	Cincinnati Fire Department Fire Training Supplement DRILL BOOK	SECTION #1 General Fire Fighting
Date: April 2018	**TOPIC TITLE:** MSA 6000 Thermal Imaging Camera	Total # of Pages: 15
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TOPIC #7 MSA Evolution 6000 Thermal Imaging Camera

This section is designed to give the fire fighter the basic information for the operation and normal maintenance of the MSA Evolution 6000 Thermal Imaging Camera.

The Evolution 6000 Thermal Imaging Camera (TIC) can be used to aid fire fighting in scenarios such as:

1. Initial Size-Up / Scene Assessment
2. Locating the source or seat of the fire
3. Determining the extent of the fire
4. Determining entry and ventilation points
5. Detection or identification of potential flashover conditions
6. Search and rescue operations
7. Hazmat Incidents
8. Overhaul
9. Supporting Police work
10. Vehicle navigation (darkness / smoke)

Restrictions:

1. TIC is not waterproof and is unable to take underwater images. They do not see under or through water by any means whatsoever.
2. Does not see through glass, water or shiny surfaces such as mirrors.
3. Does not improve a user's sight.
4. Do not see through walls
5. Do not see through smoke – it sees "convection"
6. Do not detect ambient temperature
7. Cannot operate in extreme uninhabitable heat conditions
8. These devices are tools, they can fail – ensure you utilize standard search patterns to maintain orientation.

USE & OPERATION OF THE MSA 6000 TIC

3.1 Safety Instructions

Check the batteries before and during use

Check whether the batteries are fully charged before using. If not fully charged, the nominal operating time cannot be achieved. Also check the battery level during use.

OFF
ing → chapter 3.11.

Switching ON in normal mode, function test

Fig. 2 ON/OFF button

(1) Press green ON/OFF button for approx. 1 second.

- Within 5 seconds, the TIC carries out a self-test of the sensor electronics.
  - ▷ Status LEDs under display illuminate according to battery status
  - ▷ The current software version briefly displays.
  - ▷ An image appears after a few seconds on the display.

(2) Check camera function:

- Direct the camera toward an object or person until the thermal image shows on the display.
  - ▷ The camera is now ready for use.

Switching OFF

(1) Keep ON/OFF button pressed for approx. 3 seconds until all LED indicators switch off.

(2) Release the ON/OFF button as soon as all LED indicators switch off.

- ▷ The camera is switched OFF.

3.3 Securing the Camera during use

The camera may be secured to the user in different ways using one of the self-retracting attachment cables.

Fig. 3 Attachment cable locations

To use the attachment cables:

(1) Pull the spring loaded cable out and away from the camera body.

(2) Slip a carabineer or similar securing device through the cable loop.

(3) Release the cable.

- ▷ Internal springs automatically pull the attachment cables in tight to the camera housing to minimize any snag hazards.

NFPA 1801 Basic and Plus Mode Operation

Certain Evolution 6000 camera models are compliant with
NFPA 1801 Standard on Thermal Imagers for the Fire Service; 2013 Edition.

See approval information on the label located on the underside of the camera housing.
NFPA 1801 describes a required "Basic Mode" of operation common among all compliant thermal imaging cameras. It also allows for a "Plus Mode" operation which, once accessed, provides a number of useful features and options for the firefighter trained in their use.
The EVOLUTION 6000 camera always operates in the NFPA 1801 defined "Basic Mode".

3.4 User Interface and Operation (All Models)

On-Screen Indicators (All Models)

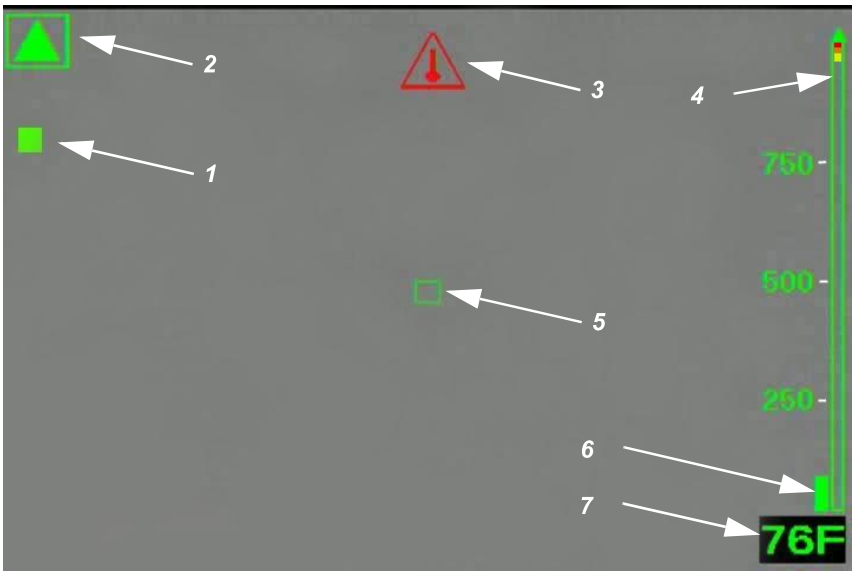


Fig. 4 On-Screen indicators

1	*Shutter indicator*	*5*	*Digital temperature target*
2	*Low sensitivity mode indicator*	*6*	*Temperature indicator bar*
3	*Internal over temperature indicator*	*7*	*Digital temperature indicator*
4	*Color reference bar*		

High and Low Sensitivity Mode

The camera has a high and a low sensitivity mode for showing images in different temperature ranges.

- After turning the camera ON it will be in the high sensitivity mode.
- The camera automatically switches from high sensitivity mode to low sensitivity mode in case of extreme heat (a significant portion, 32% of pixels) of the image exceeding 140 °C.

  In this case, the display shows a small green triangle above the color reference bar to indicate that the scale changed from the high sensitivity mode scale. A larger green triangle appears in the upper left-hand corner of the display.
- The camera switches from low sensitivity mode to high sensitivity mode when 89% of pixels show less than 120 °C.

In the low sensitivity mode, the camera's dynamic range expands to enable the user to distinguish objects and people more easily in environments with large temperature ranges. This mode also prevents white-out. (White-out or oversaturation occurs when a thermal imaging detector is subjected to too much thermal energy, and the image, which appears as a white cloud, no longer identifies fine details in the scene.)

Shutter Indicator

When the camera is in operation, it is periodically necessary to refresh the focal plane array in order to operate properly. This occurs via an internal shutter mechanism. When the camera shutters, the camera image freezes for approximately one second.

The shutter indicator is a green [illegible] t of the display for approx. 3 sec before and during the shuttering cycle (Pos. 1, Fig. 4, page 15).

Shuttering may occur more frequently with greater heat load.

Digital Temperature Target/Digital Temperature Indicator

The Digital Temperature Indicator provides an approximate numeric temperature of an object in Fahrenheit or Celsius, depending on the camera setti [illegible] nperature of an object, aim the camera so the digital temperature target [illegible] in the center of the display is on the object to be measured.

NOTE: Displayed temperature is an average of pixels within the green box. An incorrect temperature could display if all pixels are not on the object to be measured.

Temperature range is:

- -40°F (-40°C) to 1022°F (550°C) in Low Sensitivity mode and
- -40°F (-40°C) to 320°F (160°C) in High Sensitivity mode.

Displayed temperature is intended to provide the user with an approximate temperature reading. See chapter 4 for the Digital Temperature Indicator accuracy.

Temperature Indicator Bar

The Temperature Indicator Bar works with the Digital Temperature Indicator to graphically represent the approximate temperature of an object in the green box in the center of the display.

Color Reference Bar

The Color Reference Bar spans temperatures from 0°F (0°C) to 300°F (160°C) in High Sensitivity mode and 0°F (0°C) to 1000°F (600°C) in Low Sensitivity mode and provides a temperature reference for the Temperature Indicator Bar. The scale dynamically changes with a change in sensitivity mode. A green triangle appears over the scale to indicate a sensitivity mode other than high-sensitivity mode.

- The scale is also used as a reference for image colorization. The yellow, orange and red segments of the bar correspond to the temperatures at which colorization is introduced on the camera.

NOTE: Colorization is introduced at different temperatures depending on whether the camera is in High or Low Sensitivity mode.

The Color Reference Bar is only visible for "White Hot" imagery.

In High Sensitivity Mode

When Temperatures are	Objects:
below 291 °F (144 °C)	Are shown as standard gray scale images
between 291 °F (144 °C) and 302 °F (150 °C)	Turn **yellow**, starting with light shades changing to darker shades
between 302 °F (150 °C) and 311 °F (155 °C)	Turn **orange**, starting with light shades changing to darker shades
over 311°F (155 °C)	Turn **red**, starting with light shades changing to darker shades

In Low Sensitivity Mode

When Temperatures are:	Objects:
between 1000 °F (540 °C) and 1047 °F (564 °C)	Turn **yellow**, starting with light shades changing to darker shades
between 1047 °F (564 °C) and 1090 °F (588 °C)	Turn **orange**, starting with light shades changing to darker shades
over 1090 °F (588 °C)	Turn **red**, starting with light shades changing to darker shades

Over Temperature Warning

An Over Temperature Warning activates when the internal system electronics approach maximum recommended operating temperature limits.

- A red indicator flashes on the center top section of the display area when the camera exceeds recommended operational thermal limits.

⚠ WARNING
Most electronic devices cease to operate at certain high temperature extremes. Tests on the EVOLUTION 6000 series of TICs indicate that they provide an acceptable image when subjected to an ambient temperature of approximately 120°C (248°F) for about twenty minutes. Exposure to conditions exceeding these may result in deterioration and loss of image.

Battery Status Indicator

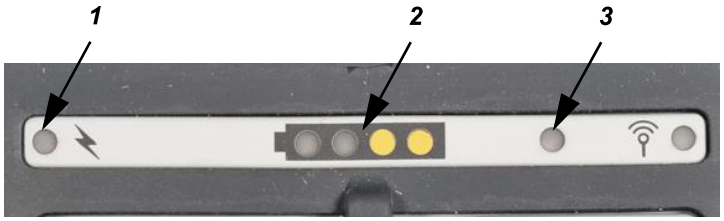


Fig. 5 On-Screen indicators

1 Battery charging indicator
2 Battery status indicator
3 Display brightness sensor

Remaining battery capacity is shown by 4 equal battery segments:

Indication	Remaining Battery Capacity
4 green segments	Nominal 75 to 100%
3 green segments	Nominal 50 to 75%
2 yellow segments	Nominal 25 to 50%
1 red segment	Nominal 0 to 25%
1 red segment flashing	Critically low battery (5 minutes or less remaining)

NOTE: If the red segment flashes three times at turn-ON, the battery is too low to operate the camera and the camera will switch OFF.

Trigger Button

Fig. 6 Trigger button

Flashlight and Laser Pointer

⚠ WARNING

Safety measures which must be observed:

Observe the appropriate country-specific safety measures for users of laser class 3R equipment.

Laser class 3R laser equipment is potentially hazardous to eyes. Use of operating and adjustment equipment and procedures other than those indicated here can lead to dangerous exposure to radiation. Modification of the laser equipment is not permitted. This Operating Manual must be retained and passed to the next owner of the laser equipment.

Personal safety precautions:

This laser equipment may only be used by properly trained persons. Do not aim the laser beam at people. If the laser beam falls directly on your eye, consciously close your eyes and move your head out of the beam immediately. Do not look into the direct or reflected beam. Do not aim the laser beam at people. Persons under 18 years of age must not use this equipment.

Safety measures to be applied in areas where the equipment is used:

Ensure that no-one can look directly into the laser beam:

- Avoid accidental reflections, for example by covering or removing reflective surfaces in the vicinity of the laser equipment
- Position / align the laser beam well away from eye height
- Restrict the laser beam to the area where it is to be used, for example by screening with non-reflective surfaces
- When not in use, store the laser equipment so that it cannot be accessed by unauthorised persons

The built-in flashlight and laser pointer is standard equipment in the camera.

The flashlight is an LED-based light that can be used to aid navigation in darkness and light smoke.

The laser pointer tool allows the camera operator to highlight an object or area requiring attention.

NOTE: The laser pointer and flashlight will not function at the same time.

NOTE: Should the laser beam appear to be weak or distorted, ensure that the laser pointer window on the front of the camera is free of dirt and water.

Trigger Button Operation	Result
First short press	Turns ON the flashlight
Second short press	Turns OFF the flashlight and turns ON the laser pointer
Third short press	Turns OFF the laser pointer

3.10 Battery Installation

WARNING

Risk of injury!

Never replace the batteries in a hazardous location or an explosive atmosphere. There is a risk of explosion since the batteries can spark when being changed!

The EVOLUTION 6000 series cameras run on a single lithium Ion battery pack.

Replacement batteries must have the same power and layout as those delivered by MSA with the camera. Unsuitable batteries can lead to a system failure.

(1) Place the camera on a clean, non-abrasive surface.

(2) Open the battery compartment by pulling down on the battery latch and swinging the battery compartment door forward.

(3) Place the battery inside the battery compartment with the battery logo and arrow pointing toward the top of the camera. The battery compartment is designed to prevent incorrect battery insertion.

(4) Gently push the battery into place.

(5) Close and latch the battery compartment.

NOTE: To remove battery, reverse the above Battery Installation procedure.

Multi-Use Charger

The MSA Multi-Use Charger may be used to simultaneously charge up to two spare Evolution 6000 TIC batteries. This charger is supplied with a 120/240 VAC universal power adapter and a 12 V automotive lighter/power outlet cable for mobile use. See Multi-Use Charger instructions for complete details.

To charge a spare battery:

(1) Ensure that camera battery adaptor insert (supplied with Multi-Use charger) is properly inserted in the Multi-Use Charger nest (Fig. 12).

NOTICE
Failure to insert the camera battery adaptor may lead to misalignment and damage to the charging connector on the pack and on the charger.

(2) Ensure that charge indicator light (associated with the charging nest being used) lights when the battery is inserted.

Indication	Status
Red light	Battery is charging
Green light	Charging is complete
Flashing red light	Error has occurred

Fig. 12 Battery insert placement in the Charger nest

A fully depleted battery recharges in the Multi-Use Charger in approximately 4 hours.

Cleaning:

After each use, clean all external surfaces by wiping with a solution of mild detergent and warm water. Dry with a soft, lint free cloth to avoid scratching the optical surfaces.
Never use solvents or thinners to clean the camera.

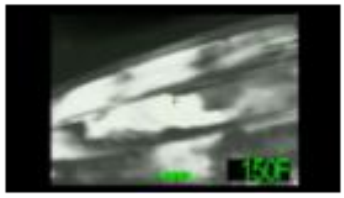
WARNINGS!!

1. Thermal imaging cameras must be used with standard search patterns and techniques. Do not rely on the thermal imager for orientation within a structure.
2. Do not remove the thermal imaging camera cover or casing as the system operates on high voltage.
3. The thermal imaging system is not rated as "intrinsically safe". Do not use the system in environments or atmospheres where static or sparks may cause explosion.
4. Do not point the thermal imaging camera directly at the sun as serious damage to the detector will result.

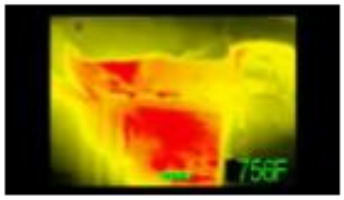
Thermal Imaging – General Principles

Thermal Imagers / Infra-Red Cameras detect minute differences in the temperature of a given surface as displayed on the screen of the camera.

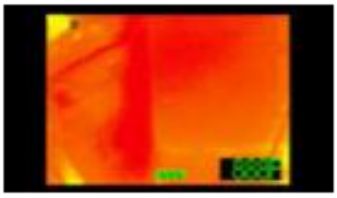
The 3 Principles of Infra-Red

1. 

Conduction: The transfer of heat through a solid object

2. 

Convection: The movement of hot air currents

3. 
Radiation: Direct sensor of temperature in highest heat detection

Conduction – This is a thermal imaging view of a roof and soffit facia detail during live fire it shows framing and obvious hot and cold spots utilizing the principle of conduction

Convection – The outside portions of light hazy yellow are also typical in thermal imagers that do not have colorization to show the hazy areas of difference in temperature that are moving, which are heated air currents going in the direction of ventilation

Radiation – This depicts the hottest area in the focal plane offering evidence of the seat of the fire or areas of extension from the seat of the fire.

Image Interpretation
The thermal imager simply sees differences in temperatures and displays them in a grayscale format. White is hot, black is cold and the temperatures in between are shades of gray. Ambient conditions play a role in various imaging situations.

Thermal Imager is not a Video Camera. Don't quickly move the imager across the room. Move slow and interpret the scene. There are slight color differences when everything in the room is the same temperature. It takes a moment to see the movement of HEAT or convection in a scene. Your ability to interpret the differences will make you better at fire travel detection.

Temperature displays are relative to the scene. What is "hot" in one scene may appear "cool" in another, even though its actual temperature has not changed.
What are the dangers to be considered while using Thermal Imagers?

A firefighter, before the fire, will generally appear as white in color because the firefighter is warmer than the background

The same firefighter during the fire may appear black in color as the firefighter is now cooler than the background

There is a great danger in firefighters utilizing thermal imaging to navigate full time during operation with a thermal imager.

These are electronic pieces of equipment that are intended for scanning purposes and navigational purposes only. A Firefighter using a thermal imager for anything other than what is recommended faces potentially being lost in the building by not utilizing his points of reference by left and right hand search techniques.

What do thermal imagers NOT do?

- Thermal Imagers DO NOT see through walls or glass, or water.
- Thermal Imagers DO NOT see smoke. They see convection.
- Thermal Imagers DO NOT detect ambient temperature.

What are the limitations of Thermal Imagers?

- Thermal imagers do not see into, through or under water by any means whatsoever.
- Thermal imagers can NOT operate in extreme uninhabitable heat conditions.
- They do not posses super human powers and are not intended to conduct anything other than what the firefighter is capable of doing based on his training.

Proper Safe use of Thermal Imagers

Never use a thermal imager exclusively to navigate throughout a building.
Thermal Imagers are an electronic piece of equipment dependent on battery power hence to be respected as such.