The General Fuel Ratio Expression Table (GRFE)

Jarrod Brown
U.S. EPA Office of Transportation and Air Quality

FACA Modeling Workgroup Meeting
April 30, 2013

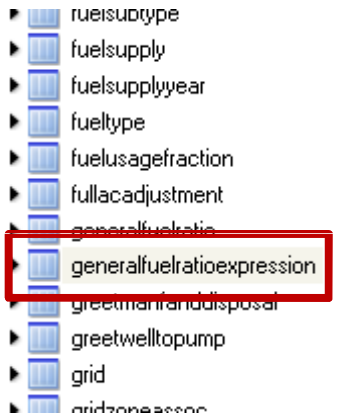
MOVES

Background / Overview

- EPACT fuel adjustment equations cannot be applied in the same tables as the predictive and complex models
- Consolidation of fuel effects for both criteria and toxics into one table simplifies searches
- Generalization of fuel effects equations allows new data to be more easily integrated in the future
- Fully transparent modeling equations are used in the GFRE in contrast to previous fuel effects models running in MOVES

What is the GFRE Table?

G eneral
F uel
R atio
E xpression




```
'if(sulfurLevel > 30,(exp(-4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-
0.01953*((aromaticContent-25.629630)/(10.015366)))+(-0.03553*((RVP-
8.517778)/(1.611374)))+(0.05008*((T50-190.611111)/(28.579112)))+(0.05136*((T90-
320.533333)/(19.480128)))+(0.03373*(((((T50-190.611111)/(28.579112))*((T50-
190.611111)/(28.579112)))-(0.962963))/(0.739766)))+(0.5*0.90557))*((1+((0.425*(exp(0.168*ln(303))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))+0.575*(2.5*(exp(0.168*ln(sulfurLevel))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))))/1.20177969806)/0.0159236555095),((exp(-
4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-0.01953*((aromaticContent-
25.629630)/(10.015366)))+(-0.03553*((RVP-8.517778)/(1.611374)))+(0.05008*((T50-
190.611111)/(28.579112)))+(0.05136*((T90-320.533333)/(19.480128)))+(0.03373*(((((T50-
190.611111)/(28.579112))*((T50-190.611111)/(28.579112)))-
(0.962963))/(0.739766)))+(0.5*0.90557))/0.0159236555095)*(1-0.018125647*(30-sulfurLevel))))',
'if(sulfurLevel > 30,(exp(-4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-
0.01953*((aromaticContent-25.629630)/(10.015366)))+(-0.03553*((RVP-
8.517778)/(1.611374)))+(0.05008*((T50-190.611111)/(28.579112)))+(0.05136*((T90-
320.533333)/(19.480128)))+(0.03373*(((((T50-190.611111)/(28.579112))*((T50-
190.611111)/(28.579112)))-(0.962963))/(0.739766)))+(0.5*0.90557))*((1+((0.425*(exp(0.168*ln(303))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))+0.575*(2.5*(exp(0.168*ln(sulfurLevel))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))))/1.20177969806)/0.0159236555095),((exp(-
4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-0.01953*((aromaticContent-
25.629630)/(10.015366)))+(-0.03553*((RVP-8.517778)/(1.611374)))+(0.05008*((T50-
190.611111)/(28.579112)))+(0.05136*((T90-320.533333)/(19.480128)))+(0.03373*(((((T50-
190.611111)/(28.579112))*((T50-190.611111)/(28.579112)))-
(0.962963))/(0.739766)))+(0.5*0.90557))/0.0159236555095)*(1-0.018125647*(30-sulfurLevel))))'
```

- **Provides an updated, flexible table for fuel effects**
- **Applies fuel effect corrections to both criteria pollutants and toxics**
- **Will override ratios generated by the complex and predictive models inside MOVES**

MOVES

GFRE Parameters

- fuelTypeID: which fuels are applicable to the ratio
- polProcessID: which polProcess is applicable to the ratio
- min/maxModelYearID: the applicable MY range
- min/maxAgeID: the applicable age range
- sourceTypeID: the applicable source type
- fuelEffectRatioExpression: a ratio equation itself
- fuelEffectRatioGPAExpression: a ratio equation specific to the Geographic Phase-in Area

MOVES

GFRE Equations: A Two-headed Beast

- The GFRE provides a table holding both criteria pollutant ratios as well as toxics ratios
- These two effects ratios do not represent the same thing in MOVES!
- *Criteria pollutant ratios* represent a scaling factor for fuel adjustments based on the MOVES base fuel (ie. the base fuel will produce 1.0 in the ratio eq.)
- *Toxics ratios* represent the fraction of a toxic multiplicatively from MOVES VOC (ie. these ratios will usually be quite low)

MOVES

A GFRE Equation Explained

```
if(sulfurLevel > 30,(exp(-4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-
0.01953*((aromaticContent-25.629630)/(10.015366)))+(-0.03553*((RVP-
8.517778)/(1.611374)))+(0.05008*((T50-190.611111)/(28.579112)))+(0.05136*((T90-
320.533333)/(19.480128)))+(0.03373*(((((T50-190.611111)/(28.579112))*((T50-
190.611111)/(28.579112)))-
(0.962963))/(0.739766)))+(0.5*0.90557))*((1+((0.425*(exp(0.168*ln(303))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))+0.575*(2.5*(exp(0.168*ln(sulfurLevel))-
exp(0.168*ln(30)))/exp(0.168*ln(30)))))/1.20177969806)/0.0159236555095),((exp(-
4.653+(0.03268*((ETOHVolume-10.313704)/(7.879557)))+(-0.01953*((aromaticContent-
25.629630)/(10.015366)))+(-0.03553*((RVP-8.517778)/(1.611374)))+(0.05008*((T50-
190.611111)/(28.579112)))+(0.05136*((T90-
320.533333)/(19.480128)))+(0.03373*(((((T50-190.611111)/(28.579112))*((T50-
190.611111)/(28.579112)))-
(0.962963))/(0.739766)))+(0.5*0.90557))/0.0159236555095)*(1-0.018125647*(30-
sulfurLevel))))
```

EPACT Model SULFUR Model Control St.

- **The equations are long, but simple in structure**

MOVES

The Current State of the GFRE

- **The GFRE contains:**
  - EPACT Criteria Equations for LD MY2001+
  - EPACT Toxics Equations for LD MY2001+
  - New low sulfur equations for LD MY2001+ (and continued previous sulfur modeling for S > 30ppm)
  - Biodiesel adjustments for MY2001-2010
  - Adjustments for E85 to Criteria, PM and major HAPs MY2001+
- **The flexibility of the GFRE allows us to update the ratio equations as more data becomes available in the future**