**National Fire Danger Rating System (NFDRS)** [https://www.nwcg.gov/sites/default/files/products/pms932.pdf]

The fire danger rating system provides numeric indices according to the integration effects of fire danger factors that affect the initiation, spread and difficulty of control of wildfires. The structure of NFDRS consists of three components: Scientific basis, user-controlled site descriptors, and weather and non-weather data [1].

In the scientific basis of NFDRS, mathematical models are used to calculate fire danger. These models represent the basic principles of combustion physics. User-controlled site descriptors explain the area where the fire danger ratings are calculated. The subcomponents of site descriptors are Fire danger rating area, fuel models (reflects the volume, size, weight, type, depth, physical properties etc.), slope class of the terrain, grass type (live fuel), Climate class and precipitation. As weather data, environmental temperature, relative humidity, wind speed are observed. Season codes, Keetch-Byram Drought index, Staffing index etc. are the other NFDS parameters. These inputs are used to calculate the following indices and components to determine the NFDR.

**Ignition Component (IC)**: The rating of the probability that a firebrand causes a fire requiring a suppression action. It ranges on a scale of 0 to 100 where 100 is the ability of every firebrand can cause an ignition that needs suppression action.

**Spread Component (SC)**: Rate of spread of head fire (ft/min). The key inputs of the calculation of SC are wind speed, slope, and fine fuel moisture.

**Energy release component (ERC)**: This is the numerical value related to the available energy per unit area within the flaming front at the head of the fire (BTU/ft2). It represents the heat release rate per unit area in the flaming zone and a function of FMC and fuel type.

**Burning Index (BI)** explains the difficulty of controlling the fire and it is derived from a combination of spread component and the Energy release component. This index reflects the potential flame length over a fire danger rating area. The relationship of **ERC**, **SC** and **BI** is shown in **Fig. 1** todetermine the **NFDR**. The structure of the National fire danger rating system is given in [1]. The basic equations of **FMC content, fuel load, Rate of spread, energy release, burning index,** and **fire load index (FLI)** to determine the NFDR are given in [2].

**Constructing Buildings in WUI and Standards**

National Fire Protection Association (NFPA) in the USA is responsible for preparing the general regulatory conditions of the design and construction of buildings in the WUI. NFPA presents the standards documents [3] of,

* NFPA 1141-Standard for fire protection infrastructure for land development in wildland, rural and suburban areas
* NFPA 1144 - Standard for reducing structure ignition hazards from wildland fire

NFPA 1144 mainly provides a methodology for assessing wildland fire ignition hazards around existing structures and provides requirements for new construction to reduce the potential of structure ignition from wildland fires. Similar to the AS 3959, it explains the construction requirements of housing components (Roofs, walls, openings, chimneys etc.) according to the housing location in the Home Ignition Zone (HIZ).

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| Fig. 1. Fire characteristic chart developed by Andrews and Rothermel, 1982 |

**Home Ignition Zones and Radiant heat Flux**

NFPA defines home ignition zones as **Immediate zone (0-5 ft from the house), Intermediate zone (5 to 30 ft),** and **Extended zone (30 to 100 ft)**. The landscape and vegetation management to reduce ember ignition and fire spread should be done according to the standard considering the fuel types, height, separation distance etc. The concept of the home ignition zone was developed by fire scientist Jack Cohen, following some breakthrough experimental research into how homes ignite because of radiant heat. The vegetation of the experimental site is variably composed of an overstorey **Jack Pine** (*Pinus Banksiana*) and **Black Spruce** (*Picea mariana*)[4].

According to the experiments of Cohen et al. [4, 5], the incident radiant heat flux and ignition time was measured as a function of the distance between the flame and the wall as in **Fig. 2**. The flame of the experiment was given as 20 m in height, 50 m wide, uniform, and temperature of 1200 K [4]. Some other findings of the experiments are as follows [5].

1. Minimum ignition time vs incident radiant heat
2. Incident radiant flux effect of tree density
3. Incident radiant heat flux burning vegetation

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| Fig. 2. The incident radiant heat flux is a function of the distance between the flame and the wall.[4] |

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