ES&S Expertise
Vulcan Foam Replacement program

Being Brilliant @ the Basics

"We can only be Brilliant @ the Basics,
if we spend time and efforts on the details"

April 2025

PROJECT VULCAN – GLOBAL FOAM REPLACEMENT PROGRAM

- Scope: replace all existing PFAS/PFOA/Fluorine containing fire fighting foam (AFFF) with Fluorine Free Foam (FFF).
- Global Program with corporate funding,
- Selection of effective FFF formulations for broad spectrum of HydroCarbons and Polar fuels,
  - Application for fire extinguishment and vapor suppression.
- Define application techniques, translated in design of fixed and mobile response equipment and tactics,
- Objectives:
  - Select foam formulations with effective performance that do not need modification of system components or upgrade of system capacity (drop-in principle),
  - One foam to do the job for large sites with diversity of chemicals,
    - ✓ Exceptions to be defined based on proven challenges related to efficacy.
- Just in Time implementation: start change-out for a specific site 9 months before regulations come into force. Regulations can be:
  - Banning use of AFFF,
  - Restricting use of AFFF or requiring significant action for remediation after use of AFFF (cost effect of use).

History in Foam selection and Development

- Journey started in 2010 in Terneuzen, the Netherlands:
  - Used moment of PFOS ban to move to FFF,
  - Started foam testing of FFFs in 2010 to select one fluorine free foam for a large integrated site,
  - Changed out in 2011, 200,000 liters of concentrate.
- 2014; Conducted new sequence tests for implementation on a Middle East site.
- **Corporate Program Vulcan** kicked off in 2020,
  - ES&S conducted over 350 live fire tests on different fuels and using different application techniques,
    - ✓ Using certification protocols with added Dow ES&S functional requirements for fire extinguishment and vapor suppression performance.
  - Dow ES&S and R&D have been involved in two parallel Foam development projects:
    - ✓ DIS with 3rd party to develop and market foam,
    - ✓ DCS R&D supporting 3rd party to improve efficacy to meet Mill Spec for certification,
    - ✓ Both projects were discontinued due to commercial/contractual context.
  - ES&S Expertise has selected two commercially available foams for change out:
    - ✓ Both have proven efficacy on hydrocarbons and polar chemicals used in Dow,
  - Chlorosilanes chemistry has been challenging for foams to perform and be effective:
    - ✓ Need for a special designed formulation and most probable specific application technique.

Basic Principles for Foam Replacement

Objectives:

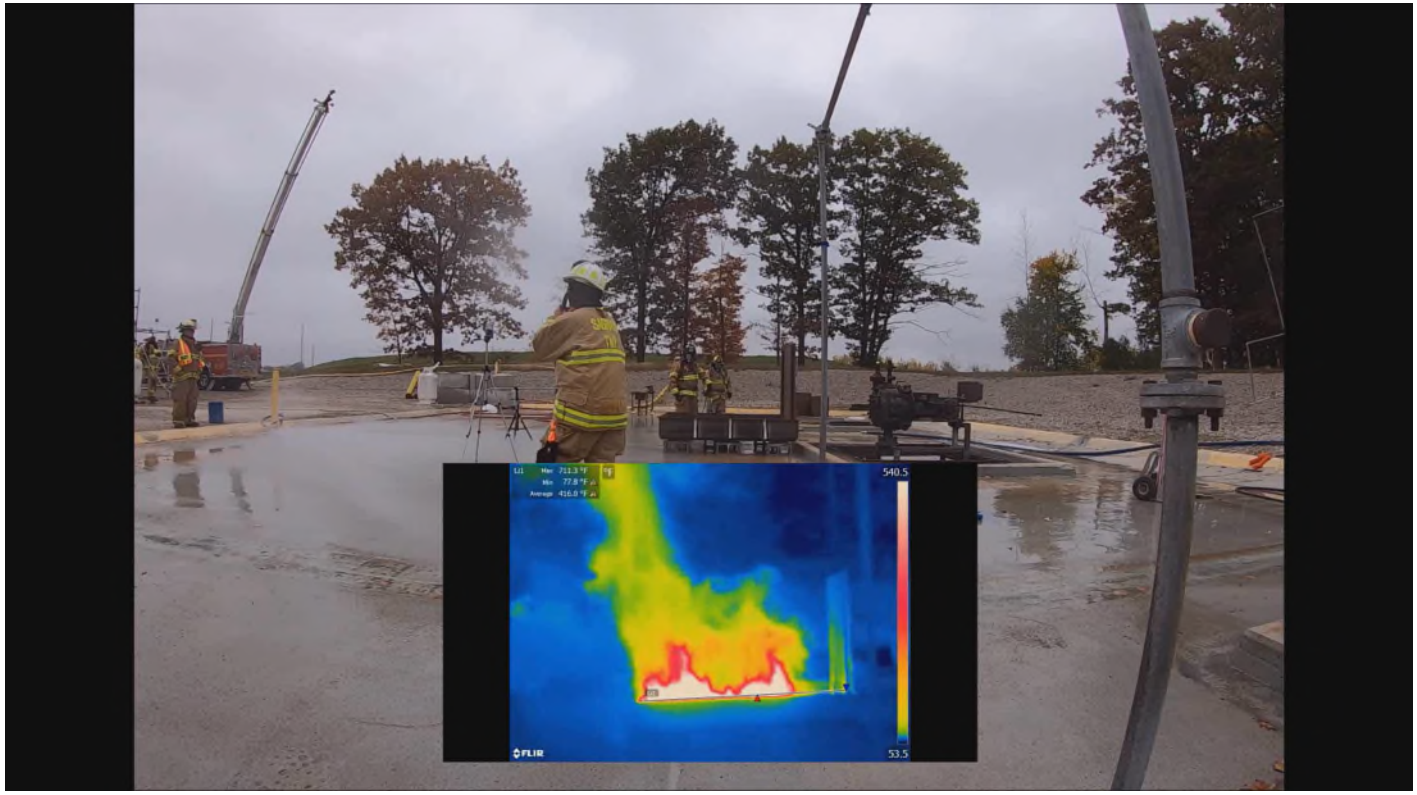
- One foam for a single site, good performance on hydrocarbons and polar fuels,
  - Exception for defined group of specialty chemicals.
- Foam needs to perform as drop-in solution; no upgrade in concentration, application rate, equipment/components design, good performance in stationary and mobile application,
- Meet performance criteria set by Dow ES&S Expertise:
  - UL162/EN1568 testing scheme +
  - Quick spread over liquid pool to get quick heat knock down +
  - Good vapor suppression in fire and liquid spill scenario: maximum 10 ppm vapor pass through +
  - Can withstand aggressive torch test +
  - Full re-healing/sealing of foam blanket after stove pipe test or blanket disruption +
  - Foam blanket stability proven for longer than 30 minutes +
  - Application according to current fire protection system design and using regular components +
  - Performs with fresh and salt/brackish water.
- Full Green Screening certification: concentrate not harmful to human health and organisms living in natural water sources.

Visualization of Testing; From UL162 to Handline application

50 ft2 pan – Dow test set up

230 ft2 T- pan – Dow test set up

Measuring and Reproducing testing



50 ft2 pan – Methanol fire

From Small to Large and from Fire to Hazmat

50 ft2 pan Chlorosilanes testing

Dow Foam School at LSU,
1000ft2 full surface tank fire

From Designed Test nozzle to Realistic Sprinkler Application

50 ft2 pan Sprinkler rack testing

Re-ignition test after extinguishment

Realistic 230 ft2 in T shape pan Fire for Handline application

230 ft2 T-pan on fire

1000 FT2 FULL SURFACE TANK FIRE EXTINGUISHMENT WITH 1 HANDLINE

2023 Dow Foam School – 1000 ft2 full surface tank fire extinguishment @ 4 times speed

Foam replacement program Management of Change approach

- Build overview of foam systems, mobile equipment and inventory of foam:
  - Including information on current foam brand/type/quantity, scenario, concentration, application rate, fuel, contamination risk (to open water),
  - 86 sites, over 500 “systems”, 130 fire trucks, 90 inventory locations,
  - 465,000 gallons (1,760,000 liters) of concentrate,
- Defined corporate funded (capital and expense) program for financial funding and prioritization.
- Developed common scope per type of system for:
  - Spill containment, clearing and waste packaging,
  - Clean out/rinsing,
  - Replacement of key components (bladder, proportioner*, carbon steel concentrate lines),
  - Installation of test connection,
  - Filling of system,
  - Re-instatement and testing protocol,
  - Waste disposal.
- Defined site engagement protocol and RACI for activities:
  - Site based project approach with local resources.
- Developed Just-in-Time change out approach: kick off 9 months before regulations come into effect.
- Global procurement strategy and contracts for foam concentrate.

Project Preparation and Execution

- Four project phases for a site:
  1. Project Scoping and Capital/Expense planning,
  2. Site scope preparation,
  3. Execution,
  4. Close out and Evaluation.
- RACI approach to assign roles and responsibilities on site, regional, corporate. Project Vulcan Site engagement RACI
- Conduct site visit for local team kick off, introduction, scope review, role assignment, SiteName Foam systems site review scope
- Capital and Expense project gate 13 authorization review to allocate funds from corporate program to business/plant.
- Expertise/Techcenter review process for exemptions to common approach, technology and foam selection.
  - Global Fire Protection Engineering partner selected and assigned for specific design reviews for exceptional cases (mainly storage tank/tank farm related applications),

Program Learnings

- FFF works with much lower expansion ratio (7 or 8:1 instead of 20:1),
- Application technique for FFF is more critical than with AFFF due to absence of film layer,
- More than 20 different foam concentrates in use, mainly based on local marketing & sales,
- Knowledge of fire protection systems is low, organization depends on local fire protection system supplier knowledge and supply,
- Lots of biased opinions, based fairy tales and disbelief in foam market,
- Experience with fire fighting foam has diminished due to restrictions for use,
- Schooling of incident commanders and fire fighters needed for understanding of critical parameters for effective foam application:
  - Implemented Foam schooling for these roles; from lab scale introduction of fuel and foam parameters to full scale tank fire foam application,
  - Explain and show difference in how FFF works vs AFFF and important performance factors,
  - Train/explain designed functionality of fixed system vs mobile response:
    - ✓ Immediate vs emergency response, task-time diagram, critical application techniques,
- Set up a Dow Tank Fire Task Force:
  - Consistent pre-planning, development of tactics and selection of equipment,
  - Act as sub regional support network in knowledge and response capability,

Seek

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