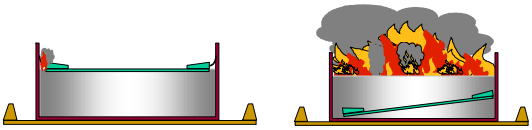
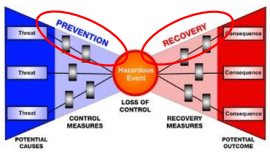
The Organisation

A consortium of international oil companies developing best industry practice in storage tank Fire Hazard Management through operational feedback, networking, incident analysis and research



Fire Hazard Management



Both sides of the bow tie!

www.lastfire.org.uk

Current Members

Full members

Associates

Project Coordinator

www.lastfire.org.uk

Overview of Foam Development to Present Day

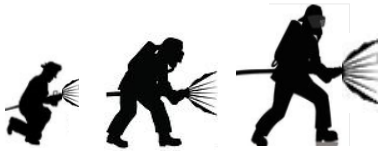
Dr. Niall Ramsden
ENRg Consultants
LASTFIRE Project Coordinator
niall.ramsden@lastfire.org

Niall Ramsden

- **Previously with foam manufacturers**
- **Independent consultant since 1990**
- **NFPA 11 Committee**
- **EN13565 Part 2 Committee**
- **NFPA 30 Committee (Past)**
- **Etank fire Project involvement**
- **Energy Institute Process Safety Committee**
- **Extensive experience of running different fire performance tests and demonstrations.**
- **LASTFIRE Coordinator**
- **Adviser at Buncefield Terminal event**

"Incident Commander (White surcoat) consulting industry expert and bronze commanders." Photograph and comment from official HFRS Incident Report. Industry Expert – Niall Ramsden

The evolution of fire fighting foam
Niall Ramsden



How did we get where we are today?

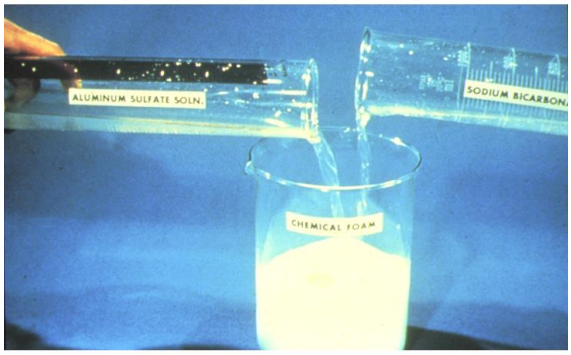
"Class B" Foams

Flammable Liquid Fires

A very old picture!!
~1980
Still very relevant

If you believe Wikipedia!
1902
Aleksandr Loran
Tested first foam

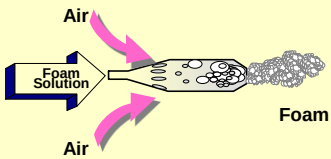
Chemical Foams



Chemical Foams

Mechanical Foams

Produced by mechanical action mixing air with foam solution



The names you hear

Protein

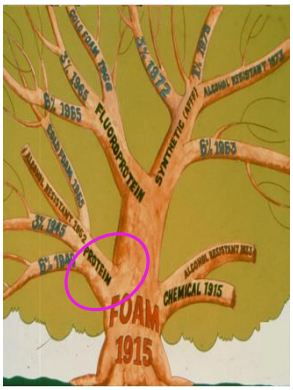
Fluoroprotein (FP)

Aqueous Film Forming Foam (AFFF)

Synthetic Detergent (Syndet)

Film Forming Fluoroprotein (FFFP)

Multi – purpose (Alcohol Resistant) Fluorine Free



"Mechanical Foam"
~1940

Based on protein source

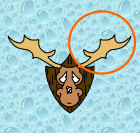
Protein

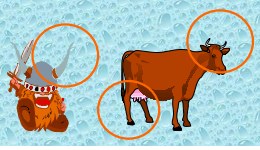
Many sources available

but quality & consistency important

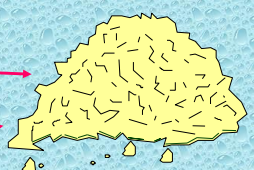
Protein

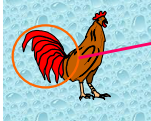
Collect the raw material

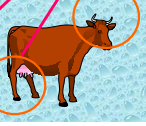




Protein

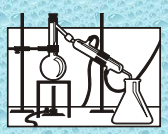






Protein

Hydrolysis

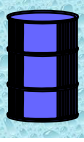


Protein liquor

Protein

Protein liquor

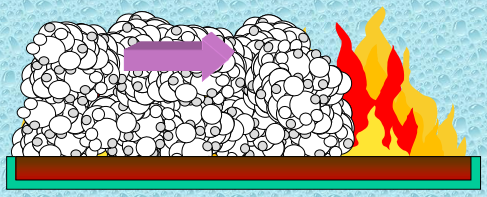
Stabilisers
Biocides
Corrosion inhibitors
Etc.



Protein foam concentrate

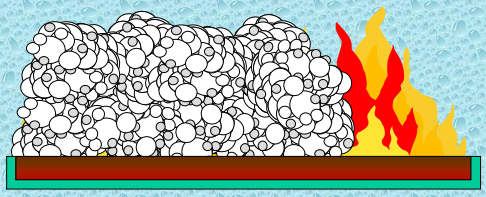
Protein

Thick, stable, slow moving blanket

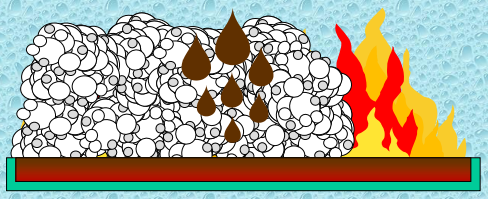


Protein

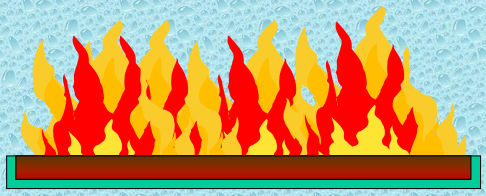
No fuel tolerance so had to be applied very gently



Protein



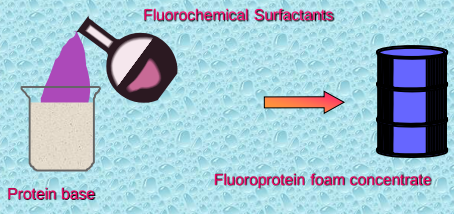
Protein



Fluorosurfactants 1960s
Fluoroprotein foam
Well established technology

Fluoroprotein

Derived from Protein base
+
Fluorochemical Surfactants



Fluoroprotein

What do fluorochemicals do?

Modify bubble surface properties to:-

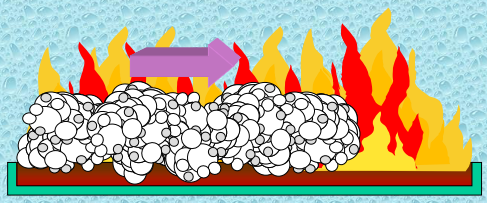
Shed fuel

Flow more readily

"Teflon coats" the bubbles

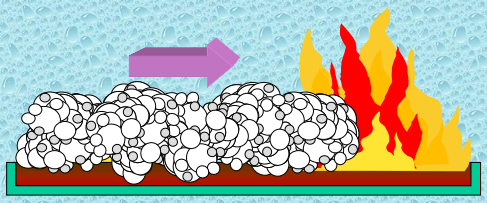
Fluoroprotein

Faster moving blanket



Fluoroprotein

Still not fast enough for some!



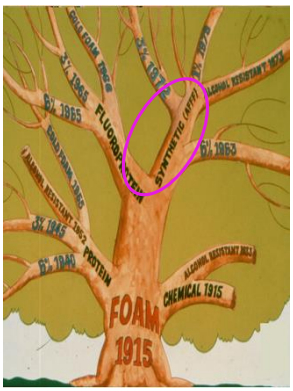
Aqueous Film Forming Foam (AFFF)

Developed to meet a perceived need for faster fire control

United States Navy

Wanted a faster knockdown foam

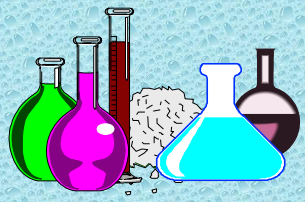
For rapid rescue situations such as aircraft carriers



AFFF 1960/70s

Aqueous Film Forming Foam (AFFF)

A blend of synthetic chemicals



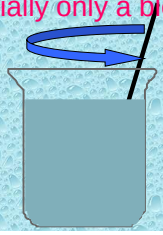
Aqueous Film Forming Foam (AFFF)

A blend of synthetic chemicals

Aqueous Film Forming Foam (AFFF)

No process plant required

Essentially only a blending plant



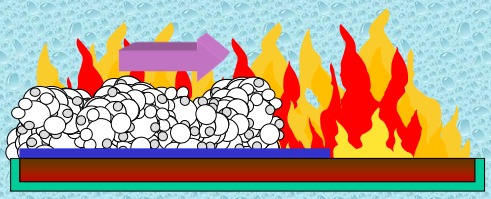
and a

GOOD

recipe

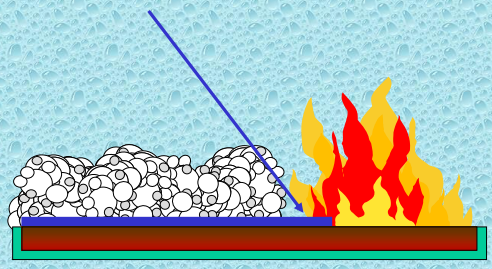
Aqueous Film Forming Foam (AFFF)

Thinner fast flowing blanket blanket



Aqueous Film Forming Foam

Film of foam solution



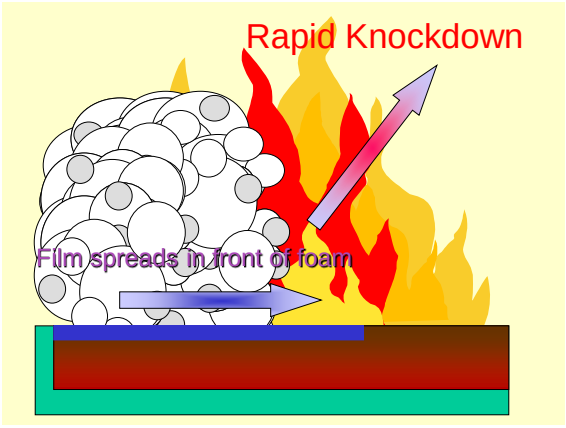
Aqueous Film Forming Foam (AFFF)

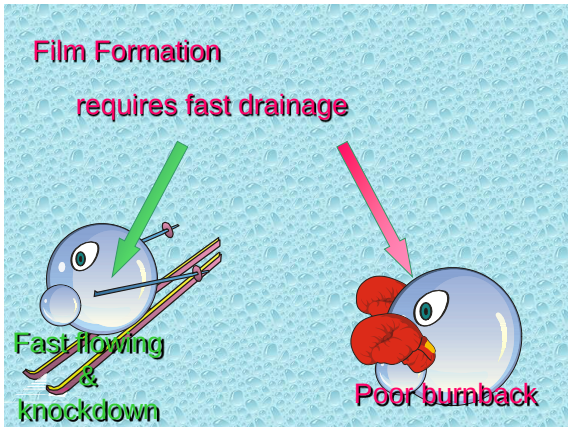
Water floats on fuel?

What causes the Aqueous Film?

Fluorochemical Surfactants

(Fluorosurfactants)





AFFF

Good marketing!!

- Is it really ideal for everything?

No!!

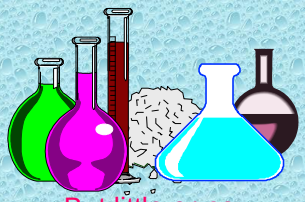
- Generally poor burnback and heat resistance

Applications

- Spill fires
- Rescue situations
- "Pure AFFF" not ideal for tank fires

Synthetic Detergent

A blend of synthetic chemicals



But little or no
fluorochemical surfactants

Synthetic Detergent

Generally intended for
High Expansion use

Film Forming Fluoroprotein (FFFP)

A film forming concentrate based on protein

An attempt to combine the best properties of an AFFF with those of a Fluoroprotein

Film Forming Fluoroprotein (FFFP)

Ultimately high fluidity requires fast draining foam, burnback resistance requires slower draining foam

Therefore always some compromise

Multi-purpose AFFF
AFFF AR
1970s

Multi-purpose Foam

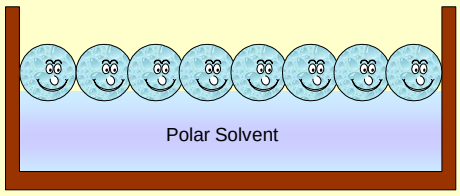
Polar Solvents

Water soluble

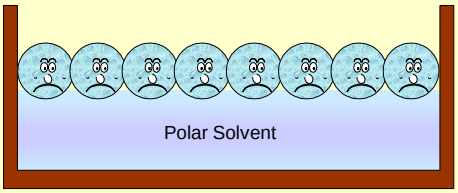
Destroy "Standard foams"

Multi-purpose Foam
Can be used on
Hydrocarbons
&
Polar Solvents
Often referred to as
"Alcohol Resistant"
Foam

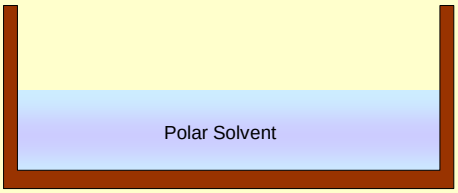
Standard Foam



Standard Foam

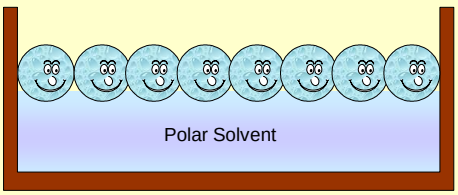


Standard Foam

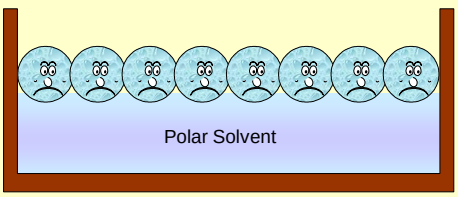


"Polymer Layer" Mechanism

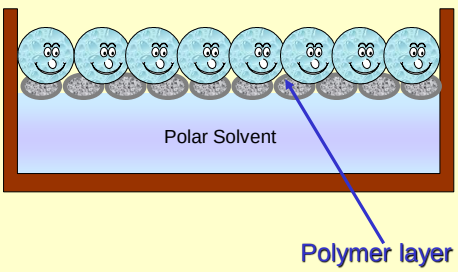
Multi-purpose Foam



Multi-purpose Foam



Multi-purpose Foam with polymer



Multi-purpose Foam

Polymer content makes concentrate viscous and "Non Newtonian"

Could cause problems with proportioning

Multi-purpose Foam

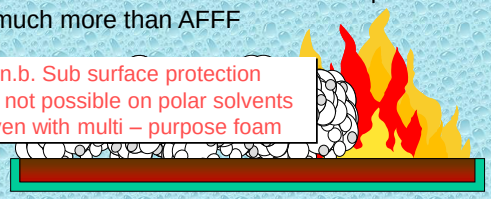
Polymer content can be prone to separation in freeze-thaw cycles

Multi-purpose

Tends to be faster flowing than Fluoroprotein but slower than AFFF

Burnback Resistance less than Fluoroprotein but much more than AFFF

n.b. Sub surface protection still not possible on polar solvents even with multi – purpose foam



So good for tank fires etc!

Property	P	FP	AFFF	SD	FFFP	MP
Cohesion	****	***	**	**	***	***
Vapour Suppression	****	****	**	**	***	****
Stability	****	***	**	**	***	***
Flowability	*	**	****	***	***	***
Heat Resistance	****	****	**	*	***	***
Resilience	****	****	**	*	***	***
Burnback	****	****	**	*	***	****
Fuel Tolerance (Hydrocarbons)	*	***	***	*	***	***
Fuel Tolerance (Polar Solvents)	O	O	O	O	O	***

Possible but not guaranteed

You need a good formulation!!

May 16th 2000, 3M announced withdrawal from market due to possible environmental and health effects of their fluorosurfactants (PFOS)

Major impact on industry

Focus on environmental issues

Hence:

- Fluorine Free
  - Different mechanisms
- Lower chain length surfactants
- Are they equivalent?

LASTFIRE

- Tank Fires
- The LASTFIRE Test
- A very special and critical application
- Not seeing previous levels of performance in tests
  - Flash over full surface
  - Salt water issues
- Commercial pressure?
- Formulation changes?
- Other, general application tests, less critical
- Do not show up differences
- Different industries have different emphasis
- Need greater industry input!

Current situation?

- Rapidly changing situation
- No “ideal” truly universal foam
- No “drop in” replacement yet for every application
- Everything has some environmental effect
- Perhaps different application techniques!

Expertise
Optimised Formulations
Physical Properties
Proven Performance
Experience
Built up over a long period

What do we need to know if we have to change?
FF or C6 or anything else!
We need to get the same information and experience but quickly!

We have been through the problems before

Will the foam proportion correctly?

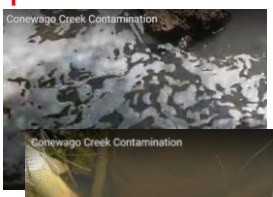
We have been through the problems before

Will the foam concentrate be stable?
Will it degrade?
Accelerated ageing?

We have been through the problems before

Storage material, pipework, valve seats, etc

We have been through the problems before



Health and Environmental Effects Data

CERTIFIED

It takes time
It is expensive

We have been through the problems before

Long term availability?
Future additional restrictions?

We have been through the problems before

If you have to change
- Procedures
- Criticality of cleaning
- Disposal of old foam?

The Future?

- Increasing controls
- Further developments
  - Application Rates/Equipment/Techniques
- "Cradle to Grave" approach
  - Containment
  - Control
  - System Assurance
  - Training
  - Disposal
- Don't rush into change!!

But we might have to!

A crisis?
No - an opportunity
Fresh thinking!
Cradle to Grave Approach
Not just actual use
- Training
- Testing
- Containment
- Disposal

LASTFIRE
Large Atmospheric Storage Tank Fires

Developed an Assurance Protocol

Looking forward to the event!