THE RANGE IGNITION PROBABILITY (RIP) TOOL

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Summary

The RIP Tool combines a physical ballistics model with information about tracer burnout to calculate the spatial distribution of wildfire ignitions on live-fire ranges. This information is used to more accurately estimate fire risk to protected resources and to improve fire management and range planning. The current prototype is limited to small arms tracer ammunition, but a fully functional RIP Tool that will include a wide variety of commonly used munitions is under development.

Who will use it:

- Wildland Fire Managers
- Natural Resources Managers
- Range Planners
- NEPA Specialists
- Public Affairs Officers

Photo Credit: Staff Sgt. Liesl Marelli

What it does:

Predicts where live-fire training is likely to ignite wildfires.

How it can help:

- Provide fire managers with critical information for pre-suppression planning.
- Reduce fires in unexpected or sensitive locations.
- Allow Range Planners to visualize the consequences of different range alignment scenarios.

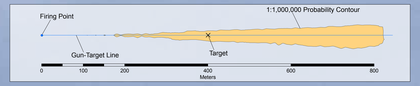
Methodology

The RIP Tool is based on a probabilistic, next generation Surface Danger Zone (SDZ). The probabilistic SDZ utilizes a model that considers projectile physical characteristics, firing point and target position, terrain, shooter position (prone, kneeling, standing) meteorological conditions, and aimer error to determine where a round may land. It also includes a ricochet model based on laboratory and field experiments to determine ricochet probability and trajectories. The probabilistic SDZ fires many rounds with randomly assigned, but normally weighted, error budgets. By simulating many trajectories it is possible to assign a number to the probability of a round impacting anywhere on a range. It is capable of determining SDZ's for stationary targets, moving targets, and baffled ranges. The U.S. Army is currently considering replacing the existing SDZ methodology with this new model.

The RIP Tool adds an additional piece of information denoting the status of the tracer compound when the round impacts the surface. This information was collected from previous munitions tests to determine the tracer burnout time for the M196 round under real-world conditions. The probabilistic SDZ model was modified so that rounds are not counted in the probability calculations if they impact after the tracer burns out.

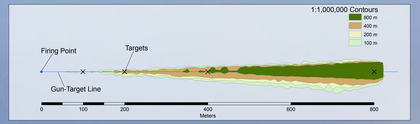
Testing

We first tested the model using a single target at 400 m on a hypothetical flat range to minimize sources of error.



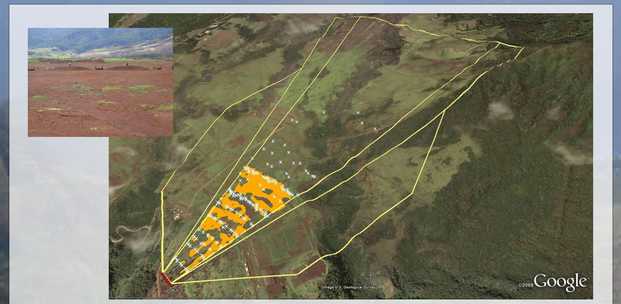
Flat terrain test of the RIP Tool with a single target at 400 meters and a 1:1,000,000 contour output.

We then tested the model on the hypothetical flat range using a typical qualifying range target setup with targets at 100, 200, 400, and 800 m.



Flat terrain test of the RIP Tool on a single firing lane with targets at 100, 200, 400, and 800 meters and a 1:1,000,000 contour output.

Finally, we tested the RIP Tool on a real-world range at Schofield Barracks, Hawaii. The range has six lanes with 16 to 17 targets per lane. Engineering drawings and engineering grade elevation point data from U.S. Army Garrison, Hawaii were used to create a digital elevation model and locate each firing point and target.

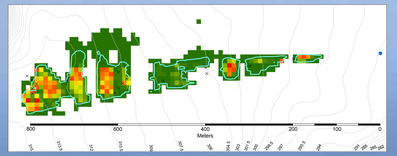


Real-world test of the prototype RIP Tool on the MF-2 Range at Schofield Barracks, Hawaii for 5.56 mm M196 tracer ammunition. The area affected by potential ignitions according to the RIP Tool (orange) is 3.2% of the size of the bat wing SDZ (yellow line). Red points are firing points and X's are targets.

Outputs

The RIP Tool can produce probability contours or gridded output. Probability contours are useful for quickly identifying areas at risk and can be set to any level of risk a manager is willing to accept. Gridded outputs are useful when more detailed information about the distribution of ignitions is desired.

The 1:1,000,000 RIP Tool probability contour (light blue line) compared to grid output for one lane on the MF-2 range at Schofield Barracks, Hawaii. The grid data ranges from low probability of ignition (green) to high probability (red). Grid data outside of the contour has a probability of less than 1:1,000,000. Grid data provides a great deal more information than contours alone. The blue point is the firing point, X's are targets, and the light grey elevation contours are in meters.

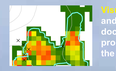


Uses

The RIP Tool will first be used for the U.S. Army, Hawaii where high value natural resources exist in close proximity to live fire ranges. Damage to these resources from past fires has resulted in restrictions on the use of ranges and mitigation costs of approximately $10 million per year. A portion of the mitigation costs are directly related to simulations of wildfires, which depend in part on an assessment of where ignitions are likely to occur. That assessment currently assumes wildfires are equally likely anywhere within the bat wing SDZ's. By using the RIP Tool, we can drastically reduce the area considered at risk of ignition, possibly by 90% or more. Associated mitigation costs are then limited by the reduction in the area perceived to be threatened by fire.

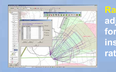
Two fires (orange area) simulated under identical conditions, with the exception of the ignition location (red dot), demonstrating the dramatic effect ignition location can have on fire extent. The distance between the ignition points is 1.2 kilometers.

Uses cont.



Visualization Grid outputs from the RIP Tool can provide a better visual reference than the more abstract and homogenous idea of an SDZ for use when consulting with regulatory agencies, in environmental documentation, or at public meetings. Because the grid output represents the spectrum of ignition probabilities throughout the range, the task of explaining that ignitions are much more likely to occur near the targets and in the center of the range is greatly simplified.

Fire Management The RIP Tool can help fire managers assess overall fire risk. The grid outputs from the RIP Tool can be used to create far more realistic ignition inputs into wildfire simulations, such as the commonly used Fire Area Simulator (FARSITE) that make up a fire risk analysis. Determining where ignitions should be placed on the landscape is often one of the most difficult parts of assessing fire risk. The RIP Tool can provide a concrete answer to this question and help to create a robust fire risk assessment. These simulations and assessments are invaluable for wildfire management planning and determining where firebreaks and wildfire fuel treatments will be most effective.



Range Planning Range Planners can use the RIP Tool to easily visualize where ignitions are likely and adjust their planning accordingly. By including fire mitigation in the range planning process, the potential for unintended ignitions and wildfires can be mitigated before they ever become a problem. As a result, installations can expect a lower incidence of fires in unexpected or sensitive locations and higher success rates in containing fires.

155 mm artillery round

White phosphorus artillery round exploding.

Invasive grasses burning at Schofield Barracks, Hawaii.

Burned area at Schofield Barracks, Hawaii.

Implementation

The prototype RIP Tool is limited to the 5.56 mm M196 tracer round. Additional funding has been secured to develop a fully functional RIP Tool that will allow spatial ignition prediction for the following munitions. Completion is expected by fall 2010.

- 5.56 and 7.62 mm Tracer
- .50 Caliber Tracer
- 40 mm Grenade
- 60 mm, 81 mm and 120 mm Mortar - HE, Smoke, Illumination
- 105 mm Artillery - HE, Smoke, Illumination
- 155 mm Artillery - HE, White Phosphorous, Smoke, Illumination
- 105 mm and 120 mm Tank/Stryker - HE
- 2.75" Rocket (pending available ricochet data)

When completed, the RIP Tool will be submitted for inclusion in the Range Managers Toolkit.

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