PROJECT FINAL REPORT

Final Publishable Summary Report

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Project acronym: FIRELI

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1. Background

Forest fires are a global challenge, seriously affecting Europe and the rest of the world. The Southern European countries (Greece, France, Italy, Portugal and Spain) are endangered by more than 50.000 fires annually, destroying an average of 600.000 to 800.000 hectares of forest every year, with an estimated cost to the European economy of between €600 M and €800 M every year; excluding rural and tourism effect. Forest fires are also the cause of an average of 400 people injured in Europe per annum, with an average number of 15 fatalities per year; most of them fire-fighters in the line of duty. On the other hand, forest fires are also progressively becoming a serious problem in northern European countries due to the long-term effect of global warming.

Generally, vegetation fire can be considered as a four-phase process consisting of the pre-ignition, flaming, smouldering and glowing phases. In the first phase (pre-ignition), heat from an ignition source or the flaming front evaporates water and low volatiles from the fuel and the process of pyrolysis begins. In the second phase (flaming), combustion of the pyrolysis products (gases and vapours) with air takes place. Flaming occurs if these products are heated to the ignition point, in contact with heat, e.g., flames from the fire-front. Temperatures in this phase range between 325-350°C. The third phase (smouldering) is a very smoky process occurring after the active flaming front has passed. Combustible gases are still produced by the process of pyrolysis, but the rate of release and the temperatures are not high enough to maintain flaming combustion. Smouldering generally occurs in fuel beds with fine packed fuels and limited oxygen flow. In the fourth phase (glowing), most of the volatile gases have been burned and oxygen comes into direct contact with the surface of the charred fuel. As the fuel oxidizes, it burns with a characteristic glow, until the temperature is reduced so much that combustion cannot be continued, or until all combustible material is consumed.

Modern technical aids are routinely been used to combat forest fires; including airborne and terrestrial. However, direct earth fire combat remains the principal means used to fight fires; especially where the orography is difficult or meteorological conditions are adverse.

Equipment for ground forest fire fighting includes pumps, hoses, vehicles, water tankers and hand tools. Given the unpredictability of fire in natural environments, versatility and safety are key

element to the successful action of the fire brigade. Hoses are important means to combat fires and are done of materials with special properties. Hoses are used primarily for forest fire suppression but they can also be used for water transfer in water tankers. Important parameters for forest fire hoses from the operational point of view include size (diameter, length), relative humidity, flexibility, heat resistance, abrasion resistance, chemical resistance, weight, maintenance, storage and cleaning capacity.

2. The Need

For the non-expert, fire hoses look simple aids. However, as any safety equipment, many considerations must be made and a number of strict regulations must be complied with to design a fire hose. In fact a fire hose is an element involving sophisticated design and manufacturing processes in fields as diverse as: materials technology, coatings, mechanical design, fluid dynamics, multilayer blending and mixing, extrusion processes, etc.

Some key parameters on the hose specifications are mechanical flexibility and resistance to different pH. Mechanical Flexibility enables an effective attack in a number of changing situations and rough topographies, such as when the fire is intense and fast moving, the terrain shows big variety, or the fire reaches the interface of the forest-urban area. Resistance to different pH is important due to the fact that fire suppression uses different types and qualities of water, including water with forest fire retardants, sea water and water from wells that could effectively degrade the inner wall of the hose. Abrasion resistance and cleaning capacity are also important parameters depending on the type of terrain (rocks, muddy).

A further limitation with current hose couplings is the large charge loss produced when long hoses are deployed for fire extinction in areas of difficult access. At each coupling there is a loss of charge due to the variable section of the conduct at the coupling that can reach 15%. The serial sequence of multiple couplings gives rise to a cumulated water charge loss at the nozzle, meaning a very important loss of extinction capability.

We must also consider temperatures in forest fires can exceed 350°C and reach up to 1000°C in crown intense forest fires. The experience has shown that in all four stages of forest fire suppression, the hoses can temporarily be exposed to different temperatures ranges. However, it is particularly common for many terrains that part of the deployed hoses are exposed to temperatures in the range of 350°C, as a consequence of sudden regeneration of fire in the smouldering phase. Currently used fire hoses cannot resist more than 1 minute to a direct fire of 350ºC, resulting in many cases in hoses burning as a consequence of fire start ups. This has shown dramatic consequences in fire-fighter´s safety, as well as a decrease in the versatility and efficiency of direct fire combat action plans.

3. The FIRELI product

The FIRELI product offering consists of two basic innovations: a novel fire-fighting hose, with increased fire retardant properties, and a new coupling design for forestry applications able to provide enhanced versatility, efficiency and safety for fire-fighters.

The FIRELI hose will withstand temperatures as high as 400ºC for more than 15 minutes (three times more time than any previous hose system), while still retaining the required properties with regard to low weight, service pressure, curvature radius, plus resistance to abrasion, chemicals, hydrocarbons and ozone.

The designed fire retardant system has been the result of a broad study on flame retardant rubber formulations with the aim to provide a durable fire resistance effect. In that sense we developed a new polymer formulation based on a PVC/NBR rubber matrix using intumescent additives and fire-resistant components; as well as PVC plasticizers. The designed formulation / additives were selected to be non-toxic and have low smoke production potential. Also, these fire retardants do not volatilize easily so as to prevent detrimental effects to the mechanical, physical and other hose properties.

FIRELI hose is composed of 4 layers of rubber coextruded through a polyester textile wave (see pictures). While the base rubber is the same in all four layers, only the outer layer is filled with fire resistant additives. This approach allows us to achieve the best compromise between fire resistance and cost.

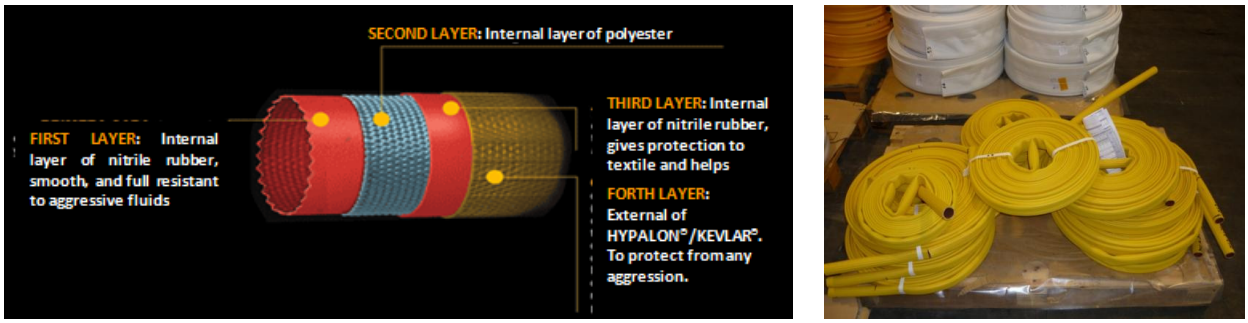

Figure 1. (Left) The FIRELI hose, showing its four layer arrangement. (Right) Finished Yellow product.

The FIRELI hose is about to enter into industrial production and can be supplied with diameters of between 1" to 3" (25 to 75 mm) and weights of 270 and 770 grams, depending on the diameter.

The second innovation in the FIRELI product line is the new coupling. FIRELI coupling has been designed using latest technologies in Computational Fluid Dynamics (CFD). The coupling is single piece, can be manufactured in different sizes and materials (including aluminium, stainless steel and brass) and offers significant advantages in terms of usability and reduced pressure loss at the joints. Also, the FIRELI coupling includes an optional thermal barrier coating designed to provide optimal protection to the inner rubber layer of the hose.

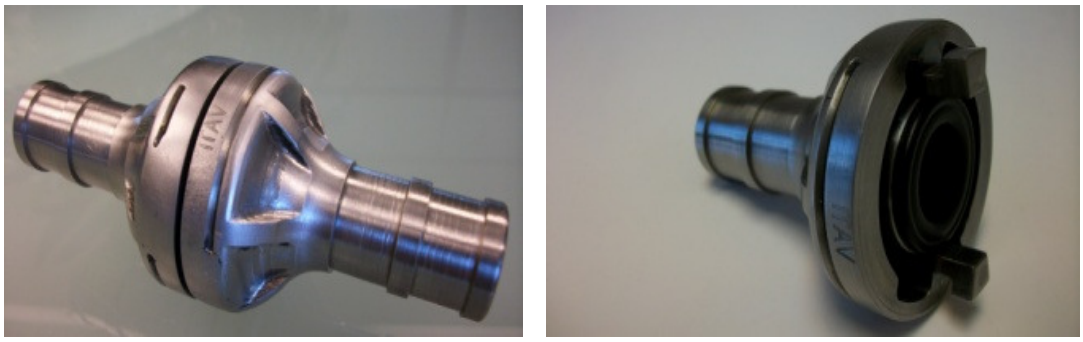

Figure 2. Two views of the FIRELI coupling

The problem of pressure loss will always exist as long as couplings are needed, but the particular design of the FIRELI coupling minimizes these losses by offering 30% less pressure drop per joint; as compared to the best existing design. On the other hand, the new coating protects the inner rubber layer of the hose against heat transmission through the coupling.

The smooth design of the external surface of the coupling prevents any jamming during fire forest operations, when the hose is dragged on the floor. Also, the optimised design of its mechanical fitting contributes to better usability since a simple 20º turn is sufficient to securely lock the device. We also designed a new bracket aimed at combining the advantages of both internal and external hose fixing.

The FIRELI coupling offers the above improvements at a cost similar to other existing products. Also weight is 18% lower. It can be used with both wire-wrap and ring clamps binding. The standard design is made with two lugs. However, three lugs versions can be manufactured also for specific demands. FIRELI design is hermaphrodite and, hence, the same design covers both ends of

the hose. Also it is symmetrical; resulting in easier mould manufacturing and reduced production costs.

It is also noted that the standard product has been designed for a hose diameter of 1 inch. However, the same design is susceptible to be adapted to different diameters. FIRELI coupling can also be offered with or without coating. All these combinations will allow FIRELI manufactures to address the demand of both high end and low cost products.

4 Market Aim

The FIRELI project intended to help the European sector of fire-fighting manufacturers to face global competitors by developing a new advanced fire hose to enhance current features and provide the user with higher versatility. The main focus of FIRELI products is forest fire fighting. Target groups included mainly fire-fighting organizations such as fire-fighting services, civil protection, military and NGOs. With the scope of promoting the product among potential customers, dissemination activities have been organized for reaching out decision makers in those services.

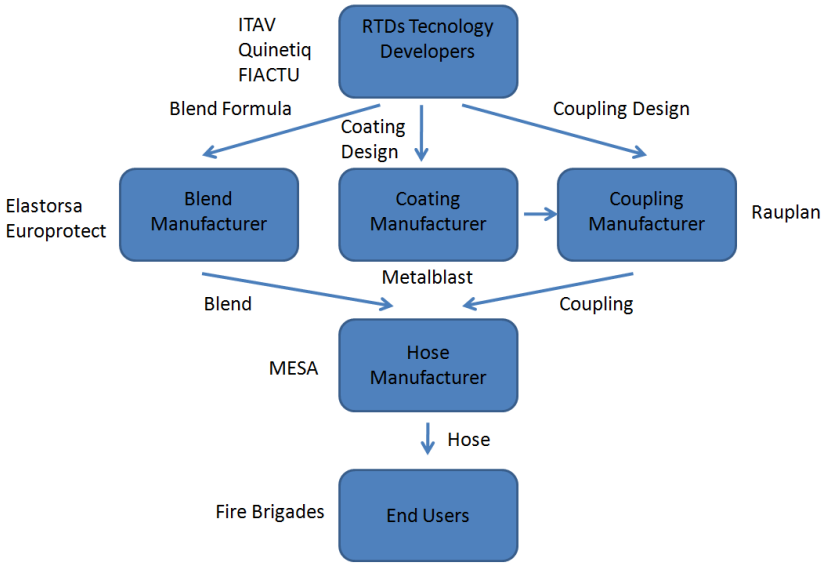

Figure 3. FIRELI supply chain.

Nevertheless, couplings manufacturers will be able to address a wide variety of applications with a single design; thus reducing engineering and manufacturing costs. In that sense, the FIRELI system (hose/ coupling combination) is suitable for both suction and delivery and can be used in applications other that forest fire fighting, such as: fire suppression in buildings, agriculture, heavy industry (oil refineries, mining, iron and steel industrial sector), construction, maritime, etc.

The supply chain of the FIRELI product is composed of some relevant members of the FIRELI Consortium. In that sense, Productos MESA, the project coordinator, will produce

and commercialise the fire hose products. ELASTORSA will supply the rubber blend used to extrude the hose. Europrotect will supply the nylon textile material used to reinforce the inner layer of the hose. Rauplan will manufacture and supply the couplings. Finally, Metalblast will be the supplier of the coating material to be used in the coupling. The supply chain is complemented with the support of ITAV (PERA group), Quinetiq and FIACTU who will provide the technical assistance necessary to industrialise the FIRELI products.

4. Consortium Members

PARTNER	PARTNER	SHORT NAME	COUNTRY
	Productos y Mangueras Especiales S.A.	MESA	Spain
	Elastómeros Riojanos S.A..	ELASTORSA	Spain
	Europrotect France S.A.	EUROPROTECT	France
	Rauplan Oy	RAUPLAN	Finland
	Qse Metalblast Ltd.	METALBLAST	UK
	QinetiQ Ltd.	QINETIQ	UK
	Tecnologías Avanzadas Inspiralia	ITAV	Spain
	Field Analytical Chemistry and Technology Unit (FIACTU), National Technical University of Athens (NTUA)	FIACTU	Greece
	LAVIOSA Chimica Mineria	LAVIOSA	Italy

5. Project Contact

Any information or request about the project or the FIRELI products, please direct it to the project contact point:

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