

Text for the chapter on "Combating forest fires"

Introduction

The extinguishing of the source of a fire in terrain which is difficult to access, such as a forest fire in the mountains, for example, represents a particularly major challenge for man and material. The heavy equipment used by fire brigades is only suitable to a limited degree for rough terrain so that over and over again there are logistical difficulties in bringing sufficient fire engines and water to the scene in order to prevent a small fire from developing into an extensive one. That is why it is very often only possible to extinguish the fire from the air or by using so-called "smoke jumpers" or "heli jumpers" where fire fighters are dropped down via parachute or helicopter near to the source of the fire. In the latter case however, the fire is generally fought without the use of water.

In the case of the conventional low-pressure extinguishing method for fire-fighting, the extinguishing water is commonly deployed as a water jet whereby water consumption is extremely high and, as a result, is used up within a short space of time. In addition, the extinguishing effect of such a water jet is comparatively low.

When combating forest fires and other major fires, large appliances must fulfil five different requirements:

1. Safety of the personnel
2. Rescue of trapped persons from the fire
3. Protection of buildings
4. Rapid combating of incipient fires
5. Extremely high extinguishing capacity

It is furthermore very important that forest fires are reliably detected at an early stage of their development in order then to be able to implement suitable countermeasures as rapidly as possible. The presence or rapid establishment of an adequate logistical infrastructure is necessary for this in order to bring the right material and trained personnel to the source of the fire. The training of personnel is an important component and prerequisite for successful combating of forest fires.

Integrated approach to combating forest fires

In order to be able to combat forest fires effectively, an integrated approach is needed, as presented in Figure 1. Depending on the situation, the following work steps take place:

- 1) The spot where a fire is suspected is registered via cameras which are installed on observation towers erected over a large area. The recorded pictures are transmitted to a control centre. These pictures are evaluated there using appropriate software. If a fire is clearly identified, then the alarm is raised for the fire fighters.
- 2) If the fire is not clearly identified, then an unmanned and remote-controlled drone, which is stationed on a platform on the observation tower, can fly to the spot where a fire is suspected and send back detailed pictures. Depending on how the pictures are evaluated, the fire fighters move in.
- 3) The fire fighters are directed to the source of the fire by the control centre. Whilst the fire is being extinguished, it continues to be observed by the unmanned drones. In the case of an extensive forest fire, observation can also take place via cameras attached to a zeppelin. The pictures are always transmitted to the control centre and from there directly to the command vehicle of the fire-fighting crew and to the fire-fighting vehicles.
- 4) The control centre has at its disposal modern simulation software so that it is in a position, by knowing the vegetation and meteorological data such, for example, as wind velocity, to determine and predict the expected course of the fire.
- 5) The control centre makes sure the necessary reinforcements of fuel and water are supplied. Depots in the form of easily assembled containers are set up at suitable locations which are near to the fire but safe and where the fire fighters can be appropriately provided for.
- 6) The containers can be filled either from the air by helicopter or with conventional tankers, depending on the location.

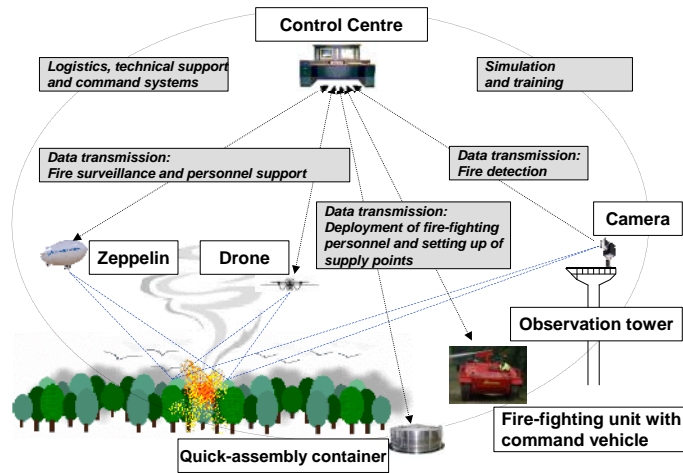


Figure 1: Schematic presentation of the "integrated" combating of forest fires

Deployment of fire-fighting personnel

Depending on the accessibility of the forest fire, the fire fighters can be transported to the scene using conventional wheeled vehicles. In most instances however this is not the case, so that tracked fire-fighting vehicles are far preferable. These tracked vehicles must also be fitted out with new extinguishing technology with a substantially lower water consumption. They must also be able to tow away vehicles which have broken down or been left in the danger zone and to cut fire breaks. Oxygen supplies carried in the vehicle must guarantee that they can even be deployed in the fire itself, for example to rescue trapped persons.

A suitable solution for a basic fire-fighting vehicle is the conversion of an armoured tank as known from military use, in particular the Marder A3. As a heavy vehicle for towing and for cutting fire breaks, the Leopard A2 retrieving tank is used as a fire-fighting vehicle and bulldozer. In order to extinguish a fire efficiently, a fire-fighting crew is deployed which always comprises five basic fire-fighting vehicles and one fire-fighting/bulldozing vehicle. This fire-fighting crew, [Figure 2](#), is led by a command vehicle such as a pick-up equipped with the new fire-extinguishing technology. The personnel in the command vehicle are able – via the direct remote control of an unmanned drone – to observe the course of the fire from the air in order thus to be able to steer the fire fighters' activities at the scene in an optimum way.



Figure 2: Composition of a fire-fighting unit: Five basic Marder A3 fire-fighting vehicles in deployment and a Leopard A2 fire-fighting vehicle with bulldozer, bottom right

It is especially important that the fire-fighting crew can always be supplied with water and fuel near to the scene of the fire. Thanks to simulation calculations the control centre is in a position to predict the course of the fire and can thus direct the fire-fighting crew in an optimum way and also to determine the best supply points for the quick-assembly collecting tanks. These are containers with an aluminium shell which can be loaded on a euro pallet, have a capacity of up to 70 m³ and can be easily erected in 15 minutes and disassembled again after use, see [Figure 3](#).



Figure 3: Quick-assembly collecting tank

Description of the basic fire-fighting vehicle with novel high-pressure vortex extinguishing technology

[Figure 4](#) gives a schematic presentation of a tracked fire-fighting vehicle in its required state on the basis of a MTW 113 personnel transport vehicle, [Figure 5](#) shows the vehicle on the basis of the Marder A3 armoured tank. In order to increase the flexibility and mobility of the tracked fire-fighting vehicle, a rake blade is fixed to the front. The extinguishing mist is sprayed on the source of the fire via a water cannon. A spray device over the entire surface of the vehicle is foreseen which wraps the vehicle in a mist of water when it is near or actually in the source of the fire and thus protects it securely from any fire damage. This self-protection device mainly comprises small rotating jet rails which produce a high-volume mist via a steel pipe facing the outside. The floor of the vehicle is already fitted or subsequently fitted with a fireproof plate so that the vehicle can be deployed over hot terrain. The entire surface of the vehicle can also be coated with an insulating fireproof layer (not shown here).

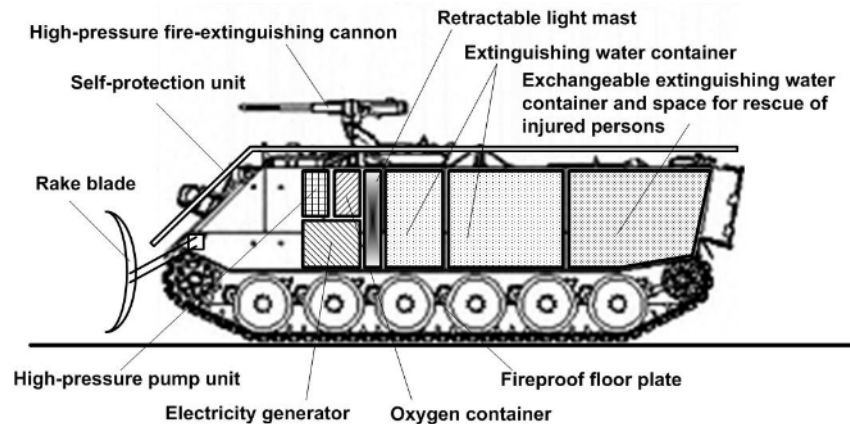


Figure 4: Schematic presentation of the tracked fire-fighting vehicle using the model of a MTW (M 113)

In the dark or in a smoky environment, the terrain can be illuminated via a retractable light mast. The space formerly put to military purposes is mainly fitted with water containers whereby the container can be

blasted off or quickly emptied in order to create space quickly for injured persons during a rescue operation.



Figure 5: Basic fire-fighting vehicle on the basis of the Marder A3 armoured tank, right, and same vehicle with self-protection unit for the vehicle at the front

Since the oxygen content of the air for maintaining the life functions of man and motor is frequently insufficient close to the fire due to the combustion of organic substances, a sufficient supply of oxygen is carried in the vehicle in pressurized canisters and can be provided to the crew via oxygen masks. At the same time a steering system is foreseen which ensures that a sufficient volume of oxygen is automatically injected into the air suction pipeline of the motor in the case of a lack of oxygen in the outside air so that the motor always functions and thus also the entire vehicle. In order to guarantee this, an oxygen measuring device is integrated in the air suction pipeline. In this way, the vehicle is able to go into action for a short period directly in the fire. A measuring device for monitoring the oxygen content of the air is located in the vehicle. If the level drops below a minimum value, an optical and acoustic alarm is signalled so that the crew has sufficient time to put on the oxygen masks.

The high-pressure pump unit supplies the extinguishing water at a pressure which generally exceeds 20 MPa. The extinguishing water forms a mist via jets and is then used to combat the fire via the water cannon. The water cannon can be remote-controlled by the crew in the vehicle (not shown here). It is a fast-rotating high-pressure pipe bundle comprising five high-pressure pipes with high-pressure jets which produce a point jet which reaches a long distance. In order to disperse this point jet with its high kinetic energy over a broad area, the pipe bundle is rotated at up to 2.000 min⁻¹. This device is installed in a revolving tower with an opening on the tracked fire-fighting vehicle so that fires can be combated without any hindrance and ensuring protection from external mechanical influences, e.g. from falling trees. The crew steers and activates the fire-extinguishing cannon by means of a joystick.

This novel extinguishing technology has an extremely low water consumption while at the same time producing the same extinguishing performance as conventional extinguishing techniques. Tab.1 presents some data on water consumption.

Tab.1: Features of tracked fire-fighting vehicle

Max. water load:	8.000 l
Extinguishing time – Full jet:	at around 100 l/min. about 1.5 hrs.
Extinguishing time – Vortex jet:	at around 300 l/min. about 0.5 hrs.
Extinguishing time – Front extinguishing unit:	about 2 hrs.
Extinguishing time – Hand lance:	at around 50 l/min about 3 hrs.
Max. hose length for the hand lance:	about 500 m
Capacity when rescuing trapped persons after rapid emptying of tank:	max. 10 persons
Max. water pressure at extinguishing monitor:	50 MPa
Max. pressure of hydraulic system:	30 MPa
Performance decrease for water pressure:	120 kW

Oxygen supply 400 l at 20 MPa
for rescue mission in and at source of fire:

5 minutes without atmospheric
oxygen