M e m o r a n d u m

To: **BEU Staff**

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Subject: Live Fuel Moisture, ERC, and Fire Behavior

The grass is no longer green, and the fuels are drying out. It is time to reassess fuel conditions and out understanding of fuel moisture indicators. Following are some practical activities or applications to see how dry it is and to monitor fuel and weather conditions.

- During PT, find a chamise bush and run you hand up a branch and see how many leaves come off (the leaves look like needles). Yellow or off-colored leaves are an indicator of moisture stress in the plant. Note how much new growth there is this year (this will be fully dried out and behave similar to old growth within a few more weeks).
- Look for branches that are dense with all green leaves. They are hard to find right now and healthy, vigorous bushes are difficult to locate as well.
- Look for new growth (slender, reddish stems near the ends of branches) and bend the twig over to see how far it bends before it snaps. New growth at this time of year should bend nearly 180 degrees before snapping.
- Take a Pulaski and see how deep you have to dig before finding perceptible soil moisture.
- 1000 hour fuels (3-6 inch diameter) are at 5-8% in the central coast interior, and 10-15% in the central coast. Kiln dried lumber from a sawmill typically has a moisture content of 10-15%.

I have compiled some information on fire behavior terms and concepts. Please review these with your personnel. If you have any questions about the fuel moisture, ERC, or precipitation data that I send, please contact me. Being a student of fire behavior may save your life.

Live Fuel Moisture:
http://www.fs.fed.us/r2/fire/live_fm/Live_moisture_sampling_procedures.pdf

Fuel moisture. Fuel moisture content describes how wet or dry the fuels are. Moisture content is the single most important factor that determines how much of the total fuel is available for burning, and ultimately, how much is consumed. Fuel moisture determines if certain fuels will burn, how quickly and completely they will burn, and what phases of combustion the fuels will support. Fuels with a higher moisture content reduce the rate of energy release of a fire because moisture absorbs heat released during combustion, making less heat available to preheat fuel particles to ignition temperature (Burgan and Rothermel 1984). Ignition will not occur if the heat required to evaporate the moisture in the fuels is more than the amount available in the firebrand (Simard 1968).

Fuel moisture formula. Fuel moisture content is the percent of the fuel weight represented by water, based on the dry weight of the fuel. In a word equation, it is:

Percent Moisture Content = Weight of Water / Oven-dry Weight of Fuel x 100

Moisture content can be greater than 100 percent because the water in a fuel particle may weigh considerably more than the dry fuel itself. For example, a green leaf may contain three times as much water as there is dry material, leading to a moisture content of 300 percent. Moisture content of duff and organic soil can be over 100 percent.

Burning Index: http://www.wrh.noaa.gov/sew/fire/olm/nfdr_ind.htm

A number relating to the potential amount of effort needed to contain a single fire in a particular fuel type within a rating area. NFDRS uses a modified version of Bryam's equation for flame length - based on the Spread Component (SC) and the available energy (ERC) - to calcuate flame length from which the Burning Index is computed.

The equation for flame length is listed below:

$$F_L=j[(SC/60)(25(ERC))]^{0.46}$$

where (j) is a scaling factor, (SC) is the spread component, and (ERC) is the energy release component. Consequently, the equation for the Burning Index is:

$$BI = j_1 * F_L$$

where j1 is the Burning Index scaling factor of (10/ft). Therefore, dividing the Burning Inex by 10 produces a reasonable estimate of the flame length at the head of a fire. A unique Burning Index (BI) table is required for each fuel model, similar to the one shown below.

Ignition Component (IC): http://www.wrh.noaa.gov/sew/fire/olm/nfdr_com.htm
The Ignition Component is a number which relates the probability that a fire will result if a firebrand is introduced into a fine fuel complex. The ignition component can range from 0 when conditions are cool and damp, to 100 on days when the weather is dry and windy. Theoretically, on a day when the ignition component registers a 60 approximately 60% of all fire brands that come into contact with wildland fuels will require suppression action.

Ignition normally takes place in the dead component of the fine fuels. Three distinct steps must be considered in this ignition process. They are 1) a firebrand must come into contact with the dead fuel, 2) the fuel particle must be dry, and 3) the temperature of the fuel particle must be raised to the kindling point, which is about 380 degrees centigrade.

Living material in the fine fuel complex reduces the efficiency of ignition. Therefore, an adjustment to the ignition component is made based on the percentage of live fuel (herbaceous vegetation) in the fine fuel complex.

The moisture content of the dead component of the fine fuel (1-hr. timelag fuel moisture) is determined by the state of the weather (sunny or cloudy), air temperature, and relative humidity at the time of the 2 p.m. fire weather observation.

The condition of the herbaceous (live) vegetation and the 1-hr. timelag fuel moisture are then integrated in the calculation of the fine fuel moisture (FFM) which expresses the effective moisture content of the fine fuels.

The closer the initial temperature of the fuel is to the ignition temperature, the more likely a fire will result when a firebrand is introduced into the fine fuel complex, since not much energy is required to raise the fuel particle to its ignition temperature.

Spread Component (SC): http://www.wrh.noaa.gov/sew/fire/olm/nfdr_com.htm
The Spread Component is a numerical value derived from a mathematical model that integrates the effects of wind and slope with fuel bed and fuel particle properties to compute the forward rate of spread at the head of the fire. Output is in units of feet per minute (roughly equivalent to chains per hour). A Spread Component of 31 indicates a worst-case, forward rate of spread of approximately 31 feet per minute.

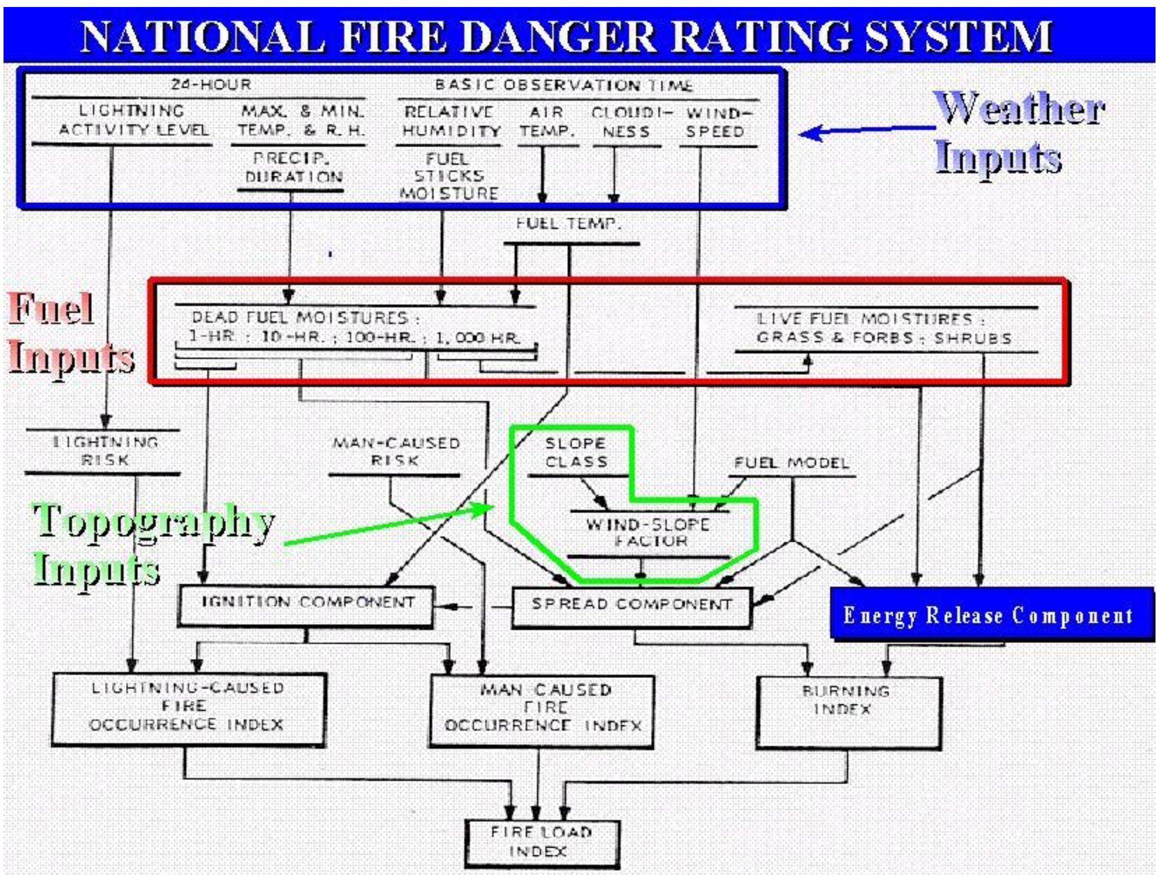
The inputs required to calculate the SC are wind speed, slope, fine fuel moisture (including the effects of green herbaceous plants), and the moisture content of the foliage and twigs of living, woody plants.

Since the characteristics through which the fire is burning are so basic in determining the forward rate of spread of the fire front, a unique SC table is required for each fuel type.

Energy Release Component (ERC):
http://www.wrh.noaa.gov/sew/fire/olm/nfdr_com.htm
The Energy Release Component is defined as the potential available energy per square foot of flaming fire at the head of the fire and is expressed in units of BTUs (British Thermal Units) per square foot. Like the Spread Component, the Energy Release Component is calculated using tables unique to each fuel model. The rate of combustion is almost totally dependent on the same fuel properties as are considered in the SC calculation. However, the principal difference in the calculation of the two components is that SC is determined primarily by the finer fuels, whereas ERC calculations require moisture inputs for the entire fuel complex, i.e., 1-hr., 10-hr., 100-hr., 1000-hr., and the live fuel moisture.

National Fire Danger Rating System (NFDRS):
http://www.wrh.noaa.gov/sew/fire/olm/nfdrs.htm

The National Fire danger Rating System is a set of computer programs and algorithms that allow land management agencies to estimate today's or tomorrow's fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire danger rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather, or what is commonly called the fire triangle. NFDRS outputs give relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are guides for initiating pre-suppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site- and time-specific information. It links an organization's readiness level (or pre-planned fire suppression actions) to the fire problems of the day.



All this information is valuable and can be used to develop predictions of fire behavior. **However, there is no substitute for being aware of weather and fuel conditions and how they might impact fire behavior and tactics where you are fighting fire.**

For more information, and to stay current on conditions in your area, check the following websites regularly:

http://gacc.nifc.gov/oscc/predictive/weather/index.htm
SOPS Weather Page, includes a webcast discussion of weather and fuels (bottom of page)

http://gacc.nifc.gov/oscc/predictive/fuels_fire-danger/index.htm
SOPS Fuels Page with many links

http://radar.srh.noaa.gov/fire/
National Weather Service Fire Weather Page

http://www.weather.gov/
National Weather Service Page – enter zip code or city, state for weather forecast. Click on the area discussion for a more detailed explanation of weather patterns.

http://72.32.186.224/nfmd/public/index.php
National Fuel Moisture Database – look up fuel moisture information from participating sites (more entered frequently; CAL FIRE, USFS, BLM, NPS, etc.).

http://mesowest.utah.edu/cgi-bin/droman/mesomap.cgi?state=CA&rawsflag=3
MesoWest – current RAWS data, as well as archives of RAWS station weather readings