

# The Simulated Infrared Earth Environment Laboratory, an Infrared Signature Resource to Support Test & Evaluation

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Thermal sensors are highly prevalent on the modern battlefield and test & evaluation (T&E) of these sensors requires thermal infrared (IR) signature representations of threat systems. These signature requirements range from user training and model inputs for digital sensor simulations, to full-scale targets that are deployed to test ranges for destructive testing of weapon systems. IR signature data for threat systems is not something that is normally readily available to a tester or evaluator, but there are resources for this type data for the T&E community.

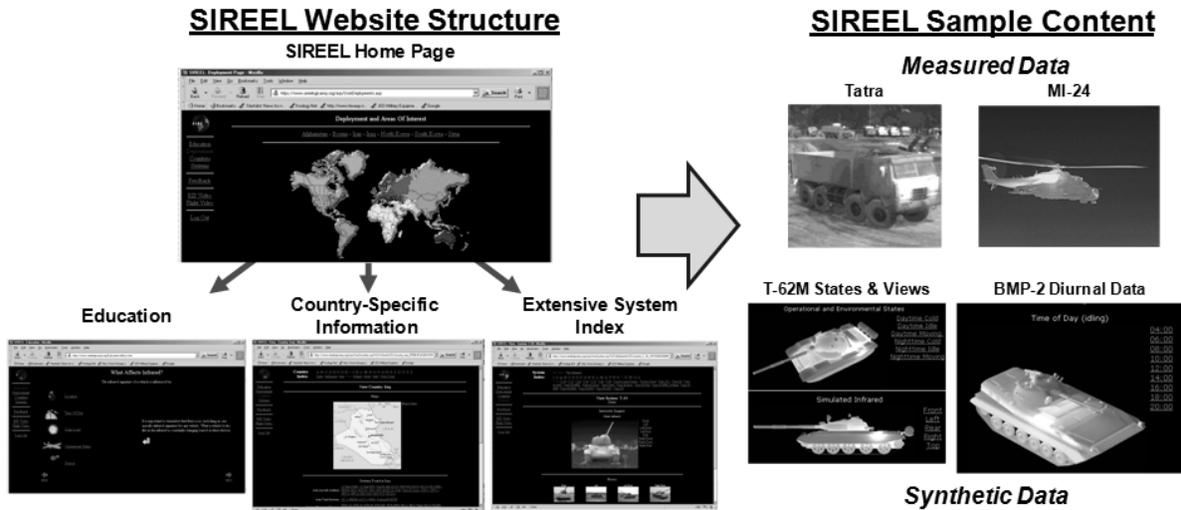
One such resource is the Simulated Infrared Earth Environment Laboratory (SIREEL) website. The SIREEL website was created for support of gunner training. The SIREEL web site contains extensive infrared signature data on numerous threat and friendly vehicles and the site is designed to provide country-specific vehicle identification training in support of US military deployments. However, the information on this website and the models used to generate content for the website can be utilized to support T&E of emerging sensor technologies. Figure 1 shows an example of the SIREEL website structure and sample content.

It is important to note that SIREEL is not just a website, it is also an IR signature modeling program. The core component of the SIREEL website is its System

Index which organizes IR signature data for over two hundred foreign systems. This online encyclopedic IR signature reference system contains both measured and synthetically generated IR signature data. The synthetic data is generated with predictive, physics-based IR signature models that allow a user to generate a vehicle signature under any operational and environmental state.

The IR signature of a ground vehicle is highly dimensional, and predictive, physics-based modeling offers an approach to providing IR signatures to support a wide range of T&E activities. It is simply not possible to measure the IR signatures of threat ground vehicles in sufficient quantity and fidelity to support all of the needs of the T&E community. Some reasons for this are:

- many threat systems required for T&E are not available for signature measurements or range testing
- IR signature data supporting simulations must be environmentally correlated (same place & time) for multi-target scenarios and measuring data in this manner is challenging and expensive
- the IR signature of a ground vehicle is affected by so many different factors that it is simply not possible to capture *every* signature state.



**Figure 1: SIREEL website structure and sample content**

Predictive IR signature modeling can fill in these signature requirements gaps and the SIREEL program has an archive of over 200 signature models that are available to support T&E needs. The signature data on this website and the models used to create this data have been used to provide IR signature design support for multiple range target development programs. These include the Threat Vehicle Surrogate Target (TVST) program, the Realistic Low Cost Targets (RLCT) program, and the Precision Target Signatures (PTS) programs. Literally thousands of users have gained access to the SIREEL website since it was launched. While it is not practical to track the end use of the IR signature data obtained by these users from the website, it is known that multiple T&E target-related programs in addition to those mentioned above have benefited from the SIREEL program.

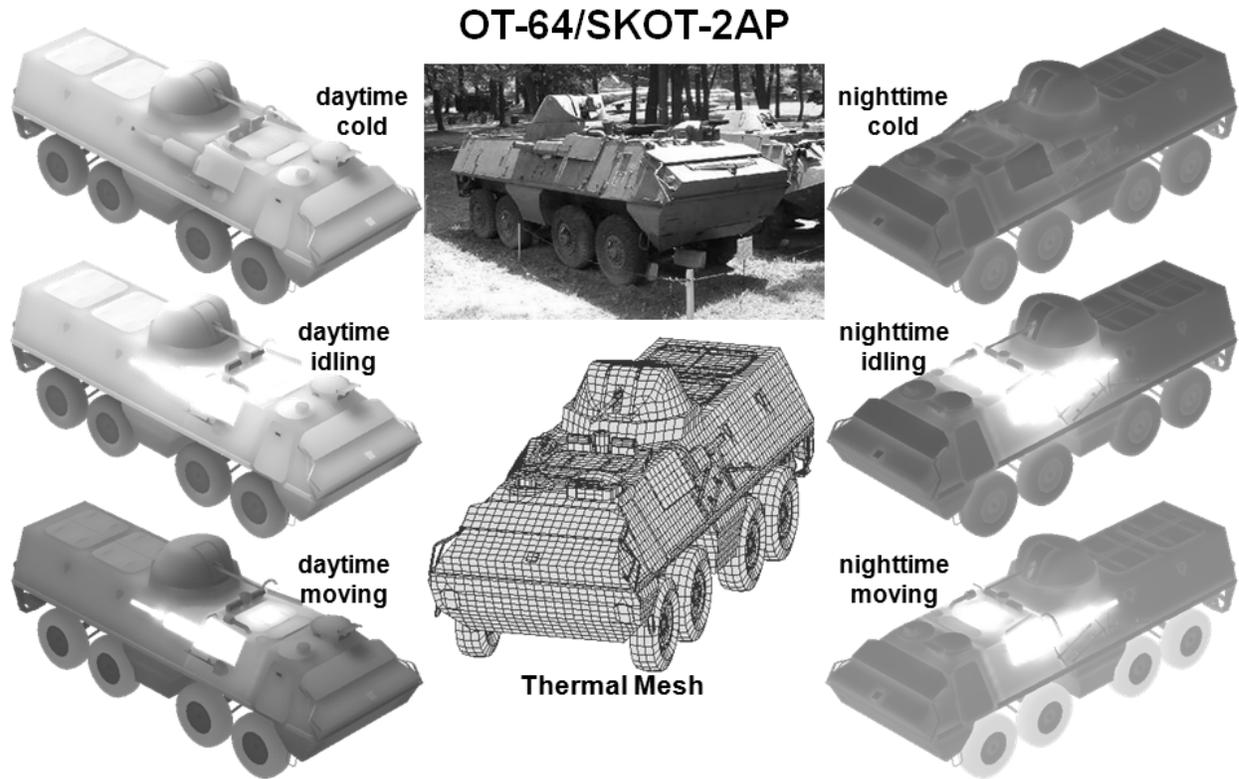
Example SIREEL signature model outputs are shown in Figure 2. This figure demonstrates the six fundamental

signature states of a ground vehicle, the environmental states of daytime and nighttime, and the operational states of cold (engine off), idling, and exercised. This is a *gross simplification* of the dimensionality of ground vehicle IR signatures, but it demonstrates the majority of a target's critical IR signature features.

Creating this type of signature model requires the following steps:

- building a geometry model in a computer-aided design program
- converting the geometry into a thermal mesh suitable to accurate temperature calculations
- segmenting and attributing the thermal mesh with thermal properties
- developing the algorithms to calculate engine-related heat transfer
- executing a scenario specific simulation in an IR signature code such as the Multi-Service Electro-Optic Signatures (MuSES) code

Figure 2 shows daytime signatures on the left, nighttime signatures on the right, and cold, idling, and exercised



**Figure 2: Example SIREEL signature model outputs**

signatures going from top to bottom. Hot, engine-related target components are apparent in the idling and exercised cases and tire heating and hull cooling is shown in the exercised signatures.

This is just a limited example of the power and flexibility of predictive IR signature modeling to support T&E by filling in the IR signature gaps for emerging IR sensor technologies. The SIREEL Program has a large archive of these models and they are available to end users for generating signature data for a wide range of T&E applications.

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*SIREEL program since its inception. Dr. Sanders received a BSEE, MSEE, and a PhD in engineering from Memphis State University in 1987, 1990, and 1994 respectively. Questions and comments can be directed to him at [jsanders@trideum.com](mailto:jsanders@trideum.com), 200 West Court Sq, Suite 103, Huntsville, AL 35801.*

### **Acknowledgements**

The SIREEL point of contact is Daniel J. Rinald ([daniel.j.rinald@us.army.mil](mailto:daniel.j.rinald@us.army.mil)). Access to the SIREEL website for official DoD uses only can be requested at <https://sireel.ngicarmy.org>. (.gov or .mil e-mail address required to request a login)