



Handheld Infrared Viewers for Wildland Fire Applications

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This report describes commercially available handheld infrared (IR) viewers (Figure 1) and presents information to help Forest Service employees make purchasing decisions. A low-cost infrared temperature scanner and thermometer were evaluated and found unsatisfactory for wildland fire applications.

The two largest manufacturers of IR viewers are FLIR Systems and Raytheon Systems. Several smaller companies offer suitable viewers. New, less expensive equipment is likely to be introduced in the coming year.

Table 1 lists IR viewers that are suitable for aerial and ground wildland fire applications.



Figure 1—The Palm handheld infrared viewer.



Table 1—Handheld infrared viewers suitable for wildland fire applications.

Company	Model	Spectrum microns	Detector type	Array size or resolution (pixels)	Weight with battery lb (kg)	Size inches (mm)	Battery run time (hours)	Power consumption (watts)	Price (dollars)	Comments
Raytheon	Palm IR 250	7 to 14	Uncooled ferroelectric BST	320x240	3 (1.4)	9.5x4x4 (241x102x102)	4	3.5	11,995	Black-and-white viewfinder. Video output. Motorized focus on standard 75-mm lens.
Raytheon	Palm IR Pro	7 to 14	Uncooled ferroelectric BST	320x240	4 (1.8)	10x5.5x4 (254x127x102)	2	7	17,995	2.5-inch color LCD display. Video output. 60-image digital storage.
FLIR Systems	AGEMA 510	3 to 5	Linear array thermoelectric-cooled PbSe	320x160	4.4 (2)	3.6x5.8x6.7 (92x148x171)	1.5	Unspecified	13,175 GSA	Black-and-white viewfinder. 2X and 4X electronic zoom. Video output.
FLIR Systems	Thermacam 545	7.5 to 13	Uncooled microbolometer FPA	320x240	5.1(2.3)	8.7x5.2x5.5 (220x133x140)	2	Unspecified	23,750 GSA	Color viewfinder or optional LCD. Digital image storage on PCMCIA cards. Video output.
FLIR Systems	Thermacam PM 575	7.5 to 13	Uncooled microbolometer FPA	320x240	5.1(2.3)	8.7x5.2x5.5 (220x133x140)	2	Unspecified	35,507 GSA	Color viewfinder or optional LCD. Digital image storage on PCMCIA cards. Video output. 4X continuous electronic zoom.
FLIR Systems	Thermacam PM 595	7.5 to 13	Uncooled microbolometer FPA	320x240	5.1(2.3)	8.7x5.2x5.5 (220x133x140)	2	Unspecified	42,450 GSA	Color viewfinder or optional LCD. Digital image storage on PCMCIA cards. Video output. 4X continuous electronic zoom.
FLIR Systems	Inframetrics Thermacam PM190	3.4 to 5	Sterling-cooled PtSi/CMOS FPA	256x256	3.7 (1.7)	8.3x4.5x3.5 (210x114x89)	2	1.1	37,500 GSA	High degree of sensitivity and accuracy where temperature variations are small or high precision is desired. Color viewfinder. Video output. PC digital storage card.
FLIR Systems	SeekIR	8 to 14	Uncooled PbZr	200x200	4.1 (1.9)	7.2x3.6x5.5 (183x91x140)	1.5	Unspecified	13,175 GSA	Monochrome viewfinder. 50-mm lens. Video output.
Monroe Infrared Technology, Inc.	Heat Find-IR 1350	7.5 to 13.5	Uncooled FPA BST	320x240	4.3 (1.9)	5.1x4.4x3.5 (130x112x89)	3	8.4 to 13.2	14,495	Viewfinder is 3-inch color LCD on top of camera. Looks more fragile than most equipment. Same detector array as Raytheon Palm IR. Built-in visual camera. Video output.
Infrared Components Corp.	FireOptIC	7 to 14	Uncooled microbolometer	320x240	6.4 (2.9)	4.9x7.9x7.9 (124x201x201)	1 hr 1 bat. 3 hrs 2 bat.	Unspecified	14,900 (special)	Designed for fire/rescue service. Rugged all-metal waterproof chassis. 4-inch LCD viewing screen.
Infrared Solutions, Inc.	IR SnapShot	8 to 12	Uncooled thermoelectric	120x120	4.4 (2)	9.4x3.9x5.1 (240x100x130)	1	Unspecified	13,500	Camera stores images digitally on PCMCIA card. Slow 1.5-second capture time limits applications.
Cincinnati Electronics, Corp.	NightMaster	3 to 5	Sterling-cooled InSb	256x256	6.2 (2.8)	13.8x5x3.6 (351x127x91)	2	10	65,000	Older detector technology provides discrimination of small temperature differences for surveillance applications. Features 50/250-mm selectable lens focal length.
Cincinnati Electronics, Corp.	IRRIS-256ST	3 to 5	Sterling-cooled InSb	256x256	7 (3.2)	11x4.5x5.5 (279x114x140)	1	30	60,000	—
Infrared Solutions, Inc.	IR-320	8 to 14	Uncooled microbolometer FPA	160x120	0.5 (0.23) without lens	4.3x3.9x4.2 (109x99x107)	NA.	3	12,500	Camera and lens only. Designed for fixed installation. Requires 9 to 12 VDC. Video output. Handheld unit based on this model will be available.

Infrared Viewers

The spectrum column of Table 1 shows the wavelength of infrared energy that the detector is sensitive to. Current viewers operate in the 3- to 5-micron portion of the middle infrared or the 7- to 14-micron portion of the far infrared spectrum. In theory, viewers operating in the far infrared are less likely to see hot gases and solar reflections. Also, they can see through smoke better. However, for fire applications the differences in demonstrated performance between equipment operating in the middle and far infrared ranges of the spectrum are not significant.

Several detector technologies are currently being used. The technologies can be divided into two major classes, cooled and uncooled. Uncooled detectors allow for the lightest-weight, most-compact, lowest-power-consumption, and least-expensive equipment. Thermoelectric cooling is a reliable means of cooling detectors that must be operated at low temperatures. It is also used to stabilize the temperature of some uncooled detectors. Sterling coolers have been developed that are compact and can operate reliably for 5,000 hours.

The array size, or resolution, determines how small an object can be resolved and how clearly larger objects can be defined. Large arrays are desirable.

Lightweight, compact units reduce operator fatigue.

Battery life, power consumption, size, and weight are closely related. A low-power design requires less battery power for a given period and reduces overall weight and size.

The price column gives the list prices and discounted prices, where applicable. The Government Services Administration price is given for items covered by the schedule. Raytheon sells through distributors who sometimes offer special prices lower than the list price. Considerable savings can be obtained by getting competitive price quotes. Demonstrator units are usually substantially discounted. This report includes a list of Raytheon dealers. Contact information is provided for other manufacturers. Sierra Pacific Innovations sells thermal viewers from several manufacturers and offers demo prices.

Any of the listed thermal viewers are likely to provide satisfactory results. However, ergonomics is an important consideration. Equipment should be evaluated under field conditions before it is purchased.

Black-and-white viewfinders are good for handheld ground applications. A remote display is advisable when IR viewers are in aircraft. Remote displays reduce fatigue and motion sickness. Many IR viewers that have eyepiece viewfinders also have a standard video output that can be connected to one or more battery-powered color LCD monitors. High-contrast monitors that can be viewed in bright light are available from sources such as Marshall Electronics, Inc., for \$225 or more, depending on size and features.

Lens length determines the field of view and the apparent size of a viewed object. The lens specifications for infrared viewers are similar to those used in standard cameras. The viewers' standard lens length of 50 mm to 75 mm is suitable for the majority of applications. Longer lenses provide increased magnification, but decrease the field of view. Image blur increases with longer lenses because users cannot hold the viewer steady. Long lenses are more expensive and heavier than standard lenses. Lenses that are shorter than the standard lenses increase the field of view but decrease the apparent size of objects. Some small objects may not be visible at all.

The standard lens provides a reasonable tradeoff, allowing a fairly large area to be seen with a reasonable amount of detail. Standard lens lengths have proven to be suitable for aerial observations at altitudes of 500 to 2,000 feet above ground. The expensive NightMaster from Cincinnati Electronics Corp. allows the user to select a 50- or 250-mm lens by twisting a ring. Electronic zoom lenses increase the size of the viewed object, but do so at the expense of resolution. They basically just reduce the number of pixels displayed while increasing the size of each pixel.

Infrared viewers should have manual adjustments for gain and contrast. These adjustments will allow an experienced operator to adjust the display so that hot targets stand out from the background with a minimal loss of detail.

Infrared Temperature Scanner and Thermometer

Infrared temperature scanners and thermometers are used to measure temperature when conventional sensors cannot be used. These applications include measuring the temperature of moving or hazardous objects (for instance, when high voltage is present), or to protect the objects being measured from contamination. The scanner and thermometer operate on principles similar to those used in the infrared viewers. They might be thought of as single-pixel viewers with a temperature display. The field of view is an important consideration.

The optics of the unit determines the field of view, which increases as the distance to the observed object increases. The pyrometer determines the average temperature of all surfaces within the field of view. For an accurate temperature measurement, the object must fill the entire field of view.

The two instruments evaluated had different fields of view. The Omega OS93 infrared scanner has a narrow field of view where the spot diameter is: $0.625 + (\text{distance to object}/87)$ inches. The Omega OS520 has a medium field of view where the spot diameter is: $\text{distance to the object}/10$.

Fire hotspots would not need to fill the entire field of view, but the hotspot would need to have a temperature noticeably higher than the background for it to be detected. Table 2 shows the theoretical temperature reading produced by hot objects that do not fill the entire field of view. The hotspot's temperature was assumed to be 932 °F (500 °C) and the background temperature was assumed to be 77 °F (25 °C).

The OS93, with its narrow field of view, can detect a 1-inch (2.5-cm)-diameter hotspot over 10 feet (3 meters) away. It can detect a 6-inch (15-cm)-diameter hotspot over 100 feet (30 meters) away. The small field of view, 2 inches at 10 feet (3 meters) or 14 inches (36 cm) at 100 feet (30 meters), requires that the instrument be carefully aimed and moved to completely cover an area. It would not be practical to survey a large area with the OS93 because it would take too long and the operator would become fatigued.

The OS520 has a larger spot size that makes it easier to scan an area. The spot size is 6 inches (15 cm) at 5 feet (1.5 meters) or 12 inches (30 cm) at 10 feet (3 meters). However, the OS520's ability to detect a hotspot is considerably reduced. The maximum range to detect an 1-inch (2.5-cm) spot is 5 feet (1.5 meters). The maximum range to detect a 6-inch (15-cm) object is 10 feet (3 meters).

Table 2—The theoretical difference from the background temperature when a hotspot does not fill the field of view for an infrared scanner or thermometer.

Distance to hotspot feet (meters)	Field of view inches (centimeters)	Hotspot diameter inches (centimeters)	Average temperature above background °F (°C)
OMEGA OS93			
5 (1.5)	1.3 (3.3)	1 (2.5)	495 (275)
10 (3)	2.0 (5.1)	1 (2.5)	213 (118)
100 (30)	14.4 (36.6)	1 (2.5)	4.1 (2.3)
100 (30)	14.4 (36.6)	6 (15)	148 (82)
OMEGA OS520			
5 (1.5)	6.0 (15.2)	1 (2.5)	23.8 (13.2)
10 (3)	12 (30.5)	1 (2.5)	5.9 (3.3)
100 (30)	120 (305)	1 (2.5)	0.0 (0.0)
10 (3)	12 (30.5)	6 (15)	214 (119)
100 (30)	120 (305)	6 (15)	2.1 (1.2)

The OS520 thermometer has an audible and visible alarm that can be set to go off when the temperature is higher than an alarm point. When the alarm is set a few degrees above the warmest background temperature, the alarm will go off when the unit scans a hotspot. The operator does not have to concentrate on the displayed temperature reading. Table 3 shows specifications of the OS93 and OS520 thermometers.

because the unit must be pointed directly at a hotspot. It is difficult to completely scan a large area without having gaps in the coverage. The unit could be used to supplement conventional cold-trailing techniques by using it to look at hard-to-reach areas. Conventional techniques are more reliable and cost effective. These infrared units cannot reliably be used to detect hotspots.

Field Evaluation

The infrared scanner and thermometer were given to two interagency hotshot crew members for evaluation in hotspot mopup operations. The crew members liked the concept of using relatively inexpensive instruments to detect hotspots that might otherwise be overlooked. However, the infrared pyrometer performance was inconsistent. Its maximum usable range was about 5 feet (1.5 meters).

The units would respond when aimed at known hotspots, but they missed many hotspots when they were used to scan an area. This probably occurred

Conclusions

Handheld infrared viewers are useful tools for locating hotspots during mopup and can see through smoke to help locate the borders of a fire. They can be used in aerial and ground operations.

Improvements in recent years have made the units smaller, lighter, more reliable, and easier to use. Prices have fallen substantially and are likely to fall farther in the next few years.

The handheld infrared thermometer and scanner devices commonly used in industry do not have any suitable applications for wildland fire activities because their detection range is short and their field of view is narrow.

Table 3—Specifications for the OS93 infrared scanner and OS520 thermometer.

Specifications	OS93 Infrared Scanner	OS520 Thermometer
Autozero ambient reference range	32 to 122 °F(0 to 50 °C)	NA.
Temperature range	0 to greater than 100° above reference	0 to 750 °F (-18 to 400 °C)
Accuracy	+/- 1 segment on each range	+/- 2% reading or 3 °F (1.7 °C)
Resolution	1 °C	1 °F or 1 °C
Spectral response	2 to 20 microns	8 to 14 microns
Spot size	0.625 + distance to object/87 inches	distance/10
Time constant	0.05 sec	0.5 sec
Emissivity	0.9 fixed	adjustable 0.10 to 1.00
Power	9-volt battery	4 AA alkaline
Battery life	200-hr minimum continuous	60 hr
Dimensions	3.5 (H) x 5 (W) x 7.5 (D) in (89 x 127 x 190 mm)	8.6 x 6.6 x 2 in (218 x 168 x 50 mm)
Weight	7 oz (198 g) with battery	6.5 oz (184 g)
Price	\$599	\$345

Raytheon List

Accurate Locators

521 S. Central Avenue
Medford, OR 9750
Phone: 541-855-1590
Fax: 541-855-1023
Wayne Good

Bcon, Inc.

8333 Seaview Street
Anchorage, AK 99502
Phone: 907-243-2634
Fax: 907-243-7220
Bryan Bazemore

Canyon State Emergency Products

8557 N. 78th Avenue
Peoria, AZ 85345
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Tom Webber

Cincinnati Electronics Corp.

7500 Innovation Way
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Phone: 513-573-6744
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Web site: <http://www.cinele.com/products/infrared/ir/imagers/index.html>

Compix

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Tualatin, OR 97062-0885
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Marshall Electronics, Inc.

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Web site: <http://www.x20.org/thermal/index.htm>

Skaggs Telecommunications Service

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