0. 502407104422033 0. 450218248319144 0. 398029392216255 0. 345840536113366 0. 293651680010477
0. 277327319275354 0. 327673147652673 0. 40426246977762 0. 44761773507722 0. 482342486256147
0. 50837855661149 0. 516864430200016 0. 562849062384127 0. 617268116552116 0. 665636266259549
0. 713320258048275 0. 769862537686284 0. 834595047552615 0. 911161894308293 0. 972901474467988
1. 01076916228005 1. 05992903741348 1. 12856980222041 1. 19548718765938 1. 2644353487999
1. 33486249881237 1. 40997757460597 1. 48626817147883 1. 5625587683517 1. 63884936522457
1. 71020980121864 1. 79941774485586 1. 88862568849307 1. 97783363213029 2. 05093035121645
2. 12983550311083 2. 2087406550052 2. 28764580689958 2. 38484914333606 2. 48455015078826
2. 58425115824047 2. 69530236163529 2. 83377602920656 2. 97224969677782 3. 11072336434909
3. 24459650723921 3. 49328133107869 4. 03480625168778 4. 53487580182286 5. 03494535195795;
0. 535900911383501 0. 483712055280612 0. 431523199177723 0. 379334343074834 0. 327145486971946
0. 325252288869156 0. 367181594791233 0. 427210128956844 0. 482170237716898 0. 521227443156029
0. 561443063889075 0. 577789626811626 0. 62686791837906 0. 693020072700667 0. 744927024198955
0. 795856824309629 0. 859146160183555 0. 924302249781508 0. 999303925796833 1. 06659925097205
1. 13082682037794 1. 19922251460536 1. 25237844939562 1. 31757013791322 1. 38721095350105
1. 45752158022814 1. 54223086738437 1. 63006346201514 1. 71081820920209 1. 79157295638904
1. 87483264023446 1. 96379833617851 2. 05276403212257 2. 14268467928448 2. 23727256711811
2. 3164123167475 2. 3955520663769 2. 48241315896475 2. 59826451091323 2. 69873797725318
2. 79921144359312 2. 91351041099177 3. 06492504509486 3. 20756555242446 3. 35020605975405
3. 50489295732366 3. 84210210542424 4. 36942448872195 4. 86949403885703 5. 36956358899212;
0. 56939471834497 0. 517205862242081 0. 465017006139192 0. 412828150036303 0. 360639293933414
0. 373177258462959 0. 398846061985505 0. 468577627366957 0. 513887392580743 0. 556381248272015
0. 601046535636373 0. 636334323437094 0. 70086910842849 0. 771295619666234 0. 826245573776016
0. 881161866572484 0. 945383760021285 1. 01594015531651 1. 08493810370389 1. 16037820216407
1. 24228053094545 1. 31051176595664 1. 36976973438262 1. 43965338950148 1. 51159332252774
1. 60144129658168 1. 69314721389214 1. 79607631883151 1. 87683106601846 1. 95758581320541
2. 04084494809316 2. 12981064403722 2. 21877633998127 2. 32706309744749 2. 42165761036825
2. 50079735999765 2. 57993710962705 2. 68927832060158 2. 82555000237786 2. 93257924653672

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

3. 03305271287667 3. 14735803808727 3. 32522674624779 3. 46786725357739 3. 61050776090698
3. 76518940740811 4. 1909228797698 4. 70404272575612 5. 2041122758912 5. 70418182602629;
0. 602888525306439 0. 55069966920355 0. 498510813100661 0. 446321956997772 0. 394133100894883
0. 421102228056762 0. 431308957819187 0. 504716205778484 0. 565079372701522 0. 613951906182464
0. 660482610419592 0. 702657534667318 0. 77315976885545 0. 847683114709528 0. 908651060549082
0. 96858318120761 1. 04330762752909 1. 11650007660682 1. 19134032591149 1. 26905093985812
1. 34619875747222 1. 41475521663315 1. 49221079917236 1. 56932118449348 1. 66083851177483
1. 75235583905618 1. 8440635603999 1. 94713834494236 2. 04284392283483 2. 12359867002178
2. 20685725595186 2. 29582295189592 2. 39442951709712 2. 51144151561051 2. 6060426536184
2. 6851824032478 2. 78418485617369 2. 8961434822384 3. 0324330741124 3. 16642051582026
3. 26689398216021 3. 38120566518278 3. 56330049146653 3. 72816895473032 3. 87080946205992
4. 02548585749256 4. 53859141265521 5. 03866096279029 5. 53873051292537 6. 03880006306046;
0. 636382332267908 0. 584193476165019 0. 53200462006213 0. 479815763959241 0. 427626907856352
0. 469027197650565 0. 501882158854374 0. 536380672972756 0. 613588947733011 0. 670699286413975
0. 717222401785268 0. 764637010515305 0. 837910609980786 0. 92356635820341 0. 994674375770684
1. 05835520907774 1. 1348616321271 1. 22794419560786 1. 3097377117889 1. 38605187764532
1. 46131271812557 1. 54449807485946 1. 62178732866908 1. 71878985293238 1. 81175305424933
1. 90327038153068 1. 99497990690767 2. 09805469145013 2. 20112947599259 2. 28961152683815
2. 37286956381056 2. 46183525975462 2. 57880793526013 2. 69581993377352 2. 79042769686855
2. 87909139174581 2. 99105001781052 3. 10300864387523 3. 23931614584694 3. 37887735946319
3. 50073525144375 3. 61505329227828 3. 79714811856203 3. 97924294484579 4. 13111116321284
4. 30366373494423 4. 87320964968938 5. 37327919982446 5. 87334874995954 6. 37341830009463;
0. 669876139229377 0. 617687283126488 0. 565498427023599 0. 51330957092071 0. 463836218373832
0. 516952167244368 0. 570068116114904 0. 568199846987622 0. 645254415769512 0. 72467858830137
0. 773962193150945 0. 828197154010146 0. 90655446391015 0. 999107195385619 1. 07954457023583
1. 1464261395735 1. 23033702061781 1. 32792082119111 1. 43068024465175 1. 5069942031531
1. 58731797275667 1. 67176731437289 1. 75390511212938 1. 85093854461869 1. 95544600076137
2. 05418492400517 2. 14589625341544 2. 2489710379579 2. 35204582250035 2. 45512060704281
2. 53888187166926 2. 64617435490976 2. 76318635342315 2. 88019835193654 2. 9748127401187
3. 08595655338263 3. 19791517944735 3. 30987380551206 3. 44619921758148 3. 58576043119773
3. 72532164481398 3. 84890091937379 4. 03099574565754 4. 21309057194129 4. 39141286436578
4. 65248450928979 5. 20782788672355 5. 70789743685863 6. 20796698699371 6. 7080365371288;
0. 703369946190845 0. 651181090087957 0. 598992233985068 0. 546803377882179 0. 511761187967635
0. 564877136838171 0. 617993085708706 0. 600699078696748 0. 678507572838311 0. 760394066668423
0. 832923130895845 0. 888228743233735 0. 980908217040412 1. 07464803256783 1. 15508540741804
1. 23668263863885 1. 33031557360347 1. 42789744677435 1. 5348739312198 1. 63111809247902
1. 71332322738778 1. 79777530490995 1. 88382926290346 1. 983087236305 2. 08759469244768
2. 1921011370148 2. 2969720650156 2. 40002310877115 2. 5030741525267 2. 60612519628225
2. 71374454638144 2. 83115085524595 2. 94855716411046 3. 06596347297497 3. 18015571707828
3. 29212631350178 3. 40409690992527 3. 51606750634876 3. 66184861349858 3. 80242438507662
3. 94300015665467 4. 09039016652459 4. 27111125507787 4. 45183234363115 4. 63255343218443
5. 00130528363534 5. 54244612375772 6. 0425156738928 6. 54258522402788 7. 04265477416297;
0. 736863753152314 0. 684674897049425 0. 632486040946536 0. 580297184843647 0. 559686157561438
0. 612802106431973 0. 665918055302509 0. 633198310405873 0. 722755149925282 0. 809593461938221
0. 882176196062708 0. 951117611290225 1. 04428752327193 1. 14859070368934 1. 22899955846127
1. 33389198657611 1. 434236637656 1. 52874391857869 1. 63187841885871 1. 72898048632692
1. 81789886952918 1. 91193484868651 2. 00272830983992 2. 10560629703752 2. 20999320652807
2. 31654039848804 2. 4291814683635 2. 56414138542388 2. 66719242917943 2. 77024347293498
2. 89363374652303 3. 03091631524491 3. 14832262410942 3. 26572893297393 3. 37991874104439
3. 49188933746789 3. 60385993389138 3. 75261522588614 3. 95214837431576 4. 0927241458938
4. 23329991747184 4. 38068270008049 4. 56140378863376 4. 74212487718704 4. 93703145798404
5. 35012605798089 5. 87706436079189 6. 37713391092697 6. 87720346106205 7. 37727301119713;

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

0. 770357560113783 0. 718168704010894 0. 665979847908005 0. 613790991805116 0. 607611127155241
0. 660727076025776 0. 713843024896312 0. 71151868263231 0. 755268075326668 0. 857816768240796
0. 931429261229572 1. 01449653969811 1. 11245291689618 1. 22242195535138 1. 3190102489188
1. 42898727725497 1. 53546885353971 1. 63281803389481 1. 72942440009906 1. 82595899717308
1. 93055035200922 2. 0261511702922 2. 12500249415161 2. 22788527604133 2. 33634955080526
2. 44830923048148 2. 56095049383886 2. 7131221527537 2. 83131070583216 2. 93436174958771
3. 05775337674934 3. 22754310761976 3. 34808808410839 3. 4654943929729 3. 5796817650105 3. 691652361434
3. 82066748057138 3. 99235671704168 4. 20354047005527 4. 38302390671097 4. 52359967828902
4. 67097523363638 4. 85169632218966 5. 03241741074294 5. 28595154845489 5. 69894683232645
6. 21168259782606 6. 71175214796114 7. 21182169809622 7. 71189124823131;
0. 803851367075252 0. 751662510972363 0. 699473654869474 0. 647284798766585 0. 655536096749044
0. 708652045619579 0. 761767994490115 0. 800488022272296 0. 793551911875247 0. 897046935060599
0. 993737379022489 1. 0776145102253 1. 18591367557704 1. 29613995078171 1. 41077605398339
1. 52111202754587 1. 62723497971956 1. 73554920663515 1. 83225531978407 1. 93497366604117
2. 04120189516583 2. 14453781606609 2. 24582534298564 2. 35615870312249 2. 4681183827987
2. 58007806247492 2. 69271951931421 2. 84489117822906 2. 9954289824849 3. 09848002624044
3. 22187300697565 3. 39166273784607 3. 54785354410735 3. 66525985297186 3. 77944478897661
3. 89141538540011 4. 06040897172693 4. 23209820819723 4. 44325532120708 4. 65971717012315
4. 81389943910619 4. 96126776719227 5. 14198885574555 5. 36681917575104 5. 63487163892574
6. 04623128472515 6. 54630083486023 7. 04637038499531 7. 54643993513039 8. 04650948526548;
0. 837345174036721 0. 785156317933832 0. 732967461830943 0. 680778605728054 0. 703461066342846
0. 756577015213382 0. 809692964083918 0. 862808912954453 0. 87005562898399 0. 958988501774769
1. 055649532447 1. 14316469050621 1. 25819417487364 1. 36841943336168 1. 49433985766112
1. 60464126955015 1. 71629943184394 1. 83519043404169 1. 93189137050962 2. 0371042651845
2. 14760032639167 2. 25093843936369 2. 36023037687369 2. 48074755039108 2. 59988721479214
2. 71184689446836 2. 82448854478957 2. 97666020370441 3. 12883186261926 3. 26259830289318
3. 38599263720195 3. 55578236807238 3. 7255720989428 3. 86502531297083 3. 97920781294272
4. 12846122641218 4. 30015046288248 4. 47183969935277 4. 68297017235889 4. 89943202127496
5. 10419919992337 5. 25156030074816 5. 44768680304719 5. 71573926622189 5. 98379172939659
6. 38084952175932 6. 8809190718944 7. 38098862202948 7. 88105817216456 8. 38112772229965;
0. 87083898099819 0. 818650124895301 0. 766461268792412 0. 714272412689523 0. 751386035936649
0. 804501984807185 0. 85761793367772 0. 910733882548256 0. 958955114147967 1. 03267322028953
1. 11869955966699 1. 208919033704 1. 32483340474574 1. 44069891594166 1. 56750825460468
1. 68817051155443 1. 81592756076227 1. 93483166144823 2. 03152001839653 2. 1367225185418
2. 25275942771569 2. 36150613023689 2. 47824129376911 2. 59875986610531 2. 72068022286312
2. 84260057962093 2. 95625757026492 3. 10842922917977 3. 26060088809461 3. 41277254700946
3. 55011226742826 3. 71990199829868 3. 8896917291691 4. 05948146003953 4. 19651348109742
4. 36820271756772 4. 53989195403802 4. 71158119050832 4. 9226850235107 5. 13914687242677
5. 35560872134284 5. 54185283430405 5. 79660689351804 6. 06465935669274 6. 33271181986744
6. 71546775879349 7. 21553730892857 7. 71560685906365 8. 21567640919874 8. 71574595933382;
0. 904332787959659 0. 85214393185677 0. 799955075753881 0. 747766219650992 0. 799311005530452
0. 852426954400988 0. 905542903271523 0. 958658852142059 1. 0528198274989 1. 18441950041258
1. 26004288549955 1. 31295757661945 1. 39835257608935 1. 51702636659623 1. 64251928758886
1. 77101123402241 1. 90317954799615 2. 03647225197042 2. 13300904524303 2. 24472709389956
2. 36330370814462 2. 48539490800484 2. 6021083469837 2. 7221932116085 2. 84352566980973
2. 96485812801096 3. 09829207906553 3. 26599998979273 3. 41842810311205 3. 57085621643138
3. 72913055630566 3. 90073620764875 4. 07234185899185 4. 24394751033495 4. 42874331144274
4. 60132228614433 4. 77390126084591 4. 95638215456597 5. 18130532183892 5. 40046303237538
5. 61962074291184 5. 85562527469869 6. 13533482102608 6. 40418678378369 6. 67303874654131
7. 05008599582766 7. 55015554596274 8. 05022509609782 8. 5502946462329 9. 05036419636799;
0. 937826594921127 0. 885637738818238 0. 833448882715349 0. 794120026253719 0. 847235975124255
0. 90035192399479 0. 953467872865326 1. 01185745093346 1. 11825380793723 1. 224650164941

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

1. 37507393213423 1. 44516470558079 1. 497191912992 1. 60064482915187 1. 71956012368085
1. 84803412500587 1. 98465981941265 2. 12399770370415 2. 23760344349418 2. 35360339765855
2. 48352849448051 2. 60807276599335 2. 73025003732249 2. 85033594573094 2. 97166840393217
3. 11255191704278 3. 25546863737755 3. 46832218941739 3. 62075030273672 3. 77317841605605
3. 93145248010673 4. 10305813144982 4. 27466378279292 4. 46836306590049 4. 65391731341188
4. 82649628811347 4. 99907526281505 5. 24696305930741 5. 47187916611585 5. 69103687665231
5. 9095939106838 6. 14406971234826 6. 46293135229339 6. 731783315051 7. 00063527780862
7. 38470423286183 7. 88477378299691 8. 38484333313199 8. 88491288326707 9. 38498243340215;
0. 971320401882596 0. 919131545779707 0. 866942689676818 0. 842044995847522 0. 895160944718058
0. 948276893588594 1. 00139284245913 1. 07729143137179 1. 18368778837556 1. 29008414537932
1. 39658780696 1. 52866941005453 1. 60649771158567 1. 6842632917075 1. 80297055493223 1. 92507770952061
2. 07219632791822 2. 21152315543788 2. 33239826985987 2. 45821732871642 2. 59901071144289
2. 72830002239718 2. 85708275036003 2. 98625610357484 3. 1280291872147 3. 26980227085456
3. 41264519568958 3. 62774455823538 3. 82307250236139 3. 97550061568071 4. 1337744039078
4. 30538005525089 4. 48903057282035 4. 69353355373664 4. 87909131538103 5. 05167029008261
5. 27035099928502 5. 53754396404885 5. 76245301039278 5. 98161072092924 6. 1980173665201
6. 43251414999784 6. 75808734262152 7. 05937984631832 7. 32823180907593 7. 71868976608151
8. 21939202003108 8. 71946157016616 9. 21953112030125 9. 71960067043633;
1. 00481420884406 0. 952625352741176 0. 900436496638287 0. 889969965441325 0. 943085914311861
0. 996201863182396 1. 04931781205293 1. 14272541181012 1. 24912176881388 1. 35551812581765
1. 46191448282142 1. 56881639540937 1. 68226488797482 1. 76040467502506 1. 8797939613473
2. 01372814442093 2. 16074523207358 2. 31347235259176 2. 43893478760128 2. 5693652496478
2. 71063420401913 2. 85844559146709 2. 98753061608181 3. 13909997548309 3. 28527954102647
3. 42705262466633 3. 5698217540016 3. 78492111654741 4. 00002047909322 4. 17782281530538
4. 33609632770887 4. 50969807974022 4. 7142010606565 4. 91870404157279 5. 10426531735017
5. 29373893926264 5. 56093190402646 5. 82812486879029 6. 05302685466972 6. 27049729433608
6. 48644082235639 6. 72095858764742 7. 0465317802711 7. 37210497289478 7. 65582834034325
8. 04632996896851 8. 55401025706525 9. 05407980720033 9. 55414935733542 10. 0542189074705;
1. 03830801580553 0. 986119159702645 0. 933930303599756 0. 937894935035128 0. 991010883905664
1. 0441268327762 1. 10176303524468 1. 20815939224845 1. 31455574925221 1. 42095210625598
1. 52734846325974 1. 63374482026351 1. 74104498385874 1. 83616459984588 1. 96221942943661
2. 10269237536412 2. 25721408262982 2. 41462799747434 2. 55213719451437 2. 68256912584281
2. 82990997262933 2. 98093244860716 3. 12141622856617 3. 27295569026825 3. 4328548329745
3. 58430297847811 3. 72699831231363 3. 94209767485943 4. 15719703740524 4. 37229639995105
4. 53841825150993 4. 73486856757637 4. 93937154849265 5. 14387452940893 5. 32943931931931
5. 58431984400408 5. 8515128087679 6. 11870577353173 6. 34297722215205 6. 55892075017237
6. 77486427819269 7. 00940302529699 7. 33497621792067 7. 66054941054435 7. 98342487161056
8. 37397017185552 8. 88862849409942 9. 3886980442345 9. 88876759436958 10. 3888371445047;
1. 071801822767 1. 01961296666411 0. 967424110561225 0. 985819904628931 1. 03893585349947
1. 09205180237 1. 16719701568301 1. 27359337268677 1. 37998972969054 1. 48638608669431
1. 59278244369807 1. 69917880070184 1. 8055751577056 1. 91192452466669 2. 05115104600934
2. 19324529280486 2. 35837636670313 2. 51578364235692 2. 65543599201871 2. 80008436445645
2. 94918574123953 3. 10020678214886 3. 25259614917918 3. 40681140505342 3. 56671054775967
3. 72660969046592 3. 88417487062565 4. 09927423317146 4. 31673219629932 4. 53570953380102
4. 75080267429033 4. 95703684290727 5. 16327101152421 5. 36904501724508 5. 60770778398169
5. 87490074874552 6. 14209371350934 6. 40928667827317 6. 63140067798836 6. 84734420600867
7. 06328773402899 7. 29784746294657 7. 62342065557025 7. 94899384819393 8. 27738964927375
8. 70161037474253 9. 22324673113359 9. 72331628126867 10. 2233858314038 10. 7234553815388;
1. 10529562972847 1. 05310677362558 1. 00091791752269 1. 03374487422273 1. 08686082309327
1. 1399767719638 1. 23263099612133 1. 3390273531251 1. 44542371012887 1. 55182006713263
1. 6582164241364 1. 76461278114016 1. 87100913814393 2. 0439973299265 2. 20737223385015
2. 34813769431368 2. 51363857729398 2. 66229642457877 2. 79588034679719 2. 94047785222659

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

3. 08229184852924 3. 22410703661585 3. 38569645789535 3. 552812025464 3. 71322722139958
3. 87364241733515 4. 05631076320663 4. 297723731096 4. 51670106859769 4. 73567840609939
4. 95076986687953 5. 15700403549647 5. 36323820411341 5. 59197481249121 5. 87729779727633
6. 14437410947208 6. 41145042166782 6. 66078211598583 6. 88316786537248 7. 10407111144029
7. 32497435750811 7. 61484821503376 7. 94870280101504 8. 28255738699632 8. 62292870928231
9. 02925057762954 9. 55786496816776 10. 0579345183028 10. 5580040684379 11. 058073618573;
1. 13878943668994 1. 08660058058705 1. 03441172448416 1. 08166984381654 1. 13478579268707
1. 19166861955589 1. 29806497655966 1. 40446133356343 1. 51085769056719 1. 61725404757096
1. 72365040457473 1. 83004676157849 1. 98248034271025 2. 17630401159209 2. 36829370444339
2. 50905238031871 2. 67702030499725 2. 82637568461692 2. 94028612028294 3. 0809221880441
3. 20791223915612 3. 35022295559485 3. 53523764385308 3. 70234902581849 3. 86276422175406
4. 03378664737295 4. 23005277482972 4. 48888574948546 4. 71666994089607 4. 93564727839776
5. 15073705946873 5. 35697122808567 5. 56320539670261 5. 86061227569764 6. 14594344165608
6. 41301975385182 6. 67373477336504 6. 90706602239732 7. 1294517796944 7. 35035502576222
7. 6047582950272 7. 9538705387376 8. 28772512471888 8. 62157971070015 8. 98298898863168
9. 36940450248262 9. 89200867734106 10. 392552755337 10. 8926223054721 11. 3926918556072;
1. 17228324365141 1. 12009438754852 1. 0764788645398 1. 12959481341034 1. 18271076228088
1. 25710259999422 1. 36349895699799 1. 46989531400175 1. 57629167100552 1. 68268802800929
1. 78908438501305 1. 92096335549399 2. 11478702437583 2. 30861069325767 2. 50243436213951
2. 66996706632374 2. 83793499100228 2. 98517492401295 3. 09645255755924 3. 21363282597413
3. 33829571736703 3. 49976414155258 3. 68477882981081 3. 85188602617298 4. 01230122210855
4. 20738647439173 4. 40379478645281 4. 66262776110855 4. 91663881319444 5. 13561615069613
5. 35070425205793 5. 55693842067487 5. 81734813300023 6. 12924973890407 6. 41458908603583
6. 68166539823157 6. 92001867977653 7. 1533499288088 7. 37573569401633 7. 59663894008415
7. 94377397338186 8. 29289286244144 8. 62674744842272 8. 97683582558702 9. 34304926798105
9. 72945201347978 10. 2196488802281 10. 7271709923712 11. 2272405425063 11. 7273100926413;
1. 20577705061288 1. 15358819450999 1. 12440383413361 1. 17751978300414 1. 23063573187468
1. 32253658043255 1. 42893293743632 1. 53532929444008 1. 64172565144385 1. 74812200844761
1. 85944636827774 2. 05327003715958 2. 24709370604142 2. 44091737492326 2. 6347410438051
2. 83640840355228 2. 96534749430713 3. 11217444403938 3. 23953915461552 3. 35671904823095
3. 49155212164089 3. 65363239680664 3. 83432001576854 4. 00142302652747 4. 18571378252228
4. 38098630141052 4. 5775367980759 4. 83636977273164 5. 09520274738738 5. 33558502299451
5. 55067144464713 5. 77408399030281 6. 08598559620666 6. 3978872021105 6. 68323473041557
6. 93297133715574 7. 16630258618802 7. 39963383522029 7. 62201960833826 7. 9305668950884
8. 28278965173653 8. 63191518614528 8. 97068266254235 9. 33689610493639 9. 70310954733042
10. 0894995244769 10. 5472890831151 11. 0617892294054 11. 5618587795404 12. 0619283296755;
1. 23927085757435 1. 18708200147146 1. 17232880372741 1. 22544475259795 1. 28157420386711
1. 38797056087088 1. 49436691787464 1. 60076327487841 1. 70715963188218 1. 81355598888594
1. 99175304994333 2. 18557671882517 2. 379400387707 2. 57322405658884 2. 77720967637989
2. 99002388097948 3. 17830711840353 3. 24179025286676 3. 38010345120187 3. 49980527048776
3. 65311519141072 3. 81519064309481 3. 98386120172627 4. 16404109065283 4. 35931360954106
4. 5545861284293 4. 751278809699 5. 01011178435473 5. 26894475901047 5. 52777773366621
5. 75063863723633 6. 04272145350924 6. 35462305941308 6. 66652466531693 6. 94592399453495
7. 17925524356722 7. 4125864925995 7. 64591774163178 7. 91735981679493 8. 26958257344306
8. 6218053300912 8. 97093750984912 9. 33074294189172 9. 69695638428576 10. 0631698266798
10. 4495470354741 10. 8749292860021 11. 3964074664395 11. 8964770165746 12. 3965465667097;
1. 27276466453582 1. 22057580843293 1. 22025377332121 1. 27336972219175 1. 34700818430544
1. 4534045413092 1. 55980089831297 1. 66619725531674 1. 7725936123205 1. 93023606272708
2. 12405973160891 2. 31788340049075 2. 51170706937259 2. 7180109492075 2. 93082515380709
3. 14363935840668 3. 35645356300628 3. 51672669415087 3. 5802098286141 3. 6558266361051
3. 80952817616993 3. 97948187465333 4. 14752185399598 4. 33556671224217 4. 53115763891071
4. 72674856557926 4. 95367501303237 5. 21259053620354 5. 47150605937472 5. 7304215825459

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

5. 99084150436082 6. 30153103460486 6. 61222056484889 6. 92291009509293 7. 18798967949092
7. 42160969607664 7. 65522971266236 7. 8928468492823 8. 25421267882587 8. 60615184913097
8. 95809101943607 9. 32170998077615 9. 6908032212411 10. 0570166636351 10. 4232301060292
10. 8095945464713 11. 2200566073912 11. 7310257034737 12. 2310952536088 12. 7311648037439;
1. 30625847149728 1. 2540696153944 1. 26817874291502 1. 32129469178555 1. 41244216474376
1. 51883852174753 1. 6252348787513 1. 73163123575506 1. 86871907551082 2. 06254274439266
2. 2563664132745 2. 45019008215634 2. 6588122220351 2. 8716264266347 3. 08444063123429
3. 29725483583389 3. 51006904043348 3. 72288324503308 3. 85514626989821 3. 91862940436143
3. 95324071007934 4. 13857066480361 4. 31652947627655 4. 50444549975438 4. 70003642642293
4. 96464827496738 5. 24748053432342 5. 50639605749459 5. 76531158066577 6. 01655349329775
6. 26955166879507 6. 53598324565333 6. 84667277589736 7. 1573623061414 7. 42250200201994
7. 65612201860565 7. 88974203519137 8. 16299266993015 8. 58644013465493 8. 93837930496004
9. 29031847526514 9. 6539454615727 10. 0478358731537 10. 4170769429845 10. 7832903853785
11. 1696420574684 11. 5801041183883 12. 0653275886006 12. 5657134906429 13. 065783040778;
1. 33975227845875 1. 28756342235586 1. 31610371250882 1. 37147978817833 1. 47787614518209
1. 58427250218586 1. 69066885918963 1. 80720208829457 2. 00102575717641 2. 19484942605825
2. 38867309494009 2. 59961349486271 2. 8124276994623 3. 0252419040619 3. 23805610866149
3. 45087031326109 3. 66368451786068 3. 87649872246028 4. 08931292705987 4. 19356584564554
4. 11392306368087 4. 28221601046944 4. 48553709855712 4. 67332428726659 4. 96991035677671
5. 27748288838713 5. 54128605561447 5. 80020157878565 6. 05630797320754 6. 29309847062351
6. 55856225080671 6. 79247661699602 7. 08112498694583 7. 39181451718987 7. 65701432454896
7. 89063434113467 8. 14884275049742 8. 43313849057801 8. 90518385045802 9. 27060676078911
9. 62254593109421 9. 98618094236925 10. 3995701735722 10. 7734340767889 11. 1433506647279
11. 5296895684656 11. 9401516293855 12. 3929677914876 12. 9003317276771 13. 4004012778122;
1. 37324608542022 1. 32105722931733 1. 36402868210262 1. 43691376861665 1. 54331012562042
1. 64970648262419 1. 75610283962795 1. 93950876996015 2. 13333243884199 2. 32760056309072
2. 54041476769031 2. 75322897228991 2. 9660431768895 3. 1788573814891 3. 39167158608869
3. 60448579068829 3. 81729999528788 4. 03011419988748 4. 24292840448707 4. 45574260908667
4. 48107176098795 4. 53441520677572 4. 73049291454756 4. 97517243858603 5. 28274497019645
5. 57380844400966 5. 83509157690552 6. 09400710007669 6. 32990061326485 6. 58217236089999
6. 84757283281834 7. 08148719900765 7. 3155771979943 7. 62626672823833 7. 89152664707797
8. 13469283106467 8. 41898857114527 8. 70328431122586 9. 20102297974962 9. 59563814889406
9. 95477338692328 10. 3184164231658 10. 7398351700573 11. 1251683772073 11. 499032280424
11. 8897370794627 12. 3001991403827 12. 7206079943746 13. 2349499647113 13. 7350195148464;
1. 40673989238169 1. 35883770282589 1. 41195365169642 1. 50234774905498 1. 60874410605875
1. 71514046306251 1. 8779917827439 2. 07181545162574 2. 26840183591832 2. 48121604051792
2. 69403024511752 2. 90684444971711 3. 11965865431671 3. 3324728589163 3. 5452870635159
3. 75810126811549 3. 97091547271509 4. 18372967731468 4. 39654388191428 4. 60935808651387
4. 80692186267698 4. 90641569064793 5. 12742345731297 5. 3501945741811 5. 5955795836162
5. 8676078005935 6. 12889709819657 6. 36965509317464 6. 60349325332216 6. 87124625117647
7. 13658341482997 7. 37049778101929 7. 60441214720861 7. 86071893928681 8. 12603896960698
8. 40483865171253 8. 68913439179312 8. 97343013187372 9. 47075907464783 9. 91428969362384
10. 2860924473301 10. 6506519039623 11. 0720706508538 11. 4790745961014 11. 8657865762122
12. 2524985563231 12. 6602466513798 13. 0707087122998 13. 5695682017455 14. 0696377518805;
1. 44023369934316 1. 40676267241969 1. 46138537248954 1. 56778172949331 1. 67417808649707
1. 81647479552765 2. 01029846440949 2. 20920310874593 2. 42201731334553 2. 63483151794512
2. 84764572254472 3. 06045992714431 3. 27327413174391 3. 4860883363435 3. 6989025409431
3. 91171674554269 4. 12453095014229 4. 33734515474188 4. 55015935934148 4. 76297356394107
5. 00092885067832 5. 24731217593525 5. 49369550119218 5. 72405904843692 5. 95047333426493
6. 17686893956204 6. 4028504103885 6. 6318877079636 6. 8807696628427 7. 16032014145295
7. 42559399684161 7. 65950836303092 7. 89342272922024 8. 12733709540955 8. 39068873227979
8. 67498447236038 8. 95928021244098 9. 24357595252157 9. 74049516954603 10. 2329412383536

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

10. 6047439920599 10. 9828873847589 11. 4074834992879 11. 8324016780756 12. 2390178525484
12. 6257298326593 13. 020294162377 13. 4307562232969 13. 9041864387796 14. 4042559889147;
1. 47372750630463 1. 45468764201349 1. 52681935292787 1. 63321570993163 1. 7549578083114
1. 94878147719324 2. 15000438157354 2. 36281858617313 2. 57563279077273 2. 78844699537232
3. 00126119997192 3. 21407540457151 3. 42688960917111 3. 6397038137707 3. 8525180183703
4. 06533222296989 4. 27814642756949 4. 52310124083624 4. 76948456609317 5. 01586789135009
5. 26225121660702 5. 50863454186395 5. 75501786712087 6. 0014011923778 6. 24778451763473
6. 49416784289166 6. 74055116814858 6. 98693449340551 7. 21552369153415 7. 44193797736216
7. 71884507887375 7. 95963703014522 8. 20042898141668 8. 445976717733 8. 76114185723098
9. 07749840871381 9. 35784778704061 9. 65453383265769 10. 111514635177 10. 5558962464599
10. 9660528978362 11. 3562676394192 11. 7464823810022 12. 1707441214619 12. 5956623002496
12. 9989611089954 13. 3856730891063 13. 7908037342941 14. 2386464998602 14. 7388742259489;
1. 5072213132661 1. 5026126116073 1. 5922533333662 1. 69864969036996 1. 88726448997698
2. 09080565440114 2. 30361985900074 2. 51643406360033 2. 72924826819993 2. 94206247279953
3. 15487667739912 3. 36769088199871 3. 58050508659831 3. 79889030573723 4. 04527363099416
4. 29165695625109 4. 53804028150801 4. 78442360676494 5. 03080693202187 5. 27719025727879
5. 52357358253572 5. 76995690779265 6. 01634023304958 6. 2627235583065 6. 50910688356343
6. 75549020882036 7. 00187353407729 7. 24825685933421 7. 49464018459114 7. 74102350984807
7. 98740683510499 8. 23600529426312 8. 51272239614783 8. 77035246982034 9. 08548542291912
9. 42567424344023 9. 73175030747515 10. 0927984526786 10. 4614043958892 10. 8833062903901
11. 305208184891 11. 7271100793918 12. 1332783488095 12. 5234930903925 12. 9340047436359
13. 3589229224236 13. 7589043654425 14. 1508512452912 14. 5662867027472 15. 073492462983;
1. 54071512022757 1. 55129095680076 1. 65768731380452 1. 82574750276073 2. 03160692722875
2. 24442113182834 2. 45723533642794 2. 67004954102753 2. 88286374562713 3. 09567795022672
3. 32106269589515 3. 56744602115207 3. 813829346409 4. 06021267166593 4. 30659599692286
4. 55297932217978 4. 79936264743671 5. 04574597269364 5. 29212929795057 5. 53851262320749
5. 78489594846442 6. 03127927372135 6. 27766259897828 6. 5240459242352 6. 78118254072748
7. 03968845373034 7. 29819436673319 7. 55670027973605 7. 8152061927389 8. 11078943471971
8. 41223369737293 8. 71367796002615 9. 01512222267937 9. 31656648533259 9. 61801074798581
9. 91945501063903 10. 2283976114752 10. 5894457566786 10. 950493901882 11. 3115420470854
11. 6725901922889 12. 0545201233221 12. 4764220178229 12. 8983239123238 13. 3005037997828
13. 69726536581 14. 1221835445976 14. 5188476218895 14. 9213608172083 15. 4081107000172;
1. 57420892718904 1. 61672493723908 1. 76423051554448 1. 97240820005636 2. 18522240465595
2. 39803660925554 2. 61085081385514 2. 84323508605306 3. 08961841130999 3. 33600173656692
3. 58238506182385 3. 82876838708077 4. 0751517123377 4. 32153503759463 4. 56791836285155
4. 81430168810848 5. 06785387418897 5. 32635978719183 5. 58486570019469 5. 85377704929939
6. 15522131195261 6. 45666557460583 6. 75810983725905 7. 05955409991227 7. 36099836256548
7. 6624426252187 7. 96388688787192 8. 26533115052514 8. 56677541317836 8. 86821967583158
9. 1696639384848 9. 47110820113802 9. 77255246379124 10. 0739967264445 10. 3754409890977
10. 6768852517509 10. 9783295144041 11. 2797737770573 11. 5812180397106 11. 8826623023638
12. 184106565017 12. 5302856414923 12. 8913337866957 13. 2523819318991 13. 6476358507549
14. 0695377452558 14. 4677292507561 14. 8854441667717 15. 2814083282055 15. 7427289370514;
1. 6077027341505 1. 70271352832822 1. 91320947288396 2. 12602367748356 2. 36540747621098
2. 61179080146791 2. 85817412672484 3. 10455745198176 3. 35452520765047 3. 61303112065333
3. 89820892653229 4. 19965318918551 4. 50109745183873 4. 80254171449195 5. 10398597714517
5. 40543023979838 5. 7068745024516 6. 00831876510482 6. 30976302775804 6. 61120729041126
6. 91265155306448 7. 2140958157177 7. 51554007837092 7. 81698434102414 8. 11842860367736
8. 41987286633058 8. 7213171289838 9. 02276139163702 9. 32420565429024 9. 62564991694346
9. 92709417959668 10. 2285384422499 10. 5299827049031 10. 8314269675563 11. 1328712302096
11. 4343154928628 11. 735759755516 12. 0372040181692 12. 3386482808224 12. 6400925434757
12. 9415368061289 13. 2429810687821 13. 5444253314353 13. 8458695940885 14. 1473138567417
14. 471125526306 14. 8321736715094 15. 2407515781878 15. 6487047889457 16. 0773471740856;

Process for Generating Engine Fuel Consumption Map

(Chevy Malibu 2.5L I4 engine using Tier 3 fuel)

Version: 11-28-2016

```
1. 64119654111197 1. 94264080376519 2. 24408506641841 2. 54552932907163 2. 84697359172485
3. 14841785437807 3. 44986211703129 3. 75130637968451 4. 05275064233773 4. 35419490499095
4. 65563916764417 4. 95708343029739 5. 25852769295061 5. 55997195560383 5. 86141621825705
6. 16286048091026 6. 46430474356349 6. 7657490062167 7. 06719326886993 7. 36863753152315
7. 67008179417636 7. 97152605682958 8. 2729703194828 8. 57441458213602 8. 87585884478924
9. 17730310744246 9. 47874737009568 9. 7801916327489 10. 0816358954021 10. 3830801580553
10. 6845244207086 10. 9859686833618 11. 287412946015 11. 5888572086682 11. 8903014713214
12. 1917457339747 12. 4931899966279 12. 7946342592811 13. 0960785219343 13. 3975227845875
13. 6989670472408 14. 000411309894 14. 3018555725472 14. 6032998352004 14. 9047440978536
15. 2061883605069 15. 5076326231601 15. 8090768858133 16. 1105211484665 16. 4119654111197];
```

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engine.refuel_profile_mult = [1 2 1];
engine.refuel_profile_time_secs = [0 0.1 4];
engine.refuel_limit_gps = 3;
engine.refuel_min_defuel_duration_secs = 0.5;
```

```
engine.acceleration_penalty_gpradps2 = 0.01;
engine.acceleration_penalty_squelch_gps = 0.1;
```

```
engine.throttle_duration_secs = 0.2;
engine.boost_time_constant_secs = 0.2;
```

Published with MATLAB® R2014a

Revision History

Version 06-20-2016: Initial release

Version 11-28-2016: (a) Added transient fuel adjustments characteristics to the calibrations options; (b) modified maximum and minimum speed and torque characteristics; and (c) utilized updated fuel map grid generation method, regenerated the fuel map grid points and recalculated fuel consumption.