forest management note

Note No. 8 Northern Forest Research Centre Edmonton, Alberta

GUIDELINES FOR USE OF THE AGA THERMOVISION IN FOREST FIRE MOP-UP OPERATIONS

During forest fire mop-up operations nonsmoking hot spots are easily pinpointed from a helicopter using the AGA Thermovision[1] (Niederleitner 1976a, b). The Thermovision is a forward-looking infrared (FLIR) scanner that is capable of detecting temperature differences as small as 0.2°C. It produces real-time, two-dimensional, gray-tone, thermal imagery that resembles a black-and-white television picture, with the dark areas indicating the lowest temperatures and the light areas the highest temperatures. In operation since 1976, this scanner has proven to be an efficient, cost-effective fire control tool.

The following guidelines provide a standard reference for the use of the Thermovision in mop-up operations. The guidelines purposely do not include instructions on the mechanics of operating the equipment, because an excellent operator's manual is included with each machine. The information is presented in a sequence that would normally be considered by an agency following acquisition of a scanner. Under **Auxiliary equipment** the initial preparation of the system is outlined. The section on **Scanner crew** deals with each crew member's responsibility, and that on **Operating techniques** provides the information needed to conduct an efficient search.

Auxiliary equipment

Several items not supplied with the basic Thermovision are required before an effective and efficient search for hot spots can be conducted.

1. A sighting system is required on the camera that will enable the operator to aim at the center of the area from which the camera is receiving imagery. The sight is used by the camera operator to accurately locate on the ground a target that is visible on the monitor. Such a sight can be very simply made of aluminum to resemble a rifle sight and can be hose-clamped to the camera.

2. The standard AGA battery operates the scanner for approximately 1 hour. For longer periods of use, up to 8 hours, an alternative battery and charger system has been developed by the Canadian Forestry Service (Niederleitner and Bihuniak 1976). This system consists of a 20 ampere-hour, 12-volt gel/cell® battery and charging facilities, both enclosed in a stainless steel box. The Thermovision can also be operated using the 28-volt aircraft system as a power source by using a converter to supply 12 volts to the Thermovision.

3. A magnifying hood is a necessary accessory that can be purchased from the AGA supplier. The hood is designed to slip over the screen and fit comfortably over the monitor operator's eyes. It magnifies the viewing screen and prevents sunlight from interfering with the thermal picture.

4. The liquid nitrogen (LN_2) needed to cool the scanner is available from various sources such as Canadian Liquid Air Limited and Union Carbide Canada Limited, but stock breeders, who use nitrogen in artificial insemination, have proven to be the most convenient source of supply of both LN_2 and the large 20-L Dewar flasks that are needed for long-term (1 month) storage. An ordinary vacuum bottle with holes drilled in the cap for ventilation is used to carry LN_2 in the aircraft. A

[1] The exclusion of certain manufactured products does not imply rejection nor does the mention of other products imply endorsement by the Canadian Forestry Service.

1-L vacuum bottle will hold enough LN_2 for at least a 4-hour scanning mission.

5. When a hot spot is located it is marked for follow-up action by ground crews. Hot-spot marking is accomplished by dropping a partially unraveled roll of paper from the helicopter. The marking paper used is usually bathroom tissue, but adding-machine paper rolls have been used successfully.

6. One aircraft commonly used during scanning missions is the Bell 206B helicopter. These machines are used extensively for forest fire suppression work and are therefore usually available on site. The 206B has enough seating and load capacity to accommodate the scanning operation, and the windows on most machines will open to provide a camera port. Regardless of the helicopter selected, it is essential that the members of the scanning team be linked by a two-way intercom to provide continuous and close communication.

Scanner crew

The scanner crew consists of four people whose duties are outlined as follows:

Camera operator

The camera operator hand-holds the camera and sits in the aircraft in such a way that the pilot can see where the camera is pointing. For example, in a Bell 206B the camera operator would sit beside the pilot or directly behind him. When a hot spot is pinpointed, the pilot notes the attitude (angle) of the camera and from this is able to position the aircraft over the hot spot to facilitate marking.

The camera operator advises the pilot as to the desired speed and direction of flight, which varies according to the nature of the fire line being scanned. For example, the speed can be greater when the fire line is straight or has little available fuel nearby; however, when the line is convoluted or has large piles of partially burned material nearby, a slower scanning speed may be necessary.

When a hot spot is located, the camera operator pinpoints it with the help of the monitor operator. The camera operator then gives directions to the pilot to help position the aircraft directly over the target prior to dropping the marking material as close to it as possible.

Monitor operator

The monitor operator interprets the infrared picture and differentiates between actual hot spots and naturally warm areas. He keeps the thermal picture nearly black, with the background very faint (level control) and the sensitivity high (range setting 2, 5, or 10). This type of picture is easiest to monitor for long periods and will show hot areas clearly against the dark background (Fig. 1).

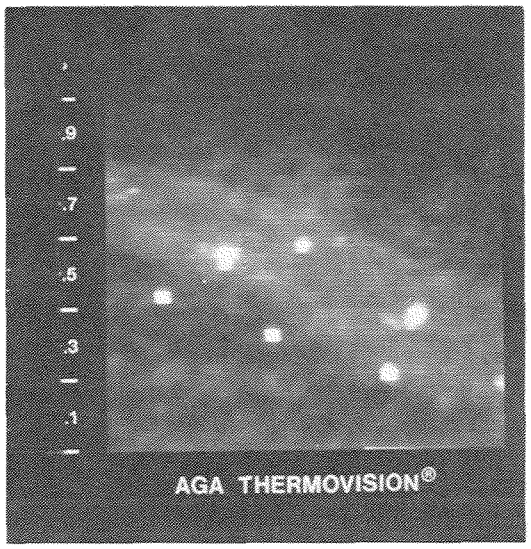

Figure 1. This Thermovision photograph illustrates the optimum contrast between the dark background and the hot spots.

When a hot spot appears on the screen, the monitor operator informs the pilot and the camera operator and assists the camera operator in pinpointing the target by directing him to move the camera left, right, up, or down to bring the target into the center of the screen.

The monitor operator is responsible for terminating the search if solar-heated areas become warm enough to be confused with actual hot spots or if the image deteriorates for reasons such as loss of LN_2, weak battery, or mechanical failure.

Pilot

The pilot must be briefed regarding what is involved and what is required of him and his aircraft, since he is responsible for flight operation safety and efficiency.

Fire or sector boss

The fire or sector boss defines the general area to be searched and locates confirmed targets on a map of the fire. This person usually accompanies the scanning crew; however, if the rest of the crew is familiar with the fire it can operate without him.

Operating techniques

The scanning crew must be familiar with the Thermovision before using it operationally. The operator's manual supplied with the system should be thoroughly reviewed and understood. On-the-ground and airborne training sessions over known targets are mandatory before a scanning team can become proficient with the system.

During the fire season the Thermovision batteries should be maintained fully charged, and a supply of LN_2 should be kept available.

The high costs involved in operating the helicopter and maintaining the scanning crew dictate that the scanning operation should be conducted when all smoking hot spots have been extinguished and the mop-up crews are idle or are spending an unacceptable percentage of their time locating hot spots.

The Thermovision is most effective when solar heating of the search area does not interfere with the interpretation of the thermal image. During sunny weather and on days that have a high overcast but are hot (25°C+), scanning should be done for a few hours at first light and during the twilight hours. During overcast and low temperature (10-25°C) conditions, scanning is effective throughout the day.

Scanning is normally carried out from an altitude of 100 m above ground level, resulting in an areal coverage of the ground of approximately 30 X 50 m (assuming the camera has the 20° lens). At lower flight altitudes increased search time is needed, particularly to cover large areas and because fire-line segments could be missed while scanning an irregular fire's edge. If the scanner is flown at an altitude of at least 100 m, the aircraft need only follow the general course of the fire line, because the camera operator can manipulate the camera to scan each small irregularity.

Where there is a dense forest canopy screening the fire line, it is advisable to fly at altitudes up to 200 m above ground level. The additional altitude increases the area covered by the camera and ensures that the entire fire line is scanned. The extra distance from the target may cause some of the weaker hot spots to fade from the monitor and go undetected, but this is an acceptable risk when compared to missing segments of the fire line.

Flight altitudes of less than 100 m or on-the-ground reconnaissance can be considered when a thorough search of a small area such as a brush pile or a log landing is desirable.

Wind conditions will often dictate how a fire line is searched, since it can be dangerous to operate a helicopter slowly when there is a tail wind. Ideally a fire scan should consist of two passes: one looking at the fire line and the unburned area from the burned area, and one looking at the line and into the burned area from the unburned area. If time does not permit two passes, the search conducted from over the burned area is recommended. This ensures that a good deal of unburned area as well as the fire line will be scanned, thereby increasing the chances of detecting any hot spots that may be outside the line. In addition, flight lines inside the fire line provide a good line of sight through the burned undergrowth.

It is important to remember that the Thermovision must have a direct line of sight to a target. Solid objects will interfere with the infrared signal, and for this reason some hot spots may go undetected.

Finally, it is recommended that at least one member of the scanning crew be a permanent staff member who will develop expertise and take responsibility for the equipment and the efficiency of the operation.

In spite of the high initial cost of the system ($34,000), correct use of the Thermovision will decrease fire suppression costs by helping fire control personnel allocate and utilize mop-up crews more efficiently and by possibly preventing fire escapes.

The preceding guidelines provide enough basic information to start using the scanner for forest fire mop-up work. This basic knowledge when coupled with experience and diligence will result in an effective scanning operation.

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REFERENCES

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