AIR SCIENCES INC.

DENVER · PORTLAND

FETS EMISSIONS CALCULATOR STRAWMAN

PREPARED FOR: Fire Emissions Tracking System Task Team

PREPARED BY: Dave Randall/Matt Mavko

PROJECT NO.:   230-1

COPIES:

DATE: April 13, 2007

This memo presents the Strawman approaches for several steps to execute emissions calculations and store fire emissions data in the Fire Emissions Tracking System (FETS). The FETS Task Team is asked to review the Strawman Approaches, consider the merits and disadvantages of the approaches, and provide input during a FETS Task Team call at 11 A.M. MDT on April 20, 2007. Approaches agreed upon during the call will be incorporated in the FETS Work Plan and implemented in the FETS.

Background.

Calculating emissions for fire data stored in the FETS is identified in the Fire Tracking System (FTS) Policy as a necessary capability, and is considered within the scope of work of the FETS Project. The Draft FETS Work Plan (distributed on 3/23/07) identifies several issues related to emissions calculations:

- Provide a rough, initial estimate of emissions calculated by WRAP method for day-to-day coordination purposes (these emission estimates may or may not be stored permanently in the FETS).

- Have several emissions estimates, all stored, at different levels of confidence – the last or final estimate is used for emission inventory purposes.

- Use of a fuel-loading classification scheme, such as National Fire Danger Rating System (NFDRS), Fuel Characteristics Classification System (FCCS), and Canadian Forest Fire Danger Rating System (CFFDRS) for Alaska.

- Allow user-defined emissions.

- Have a link to an emissions calculator on the website.

- Provide a consistent method of calculating emissions that may be used for specific applications (e.g., regional dispersion modeling).

Review & Selection of Fire Emissions Calculation Method(s).

Five emissions calculations methods, commonly used by the fire community and/or by the WRAP for emissions inventory purposes, have been reviewed by Air Sciences. Several criteria were evaluated, including:

- Ease of incorporation into the FETS.

- Feasibility of using a calculation method in its current form.

- Accuracy gained (or lost) when using a particular method.

Table 1 identifies the basic data input requirements for the emission calculations reviewed. Generic inputs used to calculate emissions are listed in the left of the table. Requirements specific to each method are listed in the "Minimum" columns. Not all inputs are required for each method, and in those cases the field has been shaded out. "Difficulty ratings," indicating Air Sciences' assessment of the ease of implementing each emission calculation method into the FETS, are listed in the last row (a lower score implies easier implementation).

The basic emission equation/calculation methods (i.e., the WRAP-modified method used in the 2002 WRAP Emissions Inventory, and the seasonal method used in the 2002 Inter-RPO Wildfire Emissions Inventory) have the lowest scores due to the need only for a series of look-up tables in the FETS database and relatively few inputs. The other three methods represent stand-alone programs, all with a Graphical User Interface (GUI), making incorporation into the FETS a more involved undertaking.

Of the three stand-alone programs, CONSUME 3.0 is the only calculator with a command-line executable capable of accepting a batch file of any number of fire events at one time. This feature simplifies the task of implementing CONSUME 3.0 into the FETS. FOFEM is integrated with the MT/ID fire tracking system, and is capable of providing emissions calculations directly from the web interface. However, the code for accomplishing is not readily available for use by the FETS Project Team (personal communication with Lee Macholz on 4/10/07) and FOFEM does not accept data in batches. FEPS is exclusively a stand-along program with a GUI interface and, therefore, would require substantial

programming to implement into the FETS. Based on this review, CONSUME 3.0 is considered the best choice among stand-alone emissions calculators.[1]

---

[1] CONSUME 3.0 has many input requirements and options for establishing universal defaults (e.g. pile dimensions, number of piles per acre, slope, etc). Air Sciences will need to resolve these input-data as we expect that such detailed data will not be provided for the majority of fires entered into the FETS.

Table 1

	CONSUME			FEPS			FOFEM			Inter-RPO			WRAP		
	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed	Minimum	Exists	Needed
Burn Type	Nonpiled/ Piled	X		Five types combine source/burn	X		Nat/slash/ pile	X		Bdcst / piled	X		Bdcst / piled	X	
Source Type	Rx, WFU, WF	X								WF / Rx	X		WF / Rx	X	
Fuel Class	FCCS number		X	FCCS or NFDRS		X	FCCS / SAF / SRM / NVCS		X	NFDRS		X	NFDRS		X
Eco-Region	Equation type		X												
Fire Shape	Piles only		X	Oval or linear		X									
Dates	Burn Date	X		Start/End	X		Season	X		Month	X				
Location	Lat/Lon	X		Lat/Lon	X		Lat/Lon	X		Lat/Lon	X		Lat/Lon	X	
Acres	Fuelbed Size	X		Acres	X					Acres	X		Acres	X	
Moisture	10hr/1000hr / Duff		X	6 classes, Very dry to Very wet		X	Vdry, dry, mod, wet		X	6 classes, Very dry to Very wet		X			
Batch/ command line	command-line batch mode	X		None		X	Possibly		X						
Additional needs	%crown consumed; Shrubland % Blackened; Slope; Days Since Rain; Number of piles		X												
Difficulty:	**4**			**6**			**4**			**2**			**1**		

Key:
 Minimum:
  Bare minimum of inputs required
 Exists: Data already incoming to tracking system / Capability exists
 Needed: Requires addition of one or more look-up tables to the database, or need to establish defaults
 Not applicable to calculation method

Hierarchy of Emission Estimates

The WRAP-modified method of emissions calculation can be readily implemented with no additional software or hardware requirements and will be implemented as the default option for calculating emissions in the FETS. The Project Team recognizes the benefit to moving toward a more resolved and widely-accepted emissions calculator. CONSUME 3.0 in its current form is the most feasible choice for incorporation into the FETS, and the Project Team will move toward a goal of implementing this as part of the full integration of the FETS with the TSS by September 2007. At this time, the WRAP-modified method of emissions calculation will continue to be used for estimating $PM_{2.5}$ emissions on a regional coordination level as a rough day-by-day guide. CONSUME 3.0 will be used to estimate emissions as accomplished acres and other post-burning reporting becomes available.
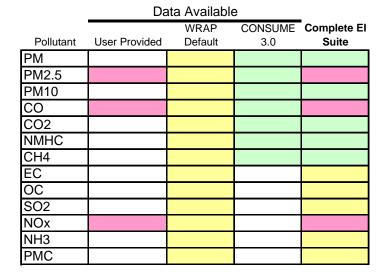
Pollutants and User-provided Emission Estimates.

CONSUME 3.0 calculates emissions for PM, $PM_{2.5}$, PM_{10}, CO, CO_2, non-methane hydrocarbons (NMHC), and methane (CH_4). Additional pollutants calculated in past WRAP emissions inventories include elemental carbon (EC), organic carbon (OC), SO_2, NO_x, ammonia (NH_3) and coarse PM. A complete suite of pollutants for each fire event will be developed by combining CONSUME 3.0 values and WRAP-method values and/or by scaling CONSUME 3.0 emissions by scalars published in EPA/OAQPS reference documents.

In addition to performing emissions calculations within the database, the FETS will accept user-provided emissions values. (In most cases, "users" will be state and tribal Smoke Management Programs). User-provided emission estimates are likely to not include all pollutants in the complete suite of pollutants. A complete suites of pollutants for each fire event will be developed by populating pollutant data fields according to a pollutant data hierarchy. An example of the pollutant data hierarchy is illustrated in Figure 1.

Figure 1: Pollutant Data Hierarchy This is an example of how pollutant-specific data from several emission calculation methods for a single fire event may be combined to develop a complete suite of emission estimates.

		Data Available		
Pollutant	User Provided	WRAP Default	CONSUME 3.0	**Complete EI Suite**
PM		yellow	green	green
PM2.5	pink	yellow	green	pink
PM10		yellow	green	green
CO	pink	yellow	green	pink
CO2		yellow	green	green
NMHC		yellow	green	green
CH4		yellow	green	green
EC		yellow		yellow
OC		yellow		yellow
SO2		yellow		yellow
NOx	pink	yellow		pink
NH3		yellow		yellow
PMC		yellow		yellow

Fuel Layer Node.

A common feature between all emissions calculation methods is the need for information pertaining to vegetative cover/fuel classification and estimates of fuel loading and fuel consumption. For users entering data via the web interface of the FETS, users will be able to select fuel class directly from a pull down data. For fire emissions data that are "mined" by the FETS or provided in batch mode by data providers, fuel class information may be missing. Therefore, the Project Team has committed to implementing a "fuel layer node" in the FETS. This node will consist of an automated routine that pulls fire events from the database (with a spatial location), drops the data onto a fuel layer map, and inserts the resulting fuel class information back into the database for each fire event. At this time, a single fuel classification will correspond to a given set of fire event coordinates—fire perimeter information will not be incorporated.

Emission Reduction Techniques

The FETS will accommodate the use of Emission Reduction Techniques (ERT). ERT data will likely come in to the FETS at different times for different states, and in many cases ERT data will not be available until after post-burn reporting has been submitted. Therefore the following general approach will be used to handle ERT information:

- For day-to-day coordination purposes, ERT application for an event will be noted (if available) but no calculations will be performed—only uncontrolled $PM_{2.5}$ emissions will be presented.

- As post-burn reports are submitted and accomplished acres recorded, ERT application will be incorporated into emissions calculations

- Final, quality-controlled emission inventory estimates will included emissions averted due to the use of ERT.

- The WRAP ERT technical package will be available as a reference for users and as a default for the calculation of emissions averted.

Server Options for Emissions and Fuel Layer Utilities.

An open-source GIS will be employed to implement the Fuel Layer Node. Because the web-server will exist on a shared host (www.godaddy.com) that cannot support individual supporting programs, the Fuel Layer Node (and perhaps the CONSUME 3.0 Utility) will need to reside elsewhere. The server at CIRA (where the FETS SQL database will reside)

could be an appropriate location, but this would add a computational burden .in addition to handling user queries and may compromise existing security practices at CIRA. Alternatively, a separate, simple server (e.g. a Linux box) that will perform the necessary functions related to GIS and emissions calculations could be set up and utilized. This will enhance performance for users since calculations may be performed at a much greater frequency, and will allow for the use of open-source GIS software (i.e. GRASS GIS) instead of relying on proprietary software such as ArcView.. Figure 2 outlines the basic architecture of this setup.

Figure 2: Server architecture that includes emissions calculation and fuel layer node.