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Frequently Asked Questions about the new Wildland Firefighter Safety Zone Guidelines And the Safe Separation Distance Evaluator (SSDE)

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Why is there a new Safety Zone Guideline?

The Incident Response Pocket Guide (IRPG) provides guidelines to Safe Separation Distance (SSD) from flames and estimates of safety zone size. These calculations were developed based on radiant heat only, and do not account for convective heat from wind and or terrain influences. Since the calculations assume no wind and no slope safety zones downwind or upslope from the fire may require larger separation distances.

What were the old guidelines?

General rule of thumb - Flame height = 2 X vegetation height (plus or minus)

SSD = 4 x flame height

What is the new safety zone guideline?

SSD = 8 x VH x Δ

SSD = Safe Separation Distance

VH = Vegetation Height

Δ = Wind/Slope/Burning Condition factor

The new guideline is based on research that accounts for slope, wind speed, burning conditions and both convection and radiation for flames.

Why did the SSD guidelines change from being based on flame height to being based on vegetation height? Given that safety zones should be designated prior to the fire reaching a particular location on the landscape, basing the SSD calculations on flame heights forces firefighters to predict flame heights ahead of time, which can be both challenging and error-prone. Instead, basing SSDE calculations on vegetation height is advantageous in two main ways: (1) it allows firefighters to evaluate SSD based on something that can be easily interpreted on the ground without having to predict fire behavior; and (2)

it enables the calculation of SSD across broad areas using GIS technology (such as the SSDE), since vegetation heights can be mapped across entire landscapes.

Where does the "8" come from in the new SSD equation?

The assumption made in this calculation is that flame heights will be approximately two times the height of the vegetation in a crown fire situation. Therefore 4 x flame height = 8 x vegetation height.

Where do I find delta (Δ)?

The new guideline will be published in the IRPG in the next revision and the delta table will be in included.

Δ values

Wind Speed		Slope: Flat (0-7.5%)	Slope: Low (7.6-22.5%)	Slope: Moderate (22.6-40%)	Slope: Steep (>40%)	Burning Condition
Light (0-10 mph)		0.8	1	1	2	Low
		1	1	1.5	2	Moderate
		1	1.5	1.5	3	Extreme
Moderate (11-20 mph)		1.5	2	3	4	Low
		2	2	4	6	Moderate
		2	2.5	5	6	Extreme
High (>20 mph)		2.5	3	4	6	Low
		3	3	5	7	Moderate
		3	4	5	10	Extreme

How were the delta values determined?

Fire behavior measurements on wildland fires over the past 20 years as well as model results were used to determine the delta values for the new safety zone guidelines. Measurements including radiant and convective heat flux, terrain steepness, wind speed, fuel moisture, temperature, and relative humidity were collected throughout the contiguous United States where wildland and prescribed fire are common. Other measurements taken include flame height, flame rate of spread and flame angle, all of which contribute to overall energy release and transport in wildland fire. Delta accounts for the combined energy threshold that can cause partial thickness, or second degree burn injury with prolong exposure.

How did you decide delta thresholds?

Slope provided an obvious break point as for slopes less than about 30% rate of spread and fire intensity are not nearly as strongly influenced as for slopes above 30%. When the slope exceeds about 30% it is likely that the flames will attach to the surface and fire spread rates and energy release will increase much more quickly than for less steep slopes. Wind demonstrates some of similar traits to slope. When wind speed exceeds 10-15 mph the rate of spread and fire intensity are much more strongly linked to wind. Thus as winds exceed 10-15 mph the fire intensity increases much more quickly. Also our measurements and modeling suggested that there is a peak fire intensity above which greater slopes and stronger winds will not have a significantly greater impact thus the delta factors tend to max out at

the high wind high slope region. We added the burning condition levels to allow the user to "tune" the SSD calculation to local burning conditions.

Are other fuel structural characteristics factored into the SSD calculation?

At present, the only fuel structural parameter considered in the SSD equation is vegetation height. While true that other fuel structural metrics (e.g., fuel loading, fuel bulk density) will affect fire behavior, and thus radiant and convective heat transfer, vegetation height serves as a simple and reliable proxy for crown fire heat release.

What is the Safe Separation Distance Evaluator (SSDE)?

The SSDE is a new interactive, web-based, open-access mapping tool for estimating SSD and evaluating potential safety zone effectiveness through geospatial analysis. This tool allows users to draw potential safety zone polygons to evaluate the suitability of the area in any environment. The tool uses high resolution Digital Elevation Model (DEM) terrain data and LANDFIRE Existing Vegetation Height to calculate SSDs on a given landscape. Users can input windspeed and burning conditions.

Where do I find the SSDE website?

https://firesafetygis.users.earthengine.app/view/ssde-en

Do I need access to the internet to use the SSDE?

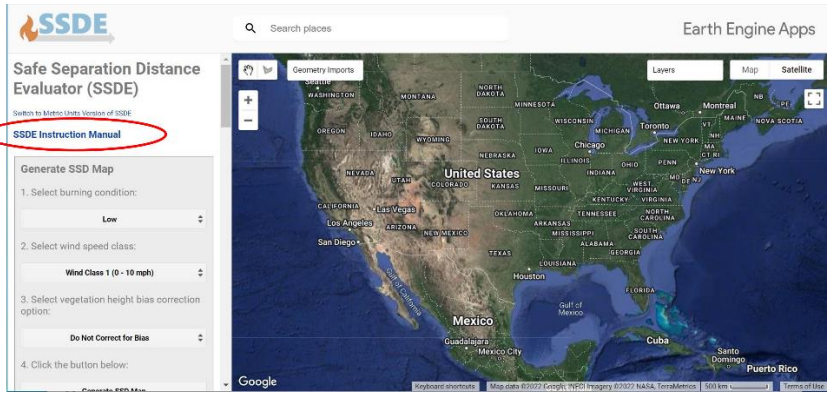
Yes, SSDE is a web-based mapping tool and will not work without an internet connection.

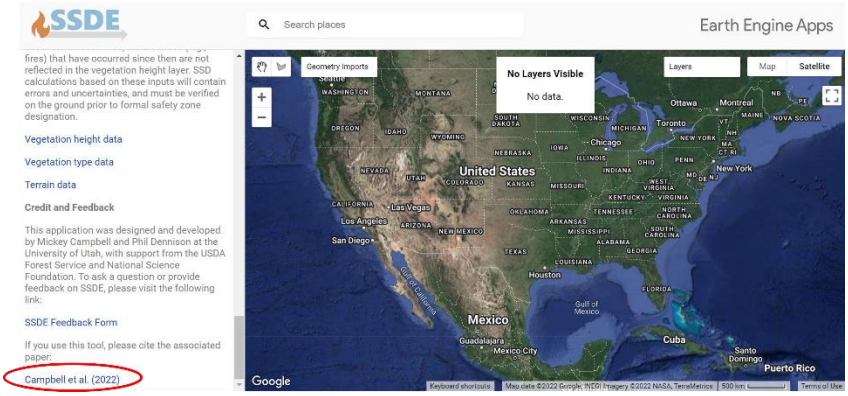
Do I need to be a GIS expert to use the SSDE?

No. The SSDE is designed to be used by anyone with a basic familiarity with web-based mapping applications (e.g., Google Maps). More important than having GIS skills is having an understanding of firefighter safety and fire behavior. This will facilitate informed and appropriate use of the tool.

How do I learn more about the SSDE?

There is a link to an instruction manual in the upper lefthand corner on the SSDE website as well as a link to the full journal paper in the lower lefthand corner at the bottom of the page.





How do I interpret SSDE products?

Viewing terrain and vegetation conditions – Given the importance of terrain slope and vegetation height for estimating SSD, users can zoom and pan around anywhere in the contiguous US, view these layers, and click on the map to query individual pixel values. Although not explicitly used in SSD calculations, users can also view and query vegetation type data.

Landscape-Level SSD Mapping – In addition to simply viewing and querying terrain and vegetation, SSDE allows users to calculate SSD on a per-pixel basis for any area of interest. Using SSD = 8xVHxΔ and the multiplicative factors for delta, SSD can be calculated for any area of interest based on the vegetation height and terrain slope data layers in SSDE, along with user-defined wind speed and burning conditions. The resulting layer is a map where each pixel represents how far one should stay from that pixel in order to avoid burn injury, should the fire consume the pixel area. This can provide valuable insight into safety zone assessment and fuel treatment options to improve a safety zone.

Safety Zone-Level SSD Mapping – While it is useful to view SSD across entire landscapes, the most important scale of analysis is that of the safety zone. SSDE allows users to manually draw in a potential safety zone polygon, and evaluate its suitability, based on the extent to which it provides SSD from surrounding flames. By comparing the size and shape of the drawn polygon to the surrounding vegetation, terrain, wind and burning conditions, SDE provides quantitative estimates of suitability, including whether or not the drawn polygon meets the SSDE guidelines, the relative proportion of SSD that is reached within the safety zone, and the location of the safest point within the drawn polygon. Users can test different polygons, wind speeds, and burning conditions to identify a set of potential safety zones. This information can be relayed to fire personnel to facilitate fire ground-level safety zone selection process.

How do I validate the SSDE results?

It is extremely important that any results derived from SSDE be independently validated on the ground. The GIS and remotely sensed data that form the basis of the SSDE calculations have inherent uncertainty. Therefore, the results that emerge from the use of SSDE likewise have inherent uncertainty. For example, LANDFIRE Existing Vegetation Height data are only updated every few years and thus do not necessarily represent the most up-to-date conditions, particularly given the changes in vegetation that occur in a wildland fire environment. Thus, SSDE should not be the sole basis of safety zone suitability assessment – it should be used to guide the selection of potential safety zones that must then be validated by fire personnel.

Can I download the results from SSDE?

Yes. You may find it useful to interact with the results that emerge from SSDE outside of the web interface. For example, if you used SSDE to evaluate a safety zone, and you would like to add that safety zone polygon to a map with other layers of pertinent data in ArcGIS or other mapping software, you can download any of the spatial datasets generated in SSDE. You can download the various outputs as raster TIF files or KML files.