

## Trex Aviation Systems FOD Finder™

### Introduction

Trex is offering its FOD Finder products for the 24/7 airport runway FOD detection. Trex FOD Finder™ has been rated the best performance product in the industry by the United States (US) Federal Aviation Administration (FAA) and other independent organizations with reported 100 percent detection and no false alarm in all weather conditions, day and night.

| FOD System                    | FAA Score   | BCIA Score  |
|-------------------------------|-------------|-------------|
| <b>Trex FOD Finder™ (USA)</b> | <b>100%</b> | <b>100%</b> |
| QinetiQ Tarsier (UK)          | 83%         | 40%         |
| Stratech iFerret (Singapore)  | 87%         | 60%         |
| X-Sight FODetect (Israel)     | 94%         | 70%         |

Trex FOD Finder is built on the patented radar technology and the most reliable manufacturing processes. Trex is a world leader of millimeter-wave (MMW) technology and engineering. During the past quarter century, Trex has received more than \$100M funding from various sources to develop MMW products for both military and commercial applications in areas of communications, security and aviation. FOD Finder radar was originally developed for the United States Department of Defense (USDoD) to detect high tension power lines in the helicopter’s flight path, to land helicopters in brown-out situation, and later was tested for trigger wire detection of roadside bomb threat. Currently, the USDoD is using the Trex FOD Finder™ at their Air Bases.

The Trex FOD Finder™ has been recognized by the industry as a ground-breaking technology which could take airport/airbase security and safety to greater heights. In 2010, Trex FOD Finder™ was the winner of the Innovation in Motion (Aerospace & Security Technologies) Award in the United States of America (USA).



### Trex FOD Finder™

The Trex FOD Finder™ is built with a patented radar design that uses low power millimeter output (<0.05W) at 78-81 GHz frequency and low-profile configuration (~1.5x1.5x1 cubic meter, <250 kg). It provides high sensitivity (target cross-section: -20 dBsm), low dwelling time (<2 min), suitable coverage (up to 300 meter) and high location resolution (<2 meter) capability. Unlike an electro-optical system, MMW radar works day and night and in all weather conditions, including fog, rain, snow, haze and sand storms, and its performance is not affected by the air shimmering observed in high temperatures.

The MMW radar can be placed either on a fixed or on a mobile platform for FOD detection as shown below:



Trex FOD Finder™ XF is a fixed-site FOD detection system designed for 24/7 continuous runway monitoring.



Trex FOD Finder™ XM is a mobile FOD detection and retrieval system designed for runway, taxiway and apron operation. XM can be operated at driving speeds up to 50 Km per hour.

Trex is the only company that makes FOD Finder™ products that provide a total solution for the airport FOD detection and retrieval covering runways, taxiways and apron area. FAA has included both Trex FOD Finder™, XF and XM, in its Nationwide Buy-American Waivers List (FOD Finder™ XF was issued August 31, 2011 and FOD Finder™ XM, May 14, 2012).

Trex FOD Finder™ has received a waiver from the US Federal Communications Commission (FCC) on July 11, 2013 to be used in and around the airports as FOD detection equipment.

**Detection of FOD on Runways**

For a typical 4000 meter runway, it requires a total of nine (9) FOD Finder nodes, and each node consists of a FOD Finder XF and a Camera as shown below.

FOD Finder™ XF

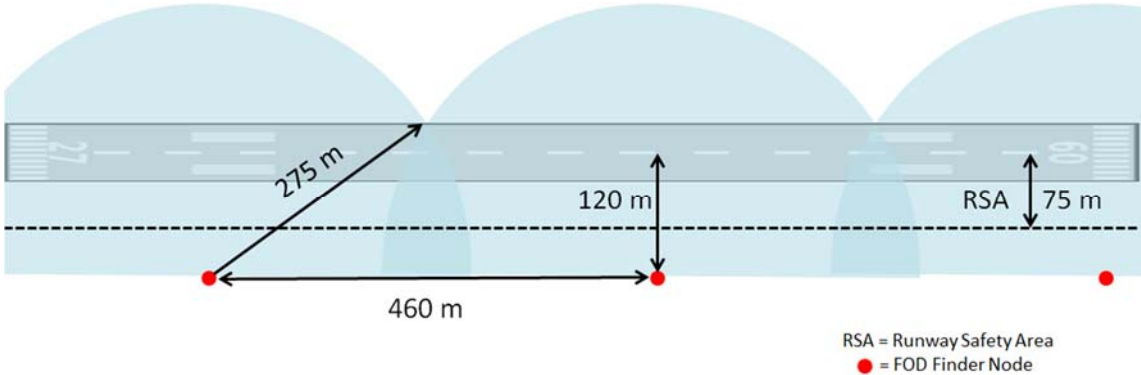


Camera



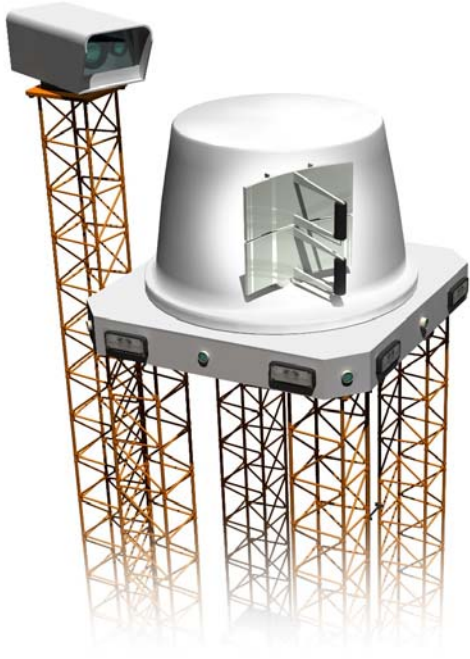
**Trex FOD Finder™ XF System**

The illustration below shows a schematic of the diagram. Each FOD Finder node is placed about 120 meters from the center of the runway and 460 meters from the adjacent node. Each node will have a MMW radar as the primary sensor for FOD detection and a camera system to image and identify the FOD.



**Schematic Diagram illustrates Trex FOD Finder™ XF System Typical Network Layout**

Both the Trex FOD Finder™ XF and camera will be placed on a structure with a total height of about three (3) to five (5) meters above the ground, with the height depending on the cross-slope of the runway. The structure will be constructed according to FAA and ICAO guideline.



**An artist rendering of the FOD Finder XF mounted on structure.**

The FOD Finder™ radar runs 24/7 continuously, scanning 150 degrees. This will cover a runway area of 460 meters, with some area overlapping the adjacent node. The system software will process the information and display the whole runway seamlessly.

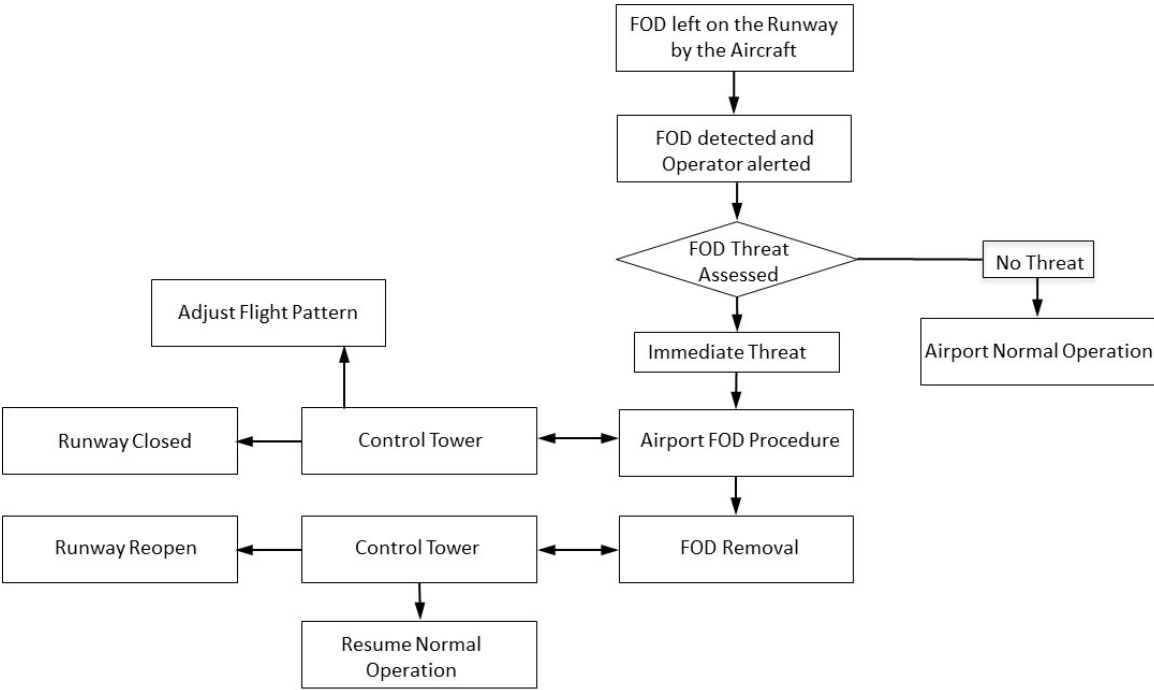
The camera is normally on a hot standby mode. When FOD is detected, it automatically zooms in on the object and takes a picture which is displayed on the monitor for further threat assessment by airport operators.

**Concept of Operation**

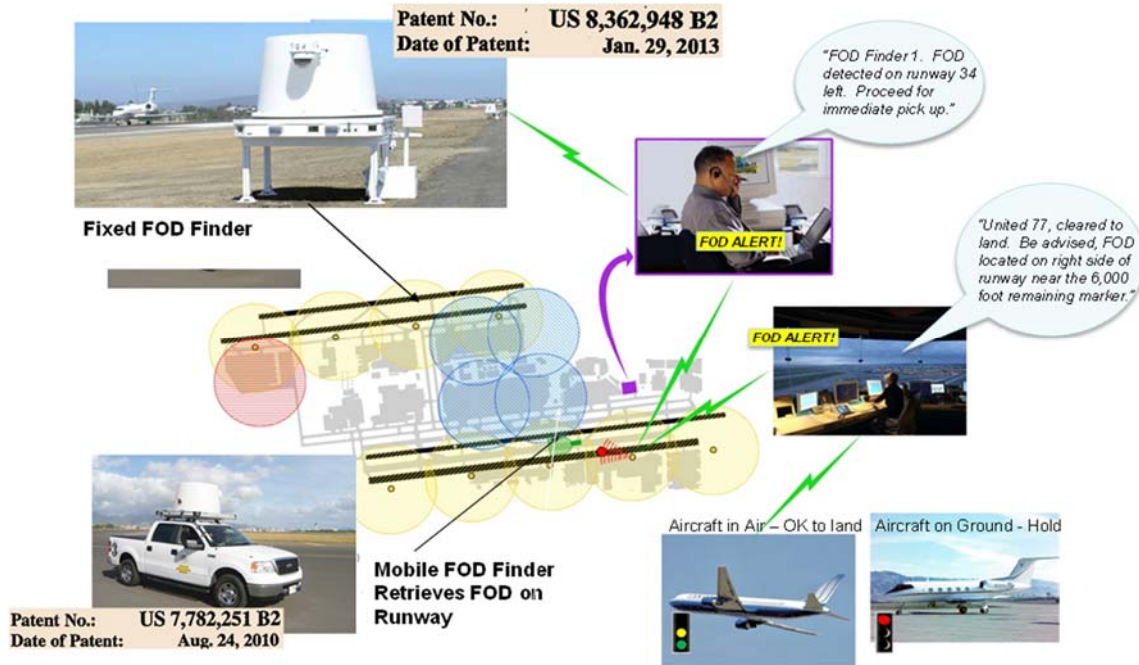
The operation flow chart is given below. A graphic description of the operation is given in figures below with a timeline of the events from the detection of FOD to determination of the threat which leads to dispatch the personnel to remove the FOD.

The operator is alerted automatically when the FOD is detected by Trex FOD Finder XF™ radar and the display of the FOD image is shown on the monitor. If and when becoming necessary, the operator can steer the camera to zoom in the FOD object and further assess the threat. Once the FOD is clearly identified, the ground operation and the control tower can then determine if the runway needs to be closed and a person should be dispatched to remove the FOD.

It should be noted that the length of time for the FOD Finder™ radar to detect and display the GPS coordinates of the FOD is less than two minutes and within 40 seconds, the camera will home in on the FOD and image will be taken and displayed on the monitor. During the night operation, the camera will be assisted by the built-in illuminator which will be turned on when the FOD is detected. The illuminator can be manually disabled by the operator.

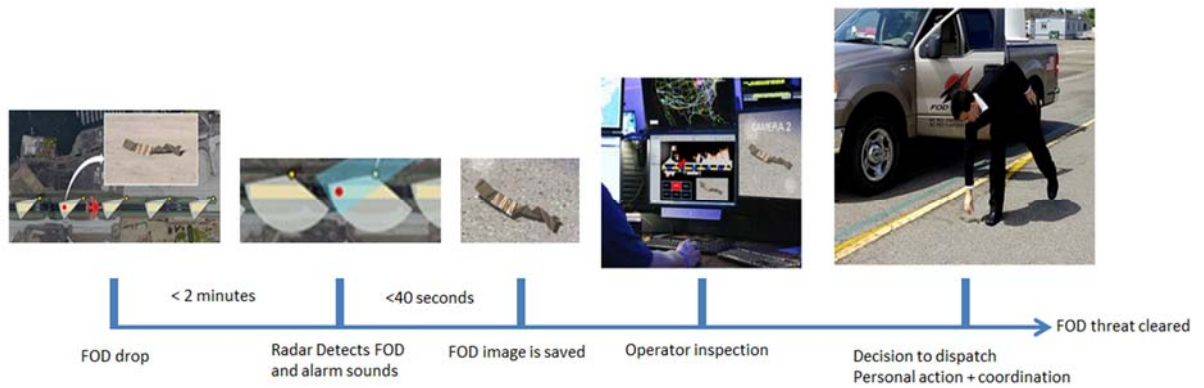


**Operation flow chart.**



Typical Example/Overview of FOD Finder™ System

Below shows the timeline of each event described in the above flow chart.



Timeline of Operation

## Performance Specifications

The following table shows a summary of the performance requirement for general runway operation.

|    | Performance Specifications  | FOD Finder Performance   |
|----|---|--|
| 1  | System is comprised of:<br>A debris detection, location and identification sub-system; An alerting and display sub-system; A logging, archiving and replay sub-system | Yes  |
| 2  | Complimentary to the existing airport's FOD detection operations which currently involve the use of airport personnel to detect FOD on airport surfaces.              | Trex FOD Finder™ XF System provides maps, geo-locations, imagery and relative locations to aid airport personnel in finding and removing FOD.  |
| 3  | Track and analyze FOD detections to identify the source of FOD  | Trex FOD Finder™ XF System database maintains a track of FOD accumulation to aid in the identification of FOD sources  |
| 4  | Continuous 24 hour surveillance and automatically detect, identify and locate debris on airport runways   | Yes  |
| 5  | Maximum time to detect is 5 minutes   | < 2 minutes  |
| 6  | Detection under clear and inclement weather typical of the Kingdom of Saudi Arabia (including rain, fog, and sandstorm)   | Yes  |
| 7  | Central Control Station contains an interactive airport map that allows the operator to Scroll, Pan, and Zoom between runways with FOD Detections overlaid            | Yes  |
| 8  | Visual and audible alarms on FOD detection  | Yes  |
| 9  | Autonomous detection of FOD w/ no interaction   | Yes  |
| 10 | Geo-tagged coordinates for FOD detection to within 5 meter accuracy   | 0-2 meter accuracy   |
| 11 | Detection and retrieval of FOD shall be assigned a unique identifier, date, time, and location  | Trex FOD Finder™ XF System database is Part 139 compliant with the FAA and ICAO standards for FOD management which encompasses these requirements  |
| 12 | Provide user with an image of the FOD to allow for assessment of risk posed by FOD  | The camera system has range of 300m and can display the details on a 2.5cm x 2.5cm target with zero ambient light.   |
| 13 | Capability to capture, archive, store, and retrieve FOD Image(s)  | Yes  |
| 14 | Confirm detected items have been retrieved  | Yes  |
| 15 | System should use State-of-the-Art Technology for automatic detection and location of debris with visual confirmation and identification                              | Trex FOD Finder™ XF System uses a Millimeter-Wave Radar sensor for detection and a camera imager for confirmation  |
| 16 | Detect and report single and multiple FOD items in the area under surveillance  | Yes  |
| 17 | Operate in conjunction with and without interference with airport and aircraft communication, navigation & surveillance systems and normal airport operations         | Trex FOD Finder™ XF System was verified by FAA and approved by FCC for operations in and around airports   |
| 18 | Minimize false alarms due to moving objects such as wildlife and small items that can blow away   | Trex FOD Finder™ XF System software architecture has specific algorithms to mitigate moving objects and transient FOD  |
| 19 | Remote Monitoring of the system to provide fault finding and maintenance  | Trex FOD Finder™ XF System has built in system diagnosis that can be automatically monitoring a wide number of systems. The automated system is configured to generate alerts to qualified personnel to evaluate the system in question at the first sign of performance that isn't meeting specification in the tender. |



## **High Quality and Reliability**

Trex FOD Finder™ products are constructed using the highest quality parts in the industry and the most stringent manufacturing processes. Our selection of the components allows the system to have high reliability, close to military grade requirements, resulting in minimal maintenance and life cycle costs.

In addition to the FOD Finder XF (Fixed) runway system, Trex Aviation has a FOD Finder™ XM (Mobile) system. This mobile unit can serve as a redundant system to replace any fixed sensor that fails inadvertently to pick up the FOD from the runways, and to locate and retrieve FOD on taxiways and aprons as well. Thus we are providing a *Total FOD Detection and Retrieval Solution* for your runways, taxiways and aprons.