siron
compressed air foam

WHITE PAPER

COMPRESSED AIR FOAM

Protection of high voltage power transformers at offshore substation platforms

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CONTENTS

SIRON BV
Holterhofweg 280A
NL-7534PT Enschede
The Netherlands
www.compressedairfoam.eu
info@compressedairfoam.eu
+ 31 53 750 30 44

1.0 OVERVIEW

In modern society, a lot of technology is used 24/7. Even to the level that we have grown to be totally dependent on electrical power, as well in our private lives as in most commercial or industrial activities.

The renewable electric power industry has installed offshore substations in their distribution grids to accommodate the ever increasing demand for dependable power with their rows of large high voltage power transformers. Many precautions have been taken to safeguard them against failure. Because when all power fails, customers complain, revenues are lost and even medical emergencies can happen.

One of the risks these large transformers have is fire. Although the manufacturers of these oil filled transformers build them with diverse imbedded safety features, if they fail they often produce very large fires that are very hard to extinguish and provoke environmental damages by the release of thick black toxic smoke and spilling of transformer oil.

This is why energy companies install fire protection systems at offshore substations to protect their investment and to prevent such fires.

SIRON BV
Holterhofweg 280A
NL-7534PT Enschede
The Netherlands
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2.0 PROBLEMS WITH THE USE OF TRADITIONAL TECHNOLOGIES

Most oil cooled high voltage power transformers have a deluge sprinkler system. Designers use NFPA-15 as a guide to design a system that will cool off the transformer and eventually, extinguish the fire.

A typical design calls for a grid of open type deluge or spray nozzles to be installed all around the transformer. Such a system will use minimum 44 nozzles and will be designed to spray at least 1.900L p/m of water for the duration of one (1) hour. That is a lot of water!
NFPA-850 for Power Plant Design goes even further, requesting water spray duration to last a full two (2) hours! But demands for sump tanks are specified to be large enough to contain the spill and the fire water from the fire suppression systems. So the size of the sump tanks is too big, the weight is too heavy and the costs are too high.

High Opex costs
Offshore Substations Platforms (OSS) are mostly unmanned and should preferably not have (sea) water based fire pumps because of the cost to maintain this system. Every 2 weeks they have to be test-operated. In the lifespan of an OSS it is assumable that the pump has to be replaced or overhauled two to three times. Mixing foam with salt water is also a very costly business because of the corroding properties of sea water. A solution to these problems is available using a SIRON's Integrated Compressed Air Foam system (ICAF).

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3.0 NFPA DESIGN

This FM Approved AFFF foam system allows the designer to alleviate many of these potential problems while providing superior fire protection (AFFF stands for Aqueous Film Forming Foam and is a fire fighting foam widely used in the industry to extinguish fires in hydrocarbon fuels such as transformer oil). NFPA-11 states that where fixed spray type systems are used to protect three-dimensional equipment like power transformers, the minimum density should be applied over the projected area of rectangular prism envelope for the equipment and its appurtenances. Furthermore, system discharge duration should be designed for a minimum period of 5 minutes.

FM Approved
Using our FM Approved ICAF Design Manual, the designer (or we can do it for you) will locate a grid of local application nozzles to cover the transformer's surfaces, based of the published square area of coverage versus mounting distance ratio of the TAR-225L Nozzles. But because of the coverage area of each nozzle and the dense texture of Compressed Air Foam, the spray nozzles grid all around the transformer uses a lot less nozzles than the equivalent deluge system. The quantity of foam concentrate is also reduced by using the ICAF System since its high efficiency is achieved while using only a 2% concentration of AFFF foam concentrate instead of the usual 3%! The above designed oil cooled transformers have been fire tested and approved by FM.

Less water
For a typical transformer such as the one shown in Figures 1 & 2 (see next page), ICAF Systems are designed at the much lower water flow rate for example 360 lpm for a grid of only 16 nozzles. Because of the much shorter discharge time of 5 minutes, the total water quantity will be dramatically reduced; only about 1.800 liters of water will be needed to completely suppress the fire.

	DELUGE SYSTEM		CAF SYSTEM
Number of Nozzles	44	44	16
Water Flow	1.900 Lpmn	1.900 Lpmn	360 Lpmn
Drainage Required	114.000L (60 min.)	38.000L (20 min.)	1.800L (5 min.)

Less weight
Immediately, one can see that the need for large sea water pumps and large sump tanks are no longer necessary and large investment savings can be made and maybe more important: weight can be reduced. Even with a much more efficient fire protection system protecting the expensive equipment.

No polution
After extinguishing, the small quantity of water, foam and transformer oil can easily be pumped and treated. Possible damage to the environment is reduced to a minimum because the risk of overflowing the sump tank with fire water and transformer oil into the sea is eliminated.

Burn-back resistant
The ICAF System is certified and full fire tested specifically for burning transformers. It provides protection against burn-back for more than 30 minutes, which other systems cannot do.

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FIGURE 1 TOP VIEW NOZZLE LAYOUT

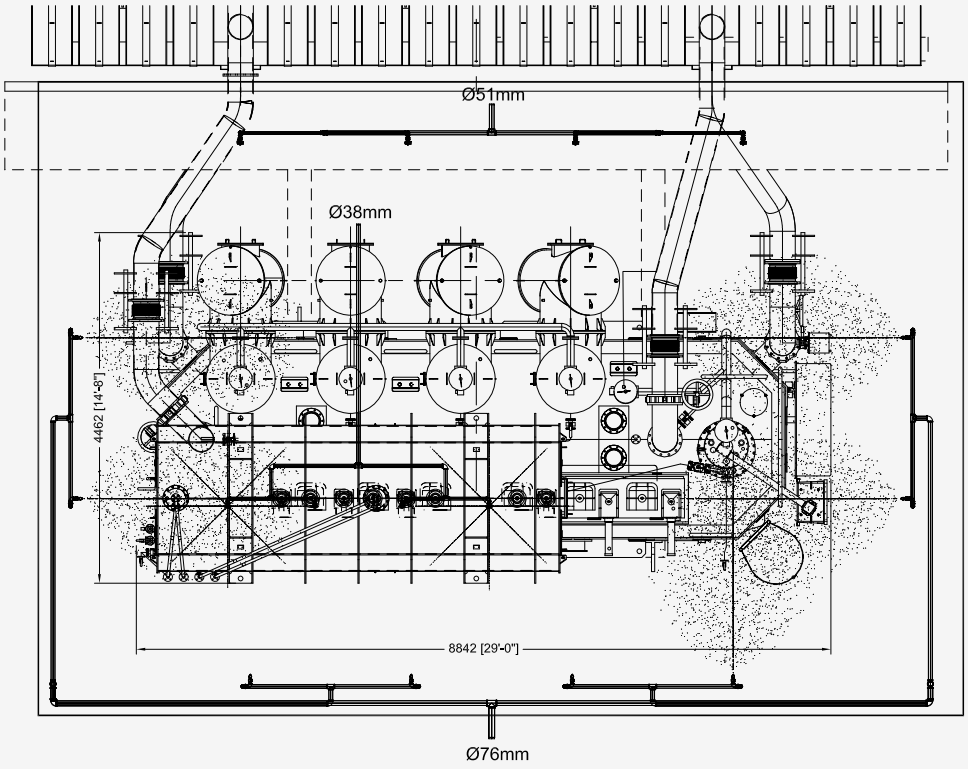
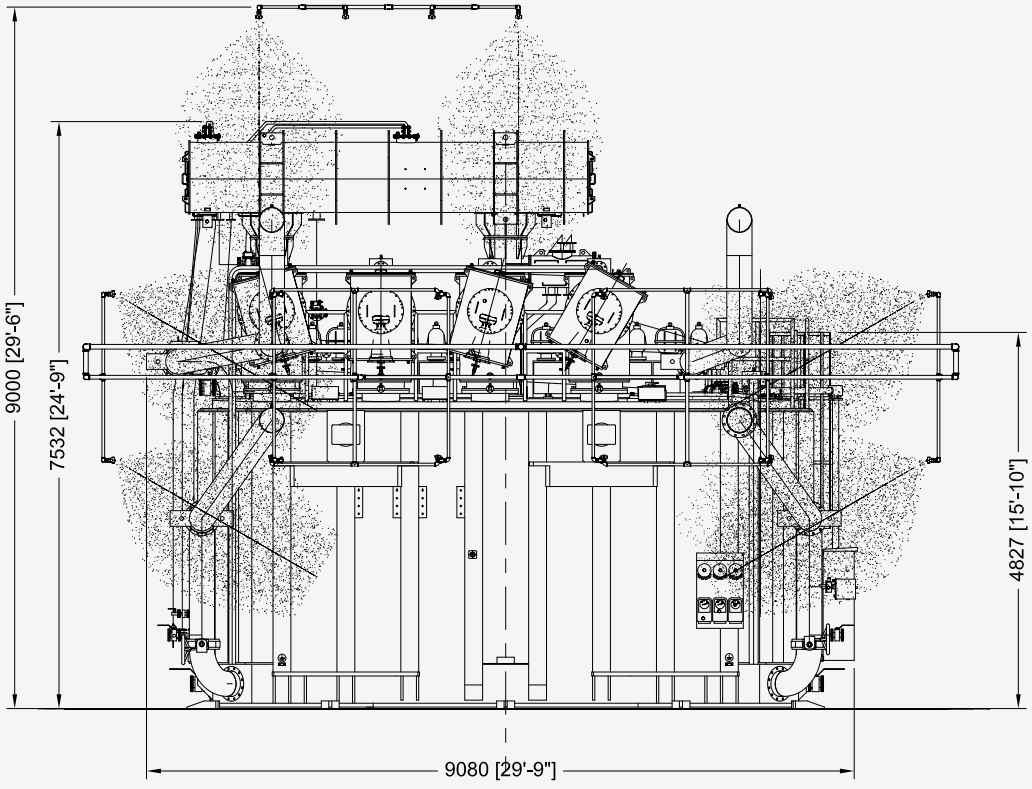


FIGURE 2 FRONT VIEW NOZZLE LAYOUT



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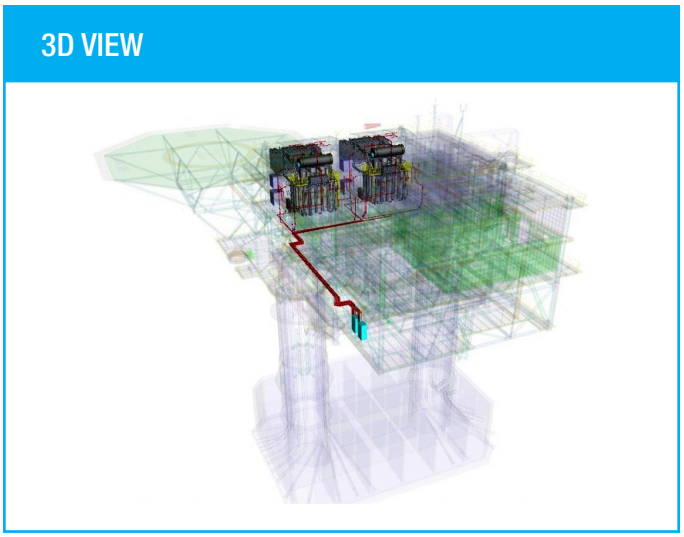
4.0 DIFFICULT TO EXTINGUISH

Typically, an oil cooled transformer fire will involve both a cascading fire from the oil coming down from the expansion tank situated at the top of the casing and a pool fire in the curb surrounding the transformer, which makes it very difficult to extinguish.

Figure 1 (below) shows a typical ICAF System installation with its grid of discharge nozzles installed around the transformer. A first row of nozzles will be aimed at the top of the transformer casing to extinguish flames from the pooling transformer oil on it's top. A second row will be installed as shown to protect the sides of the transformer casing, extinguishing the cascading fire. Foam accumulation in the curb will handle the burning oil by covering the surface. Other nozzles (as shown) will be located to properly cover the shape of the oil expansion tank.

Figure 1 – Detail of the nozzle grid around a typical transformer.



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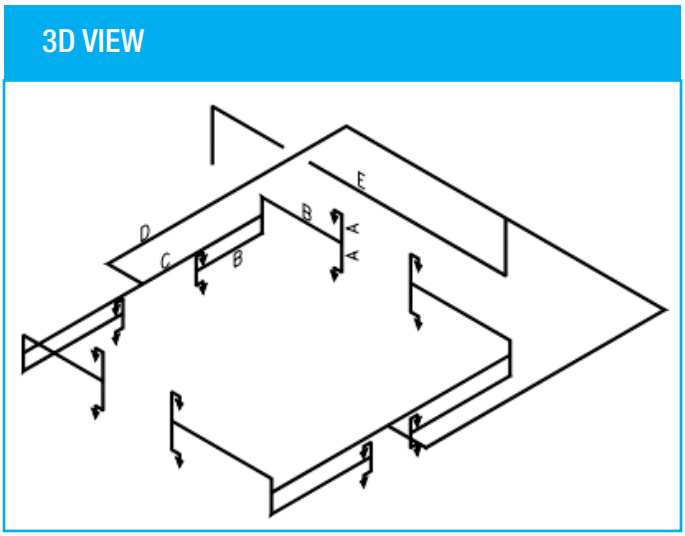
As shown in Figure 2 (below), the resulting balanced flow piping is much simpler to install and of smaller diameter than the equivalent deluge grid system, reducing costs for the installing contractor.

Figure 2 – 3D view of a typical ICAF balanced piping grid.



The ICAF System itself also has a small footprint (see Figure 3 below and next page) and can even be supplied in an Offshore DNV or Norsok approved Fire Fighting container for more flexibility. The foam concentrate and water are stored in non-pressurized tanks and does not use bladders or complicated inductors and trims. All trims are actually factory-built in user-friendly skids.

SIRON can train your designers or do the design for you. We can also train your mechanics or we can do the installation for you.

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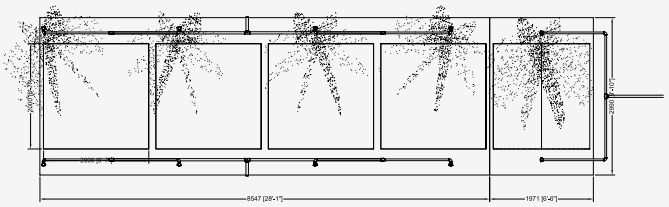
Figure 3

TOP VIEW HELIFUEL TANKS



3D VIEW HELIFUEL TANKS

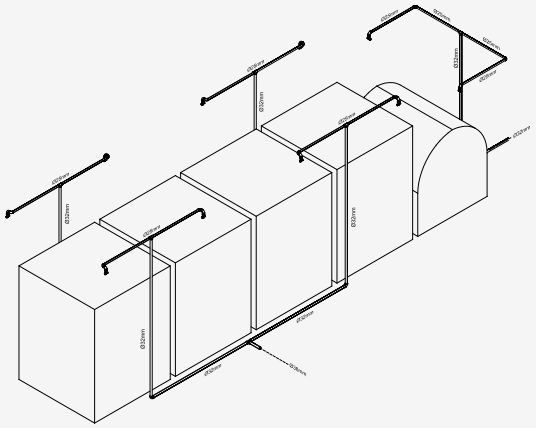


IMAGE HELIFUEL TANK

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5.0 LIFETIME FIXED PRICE MAINTENANCE

Fire protection designers now have an additional weapon in their arsenal of fire combat tools. The CAF technology is emerging as an environmentally friendly solution for protection of power transformers and other similar hazards. Our systems are fire tested and FM Approved, 100% specifically for oil cooled transformers. We do not work with selection valves but with durable fixed mixing chambers for every zone. So as long as the air, water and foam is at a fixed pressure, the foam mixing percentage will always be exactly as designed. The by the NFPA demanded monthly maintenance can be done from the onshore control room.

Our water and foam is not premixed so the quality will stay in good condition for 20-25 years. The above combination will reduce maintenance it's entire life span, so we are able to offer a fixed price for lifetime (20 years) maintenance.

ICAF Systems are very efficient at extinguishing transformer fires. Full-scale fire tests have demonstrated total suppression to be achieved three times faster than other system!

With ICAF Systems installed in offshore substations, energy companies can now better protect their investment while achieving quicker and total suppression in case of accidental fires.

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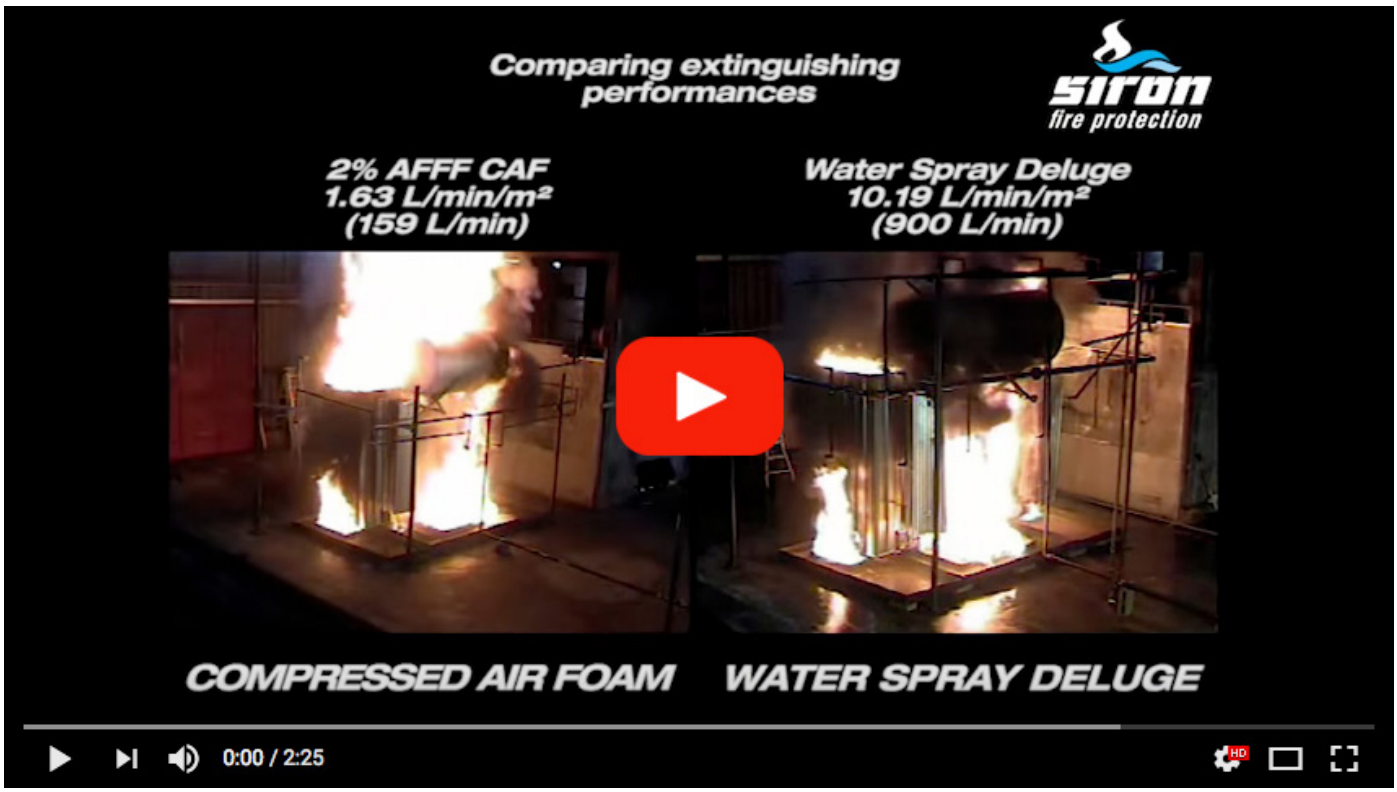
6.0 TRANSFORMERS TEST VIDEO

In the following video's the key features of Compressed Air Foam Systems are shown; using 4x less water and up to 6x less foam concentrate and reducing infrastructural requirements.

Water supply
ICAF Systems can eliminate or reduce the size of water supply tanks & fire pumps.

Drainage and containment
ICAF Systems can eliminate or reduce the size of drainage and containment systems including spill tanks and oil separators.

Disposal costs
The significant reduction in foam and water required for ICAF Systems reduces the costs associated to clean-up and disposal of foam during discharge testing or after a fire.



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