Assessing TAWS alerts is a critical element of risk monitoring of air traffic across the National Airspace System (NAS). MITRE/CAASD has developed a standards-based TAWS model to simulate the behavior of different TAWS equipment for use in a variety of safety and design applications. By providing access to this model through the Terminal Area Route Generation, Evaluation, and Traffic Simulation Tool (TARGETS), NAS-wide safety monitoring products, and Human-in-the-Loop Simulations (HITLS), the relationship between procedure design and alert incidents can be better understood, screened, and considered for operational impact.

About TAWS

TAWS equipment alerts pilots to imminent danger regarding terrain. TAWS equipment is capable of producing a variety of alerts based on the types of situations that lead to a high risk of CFIT, such as excessive descent rates, descent immediately after a takeoff, or proximity to the ground with landing gears up. Depending on the equipment available, TAWS uses measurements from the aircraft’s radar altimeter, Global Positioning System (GPS), and terrain/obstacle databases to calculate that aircraft’s risk of CFIT.

Originally, required by the FAA for all large airliners in 1974, TAWS is responsible for a dramatic reduction in CFIT incidents over the past few decades and has continually improved to include increasingly accurate and timely alerts. However, the high cost of hardware and software upgrades has resulted in many carriers delaying or declining system updates. Older equipment is much more likely to generate nuisance alerts—warnings to the crew during periods of low CFIT risk. These nuisance alerts desensitize crews to TAWS, leading to situations where crews may ignore or not fully respond to alerts that indicate real danger.

The continued elimination of remaining CFIT risk, along with the possibility of introducing new risk during redesign, necessitate a comprehensive TAWS model to understand current and potential hazards.

About the TAWS Model

MITRE/CAASD’s TAWS model conforms to the requirements of the FAA Technical Standard Order (TSO)-151b and RTCA DO-161A. Currently, the model is capable of producing the following types of alerts:

- **MODE 1**—Excessive Rate of Descent
- **MODE 2**—Excessive Terrain Closure Rate
- **MODE 3**—Sink After Takeoff
- **MODE 4**—Too Low Terrain
- Enhanced Mode—Premature Descent Alert
- Enhanced Mode—Forward Looking Terrain Avoidance

The TAWS model is also capable of generating alerts from a variety of equipment versions; this is especially important when understanding how equipment upgrades may reduce alert rates. The model has been validated against over 500 historical flights with alerts, and 95 percent of all historical alerts were replicated by the TAWS model within a
nautical mile. Currently, the model is undergoing a more extensive validation across a larger historical dataset.

**TARGETS: Incorporating TAWS into Design and Screening**

TARGETS, the primary tool for procedure design at MITRE/CAASD and the FAA, has included the TAWS model to provide rapid feedback of alert incidents during design iterations. The TAWS model can be used with historical track data or simulations to consider CFIT risks within the terminal areas of study. Additionally, viewing TAWS alerts in TARGETS is an intuitive way to detect patterns around procedures and terrain of concern. For each TAWS alert generated by the model, users can view the alert type, message, and aircraft state at the time of alert.

In early 2012, MITRE/CAASD was requested to study how differently equipped aircraft receive TAWS alerts when flying standard approaches into the Eagle County Regional Airport (KEGE) at Eagle, CO. Using the TAWS model integrated into TARGETS, it was shown that aircraft using older, overly sensitive equipment would receive two alerts for the predominantly used approach. The overhead view shows the locations of these alerts as the aircraft approach from the west to the runway. The profile view shows how the underlying terrain contributes to these alerts. Additionally, the model showed that aircraft using new equipment receive no TAWS alerts when flying this approach.

**HITLS: Understanding the Human Factors of TAWS Alerts**

The TAWS model can run as a stand-alone service for HITLS, monitoring all flights in the simulation and producing alerts to be shown to the responsible pseudo-pilots. This provides direct TAWS alert feedback to procedure designers and controllers while experimenting with high levels of traffic, aircraft vectoring, or other special conditions.

**Safety Monitoring: Seeing the Big Picture**

Currently, under development and validation, the TAWS model is being run over the Threaded Track dataset to produce a NAS-wide view of TAWS alert incidents. From this capability, current hotspots can be identified and alert rate trends can be discovered over time. This will also provide a data-driven feedback loop to understand the effectiveness of procedure design changes. As changes are published, TAWS monitoring of Threaded Track data can reveal the effect of those changes on alert rates.