TWB Referat 5
CAFS Working Group

2017 CAFS Conference Copenhagen
CAFS Components and Functions
EN 16327 Requirements
Guidelines for Selection & Specification
Basic CAFS Principle
CAFS Function Schematic from EN 16327

- Fire Pump
- Compressor
- Mixing Chamber
- Foam Pump
- Foam Discharges

Q
Early CAFS Technology Development

- CAFS was originally developed after 1930, applications were in the petrochemical industry, Railroad and Marine
- CAFS foam production was a technically complex process, operating the technology was a challenge
- CAFS operation was simplified after 1990 by the development of electronic control-devices, and safety interlocks

The very first CAFS were developed by Engineers from Denmark in the 1930’s
Recent CAFS Technology Development

- CAFS Technology and related standards have developed significantly since 1990.
- CAFS today is fully integrated into the Fire Fighting Vehicle, the operation is no different than a Standard Fire- Pump.
What is putting the Fire out?

- **Magic:**
  Certainly not, as physical and chemical laws dictate the combustion- as well as the extinguishing process.

- **Facts:**
  The amount of materials involved in the combustion process and their heat release, will have to be compensated by the cooling process. The amount of water required for that process can be calculated. The variable is the efficiency of the water application: How much water does really get evaporated?

- **CAFS requirements are defined in EN standards.**
7 Minutes after Arrival
MAR, what is it, why is it important

- MAR stands for Minimum Application Rate
- It is defined as the least amount of water in l/min which has to be applied to a fire in order to achieve extinguishment
- Physically the amount of heat being removed by evaporation from a fire must be greater, than the amount of heat actually produced by a specific fire.
- Any Fire Attack with less water than the MAR will fail!
Cooling becomes visible!
The heat released from a fire must be compensated by the agent being evaporated. During an incident, a Fire-Officer needs to know what to expect from a certain system in terms of flow (performance). The graph indicates how much heat each system size is potentially able to compensate.
EN 16327 System Designations

<table>
<thead>
<tr>
<th>Short designation</th>
<th>Guarantee point 1 Nominal foam solution delivery rate at nominal proportioning rate of 1% l/min</th>
<th>Guarantee point 2 Nominal air delivery rate at normal condition l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAFS 200</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>CAFS 400</td>
<td>400</td>
<td>1200</td>
</tr>
<tr>
<td>CAFS 800</td>
<td>800</td>
<td>2400</td>
</tr>
<tr>
<td>CAFS 1600</td>
<td>1600</td>
<td>4800</td>
</tr>
</tbody>
</table>

- Guarantee point 1 is the liquid (solution) flow which can be transferred to heat-compensation.
- Guarantee point 2 is the air flow, which allows a certain expansion ratio to be achieved.
- The end-user should specify which of the available systems is suitable for the application.
NP Curve FPN 10-3000

TYPICAL PERFORMANCE OF P2_ 3010 PUMP
WITH 140mm SUCTION HOSE

FOR TEST CONDITIONS
SEE DS 474
Typical Compressor Drive
EN 16327 PPPS Requirements

The Systems are designed to handle 1% or less Foam Concentrates

There are Single- and Dual Tank Systems

Accuracy of Dosage is defined in EN 16327

Table 2 – Classification of positive-pressure proportioning systems (PPPS)

<table>
<thead>
<tr>
<th>Short designation</th>
<th>Guarantee point 1 (nominal foam solution delivery rate at nominal dosage ratio of 1 %) l/min</th>
<th>Guarantee point 2 (foam solution delivery rate at dosage ratio of 0,5 % at least) l/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPPS 200</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>PPPS 400</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>PPPS 800</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>PPPS 1600</td>
<td>1600</td>
<td>200</td>
</tr>
<tr>
<td>PPPS 2400</td>
<td>2400</td>
<td>800</td>
</tr>
</tbody>
</table>

NOTE 1 The values stated for guarantee point 1 are minimum requirements.
NOTE 2 The values stated for guarantee point 2 specifies the values above which foam concentrate is to be added. This ensures that an adequate dosage is achieved even for delivery rates lower than the nominal delivery rate (e.g., if only one nozzle/branch pipe is utilized).
EN 16327 Ratio Definitions

3.4 wet foam
operation defined by a nominal solution/air ratio between 1:3 and 1:10, being mixed in the system, with finished foam delivered from the system with an expansion ratio between 4 and 11

3.5 dry foam
operation defined by a nominal solution/air ratio greater than 1:10, being mixed in the system, with finished foam delivered from the system with an expansion ratio greater than 11
The manufacturer has to provide a diagram as shown above with the relevant data for the system.
Typical Mixing Chamber Arrangement

- The flow from the mixing chamber can be diverted to several outlets
Application: Wet & Dry Foam

when and what for?

Wet Foam:
- Falls under „Low- Expansion Foam“ per EN 1568
- For the actual Fire- Attack, the cooling capacity is proportional to the amount of liquid applied and evaporated

Dry Foam:
- Still falls under „Low- Expansion Foam“ per EN 1568, however the lower liquid content provides a reduced cooling capacity
- Dry foam may be used as a protective or final cover on objects to protect them from ignition or re-ignition
Wet Foam pressurized and under Atmosphere Condition

Based on nominal flow of a CAFS 800 and 7 bar operation pressure
Compressed Condition = inside the system, including hoseline
Atmosphere Condition = once left the nozzle
The compressed composition expands once released to atmosphere
Wet Foam Advantages

- Straight Stream provides long reach and mechanical impact. Extended reach = more safety for the Firefighter.
- Reduced weight of the hoseline allows easier advance and faster movements
- White surfaces indicate temperatures > visually easy to recognize
- More efficient use of agent and faster knockdown provide an positive balance for the environment
- If required, Spray Pattern still adjustable (with Fog Nozzles)
- No agent lost in the flame zone, structures are getting cooled, release of flammable gasses is getting reduced
- Dry Foam may be selected once final knockdown is achieved
Wet Foam: Typical Layer Thickness
vertical
Wet Foam from Fog- Nozzles

During CAFS Operation the air may displace approx. 30 – 50% of the rated flow. Nozzle must be capable and selected to flow at least 300 l/min of water!

The „Flush“ adjustment may provide the highest expansion ratio.

Automatic Nozzles may not work well or „Automatic“ must be deselected.

Foam Expansion Rate may be reduced vs Straight Bore Nozzle
Dry Foam Application requires a Straight-Bore Nozzle
Dry Foam pressurized and under Atmosphere Condition

Compressed Condition

Atmosphere Condition

Based on nominal flow of a CAFS 800 and 7 bar operation pressure
Compressed Condition = inside the system, including hoseline
Atmosphere Condition = once left the nozzle
The compressed composition expands once released to atmosphere
Dry Foam: Typical Layer Thickness vertical
Special Application Nozzles
Testing of the produced Foam per EN 1568

- Samples are being collected and their weight is checked against the volume
- This results in an expansion rate
Diagramm resulting from Expansion Rate Testing

Blue = Produced Foam
Green = adjusted Ratio
The Dry Setting from the previous graph was re-tested with 1% Injection Rate vs 0.5%
EN 16327 Safety Requirements

The system and the associated installation shall then remain in a safe condition to ensure that further extinguishing operation with water with sufficient water pressure and water flow at the discharge is maintained.

Following modes shall be provided in case of system failures or operator error:

— Failure of CAFS: continuous operation with foam solution via PPPS;
— Failure of PPPS: continuous operation with water via fire-fighting pump.

Complete blockage of the water flow by malfunction of PPPS or CAFS shall be avoided by appropriate means. If CAFS air injection fails, any throttling of foam solution flow rate shall be automatically cancelled.

To permit safe continuation of a fire-fighting operation, the water flow rate shall meet the requirements in Table 3.

- 10 bar is the max. Operation Pressure per EN 16327, 7 bar the most common operation pressure in the field
In conjunction with:

- FPN 10-2000
- FPN 10-3000
- FPN 10-4000
- FPN 10-6000

Per EN 1028

Also comprising optional:

- FPH 40-250
Simplified Operation due to Presets

Water flow display

155
Necessary interference still possible
Determinations to be made and their documentation

- Fire Pump Designation per EN 1028
- CAFS Designation per EN 16327
- PPPS Designation per EN 16327
- Number and Size of Outlets
- Size of Foam Tank(s)
- Single or Dual Foam Tanks

**Pump Curve**
**CAFS Working Range Diagramm**
**PPPS Working Range Diagramm**
Hoses leak, Hoses burst?
- Minor leaks become visible, Hose bursts may cause a more volatile reaction, but still no issues if Safety Precautions considered

Hoses fail due to Heat Exposure?
- Extensive research conducted. No different to water up to 500°C ambient temperature. Between 190°C and 400°C the CAFS Hose may fail after 20 minutes static condition while a water hose may last. Better Hose- Qualities can compensate.

Dry Risers?
- Wet Foam required for Fire Fighting, 200 l/min (liquid) used up to 120 m elevation.

Pulsing possible?
- Yes
Thank You!
Any Questions?