Modern safety technologies on high-impact mega-fires

During the latest decades, many parts of the globe have come across noteworthy and destructive "uncontrollable" events. Nico Zorzetto, Export Director of SANCO S.p.A., Italian Company manufacturer of fire & gas detection systems and fire suppression systems, talks about this subject.

Nico Zorzetto PhD

Nico Zorzetto, Export & Marketing Director as well as shareholder of Sanco SpA., has been working in the fire fighting field for the last 44 years. Even if he graduated in Economics, he has always been dedicating its interest to technological innovation for "reliable products". He has been participating to the realization of several new products and systems; in particular he is co-creator of airmobile fire fighting systems (fixed type and rotating wing) for the fire fighting of bushfires. He has been publishing several articles – National and International – relevant to fire fighting subjects. He operates also with National and International organizations for the Civil Protection Organizations, as well as with security matters, with jobs also with NATO.

Safety is a condition determined by the absence of risks that can compromise the physical, mental and psychological integrity of man.

The term derives from the Latin "sine cura", without worries, and it defines the condition that allows a subject to carry out all his activities without worrying about risks, as they are absent.

Safety engineering analyzes risk using traditional tools joined by risk analysis techniques.

Specifically, fire safety engineering is the application of this innovative approach that aims to protect people, things and environment from the effects of fire by identifying risks, prevention and protection measures thus allowing to prevent, control and extinguish a fire.

The fire occurs due to oxidation of the carbon (C) and hydrogen (H) atoms present in the combustible substances.

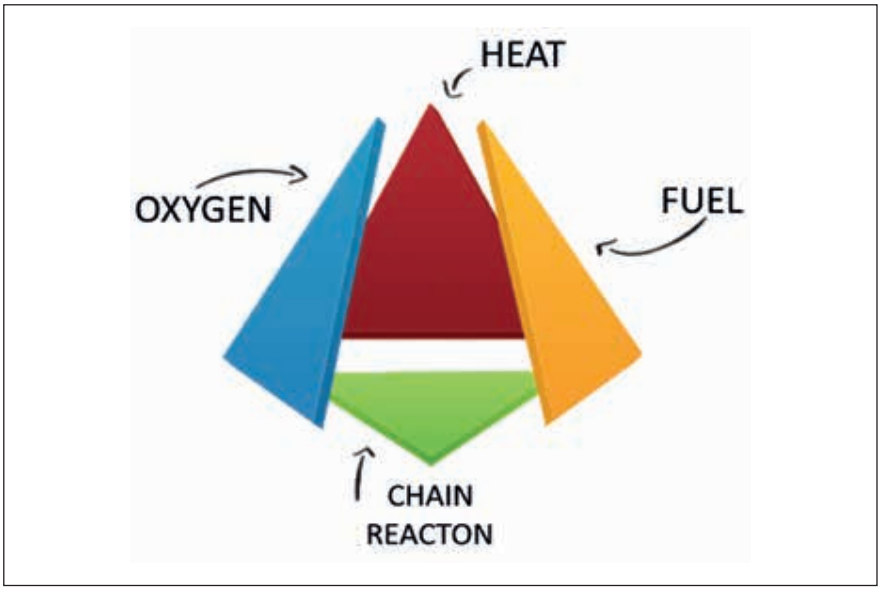
For example, in the combustion of the most common fuels (wood, coal, paper, hydrocarbons, etc.), consisting largely of carbon and hydrogen, the oxygen in the air reacts with hydrogen (forming water (H2O) in the form of steam) and with carbon (forming carbon dioxide (CO2), carbon monoxide (CO), fumes, etc.

The fire tetrahedron

Usually the comburent is oxygen contained in the air, but fires are possible thanks to substances that contain in their molecule a sufficient amount of oxygen to cause combustion, such as explosives and celluloid. Conditions necessary for combustion are the following ones:

- FUEL, anything that is flammable, such as wood, paper, fabric, or chemicals
- HEAT, the energy sufficient to release vapor from the fuel and cause ignition
- OXYGEN, which allows fire to start and continue
- CHEMICAL CHAIN REACTION, which is combustion

Removing any of these four factors will prevent, suppress, or contain the fire.

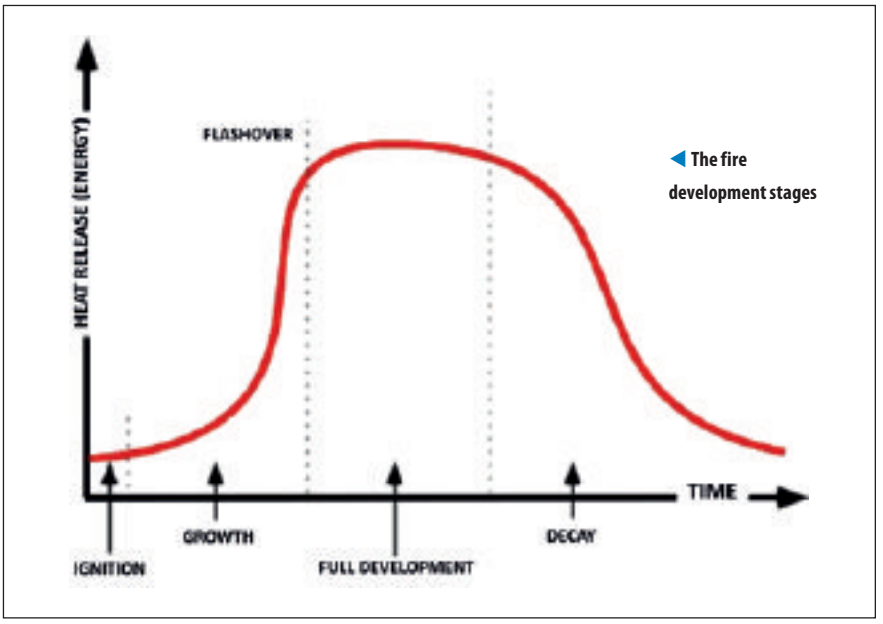


The fire development stages

Now, there are four fire development stages: chemical chain reaction, growth, full development and decay.

The fire development stages

1) the chemical chain reaction occurs, accordingly the process of pyrolysis starts
2) the fire moves further and it grows through flame spread or by ignition of other fuel
3) when flashover occurs there is a sudden transition to a state o fully developed fire; depending on several factors (type of building, heat of combustion, heat release rate, sufficient fuel or enough oxygen) the flashover will be more or less rapid or it will not occur at all. Full fire development is the hottest phase: energy release is at its greatest, all combustible materials have been ignited.
4) decay stage is characterized by a noteworthy decrease in oxygen or fuel.



◀ The fire development stages

Talking about extended fires and to the question highlighted in the first part of this article, I have personally had the chance to participate to real fire tests of even large dimensions when fire knowledge was under development and improvement in the 80s.

Budapest: tests in the 70s

Until that time, the foam concentrates used to extinguish fire coming from flammable liquids were protein and fluoroprotein type.

The purpose of the test was to demonstrate the effectiveness of the original AFFF foam concentrate called "Light Water" developed and produced in the 1960s by 3M-USA and used in the military field first, and then launched and used in the Oil sector.

Fire tests in Budapest involved 250,000 liters of gasoline on an area of 2,000 sqm (rectangular pool of 20 X 100 meters).

Fire extinguishment time was of 2 minutes 20" with AFFF 6% with specific weight 1.91 lpm/sqm (which is less than 1/3 of what NFPA11 norm indicates).

Several hundred people and representatives of European authorities participated to the tests. After that, the Romanian authority requested to repeat the test in a pool with the same surface area but circular in shape. The fire was totally suppressed in 2 minutes net.

To introduce the AFFF foam concentrate, the underwriter has organized similar fire tests on smaller scale (pool areas of 400-500 sqm) also in Algeria, Libya, Nigeria, Ex-Yugoslavia, Syria, Iraq, Egypt, etc. reaching very similar results.

▼ Budapest test.

Curacao: tests in 80s

As written above, in the 70s, after the introduction of the new synthetic foam concentrates (particularly indicated for the production of high expansion foam) and AFFF, there were two schools of thought: one said that the fluoroprotein foam concentrates were the best and most suitable for extinguishing large fires , able to ensure ensure a great resistance to burn back, while the AFFF were considered suitable for switching off the "fire spills".

The producers of AFFF foam concentrates obviously argued the opposite.

For this reason Shell International's General HSE director decided to prove both the theories of the producers by using foam pourers from the top of the storage tanks and sub-surface foam systems from the bottom.

In May 1982 I had the unique chance to participate to the real fire tests in Curacao at SHELL International fire test ground, for 2 intensive weeks.

These were "fire Olympic games" – this was my definition of that experience, to which I participated with one of the seven Companies that were invited.

Tests were carried out to check performance of foam extinguishing agents

◀ Curacao test.

of different type, from fluoroprotein foam concentrate to synthetic and universal type, with different applications of foam systems (fire suppression working on the top of tanks, subsurface injection type, etc.)

As far as I know it was the first time the new (for that time) film forming fluoroprotein (that I called FFFP) foam concentrate, suitable for the new generation of alcohols, was tested on real fires.

Preburning time was of about 30 minutes with heat temperatures reaching 800-900°C on the top of open roof tank.

Time for extinguishment during these tests was from 2 up to 4 minutes depending on the type of foam concentrate.

The results that were obtained after dozens of real fire tests (in two weeks time) showed that any "good" foam concentrate suitable for extinguishing the fire coming from flammable liquids, whether fluoroprotein base or synthetic base, can be equivalent and foam application from top or from the bottom are accepted as well.

In fact, these tests showed that fires can be rapidly extinguished but the most important factors to consider while preparing a good operational safety plan and the risk assessment are the following ones:

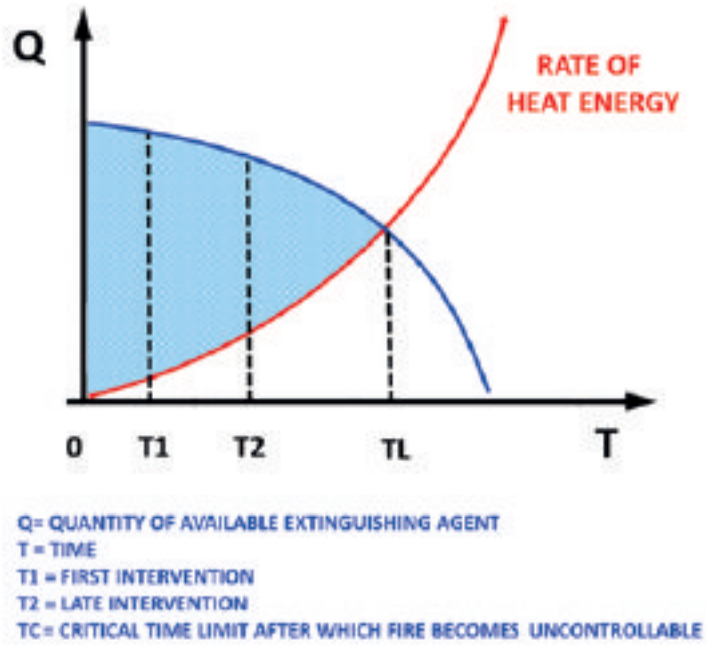
- to have adequate fire fighting and safety systems/equipment/vehicles
- a fire extinguishing agent suitable for the specific risk
- fire personnel properly trained
- adequate maintenance of fire fighting systems for having a quick response
- quick response (see previous diagram and the following one)

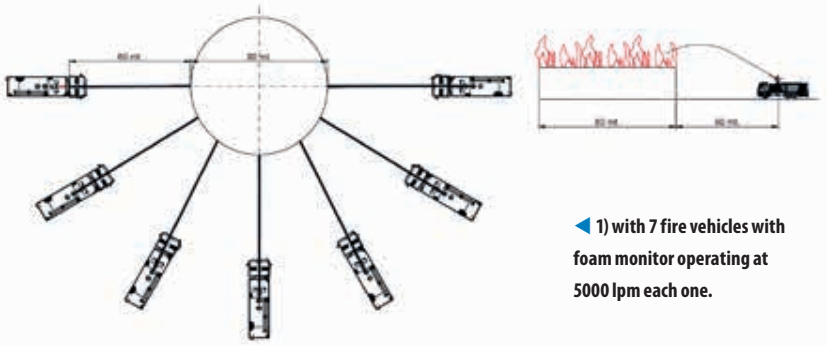
The diagram shows that if the intervention on fire occurs within time 1 (T1), the fire is minor and the quantity of the extinguishing agent allows a rapid extinction of fire.

Even within time T2 the situation is quite similar. This is possible up until the critical time, after which the fire cannot be longer shut off with the intended fire fighting systems.

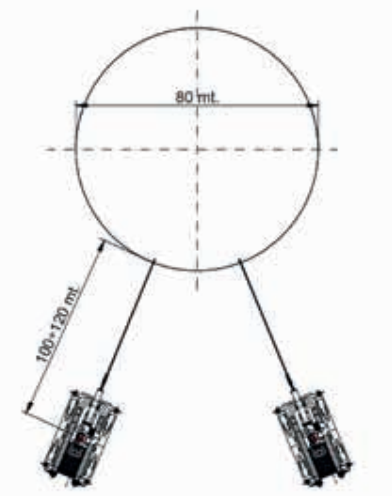
To explain the title of the article, what

▼ Heat and critical time limit.

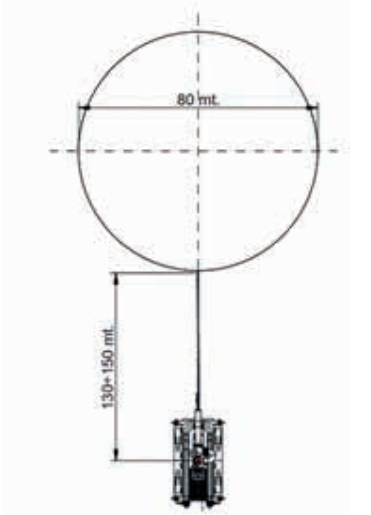




◀ 1) with 7 fire vehicles with foam monitor operating at 5000 lpm each one.



▲ 2) with 2 mobile fire foam monitors of 20,000 lpm each one.



▲ 3) with 1 mobile fire foam monitor of 40,000 lpm each on.

are the criteria and technologies for extinguishing a large fire?

They are the ones I mentioned earlier.

Unfortunately, currently, among the risks to be considered there is also arson, caused by terrorist acts and / or vandalism.

This happened in 2008: Korean historical 600-years-old landmark Namdaemun gate, in the heart of nation's capital, got burned.

Notwithstanding the fire safety advanced technologies. the monument was destroyed despite several dozen fire-fighting vehicles being used.

Very probably, from the recorded images, the flowrates of the monitors which were used were undersized for that risk, and in some cases the jet of the monitors did not reach the target.

Similar circumstances also occurred all around the worlds in last decades, showing the scarce ability to face mega fires with manual or automatic fire systems.

To sum up, we can illustrate what happens with technologies and tactics in my opinion a little outdated (which considered the autonomy of the system) to more modern technologies that mainly consider the concept of specific flow (liters / minute / sqm).

Let's take in consideration, even if in a simplified way, the fire extinguishing intervention on a tank containing flammable liquid such as a hydrocarbon

Intervention can be made in several ways, but it is mandatory to consider the characteristics of the hydrocarbon storage tank (diameter, type of fuel, etc.) thus calculating the flowrate necessary for extinguishing the fire the soonest.

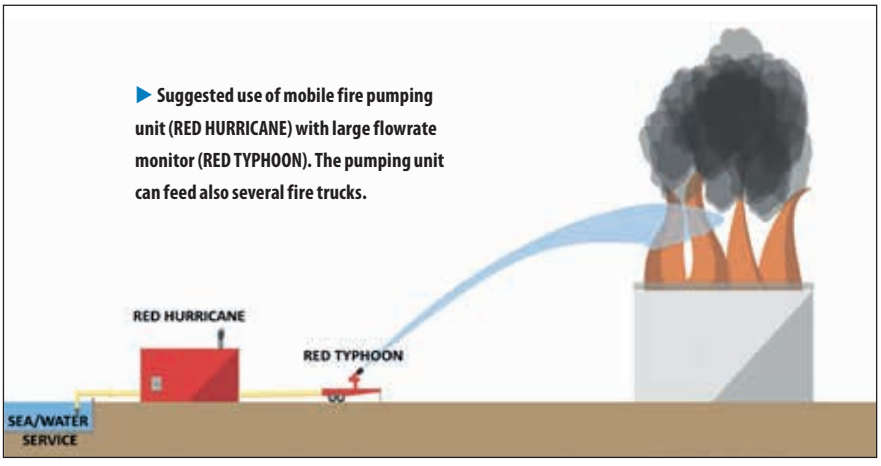
In this case, minimum flowrate to reach is about 32,000 liters (of foam solution) per minute that can be achieved as it follows:

To sum up, in my opinion ANY FIRE can be adequately extinguished and in particular mega fires can be prevented to expand first with a timely intervention that shall be suitable thanks to:

- appropriate fire fighting systems/ equipment
- proper extinguishing agent
- adequate and regular maintenance of the fire fighting systems/equipment
- trained and updated staff.

For more information, go to www.sanco-spa.it

▼ Large flowrate monitor (RED TYPHOON).



▶ Suggested use of mobile fire pumping unit (RED HURRICANE) with large flowrate monitor (RED TYPHOON). The pumping unit can feed also several fire trucks.

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