DEFINITIONS for Fire Prescription Planner Elements

Air Temperature

The forecast air temperature in Fahrenheit (F) at the 1.5 m (5-foot) level. While not the most important variable in fire behavior, a higher air temperature results in a higher surface fuel temperature, which in turn means less energy is required to heat the fuel to the ignition temperature. All other things being equal, a higher temperature will cause more intense fire behavior. For those with limited experience in prescribed burning, the recommendation is to burn only during periods where air temperatures are below 60F.

Note that air temperature is affected by such things as cloud cover amount and the timing of frontal passages. The NAM forecast, on which the OK-FIRE products are based, is not always accurate, which can result in errors in forecast air temperature. Since air temperature and relative humidity are related (for the same amount of moisture in the air, a higher temperature means lower relative humidity and vice-versa), this can lead to forecast errors in relative humidity as well. The user is encouraged to check the latest National Weather Service (NWS) forecasts for consistencies or discrepancies with the NAM forecast. NWS links can be found throughout the OK-FIRE web site. In particular, go to WEATHER / FORECAST Fire Weather and consult the products in the "National Weather Service" section.

Relative Humidity

The forecast relative humidity (RH) in percent (%) at the 1.5-m (5-foot) level. Relative humidity indicates the percentage of water vapor at that temperature that the air is currently holding (with respect to its maximum capacity at that temperature). RH is the most critical weather variable for fire behavior, as a lower relative humidity leads to lower dead fuel moisture, especially in the 1-hour and 10-hour fuels. Lower dead fuel moistures mean it's a lot easier for a fire to get started and maintain itself, as there is less water in the fuel to vaporize and consume energy.

To understand the influence of relative humidity on prescribed burning and wildfire, consult *OK-FIRE Basics for Prescribed Burning* and *OK-FIRE Basics for Fire Danger* in the "Product Information" section of the web site. Generally prescribed burns are conducted between 35% and 85% RH. For those with limited experience in prescribed burning, the recommendation is to burn only when RH is above 40%.

Note that the NAM forecast is not always accurate and a bad forecast of air temperature usually means a bad forecast of relative humidity as well. Users should consult the latest National Weather Service (NWS) forecasts for consistencies or discrepancies. NWS links can be found throughout the OK-FIRE web site. In particular, go to WEATHER / FORECAST Fire Weather and consult the products in the "National Weather Service" section.

Wind Speed

The forecast wind speed in miles per hour (mph) at the 10-m (33-foot) level. This represents the sustained speed, not the gust values that are possible. Gusts are a function of the stability of the atmosphere and the wind speed. Generally, the higher the wind speed, the more likely there will be gusts exceeding the sustained value. Also, the more unstable the atmosphere (e.g., lots of sunshine with light winds), the more likely there will be gusts. On the other hand, at nighttime with a surface temperature inversion, there will be little if any gusts.

Wind speed is the second most important weather factor in fire behavior, especially in the rate of spread. All other things being equal, the higher the wind speed, the more difficult it is to control the fire. However, for prescribed burns, a sustained wind speed of 5-15 mph is usually desirable to keep the fire moving in a consistent direction.

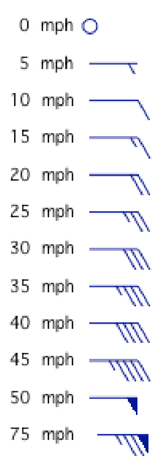
Finally, with respect to wind speeds near the ground, a general guideline is to multiply the 10-m wind speed by 0.5 in grassy areas, by 0.4 in shrubby areas, and by 0.3 in forest understories.

Note that the NAM model is not always accurate, so the user is encouraged to consult the latest wind forecasts from the National Weather Service (NWS) for consistencies or discrepancies. The NWS also forecasts wind gust values, in contrast to the NAM model. NWS links can be found throughout the OK-FIRE web site. In particular, go to WEATHER / FORECAST Fire Weather and consult the products in the "National Weather Service" section.

Wind Direction

The forecast average (sustained) wind direction at the 10-m (33-foot) level. In OK-FIRE tabular products such as the Fire Prescription Planner, the wind direction is denoted by a 16-sector lettered scheme (e.g., N, NNE, NE, ENE), indicating the direction from which the wind is blowing. *Note, however, in the Fire Prescription Planner, only 8 sectors are available for prescription.*

In the dynamic map products, the wind direction is indicated by wind vectors, with the arrows pointing in the direction the wind is blowing.



In the site-specific chart products and some maps like the fire weather map, a system of staff and barbs is utilized. The wind blows from the end of the staff (where the barbs are) toward the other end of the staff. Thus in the legend to the left, all wind directions except "calm" are from the east (E). A circle indicates wind speeds below 2.5 mph or so ("calm").

Sometimes wind direction is indicated by degrees (the direction from which the wind blows), e.g., 360^o = N, 90^o = E, etc. The degree ranges represented by the 8 sectors on the Fire Prescription Planner are indicated on that image. The degree ranges (to the nearest degree) represented by the 16-sector system which is used in the final forecast table and other OK-FIRE tabular products are as follows:

N	349^o to 11^o
NNE	11^o to 34^o
NE	34^o to 56^o
ENE	56^o to 79^o
E	79^o to 101^o
ESE	101^o to 124^o
SE	124^o to 146^o
SSE	146^o to 169^o
S	169^o to 191^o
SSW	191^o to 214^o
SW	214^o to 236^o
WSW	236^o to 259^o
W	259^o to 281^o
WNW	281^o to 304^o
NW	304^o to 326^o
NNW	326^o to 349^o

Wind direction is obviously important in wildland fire management, for it generally indicates the direction of fire and smoke movement. In prescribed burning it is desirable to have a steady wind direction during the course of the burn and not to have shifting wind directions (as might occur during the passage of a front or dry line). Note that under light wind conditions (less than 10 mph), forecast wind directions may not be that useful due to variability in wind direction as well as the influence of topography (e.g., drainage flows at nighttime under clear sky conditions).

Note that the NAM model is not always accurate, and since wind direction is so critical to wildland fire management, the user is encouraged to consult the latest wind forecasts from the National Weather Service (NWS) for consistencies or discrepancies. NWS links can be found throughout the OK-FIRE web site. In particular, go to WEATHER / FORECAST Fire Weather and consult the products in the “National Weather Service” section.

1-hour Precipitation

The 1-hour precipitation amount (rainfall equivalent) in inches forecast to fall during the previous hour. Precipitation generally increases the relative humidity of the air and the dead fuel moisture, which is a positive thing for wildfire suppression but not always useful for prescribed burning.

Of all the elements in weather forecasting, the prediction of rain, ice, or snow is the most difficult - not only the locations, which can be next to impossible to predict during hit-and-miss thundershowers, but the amounts as well. As the presence of precipitation is also linked directly to changes in relative humidity, dead fuel moisture, and the fire danger indices (e.g., burning index), errors in forecast precipitation are by far the most significant. Accordingly, users are strongly encouraged to compare the latest National Weather Service (NWS) forecasts with the NAM forecast used by OK-FIRE to determine consistencies or discrepancies in forecast rainfall amounts and locations. NWS links can be found throughout the OK-FIRE web site. In particular, go to WEATHER / FORECAST Fire Weather and consult the products in the "National Weather Service" section.

Heat Index

Heat index is an index that combines temperature and relative humidity in an attempt to determine the effect of both on the human body. It is used as a measure of heat stress. For air temperatures below 80F, the heat index is typically not calculated (in OK-FIRE, it is set to the air temperature). For air temperatures 80F and above, the heat index can either be above or below the air temperature, depending on the relative humidity. For high values of relative humidity, heat index is typically greater than the air temperature; for low values of relative humidity, heat index is typically lower than the air temperature. As an example, for an air temperature of 94F and relative humidity of 60%, the heat index is 110F.

Below are the heat index ranges and their effects on the human body:

80-90F	**Caution** - fatigue is possible with prolonged exposure and activity. Continuing activity could result in heat cramps.
90-105F	**Extreme caution** - heat cramps and heat exhaustion are possible. Continuing activity could result in heat stroke.
105-130F	**Danger** - heat cramps and heat exhaustion are likely; heat stroke is probable with continued activity.
Over 130F	**Extreme danger** - heat stroke is imminent.

The other thing to note is that exposure to full sunshine can increase heat index values by up to 14F. For this reason, in the criteria for beginning burners, we have set the maximum heat index allowed to 90F, because adding 14F to the value puts the burner at the danger threshold. Even with limited sunshine, beginning burners would still be in the extreme caution range at heat index values above 90F.

Given the physical rigor of managing wildland fire and the protective clothing that is worn, heat index is an important variable to consider. For prescribed burning it can be used to make a decision as to the wisdom of conducting the burn. For wildfire suppression, where no choice is involved, it can be used as an index of how frequently to take breaks.

Dispersion Conditions

There are six categories of "dispersion conditions" which are calculated by the Oklahoma Dispersion Model (ODM): Excellent (EX), Good (G), Moderately Good (MG), Moderately Poor (MP), Poor (P), and Very Poor (VP). The first three categories appear in various shades of green on the dispersion maps, while the last three range from beige (MP) to orange (P) to red (VP). A numbered system is also used to represent the six dispersion categories: 1 = VP, 2 = P, 3 = MP, 4 = MG, 5 = G, and 6 = EX.

The ODM estimates ground-level dispersion, which is the ability of the atmosphere to dilute and disperse a compound such as smoke as it travels downwind. The calculated dispersion categories are valid for downwind distances of 1/4 mile to several miles. The categories can be interpreted as follows – for a given downwind distance (e.g., 1 mile), the smoke concentration near the plume centerline will be greatest under VP conditions and the lowest under EX conditions. Thus, as a general guideline for prescribed burning, Moderately Good (MG) or better (G, EX) conditions should be present during the burn to avoid smoking out potential sensitive areas downwind. In this case, in the forecast element table on the Fire Prescription Planner, one would set a "Lower Limit" for Dispersion Conditions of "Moderately Good." More information on the ODM can be found in *The Oklahoma Dispersion Model* document in the "Product Information" section of the OK-FIRE web site.

Note that since the dispersion calculations are a function of the forecast weather conditions, inaccuracies in the NAM weather forecast will lead to inaccuracies in the dispersion forecast.

1-hour Dead Fuel Moisture

The % moisture content on a dry-weight basis of 1-hour dead fuels as calculated by a calibrated version of the Nelson dead fuel moisture model. Calculated values can range from 1% to 85%.

One-hour fuels are the fine dead fuels (< 0.25" diameter) such as grasses which are often involved in the initiation and maintenance of wildland fires and whose moisture contents respond quickly (within minutes) to changing weather conditions. These dead fuels include herbaceous plants, roundwood, and also the uppermost layer of litter on the forest floor.

For prescribed fire, the preferred range of 1-hour dead fuel moisture is from 7 to 20%. Below 7%, spot fires become a problem and above 20% there will be problems in starting and maintaining the fire due to too much moisture in the fine fuels. To understand the influence of 1-hour dead fuel moisture on prescribed burning and wildfire, consult *OK-FIRE Basics for Prescribed Burning* and *OK-FIRE Basics for Fire Danger* in the "Product Information" section of the web site.

Note that since the Nelson model calculations are a function of the forecast weather conditions, inaccuracies in the NAM weather forecast will lead to inaccuracies in the 1-hour dead fuel moisture forecast.

10-hour Dead Fuel Moisture

The % moisture content on a dry-weight basis of 10-hour dead fuels as calculated by a calibrated version of the Nelson dead fuel moisture model. Calculated values can range from 1% to 60%.

Ten-hour fuels are the smaller diameter dead fuels in the 0.25" to 1" diameter range. They also respond quickly to changing weather conditions, but not as quickly as do 1-hour fuels. These fuels include roundwood and the layer of litter on forest floors extending, roughly, from 0.25" below the surface to 1" deep.

For prescribed fire, the preferred range of 10-hour dead fuel moisture is from 7 to 20%. Below 7%, spot fires become a problem and above 20% there will be problems in maintaining the fire due to too much moisture in the 10-hour fuels. To understand the influence of 1-hour dead fuel moisture on prescribed burning and wildfire, consult *OK-FIRE Basics for Prescribed Burning* and *OK-FIRE Basics for Fire Danger* in the "Product Information" section of the web site.

Note that since the Nelson model calculations are a function of the forecast weather conditions, inaccuracies in the NAM weather forecast will lead to inaccuracies in the 10-hour dead fuel moisture forecast.

Burning Index

The Burning Index (BI) value (10*feet) as calculated by the Oklahoma Fire Danger Model. More information can be found in the *Products of the Oklahoma Fire Danger Model* document in the "Product Information" section of the OK-FIRE web site. BI is probably the most useful index of the National Fire Danger Rating System (on which the Oklahoma Fire Danger Model is based) since BI directly relates to the intensity of the fire (and thus is related to the difficulty of containment) and is scaled such that BI/10 is equal to the flame length (FL) in feet at the head of the fire. It is an index which integrates both the spread component (SC) and energy release component (ERC).

The traditional U.S. Forest Service interpretation of burning index with respect to fire behavior and suppression is listed below:

BI < 40 (FL < 4 ft)	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
BI = 40-80 (FL = 4-8 ft)	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
BI = 80-110 (FL = 8-11 ft)	Fires may present serious control problems - torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
BI > 110 (FL > 11 ft)	Crowning, spotting, and major fire runs are probable. Control efforts at the head of the fire are ineffective.

Burning index is a function of the fuel model being used, the live and dead fuel moistures, the "greenness" of the 1-km pixel assessed by a satellite, and the weather conditions. Accordingly, inaccuracies in the NAM weather forecast will lead to inaccuracies in the BI forecast. Also, if the fuel types, loads, and/or greenness levels are substantially different than those in the fuel model being used and/or assessed by the satellite, there will be inaccuracies as well.

Finally, it is important to realize that these indices produced by the National Fire Danger Rating system are for the conditions modeled at 1-km resolution. In other words, the fuel model represents conditions over the entire 1-km square area, so indices such as BI are not meant to be used on a field-by-field basis. As an example, if the particular fuel in the area of concern (e.g., a particular field) differs from the assigned fuel model in that 1-km square, then the Oklahoma Fire Danger Model results for that square can be expected to be different than for the particular field in question (e.g., an open grassy area in a 1-km square that has been assigned a forest fuel model). Other limitations of the model can be found in the document entitled *The Oklahoma Fire Danger Model* in the "Product Information" section of the OK-FIRE web site.

Ignition Component

The ignition component (IC) is equal to the probability (0-100%) of a firebrand producing a fire that will require suppression action. It says nothing about the intensity of the fire, which is indicated by the burning index (BI) value. IC is another fire danger index calculated by the Oklahoma Fire Danger Model. More information can be found in the *Products of the Oklahoma Fire Danger Model* document in the "Product Information" section of the OK-FIRE web site.

An IC of 100 means that every firebrand will cause a fire requiring suppression action if it contacts a receptive fuel. Likewise an IC of 0 would mean that no firebrand would cause a fire requiring suppression action under those conditions. Note the emphasis is on action. The key is whether a fire will result that requires a fire manager to make a decision. The ignition component is more than the probability of a fire starting; it has to have the potential to spread. Therefore spread component (SC) values are entered into the calculation of IC. If a fire will ignite and spread, some action or decision is needed.

Ignition component is a function of the fuel model being used, the live and dead fuel moistures, the "greenness" of the 1-km pixel assessed by a satellite, and the weather conditions. Accordingly, inaccuracies in the NAM weather forecast will lead to inaccuracies in the IC forecast. Also, if the fuel types, loads, and/or greenness levels are substantially different than those in the fuel model being used and/or assessed by the satellite, there will be inaccuracies as well.

Spread Component

The spread component (SC) is numerically equal to the theoretical forward speed of the headfire in feet/minute. It is the most variable of the fire danger indices, with variations being caused by changes in wind speed and in moisture content of the live and dead fuels. SC is another index produced by the Oklahoma Fire Danger Model. Wind speed, slope and fine fuel moisture are key inputs in the calculation of the spread component, thus accounting for a high variability from day-to-day. More information can be found in the *Products of the Oklahoma Fire Danger Model* document in the "Product Information" section of the OK-FIRE web site.

Spread component is a function of the fuel model being used, the live and dead fuel moistures, the "greenness" of the 1-km pixel assessed by a satellite, and the weather conditions. Accordingly, inaccuracies in the NAM weather forecast will lead to inaccuracies in the SC forecast. Also, if the fuel types, loads, and/or greenness levels are substantially different than those in the fuel model being used and/or assessed by the satellite, there will be inaccuracies as well.

Energy Release Component

The energy release component (ERC) is a measure of the available energy (BTU/square foot) released per unit area in the flaming zone at the head of the fire. It is the least variable of the indices on a day-to-day basis, being a function solely of the fuels (and their moisture content, which is weather-dependent). ERC is another index produced by the Oklahoma Fire Danger Model. Conditions producing an ERC value of 24 represent a potential heat release twice that of conditions resulting in an ERC value of 12. More information can be found in the *Products of the Oklahoma Fire Danger Model* document in the "Product Information" section of the OK-FIRE web site.

Since ERC represents the potential "heat release" per unit area in the flaming zone, it can provide guidance to several important fire activities. It may also be considered a composite fuel moisture value as it reflects the contribution that all live and dead fuels have to potential fire intensity. Especially for fuel complexes containing the heavier 100- and 1000-hour fuels, the ERC is a cumulative or "build-up" type of index. As live fuels cure and dead fuels dry, the ERC values get higher, thus providing a good reflection of drought conditions.

ERC is a function of the fuel model being used, the live and dead fuel moistures, the “greenness” of the 1-km pixel assessed by a satellite, and the weather conditions. Accordingly, inaccuracies in the NAM weather forecast will lead to inaccuracies in the ERC forecast. Also, if the fuel types, loads, and/or greenness levels are substantially different than those in the fuel model being used and/or assessed by the satellite, there will be inaccuracies as well.

KBDI

KBDI is a drought index calculated by the Oklahoma Fire Danger Model. Ranging from 0 to 800, the index is used to increase the amount of dead fuel available to the fire. KDBI, the Keetch-Byram Drought Index, was included in the 1988 revisions to the National Fire Danger Rating System (NFDRS) on which the Oklahoma Fire Danger Model is based. KBDI values at Mesonet sites are updated daily at 4 p.m. CST.

Drought, as defined by KBDI, is a condition of dryness in the litter, duff, and upper soil layers that progresses from saturation to an absence of available moisture. The KBDI is based on an arbitrary 8 inches of water in the litter/duff/soil column. When the column is completely saturated, KBDI = 0. As water is removed from the column by evapotranspiration, the KBDI increases in value. When KBDI reaches 800 (its max), all the water has been removed. In the NFDRS and Oklahoma Fire Danger Model, as KBDI increases above a value of 100, increasing amounts of dead fuel are provided for burning. During combustion some of this fuel contributes directly to fireline intensity (BI), but most increases total heat release (ERC) and contributes to burn severity through smoldering combustion.

In Oklahoma, the KBDI has shown itself to be more useful during the growing season than during the dormant season. Also, as it was developed mainly for forested landscapes, its usefulness for grassy landscapes is somewhat questionable. KBDI values in the 600-800 range represent the most severe drought conditions, and many states issue burn bans at these levels. In forested areas, prescribed fires should not be conducted at values over 700, as fires will be intense and deep burning. More information on KBDI can be found in the *Products of the Oklahoma Fire Danger Model* document in the “Product Information” section of the OK-FIRE web site.