# Purpose

This paper helps users understand the concept of validation in the Fire Program Analysis (FPA) software. The goal of validation is to establish a calibrated model representing the most typical fire behavior and fire management response for a Fire Planning Unit (FPU) during a defined historical period. Validation occurs after an FPU reviews and calibrates their data inputs in FPA. Inputs include:

- Arrival times

- Rates of Spread (ROS)

- Dispatch Logic

- Simulation limits

When calibrating data for the Initial Response Simulation (IRS) module, FPUs must look at, and adjust a variety of IRS parameters and FPU information input data. This paper offers suggestions for adjusting data inputs to produce a modeled Initial Attack (IA) success rate (based on fire management response) that is typical for a FPUs defined historical period.

# Terms

**Calibration**: The process of adjusting data inputs so that the Initial Response Simulation (IRS) produces outputs reflecting known results or IA success rate within an FPU.

**Fire Ignition Generator (FIG)**: FPA system algorithm that models possible fire ignition scenarios on the landscape. See Understanding the Fire Program Analysis (FPA) Fire Ignition Generator (FIG) for further information.

**Investment Alternative**: Represents the sum of a preparedness option and a fuels option for a specific budget level. See Option and Investment Alternative Development in FPA for further information.

**Preparedness Option**: Represents the sum of the Initial Response (IR) organization and prevention program.

**Validation**: Data inputs that result in logically correct output.

**Validation Preparedness Organization:** The initial response organization that represents the fire resources used to manage fire during the historic period used to calibrate the IRS model.

## Assumptions

The FPA IRS module processes data using these assumptions.

1. Users have completed all data entry for their entire FPU. This includes:

   ▪ Setting up their FPU team,

   ▪ Entering resources and dispatch locations,

   ▪ Setting attributes for each Fire Workload Area (FWA), such as:

     o FWA/dispatch location associations

     o Dispatch logic

     o Delays

   ▪ The organization that developed the initial response to fires within the FPU is represented in a preparedness option created by the FPU planner named ".validation."

2. All FWAs are calibrated to within 10% of their historic IA Success rate for modeled ignitions. FPA does not include Wildland Fire Use (WFU) and prevented fires in the IA success rate calculation. Note that for those FWA's in FPA that have their percent of fire contained at less than 80%, a report is available with tips that may be helpful to you in making changes to increase the percent of contained fires. The report is the IAAnlayis Report and is available in FPA within the detailed report of Ignition Outcomes.

## Discussion

When an FPU completes a successful IRS validation "run," the modeled outcomes should reflect the expected or the historical initial attack success rate for the FPU.

To achieve this, the FPU must calibrate the parameters in the model. IRS results may differ from an FPU's historic performance because:

- It is difficult to describe one fire suppression organization representative of all fires in an FPU during the defined historical period (the ten preceding years).

- Weather used in the Rate of Spread (ROS) calculations may not represent weather conditions at the fire site or at the time the fire started because both are random selections from historic data, not specific events.

Fire planners need to adjust certain model parameters so the IRS results reflects initial attack responses based on historical data and the unique combination of landscape, fuels and weather of their particular FPU. The IRS inputs that may need adjusting to represent the FPU's fire management strategies found in their fire or land management plans are:

- Associating Dispatch Location(s) to each FWA s

- Dispatch Logic

- Percent walk-in fires

- Percent of fires that are WFU

- Fire resource availability

- Delays (travel and non-travel)

- Fire resources. (This includes all fire resources used to achieve the expected initial response success for the calibration period, regardless of funding source.)

- Engine Tank Capacity

- Water Tenders (continuous "wet" production rate for engines)


## The Calibration Process

Before calibration begins, FPUs must define the typical initial response organization (staffing and fire resources) that responded to fires for the calibration period. Using this information, FPUs create their validation preparedness option (available in the FPA application at **Alternatives > Preparedness > Preparedness Options**). The FPU planner should name the preparedness option used for validation ".validation" and run it with a fuels option named ".existing" that is a copy of the initial ".current" fuels option prior to any treatments being added to the fuels option. (See Naming Conventions for Fire Program Analysis (FPA) Options and Analyses) for further information about naming preparedness and fuels options). *Note that although fire resource costs are not required to be entered for running the .validation option, costs must be entered for each resource before the FPU's investment options are built after the model is validated.*

After creating the ".validation" preparedness option, users must run an initial validation analysis. When the initial validation run is complete, FPUs should run output reports (available at **Reports > Output Reports** in the application) to review how their settings affect the Initial Response modeled results. Based on the information in these reports, users adjust their IRS parameters until model outcomes are within 10% of the historic initial response success for the FPU.

**Tip:** FPA Team strongly recommends that planners first calibrate each individual FWA for arrival times using initial attack resources that typically respond to fires in the FWA being calibrated. Use the information in the "Arrival Times" portion of the "Adjusting Validation Run Results" section below to calibrate the IRS Arrival Times from Dispatch Locations.

**Calibration Guidelines (starting with just one FWA):**

- Calibration tolerance guidelines are within plus or minus 10% of the typical IA success rate for your FPU.

- Run your first validation for only one year with one FWA to become familiar with the affect changes to inputs have on the outputs of IA success and average acres burned for contained fires. See a description of the various reports available to you for reviewing outputs in the "Review Post-Validation Reports" section below.

- After arrival times have been adjusted to typical historical arrival times, proceed to adjust the other parameters to calibrate to historical initial attack success. Arrival times from Dispatch Locations to FWAs should accurately represent the period being modeled. See Understanding Delays in Fire Program Analysis (FPA) Initial Response Simulation (IRS) Module for further information.

- Use the information in the "Adjusting Validation Run Results" section below to calibrate the IRS for arrival times for each FWA. When validation results represent typical response, then run a validation for ten years.

- Calibrate using the typical organization that made the initial response during the defined calibration period.

- Create and use the same dispatch logic that existed during the calibration period.

- Calibrate the calculated rate of spread using hourly diurnal coefficients. The adjusted rates of spread should represent the typical fire behavior expected for that time of day within your FPU during "fire season."

- Size of discovery should be typical for each FWA.

- Set dispatch level breakpoints so they reflect the typical distribution of fires and corresponding initial response fire resources.

- Set Exceed Simulation Limits (ESLs) to reflect guidance found within your FPUs Land/Resource and Fire Management Plans.

At this point, you should feel comfortable with how your inputs and the IRS module work together. You should proceed with entering information for all of your remaining FWAs. Run these for just one year, and utilizing the output reports, adjust FWA parameters until validation results represent typical behavior.

When you have completed the one-year validation run for all FWAs, run a validation for ten years for each FWA. When that is complete, then run ten years for all your FWAs. It is recommended that you set the number of years to persist in the output reports to just one year,

otherwise there will be output tables for each modeled year, creating more tables than can realistically be reviewed. Again, if results appear to be greater than plus or minus 10% of typical IA success rate, run 200 years for all FWAs and continue to adjust FWA parameters, persisting only one year in the output reports. When the IA success rate is within plus or minus 10% of historical results, you have completed validation.

**Tip:** Once the initial attack success rate represents your FPU, you should retain a copy of the input report titled "FPA_FWA" as documentation for key input values used to validate the IRS model.

## *Using IRS Reports in the Validation Process*

There are several output reports that you should run and analyze while calibrating the IRS model. These reports help you evaluate how parameter adjustments affect other results during calibration. Important reports to review are:

- Ignition Outcomes

- Outcome Summary: Report contains multiple tabs that display data for Fire Status, Contained by FIL, Contained by Fire Class, Ignition Totals per Year, and Deployed Fire Resources.

- Cumulative Outcome report for IA Success for the Alternative containing the validation preparedness option you are running,

- Ignition Event Details

- IR Input Report (tabbed reports listed below)

  o Fire Event Scenario: Report displays the location of the travel point/workload point (TTP Latitude/TTP Longitude), cause, Julian day, fuels for every reported fire. The Fire ID is the system ID.

  o IR Input Year: Report contains multiple tabs that display data for IR Fires, Fire Resources, Fire Resources Excluded, FWA Data, FWA FDL Data, FWA Large Air Tanker Bases, and FWA Diurnal Fire Behavior Data.

  o Scenario folders: Each folder displays a detailed activity log for every fire.

- IR Simulation Summary: Report contains multiple tabs that display the number of contained fires and walk-in/non-walk-in fires by FWA.

- Resource Utilization Outcome Summary: Report displays the number of resources sent to fire events for the alternative.

- FPU-FWA – Report summarizes input fire resources, FWA attributes, and dispatch breakpoints and logic.

## *Adjusting the Inputs Used in the Validation Runs*

When reviewing your data after a validation run, ensure the results represent a realistic picture of activity in your FPU. When they do not, FPUs should make adjustments as described below and re-run the analysis.

The following tips describe model parameters and input data that may require adjustment to ensure the system accurately represents conditions in your FPU.

**Arrival Times**

FPA calculates the travel distance from a dispatch location to a FWA Travel Time Point (TTP) in a straight line. FPA uses this distance to calculate aviation-resource travel time. For ground-based fire resources, the system uses a default value of 1.6 Air to Ground Coefficient as a multiplier of the straight-line distance to get estimated ground miles from the Dispatch Location to the FWA TTP. The default value of 1.6 may either require adjustment up or down to provide a typical ground mile distance between a dispatch location and FWA TTP. For example, changing arrival time within FPA to a shorter time means that fires will be smaller when fire resources arrive than they were prior to the change in arrival time. Increasing or lengthening the arrival time means that fires will be larger when fire resources arrive than they were prior to the change in arrival time.

Callback delays also effect arrival time. The system default of zero (0) minutes helps avoid modeling anomalies due to the models strict adherence to shift length. This delay should only be changed from zero if all other calibration settings have been used. A callback delay is set for each dispatch location and applies to all fire resources assigned to the dispatch location. The fire resources are dispatched to a fire that is discovered outside of the fire resources defined daily start and end time as well as days of week when in service. See Understanding Preproduction Delays in Fire Program Analysis (FPA) Initial Response Simulation (IRS) Module for further information about how FPA calculates delays.

Before making other data adjustments, planners should calibrate one FMU/FWA at a time to ensure the arrival time from each dispatch location to the specific FWA reflects the typical historical period within the FPU.

**Rate of Spread (ROS)**

If the fire occurs at a time other than 1300 local time, then check the ROS value and adjust it to reflect typical local conditions that occur at the time of day the fire is discovered. FPA uses a coefficient to adjust ROS for each hour that the fire spreads from the time of discovery until it is contained or exceeds simulation limits. Review your historical fire report data to determine what time of year most of the fires occur. For example, when most fires occur from June to September, adjust ROS to reflect heavier fire activity during this time. Planners can define a coefficient for each hour of the day except 1300 Local Time, which is set at 1.0.

Check the FPA website for the Diurnal Coefficient Calculator to help you develop diurnal coefficients. FPUs determine correct fire behavior based on local expert knowledge and with the Diurnal Coefficient Calculator available on the FPA website. When developing and then

applying diurnal coefficients to adjust ROS, be careful <u>not</u> to minimize ROS values so that adding or removing fire resources from those dispatched in the dispatch logic table result in no change in the IA Success percent and/or the acres burned for the contained fires.

**Dispatch Level Breakpoints**

Using Fire Family Plus, or your knowledge of fire occurrence in your FPU, analyze your modeled fire event distributions. Planners may need to adjust dispatch-level breakpoints in the FPU's dispatch logic so the breakpoints correspond with the historical breakpoint distribution. The objective is to ensure the output represents the typical initial response production capability for each dispatch level as occurred during the historical period.

The number of fire resources per dispatch level may need adjustment from the starting level if they are not representative of the typical level and response when matched with the historical distribution of fires within the FPU.

Simulation limits for each FMU and FWA may need adjustment from those initially entered if too few or too many fires are Exceeding Simulation Limits.

**Dispatch Logic**

The dispatch logic determines the kind and number of resources dispatched to a fire under a given set of conditions. (See Dispatch Logic User Guide, http://www.fpa.nifc.gov/Library/Documentation/Userguides/Docs/Dispatch_Logic.pdf)

Entering a higher number of resources for each resource category generally results in faster fire containment. Fires starting minutes apart could result in one of the fires not being contained due to No Resources sent based on the number of resources defined in the Dispatch Logic that may have been sent to the prior fire.

> **Dependent and independent resources**: The aerial resources require the support of at least one ground resource in order to start production. FPUs should ensure the dispatch logic and FWA-dispatch location association specify at least one ground resource reaches the fire quickly enough and incurs the first unit delay if aerial resources are also included in dispatch logic. Once the first arriving ground resource incurs the first unit delay, the aerial resources can start the production. (See Understanding Preproduction Delays in Fire Program Analysis (FPA) Initial Response Simulation (IRS) Module for further information about how FPA calculates delays).

> **Water Tenders**: Water tenders support the pumping production of the engines. Deploying a water tender to a fire helps provides continuous pumping production for the engines already assigned to a fire. Without water tenders, engines may run out of water based on the defined tank capacity relative to the duration of the fire event.

> **Shuttling Resources**: Smokejumper aircraft shuttle smokejumpers from the dispatch location to the fire. Smokejumpers cannot reach the fire and produce without a smokejumper aircraft. Similarly, the helitack need shuttling helicopters to reach the fire. FPUs should enter the staffing in the helitack and smokejumper resources so that is uses the crew carrying capacity of the carrier aircraft.

### Check FWA Dispatch Location Association

The resources attached to the dispatch locations that respond to an FWA are the only ones used on fires located in the FWA. Dispatch locations with higher number of resources and associated to the FWA, have a higher probability of containing fires in the FWA.

### Add Resources/Staffing

Adding resources to the dispatch locations and including them in the dispatch logic associated to the FWA may increase the containment success in the FWA. Additional staffing on the existing resources helps increase the production rate of the existing resources. Higher resource production rates ensure higher probability of fires being contained within the simulation limits set by the FPU.

### Relative Location of FWA and Associated Dispatch Locations

If the dispatch locations associated with an FWA are located near the FWA, the resources dispatched require less travel time to respond to the fires. This increases chances of fires being contained within the simulation limits set by the FPU. However, if historically more than one dispatch location responds to ignitions in an FWA, be sure to associate all appropriate dispatch locations to that FWA.

### Travel and Non-Travel Delays

After a fire is contained, or has escaped, the resources that worked on the fire incur a post-fire delay before they can respond to subsequent fires. The FPU planner can edit post-fire delays (post-containment delay, post-escape delay and unused delay.) Lower delay values means resources respond earlier to subsequent (or competing) fires. FPUs can define the reload delays corresponding to Scoopers (SCP), Single Engine Airtankers (SEATs), engines, and helicopters at the FWA level. Lower reload delay values results in early return of resources to the fire after the reload. The first unit delay is the time spent by the first arriving ground resource to plan the fire attack. Lower value of this delay might expedite the fire fighting operation. The mobilization delays (dispatch decision delay, resource response delay, and set up delay) are associated with the producer type resources and are part of the reference data. Lower delay values ensure resources respond to a fire more quickly.

### Fire Discovery Size

Fire growth using the hourly-adjusted ROS will start based upon the fire start time, in daylight savings time, and the discovery size. For most FPA users, the smallest size fire that could be reported in the agencies fire reporting system is .10 acres. If the discovery size is set larger than the typical size, this may result in fires exceeding simulation size limit for the FWA.

### Percent Walk-in Fires

Planners can adjust the percentage of walk-in fires in an FWA. Engines will not pump water or in other words use their wet production rates on walk-in fires.

**Parallel Attack Distance**

In case of parallel attack, the resources maintain an offset distance from the fire. This increases the perimeter and size of the eclipse being built by the resources around the fire. Smaller value of parallel attack distance could mean smaller perimeter and area of eclipse being built.

**Gallons per Load for the Engine**

This is an attribute of the engine resource. This value signifies the amount of water an engine can carry to the fire. The user needs to make sure that the engine's gallons per load are greater than zero for it to do any pumping production. Higher values of gallons per load could also mean that the engine could continue to pump water for a longer duration. If your FPU typically sends a water tender along with the engine, be sure to include the tender as a resource in your dispatch logic.