

## Functioning of Thermal Camera In Actions of Polish State Fire Service

Anna Szajewska\*

\*The Main School of Fire Service, Słowacki Str. 54/54, 01-629 Warsaw, Poland, ania.szajewska@gmail.com

### Abstract

The paper presents pictures and thermograms from real actions, where thermal cameras were used by firefighters in Poland. They show how thermal camera helps in the assessment of the fire situation, contributes to the safety of the rescuers, facilitates the work of rescuers, shortens the duration of firefighting operations, contributes to the reduction of the use of extinguishing agents lowering the action costs and losses caused by flooding. A thermal camera helps to save the lives of people surprised by fire, as it provides visibility in smoke-filled areas, where firefighters can quickly find victims and help them.

### 1. Introduction

Polish firefighters have been interested in thermovision since its beginning. The breakthrough occurred in 1997, when the General Headquarters bought 13 thermal cameras and forwarded them to local units. The firefighters quickly realized how useful this new equipment was. Those cameras were big, heavy and not very handy (Fig. 1).



**Fig. 1.** A firefighter with a camera *Talisman* bought in 1997 (a) and with a camera used at present: *Hornet* (b) and *Bullard Commander*

In the following years subsequent purchases were made by local units. These purchases were not managed by the headquarters. Each unit chose the camera type at its discretion. At that time, a rapid technological development of thermal cameras occurred. Cameras produced today are more modern, smaller, lighter, better adapted to firefighter working conditions and cheaper [1,5].

A thermal camera is now a standard equipment of the State Fire Service in Poland. Each Regional and District Headquarters has a portable thermal camera. In the near future it will be in every Rescue and Fire Fighting Unit. Thermal imaging cameras are basic equipment for special groups of exploration, operating in a global rescue system Urban Search and Rescue. They were used in searching the rubble after construction disasters and earthquakes (Nepal, Turkey, Italy, Haiti).

The State Fire Service has been equipped with observational cameras with built-in infrared thermometers that measure the temperature at one point. They have a built-in function of colouring that indicates places with the highest temperature, marking them with bright colour. This particular function proved to be extremely useful when searching rooms in fire. These cameras meet tough robustness requirements on dirt, impacts, moisture and high temperature. They are easy to use. The camera is operated by fingers of the hand it's in. Fig. 2 shows a couple of cameras used at present by the State Fire Service. Specialized units and Schools of Fire Service also have high-end measuring cameras. These cameras are used in fire prevention and researches [2,3,4].

Firefighting and Rescue Units of The State Fire Service are located in big towns and cities. Smaller towns have Volunteer Fire Service Units. They outnumber the units of The State Fire Service, but their equipment isn't as good. Voluntary Fire Brigades support the professional units and play an important role in rural areas, where they usually arrive

first at the scene. Voluntary Fire Brigades don't have thermal cameras which are especially useful in the beginning of a fire action.

In-site Fire Brigades work in large industrial and mining plants: petrochemical, producing mineral fertilizers, arms plants, coal and copper mines and in nuclear centres. These brigades are equipped with thermal cameras according to their needs, including the latest measuring cameras on photon matrices.



**Fig. 2.** Thermal cameras in The State Fire Service in Poland

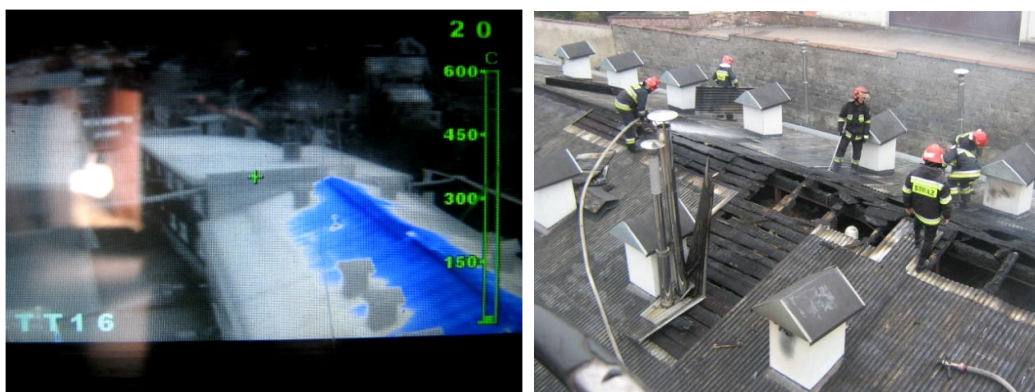
In Poland thermal cameras are used in firefighting actions mainly for:

- evaluation of the fire,
- localizing hidden fire outbreaks,
- controlling the spots being cooled down,
- searching incendies.

The following pictures and thermograms come from real actions, where thermal cameras were used. These examples show how a thermal camera helps in the assessment of the fire situation, contributes to ensuring the safety of rescuers, facilitates the work of rescuers, reduces time of firefighting operations and contributes to decreasing the amount of extinguishing agents that lowers the costs and losses caused by flooding. Thermal camera available to Fire and Rescue Units operate in long-term spectral range 7 - 14  $\mu\text{m}$ . As a result, they can detect people and animals in smoke and darkness. They repeatedly helped to save lives of people surprised by fire. Thanks to them, the firefighters could quickly find victims and provide them with assistance.

## 2. Beginning phase of a fire fighting action

A thermal camera is used in the first phase of fire fighting action mainly for evaluation of the situation and searching for fire victims [4]. Fig. 3. shows a thermogram and a picture of a production hall roof during a fire of a meat processing factory. The blue color on the thermogram indicates the most heated space. The upper corner of the LCD displays the temperature in the place marked with a cross. Inspection of the hall with the camera facilitated the evaluation of the fire situation. Firefighters recognized the source of the fire and began to extinguish the fire. Proper evaluation helped them to direct the extinguishing agent to the right places and demolish only those parts covered by fire. Temperature measurement allowed to isolate places that were certainly not covered by the fire and did not require intervention. The action was carried out quickly and efficiently with less effort.



**Fig. 3.** A thermogram and a picture of a production hall roof during extinguishing fire of a meat processing factory. Photo: Łukasz Łaciok

Thermal cameras proved to be useful in chimney and ventilation system fires (Fig.4). Fire could be located without climbing high and the firefighters didn't have to demolish entire installation. Sometimes they could wait a few

minutes and check if the temperature drops. Eventually check the temperature periodically until complete cooling down. Chimney fires frequently occur during the heating seasons. Heating up and smoldering of wooden pieces is extremely dangerous when they occur close to the chimney. Thermal cameras can help to detect and locate these embers of fire and firefighters them to ease their work. These kind of actions don't usually come with life risk, stress or rush so firefighters have time to run measurements properly.



*Fig. 4. A picture and a thermogram of a chimney. The temperature at the marked place was 171°C. Photo: Adrian Kwinciak*

Firefighters use thermal cameras during fires of electrical systems as well. As in case of chimney and ventilation system fires, thermal cameras are used to control the temperature. Measurements are taken every couple of minutes and used to evaluate the fire fighting action effectiveness. In case no thermal camera available at the scene, the temperature is checked manually. A firefighter takes off his glove and approaches the inner part of his palm to the spot. This way is uncomfortable, not precise and dangerous but it is the only possibility when no cameras are available. There were attempts to equip firefighters with widely available and cheap infrared pyrometers but they were not accepted by firefighters.

Lots of hazardous substances may be located in rooms covered by fire. Such substances are mostly canisters of gasoline, tanks of flammable liquids, combustible gas cylinders and they should be removed. Thermal cameras come with great help here. They enable to measure the temperature of the container from safe distance and sometimes they can approximate level of the liquid as well. All this without risking firefighter's life. Cylinders of acetylene are extremely dangerous. Cooling them down involves time-consuming procedure, which lasts over an hour. The camera makes it easy to carry out this procedure.

### 3. Localizing hidden outbreaks of fire

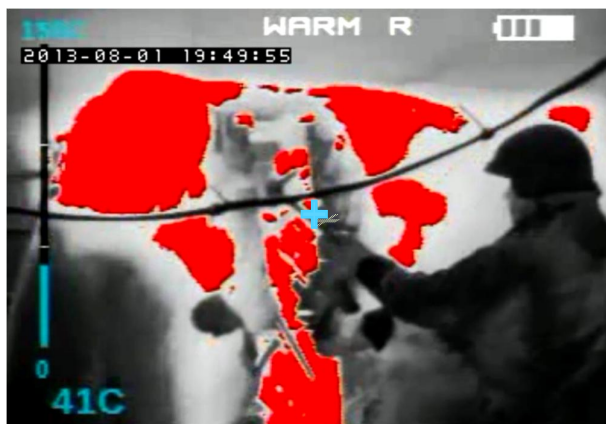
Cameras are indispensable to locate hidden fire outbreaks that occur in homes with a layered construction (Canadian style). Extinguishing fires in such buildings results in total flooding and all the consequences associated with it. Similar situation occurs in old buildings. Such facilities often come with jointed floors with thick joists, filled with sawdust or wood shavings as insulation system. In such cases, firefighting actions include demolition of some floors elements and searching the fire outbreaks. Cameras ensures locating the fire outbreaks precisely and reduce the demolition to absolute minimum. The amount of water used in such action is reduced as well as it can be directed precisely to right spots. As a result the building doesn't have to be flooded and fire losses are minimized. In some cases flooding the building constitutes 70% of overall fire losses. It seems to play particularly significant role in case of historic sites.

Sometimes it is very difficult to put out fire located in inaccessible places. Combustible materials, such as fiberboard, polystyrene or accumulated garbage located between ceilings or walls smoulder slowly because of difficult access of air. In recent years, in Warsaw, there were several incidents of putting out the same fire during three days. Such a long time was necessary to put out small fire hidden in areas between building walls. Using thermal cameras helped to complete the actions. Units engaged in this action were not equipped with thermal cameras and had to borrow them from other units.

Fires of rubbish containers and chutes constitute the majority of all fires in big cities. Rubbish chutes are not always straight and rubbish may collect in curves or near chute entries located in building halls. Fires may start from a cigarette butt dropped with rubbish. Chutes are sometimes cluttered and rubbish may burn between building levels. Old

building have their rubbish chutes made of stoneware. If it's cracked, rubbish collect between the pipe and the chute wall and smolder there. In such cases firefighters must drill holes in the wall, but before that they must localize the place of fire and watch where the fire comes out from. If the firefighters haven't got a thermal camera, they must take off their gloves and touch the wall to locate warm spots near the rubbish chute. It can be dangerous in case of damaged electric system in the building. In such case damp wall is live and may electrocute. Using a thermal camera to locate warm spots on a rubbish chute is very useful and safe. After outlining warm area, firefighters drill holes and kick a hole in the wall.

Fig. 5. shows a thermogram of the wall and firefighter kicking w hole during a real fire action. The temperature was shown in grayscale. The warmest spots, where temperature is over 50°C, are clearly visible thanks to colouring function (in red). The temperature at the spot marked with a cross was 41°C.



**Fig. 5.** A thermogram of a wall and firefighter kicking w hole to a rubbish chute. Colour red indicates the warmest spots.  
*Photo: Marek Organek*

#### 4. Conclusions

In the opinion of users cameras are very useful in fire actions and in some cases they are the indispensable. Usage of the cameras is very simple which allows the user to focus on the tasks to be performed. It must be mentioned that these cameras were perfectly adapted to work in fire conditions. The image is clearly visible on the display screen and the colouring function seems to be a particularly successful idea. Even if the quality of picture on the screen is low, bright colour indicates spots where temperature exceeds the threshold value. It helps to locate all sources of warmth and bright colours warn the firefighters against burning.

There are cameras mounted on helmets available on the market but they are not used in Poland. A research is being conducted to elaborate a firefighter helmet integrated with a thermal camera and a device transmitting data to the commanding post. Devices for data transmission are suggested as an extra equipment to a camera but they haven't been accepted by firemen as they don't ensure good quality communication during fire actions in houses and are inconvenient. Ensuring good communication level requires long time for locating aerials. Firefighters expect reliable, comfortable and easy to use system that would integrate all above functions. This would allow to use the system without manual operating and the picture would get to the fire action commander in real time.

Infrared pyrometers are commonly used for non-contact temperature measuring. They seem to be able to replace thermal cameras in many cases. Such pyrometers were offered to firefighters when cameras were too expensive but they were not accepted by firemen. In their opinion pyrometers were not very useful and not reliable as they would unnecessarily burden firefighter and drive his attention away from priority tasks.

Raports gathered from firefighters and action descriptions show that thermal cameras are used mainly in situations without time pressure, where firefighters and victims safety is described as moderate. In case of high risk, firefighters follow their tried and tested methods and don't use cameras. The same applies to the first moments of fire action where getting to victims and evacuating them from the fire zone is the priority. Special methodology for searching smoky rooms using a thermal camera is being elaborated.

Thermal camera enabled:

- faster and more precise fire evaluation,
- faster detecting and localizing sources of fire, especially hidden ones,
- more effective searching rooms in smoky conditions and darkness,
- increasing safety of rescuers,
- decreasing rescuers efforts,
- minimizing demolition to parts covered by fire,
- decreasing amount of extinguishing agents used in fire action,
- minimizing fire losses,
- evaluating effectiveness of extinguishing agents used in action,

searching the incendiaries more precisely and announcing the end of fire action.

#### **References**

- [1] Amon F., Hamins A., Bryner N., Rowe J., "Meaningful performance evaluation conditions for fire service thermal imaging cameras". *Fire Safety Journal*, vol.43, pp.541-550, 2008.
- [2] Rybiński J., "The use of thermal cameras in fire fighting and fire prevention". *Pozarni Ochrana VSB –TU Ostrava*, pp. 281-283, 2010.
- [3] Rybiński J., Szajewska A., Łaciok Ł., "Selected examples of applying thermovision in fire fighting". *Pozarni Ochrana VSB –TU Ostrava*, pp. 294-296.
- [4] Szajewska A., Rybiński J., "Thermovision in extinguishing actions". *Logistyka*, vol. 3, pp.1276-1281, 2014.
- [5] Topf T., "The history of thermal imaging innovation". *International Fire Fighter*, issue 40, pp.47-49, 2013.