Fire Emission Production Simulator (formerly EPM)

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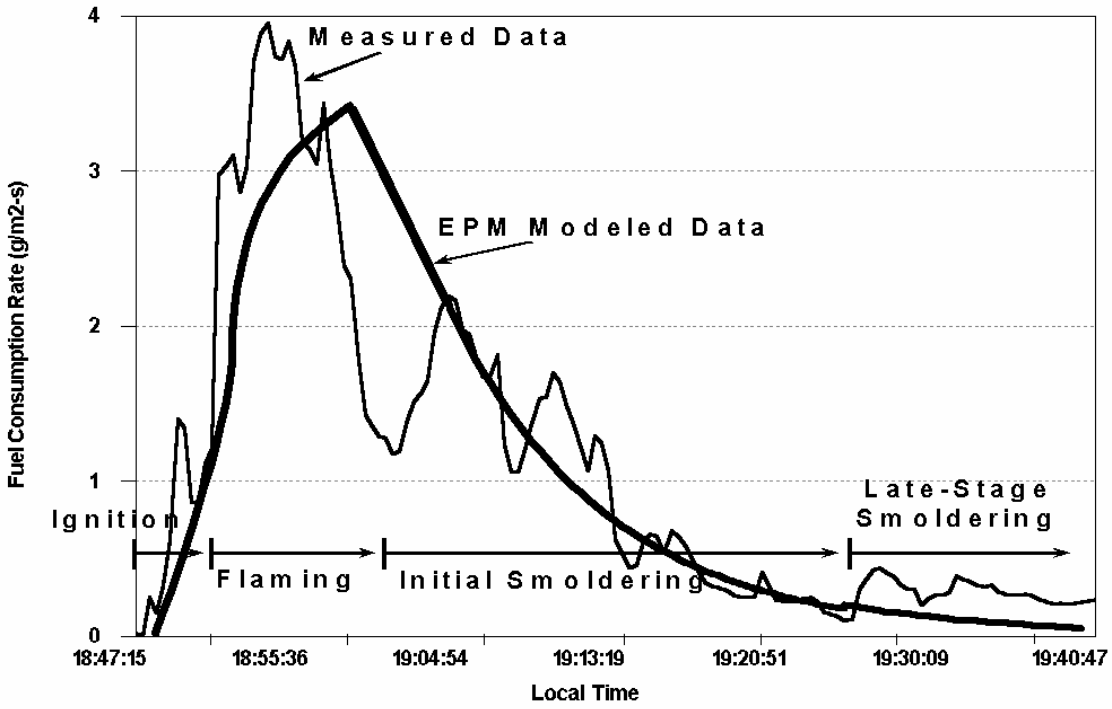
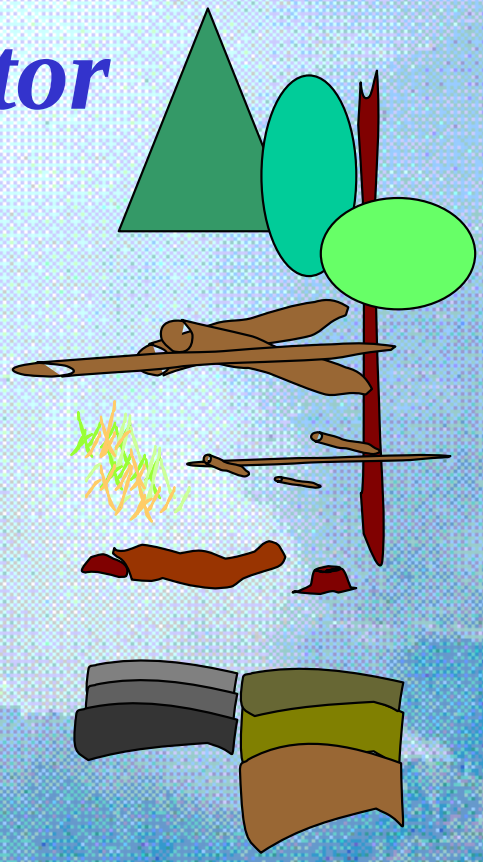
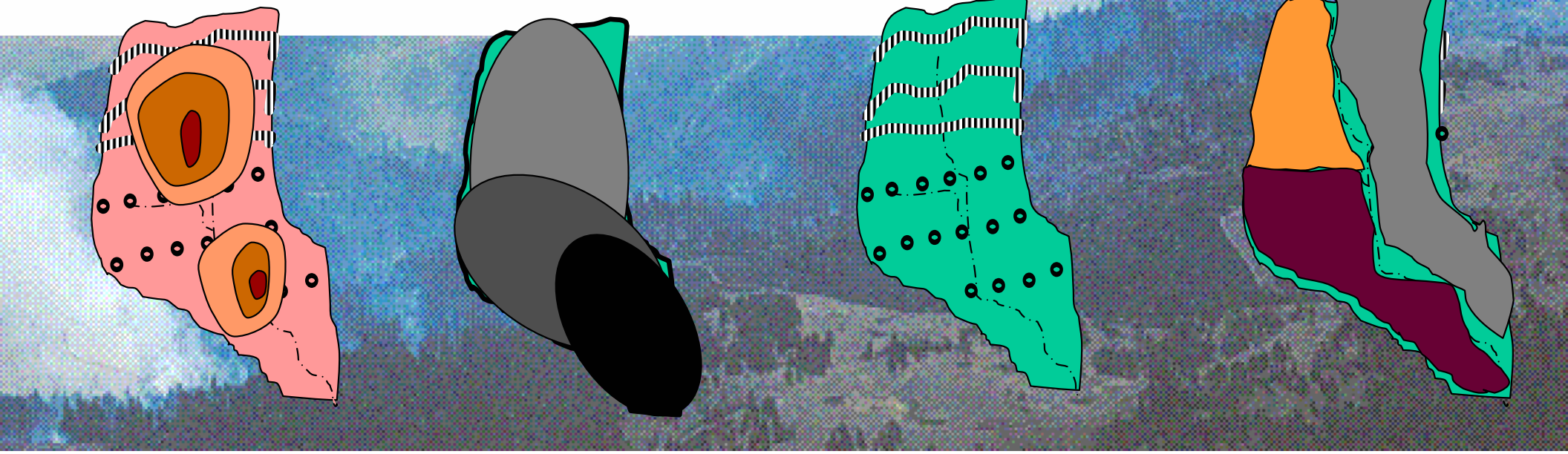
Joint Fire Science Program and
USDA Forest Service

Fire Emission Production Simulator







Fire Emission Production Simulator (FEPS)

-- an update of the Emission Production Model (EPM) --

NEW Download software and user's guide
Request a copy of the software on CD and/or a hardcopy User's Manual

Fire Emission Production Simulator (FEPS) is a user-friendly computer program designed for scientists and resource managers with some working knowledge of Microsoft Windows applications. The software manages data concerning consumption, emissions and heat release characteristics of prescribed burns and wildland fires.

The original Emissions Production Model (EPM) was designed to help managers estimate and mitigate the rates of heat, particles, and carbon gas emissions from controlled burns of harvest-slash residue in Northwest forests.

In updating EPM, a significant number of improvements were made, to the usability, applicability, and accuracy of the model. The calculation approach was totally redesigned, and the model has been renamed FEPS.

FEPS can be used for most forest, shrub and grassland types in North America and the world. The program allows users to produce reasonable results with very little information by providing default values and calculations; advanced users can customize the data they provide to produce very refined results.

Total burn consumption values are distributed over the life of the burn to generate hourly emission and release information. Data managed includes the amount and fuel moisture of various fuel strata, hourly weather, and a number of other factors.

FEPS version 1.0 produces hourly emission and heat release data for prescribed and wildland fires. The basic steps are:

FEPS Users Guide (.pdf, CD)

TABLE OF CONTENTS

ABOUT THIS USER'S GUIDE IV

FEPS AS AN IMPROVEMENT TO EPM 5

FEPS BASICS 6

Starting FEPS 6

Overview of Using FEPS 6
- Events 7
- Data Entry 8
- Validating Data Entry 9
- FEPS Screen Layout 9
- FEPS Online Help 11

FEPS DETAILS 12

Manage Events Screen 12

Data Entry Screens 17
- Overview of Data Entry 17
- Validating Data Entry 18
- Event Information Tab 18
- Fuel Loading Tab 20
- Fuel Moisture Tab 25
- Consumption Tab 28
- Hourly Input Data Tab 31

Reports and Charts Screen 39
- Overview of Reports 39
- Overview of Charts 41
- Getting to the Reports and Charts screen 42
- Displaying Reports and Charts 42
- Exporting Reports and Charts 43
- Printing Reports and Charts 43
- Manipulating Reports in the Print Preview Window 43
- Changing Report Units 45
- Returning to Data Entry 45

APPENDICES

APPENDIX A: CONVERSION FACTORS 46

APPENDIX B: INSTALLATION AND SYSTEM CONFIGURATION 47

Installing, Uninstalling and Reinstalling FEPS 47

Checking Your System Display Configuration 48

APPENDIX C: MODEL EQUATIONS 50

Introduction 50

FEPS Algorithms 51

Calculations Made for Fuel Moisture tab 51
- Percent of Loading Consumed 51

Calculations Made for Consumption tab 52
- Fuel Consumption Calculations 52

Calculations on Hourly Input Data tab 57
- Areal Measurements 57
- Meteorological Data 58

Consumption Results Calculations 59

Emissions Results Calculations 62

Heat Rise Result Calculations 66

APPENDIX D: PARAMETER AND EQUATION MODIFICATIONS 68

Parameter/Equation Modifications Overview 68

Managing Parameter/Equation Modifications 69
- Parameters 70
- Custom Equations 72
- Leaving the Parameters/ Equation screen 75

APPENDIX E: THE NATIONAL FIRE DANGER RATING SYSTEM – 1978 FUEL MODEL DEFINITIONS 76

FEPS User Guide Operating Instructions

Note Tool (S)

Data Entry

You enter data and produce reports in **FEPS** by using the following primary screens:

- Use the **Manage Events screen** to create a new Event, delete an existing Event, select an existing Event, or export an Event,
- Once an Event is created/selected use the five data entry screens, or tabs, to enter/edit Event information. Use the **Event Information tab** to initially define and enter information about an Event and define the period over which the Event occurs. Use the **Fuel Loading**, **Fuel Moisture, Consumption** and **Hourly Input Data tabs** to enter fuel loading, fuel moisture, fuel consumption and hourly data for the Event, and
- Use the **Reports and Charts screen** to view and print reports and charts.

Before discussing the details of data entry in these screens, basic methods for adding, editing and deleting information must be understood. All screens use consistent methods for adding, editing, and deleting information.

Creating a New Event	All Events must be created from a System Default, User Default, or valid User Event. First select the Event to be copied. From the menu, select **File → Manage Events** (or press CTRL-E). From the Manage Events screen, select "**the basis for your Event**" (i.e. Event Type). Select an available Event. Click **Create** (or press ALT-T.) Enter a new Event name and click **Save**. If no User Events are available, you must create one from a System Default or User Default.
Loading an existing Event	From the menu, select **File → Manage Events** (or press CTRL-E). This will display the Manage Events screen. Select "**the basis for your Event**" (i.e. Event Type). Select the Event. Click **Load** or press ALT-L. If no User Events are available, you must create one from a System Default or User Default. When initially installed, **FEPS** will only contain System Default Events.
Editing an Event	After loading an existing Event or creating a new one, make the desired changes in the five data entry tabs. The status bar at the bottom of the window will indicate that the Event is being edited. Edits must be completed or canceled before navigating to other tabs. Details on the use of the five data entry tabs is given in the FEPS Details section starting on page 17. Note: System Default Events can be reviewed, but not changed.
Saving Edits to an Event	While editing, the status bar at the bottom of the window will indicate that the Event is being edited. In addition, the **Save** button becomes active. To save changes, click on the **Save** button, click on the **Save Event** icon on the toolbar, select **File → Save Event** from the menu, or press CTRL-S. Note: Saving changes may result in calculations and changes to other tabs. For Events longer than a few days, this may take a few seconds.
Canceling Changes	While editing, the status bar at the bottom of the window will indicate that the Event is being edited. In addition, the **Cancel** button becomes active. To cancel changes on the current tab, click on the **Cancel** button, click on the **Cancel** icon on the toolbar, or select **Actions → Cancel Changes** from the menu. Canceling changes will return the Event information to the last time the Event was saved.

Deleting an Event	From the menu, select **File → Manage Events** (or press CTRL-E). Select "**the basis for your Event**" (i.e. Event Type). Select the Event to be deleted. Click **Delete** (or press ALT-D.)
Copying an Event	To make a copy of an existing Event, follow the instructions for creating a new Event. Note: You may not create a copy of an invalid Event.
Converting a User Event to a User Default	First load a valid *User Event*. From the menu, select **File → Convert Event to User Default...** The status bar will reflect the change.
Reports and Charts	Reports for valid Events may be accessed from a loaded Event, or from the Manage Events screen. From a loaded Event, select the **Actions → Reports/Charts** menu option or click the Reports/Charts icon on the toolbar. To access reports from the Manage Events screen, select **File → Manage Events** (or press CTRL-E). Select "**the basis for your Event**" (i.e. Event Type). Select the desired Event. Click **Reports** (or press ALT-R.)

Validating Data Entry

Reports and charts can be generated only for Events with valid data. Thus, knowing that data is valid is important and is closely tracked by **FEPS**. Data validity information is maintained for each data entry tab as well as the Event as a whole. The status bar located at the bottom of the **FEPS** screen indicates whether the Event and or the currently displayed tab are valid.

If the status bar indicates that the current Event is invalid, but the current tab is valid, then you must manually view each of the other four tabs to determine where invalid data have been entered. Under certain circumstances, a change you make in the data on one tab may cause the data on another tab to become invalid. For example, if you delete a Fuel Profile you may invalidate the "% of are burning for each profile" columns in the Hourly Input Data tab.

FEPS Screen Layout

As you navigate through **FEPS**, each screen is specific to action required at that time. There are however specific features in **FEPS** that remain available at all times regardless of where you are at the moment. These include items on the:

- Menu Bar
- Tool bar, and
- Status bar.

FEPS User Guide Technical Appendix A&B

Appendix A: Conversion Factors

1 lb	453.59 g
1 lb	0.453,59 kg
1 ton	907.18 kg
1 lb/min	7.559,8 g/sec
1 lb/min	0.007,559,8 kg/sec
1 lb/min	27.215 kg/hr
1 ton/hr	251.99 g/sec
1 ton/hr	907.18 kg/hr
1 btu/hr	0.292,9 watts
1 acre	43,560 ft^2
1 acre	4,046.9 m^2
1 acre	0.004,046,9 km^2
1 acre	0.4046873 hectare
1 ton/acre	224,166.65 kg/km^2
1 ton/acre	0.224,2 kg/m^2
1 inch	2.54 cm
1 inch	0.025,4 m
1 mile/hr	0.447 m/s
1 mile/hr	1.609 km/hr
1 btu/hr	0.292,9 joules/sec
1 btu/hr	1.0544 kJ/hr
1 btu/hr	0.000,292,9 kilowatts

Appendix B: Installation and System Configuration

Installing, Uninstalling and Reinstalling FEPS

FEPS requires about 12.5 MB of hard disk space. Installing and reinstalling FEPS is done from the FEPS installation file FEPS.msi. If you are reinstalling FEPS for any reason, you must completely uninstall it first.

Note: When uninstalling FEPS, the database of Events is not automatically deleted. If you need to reinstall FEPS and wish to retain your library of Events and User Defaults, make a backup copy of the FEPS.mdb file from the FEPS application directory to another location on your hard drive before you begin the reinstall process. After reinstalling the application, you can recover your User Events by manually replacing the reinstalled FEPS.mdb file with your saved backup.

To Install FEPS:

1. Obtain the latest version of FEPS from http://www.fs.fed.us/pnw/fera/feps/,
2. Save the installation file "FEPS.msi" to a temporary location,
3. Double click on the FEPS.msi icon,
4. After the install program starts, click on the **Next** button,
5. Select the location on your computer where you would like the FEPS files to reside, and click the **Next** button,
6. On the "Confirm Installation" screen, click the **Next** button, and
7. After the installation is complete, click the **Close** button.

To Uninstall FEPS in Windows® 95, 98 or NT:

1. Click the Windows **Start** button,
2. Select the **Settings** menu item,
3. Click the **Control Panel** menu item,
4. Double click the **Add/Remove Programs** icon,
5. Click on Fuel Emission Production Simulator,
6. Click the **Add/Remove** button,
7. Click the Remove Fuel Emission Production Simulator radio button,
8. Click the **Finish** button, and
9. After the uninstallation is complete, click the **Close** button.

To Uninstall FEPS in Windows® XP:

1. Click the Windows **Start** button,

   Windows XP includes a revised version of the Control Panel. To maintain similarity between versions, it is recommended that you access the control panel through the "classic view."
2. Click the **Switch to Classic View** hypertext link on the left of the screen to view the control panel dialog in classic view.
3. Double click the **Add/Remove Programs** icon,

FEPS User Guide Technical Appendix C documentation of equations

Appendix C: Model Equations

This appendix provides equations used by the FEPS model. It presents equations used to calculate both intermediate and final results.

Introduction

The Emissions Production Model (EPM) was designed over a decade ago to help managers estimate and mitigate the rates of heat, particles, and carbon gas emissions from controlled burns of harvest-slash residue in Northwest forests.

In updating EPM, a significant number of improvements were made, to the usability, applicability, and accuracy of the model. The calculation approach was totally redesigned, and the model has been renamed FEPS.

FEPS incorporates a flexible user interface that allows the user to customize a burning Event. Furthermore, many intermediate results are exposed to the user. The user may accept these results, or insert values of their own.

The user enters data using five tabbed data entry screens, starting with (1) basic Event information and (2) fuel loadings. When (3) fuel moisture information is defined, FEPS calculates (4) total consumption. The results of the total consumption calculation may be accepted by the user or replaced with specific values. Next, the user enters (5) hourly fire size and meteorological information. Finally all data and intermediate results are combined to calculate hourly consumption, emissions and heat release information, which are presented in charts and tabular reports.

This technical section presents equations in the order they are applied. Calculations that are used in the data entry tabs are described first, followed by intermediate calculations, and lastly the overall consumption, emission and heat release calculations.

The documentation for each equation includes a table that describes each variable of the equation, its units, and a code that describes where the variable can be viewed or modified in FEPS, and whether it is a result of a previously calculated equation. The location code for the result of the equation is also given, and represents where the result can be viewed. The codes are defined in the following table.

Location Codes

Code		Description
FL	-	Fuel Loading Tab
FM	-	Fuel Moisture Tab
	a	Values are entered on the Fuel Moisture tab as part of the fuel moisture profiles.
C	-	Consumption Tab
HI	-	Hourly Input Data Tab
	a	Values are entered on the Hourly Data portion of the Hourly Input Data Tab
	b	Values are entered on the Daily Temperature and Humidity Extremes portion of the Hourly Input Data Tab
	c	Value is set indirectly by choosing a Pasquill Stability Class
Admin	-	Values are set by FEPS and may only be changed by manually resetting the values in the FEPS.mdb database
	a	table tblConstants
	b	table tblEmpiricalEF

CBE	-	Cannot be entered or edited
	a	Values may not be entered, but the category and resulting values are selected by assigning a fuel moisture profile to each fuel profile.
	b	Values are populated by the system.
Eq. #	-	The parameter is a result of the specified equation.
ND	-	This intermediate result is not displayed by FEPS
Report	-	This result is displayed on a FEPS report.

FEPS Algorithms

FEPS allows the user to define up to five fuel profiles for each Event. By allowing multiple fuel profiles, FEPS can simulate burn Events over varying vegetation types. Each profile is defined independently. Intermediate calculations are carried out separately for each profile. On the Hourly Data Input tab, the user specifies the percentage of each fuel profile involved during each hour. For the final Event results, individual fuel profile results are combined by weighted average.

Calculations Made for Fuel Moisture tab

Equations (1) through (3) are used to calculate the data displayed on the bottom table of the Fuel Moisture tab, based on data on the Fuel Loading tab and in the top table of the Fuel Moisture tab.

Percent of Loading Consumed

FEPS allows the user to specify up to six moisture profiles. The moisture profiles range from very dry to very wet. Each moisture profile defines fuel moisture percentages by fuel size class. Each fuel profile in an Event is assigned one moisture profile. FEPS then calculates the percent of loading consumed in each fuel layer.

Percent Canopy, Shrub, Grass, or Duff Loading Consumed

The fraction of canopy, shrub, grass or duff loading consumed is calculated using equation (1). It is used in equations (4) and (16).

$$LC_L = 100 * \left(1 - e^{-1}\right)^{mcf} \qquad (1)$$

Where:

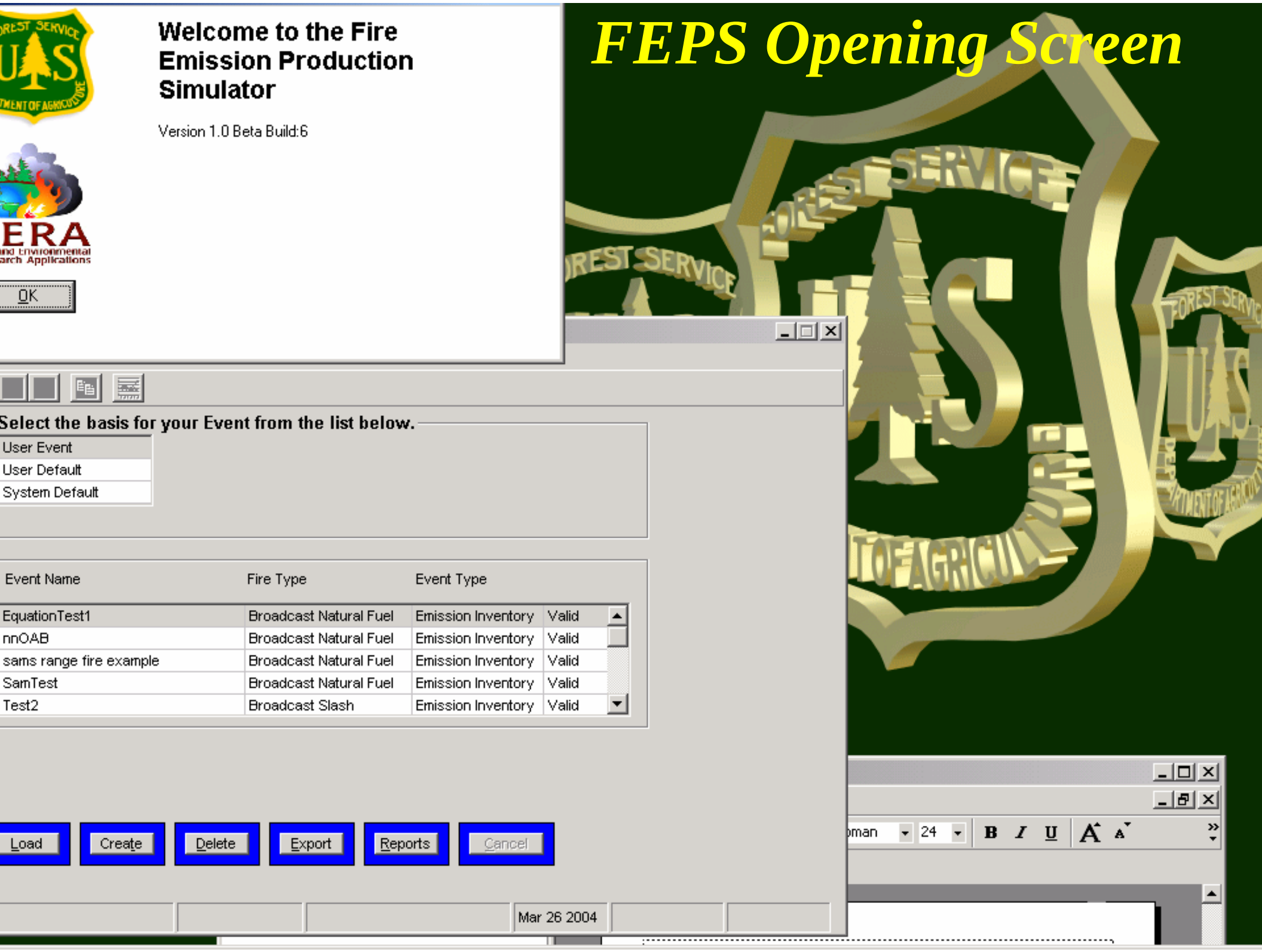
Variable	Definition	Units	Location
LC_L	The percent of loading consumed, for layer *L*.	%	FM
mcf	Moisture category factor.	--	CBE[a]

Moisture category factors are:

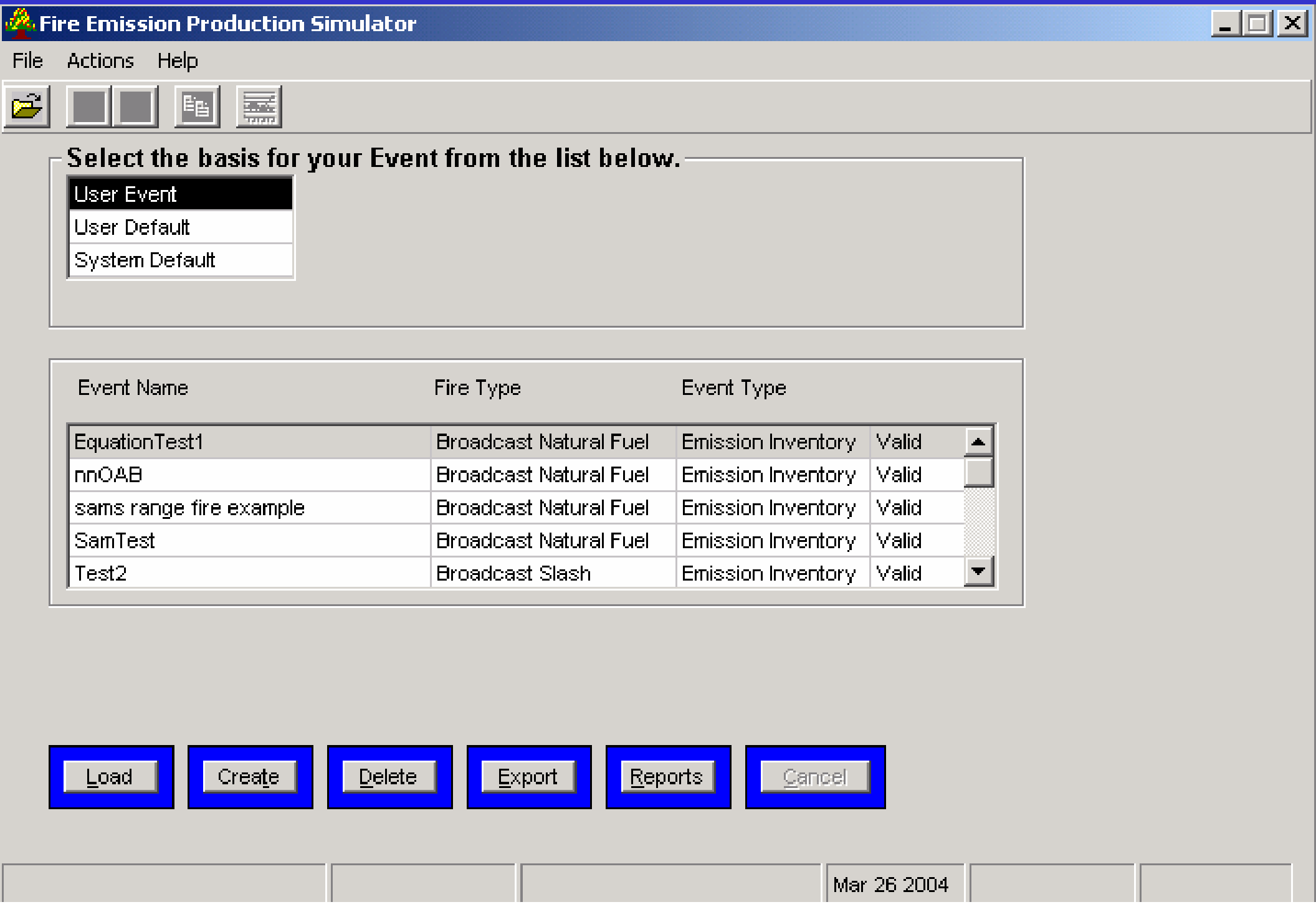
Moisture	Canopy	Shrub	Grass	Duff
Very Dry	0.33	0.25	0.125	0.33
Dry	0.5	0.33	0.25	0.5
Moderate	1	0.5	1	1
Moist	2	1	2	2
Wet	4	2	4	4
Very Wet	5	4	5	5

Two special notes apply to canopy consumption: (1) Canopy is consumed only if the Fire type set in the Event Information tab is Wildland Fire – Severe; and (2) if the fraction Woody fuel loading consumed is equal to zero then the fraction Canopy loading consumed is assumed to equal zero.

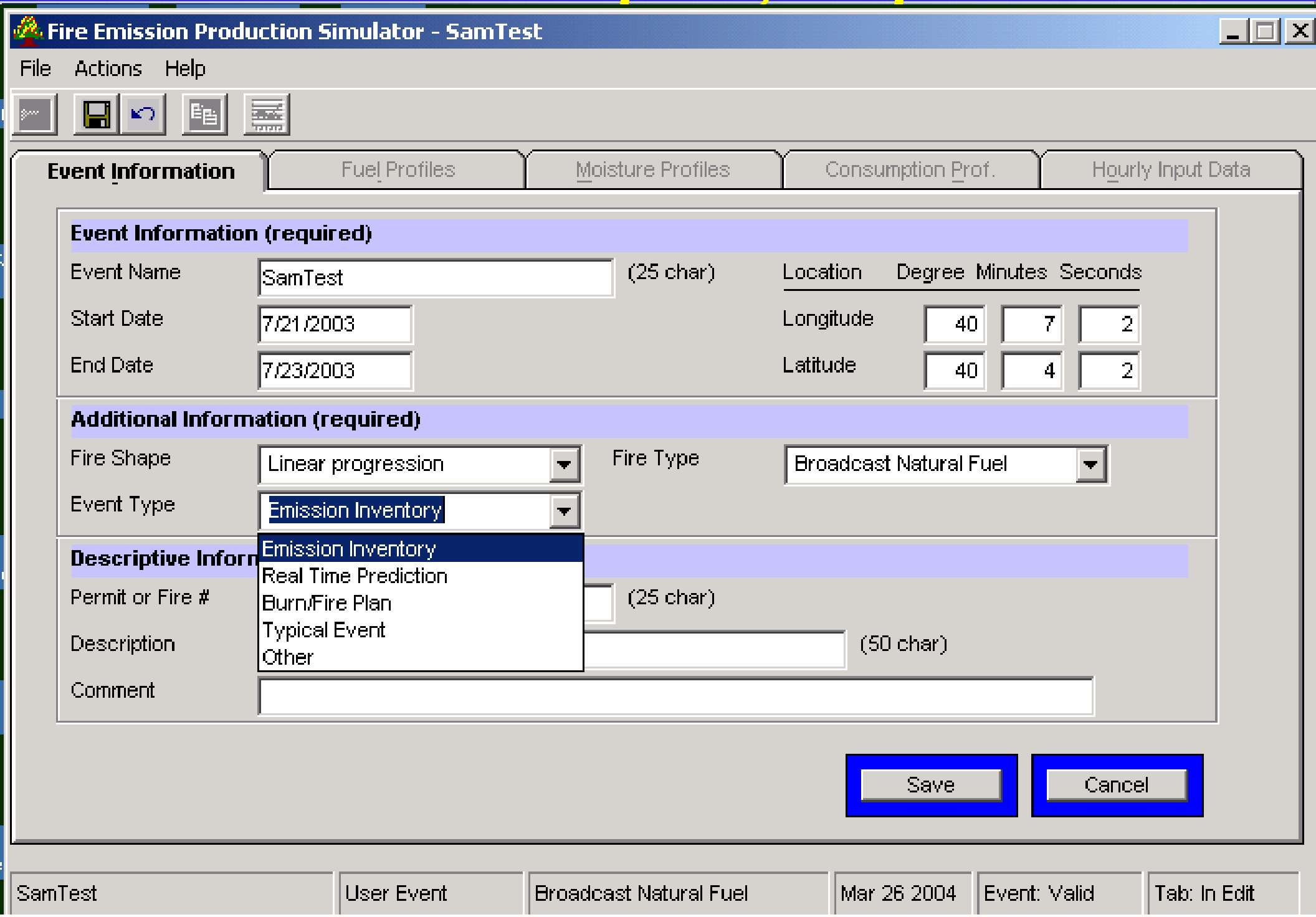
FEPS Opening Screen



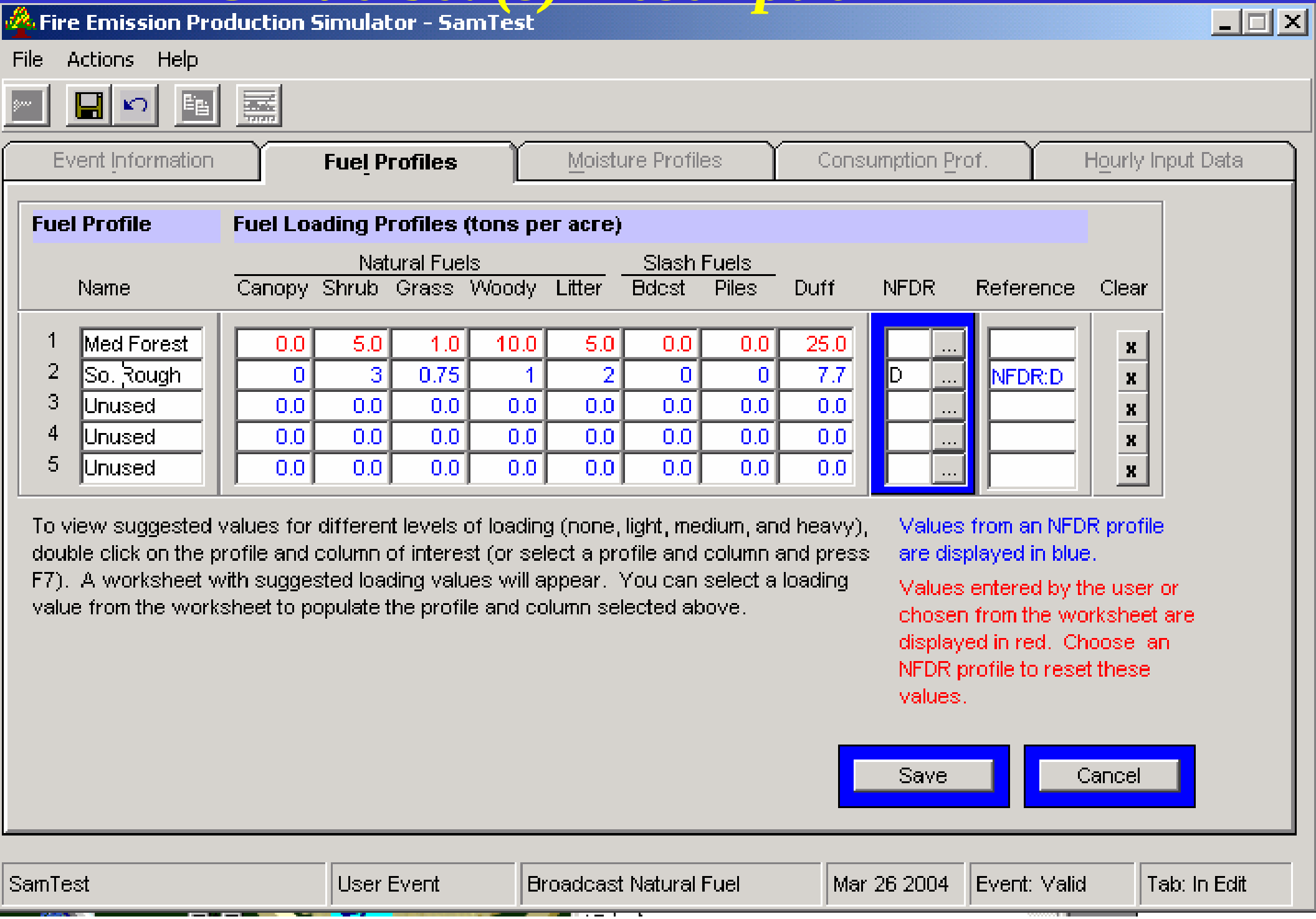
FEPS Run Mode selection



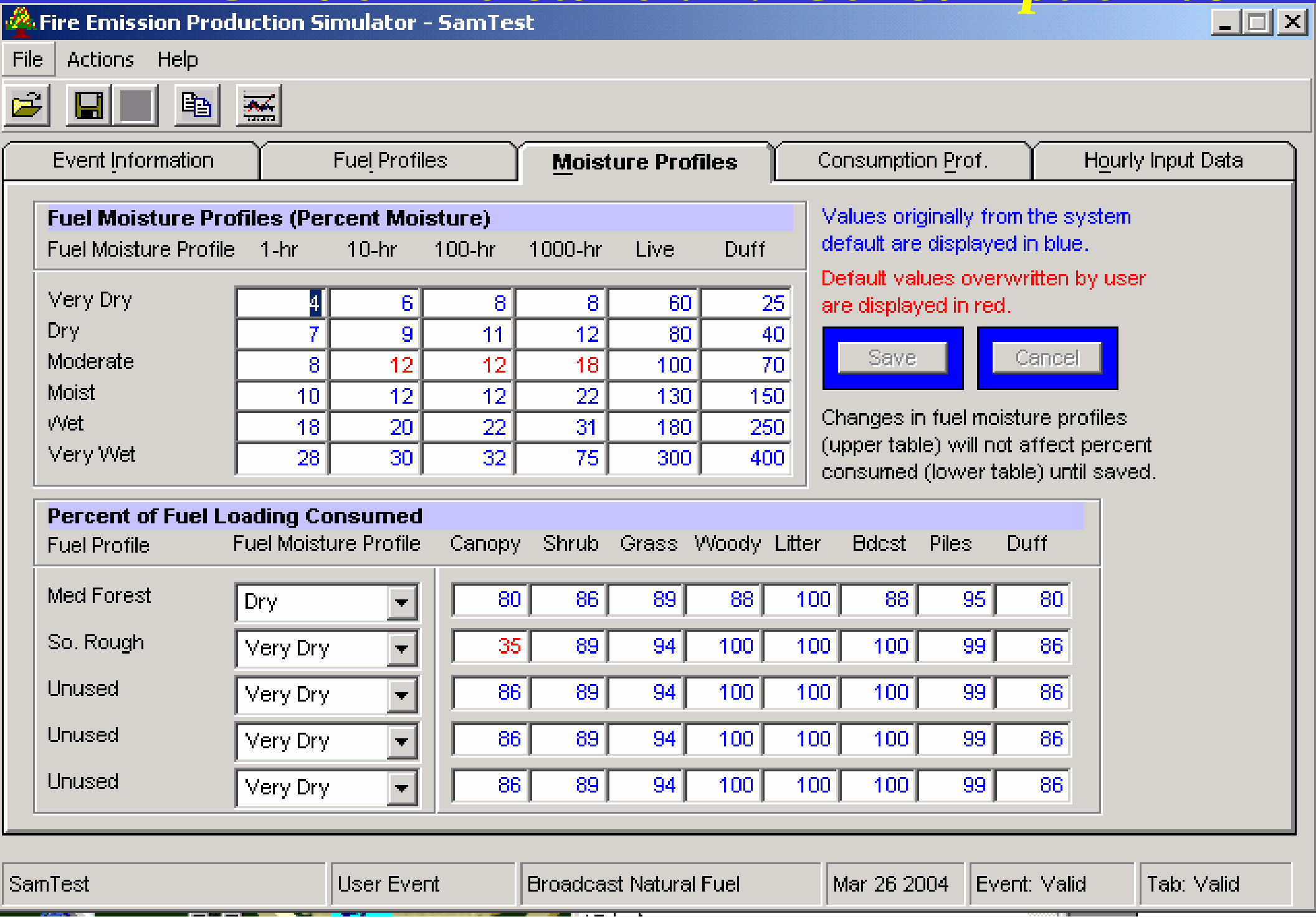
FEPS Event Description, Purpose



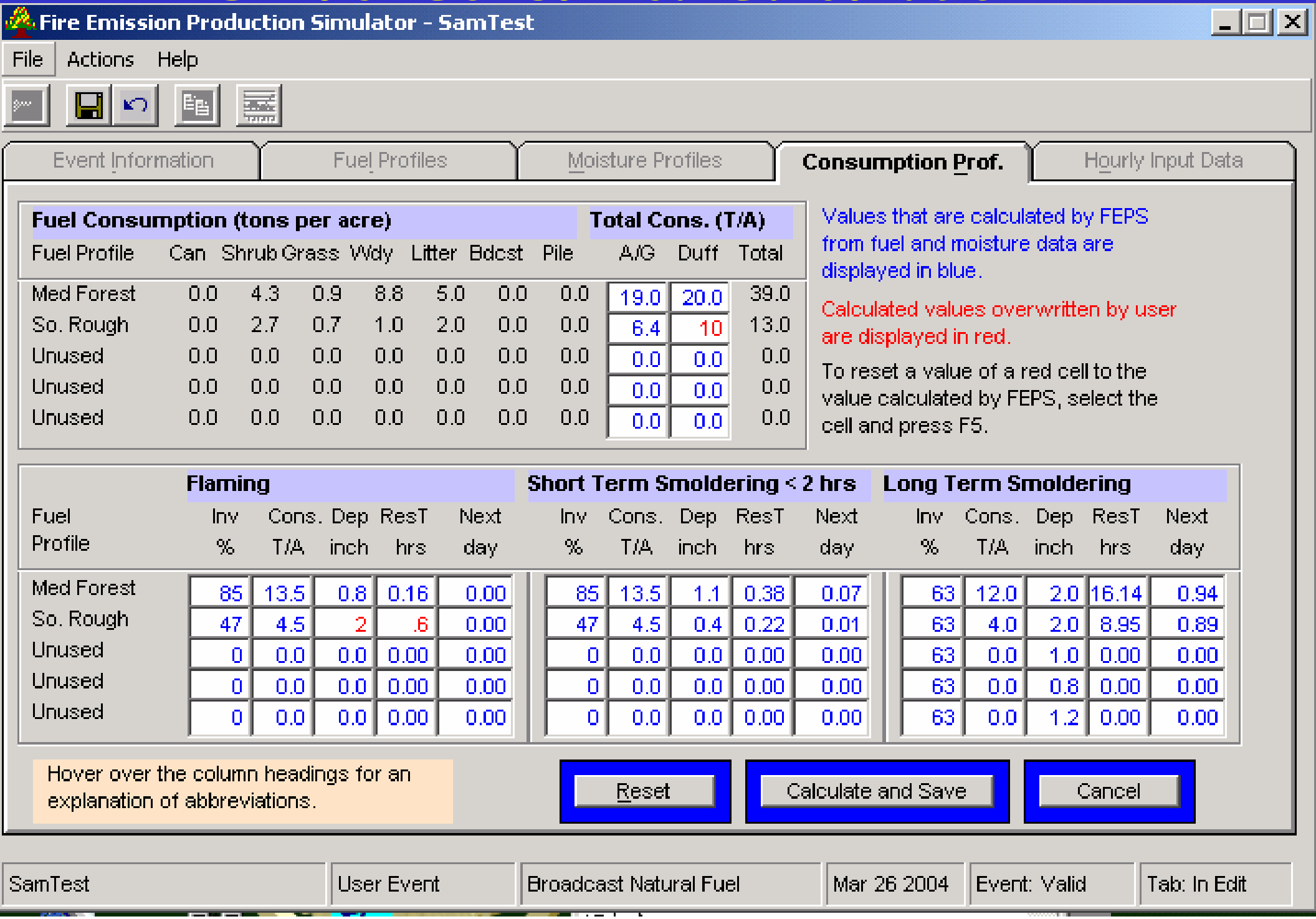
FEPS Fuelbed(s) Description



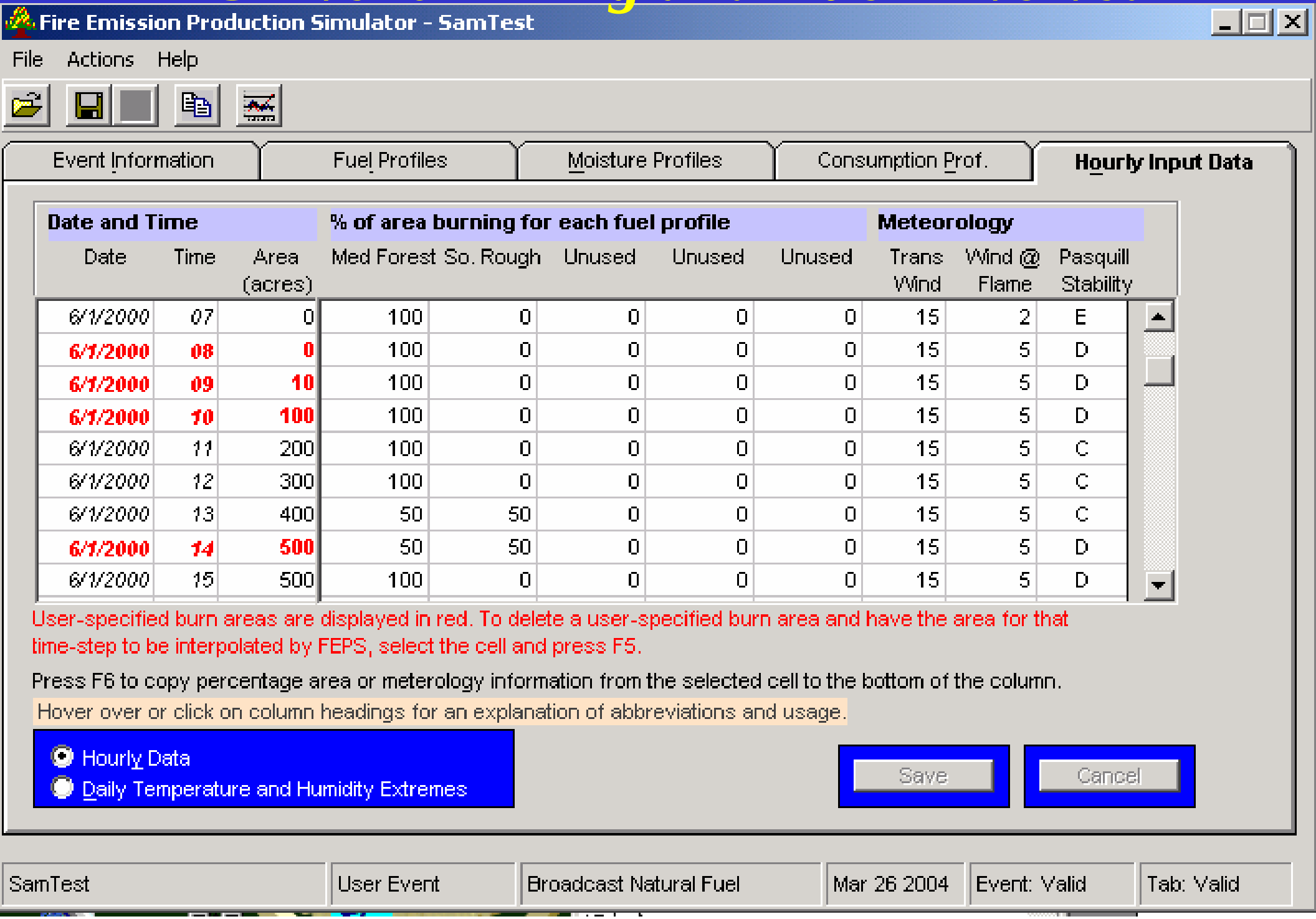
FEPS Fuel Moisture and Consumption %



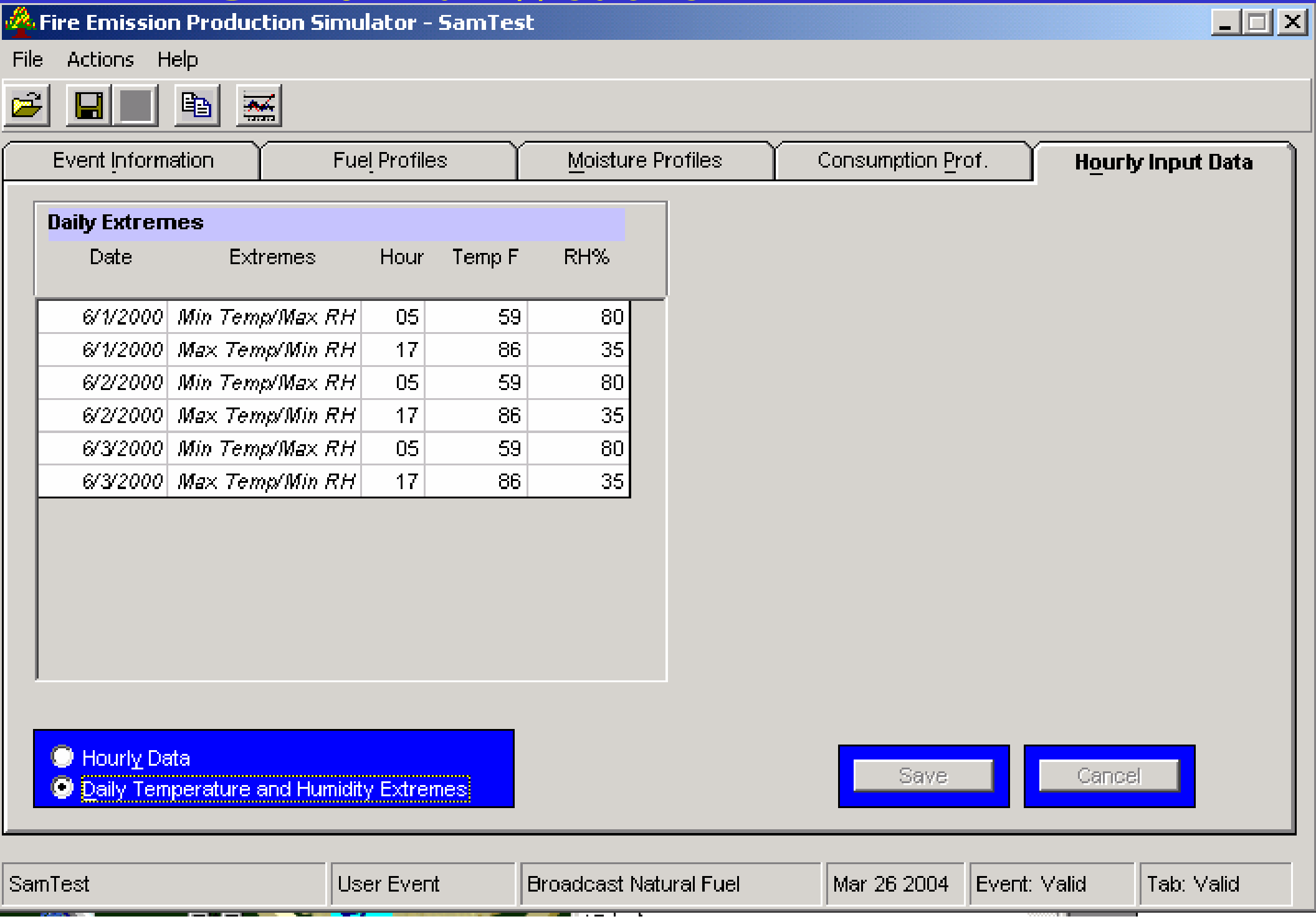
FEPS Fuel Consumed Calculation



FEPS Event Timing and Fuel Involved



FEPS Diurnal Weather



FEPS Tabular Report

Fire Emission Production Simulator - SamTest

File Actions Help

Elapsed Time Hour	Date	Hour	Temp F	RH	Fire Size acres	Fire Rate acres/hr	Flaming Cons tph	STS Cons tph	LTS Cons tph	Total Cons tph	CO Emis lb/min	CH4 Emis lb/min	PM2.5 Emis lb/min
0	6/1/2000	0	59	80	0	0.0	0	0	0	0	0	0	0
1	6/1/2000	1	59	80	0	0.0	0	0	0	0	0	0	0
2	6/1/2000	2	59	80	0	0.0	0	0	0	0	0	0	0
3	6/1/2000	3	59	80	0	0.0	0	0	0	0	0	0	0
4	6/1/2000	4	59	80	0	0.0	0	0	0	0	0	0	0
5	6/1/2000	5	59	80	0	0.0	0	0	0	0	0	0	0
6	6/1/2000	6	63	74	0	0.0	0	0	0	0	0	0	0
7	6/1/2000	7	66	68	0	0.0	0	0	0	0	0	0	0
8	6/1/2000	8	69	63	0	0.0	0	0	0	0	0	0	0
9	6/1/2000	9	72	58	10	10.0	115	59	5	178	267	15	31
10	6/1/2000	10	75	53	100	90.0	1,031	658	45	1,734	2,727	149	310
11	6/1/2000	11	78	48	200	100.0	1,147	901	88	2,136	3,602	194	398
12	6/1/2000	12	80	44	300	100.0	1,147	1,039	128	2,315	4,104	220	445
13	6/1/2000	13	82	41	400	100.0	781	711	161	1,652	3,083	163	328

Select the report: Consumption / Emission Results - Report

Select the units: English / Metric (SI)

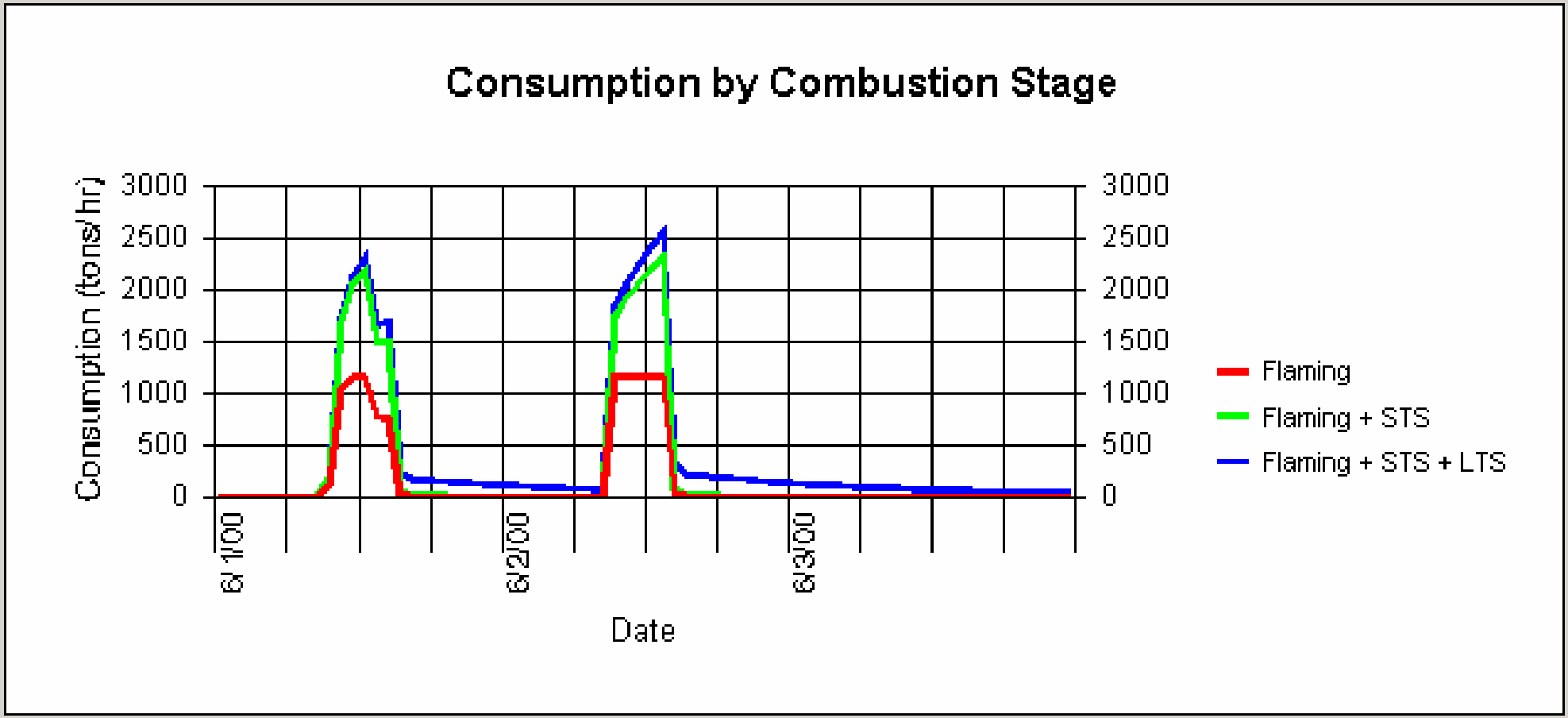
Print Preview | Export Report | Modify Data

SamTest | User Event | Broadcast Natural Fuel | Mar 26 2004

FEPS Consumption Graphic

Fire Emission Production Simulator - SamTest

File Actions Help



Select the report:

Consumption by Combustion Stage - Chart

Select the units:

English

Metric (SI)

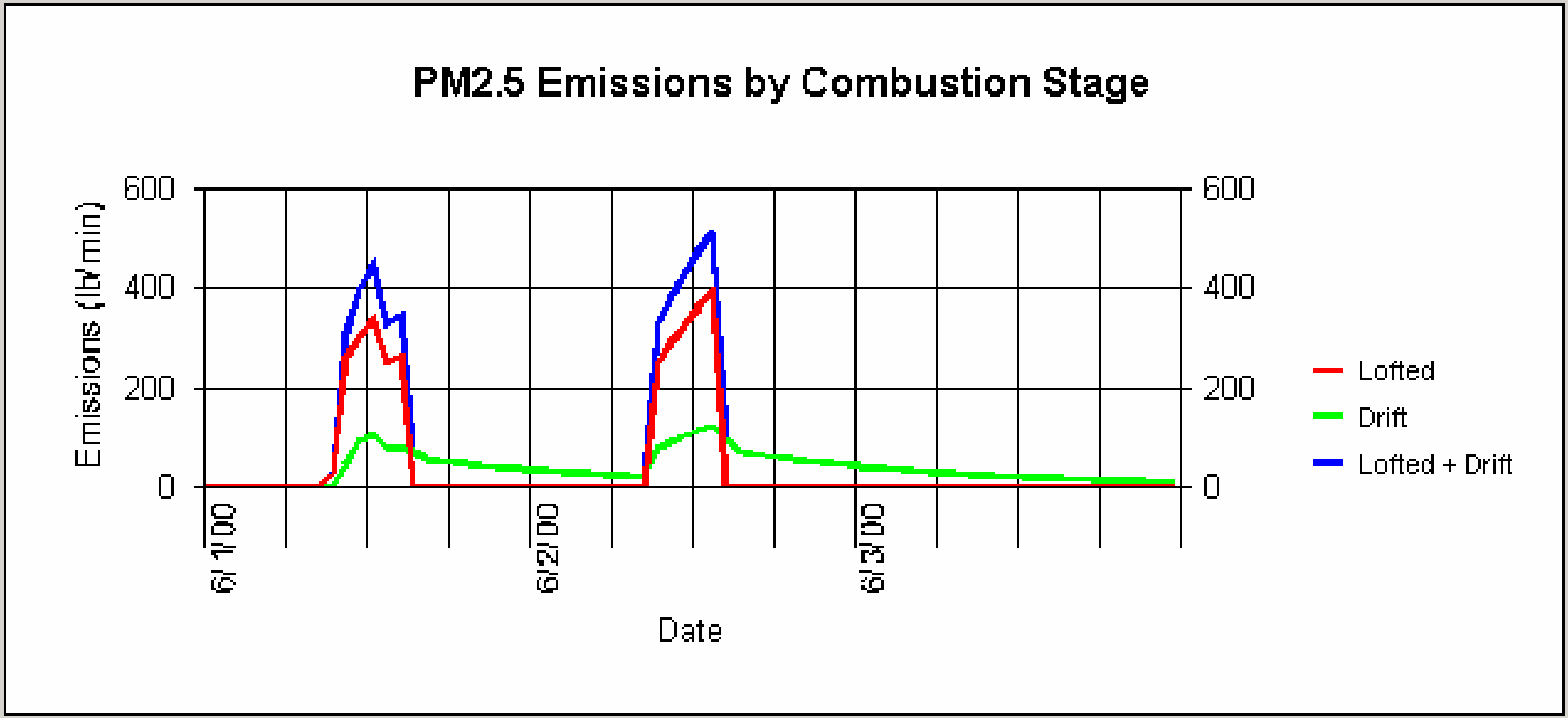
Print Chart | Export Chart | Modify Data

SamTest	User Event	Broadcast Natural Fuel	Mar 26 2004		

FEPS Source Strength and Convective Lift

Fire Emission Production Simulator - SamTest

File Actions Help



Select the report: PM 2.5 Emissions by Combustion Stage - Chart

Select the units: English / Metric (SI)

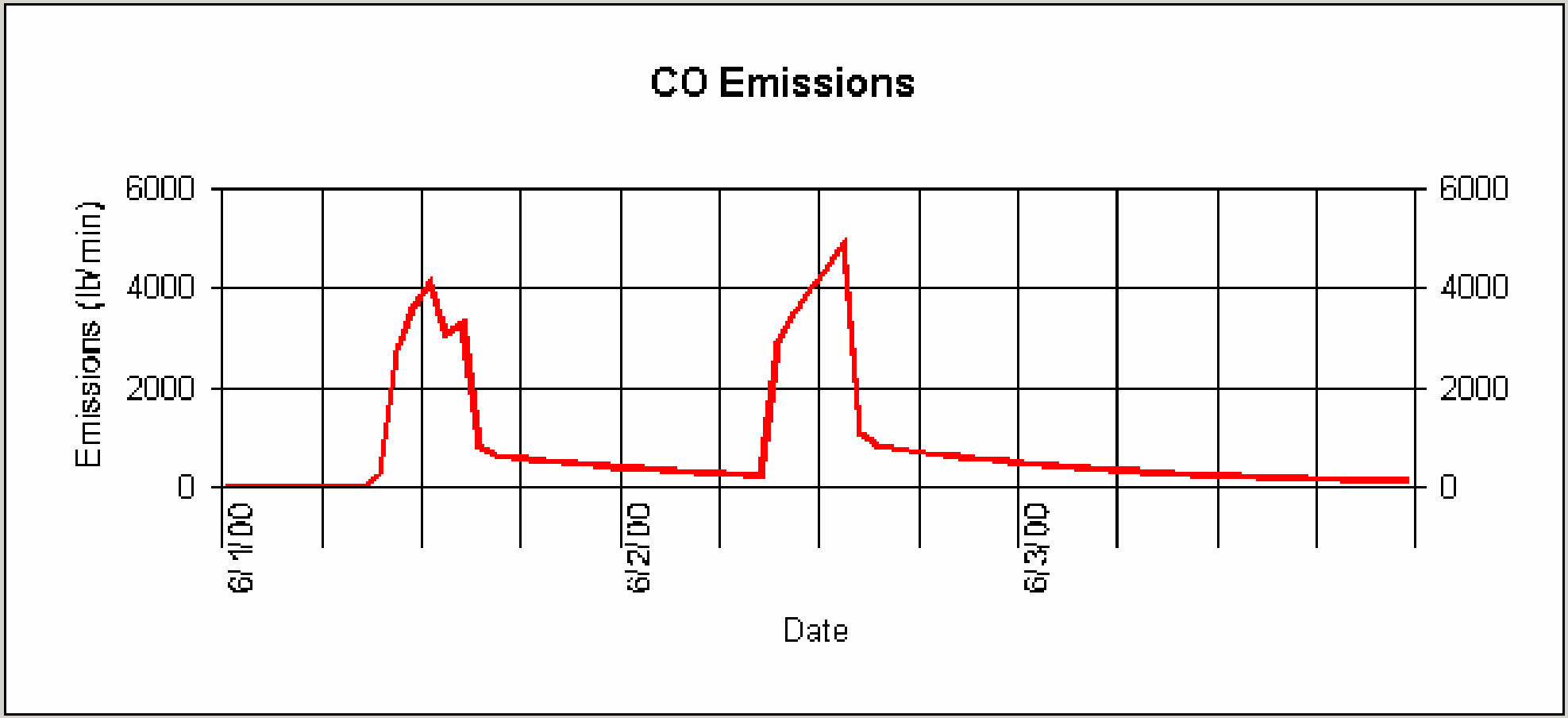
Print Chart | Export Chart | Modify Data

SamTest	User Event	Broadcast Natural Fuel	Mar 26 2004		

FEPS CO Source Strength

Fire Emission Production Simulator - SamTest

File Actions Help



Select the report: CO Emissions - Chart

Select the units: English / Metric (SI)

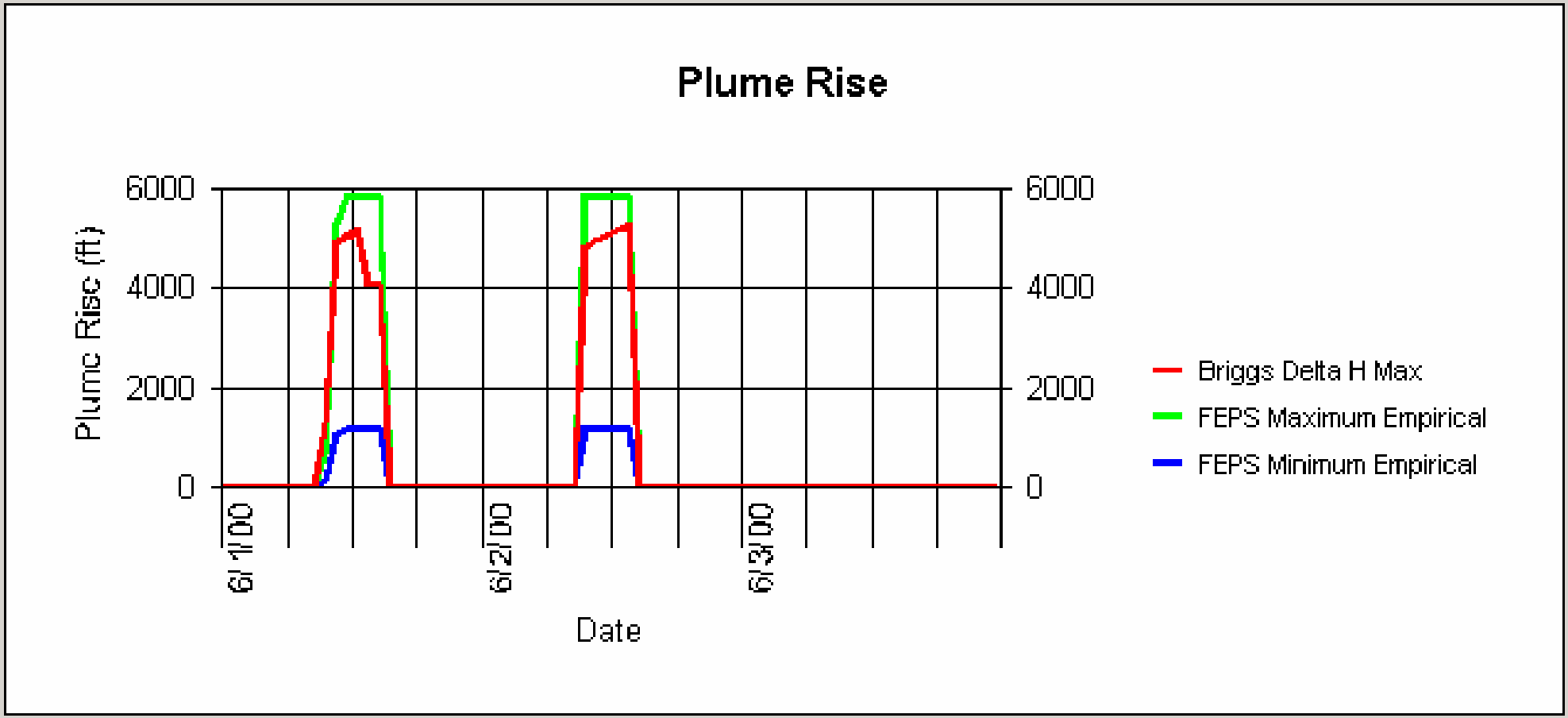
Print Chart | Export Chart | Modify Data

SamTest | User Event | Broadcast Natural Fuel | Mar 26 2004

FEPS Plume Rise

Fire Emission Production Simulator - SamTest

File Actions Help



Select the report: Plume Rise - Chart

Select the units: English / Metric (SI)

Print Chart | Export Chart | Modify Data

SamTest	User Event	Broadcast Natural Fuel	Mar 26 2004		

Emission Production Model vs. Fire Emission Production Simulator

- EPM
  - FORTRAN
  - 1 fuelbed
  - <10 burn periods, 1 day
  - Flame, Smolder stage
  - Linked with CONSUME
- FEPS
  - Visual Basic (C++)
  - 5 fuelbeds
  - n burn periods, days
  - + Residual Smoldering
  - Consumption
    - Internal calculation
    - Input file
    - User input
  - Plume rise
  - Defaults

Fire Emission Production Simulator, FEPS

What's left to be done?

1) maintenance & feedback

2) updates to lookup tables

3) revision in January

4) Batch mode

5) program in C++

6) better linkages