



Large Area Storage Tank Fires Require Strong
AR-AFFF Agents as Defined by LASTFIRE

Dr. Kirtland P. Clark
VP of R&D
Chemguard, LTD

3rd Reebok Foam Seminar September 3&4 2007

**Large Area Storage Tank Fires (LASTFIRE)
Must Be Fought With Premium Foam Concentrates**



LASTFIRE Test Protocol

- Protocol developed by Resource Protection International (RPI) under the sponsorship of BP.
- Designed to identify factors important in evaluating and choosing fire extinguishing foam concentrates acceptable for Large Storage Tank Fires (LASTFIRE).
- Examine three methods of delivering foam to the tank fire.
- Evaluate storage and handling of foam concentrates to assure acceptable performance.

Preburn period



Starting foam application (using the semi-aspirated monitor nozzle in this case)



**System Nozzle
2.50 lpm/m² Rate**



Aspirating Monitor Application 3.63 lpm/m² Rate

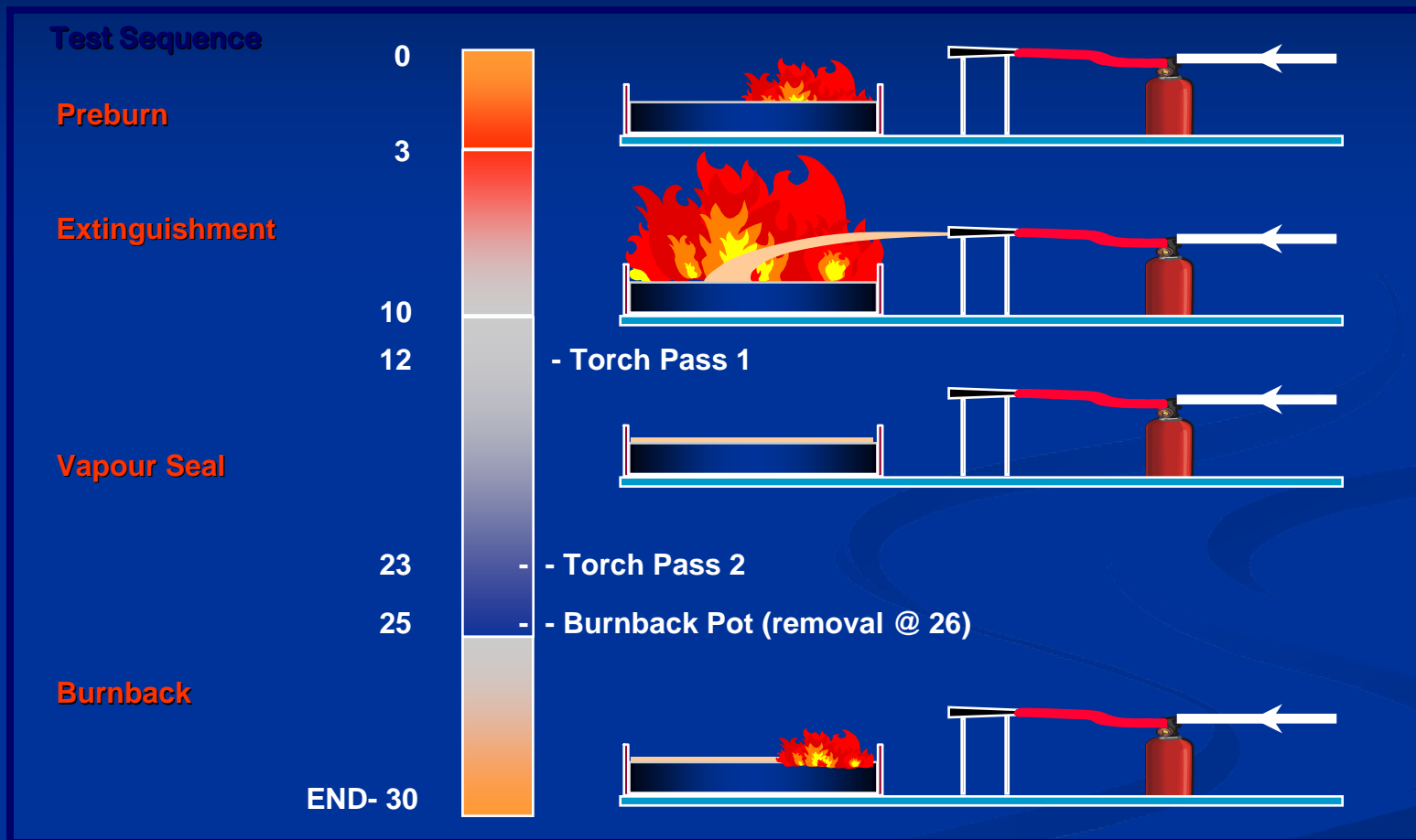


Taken from LASTFIRE report; September 2002

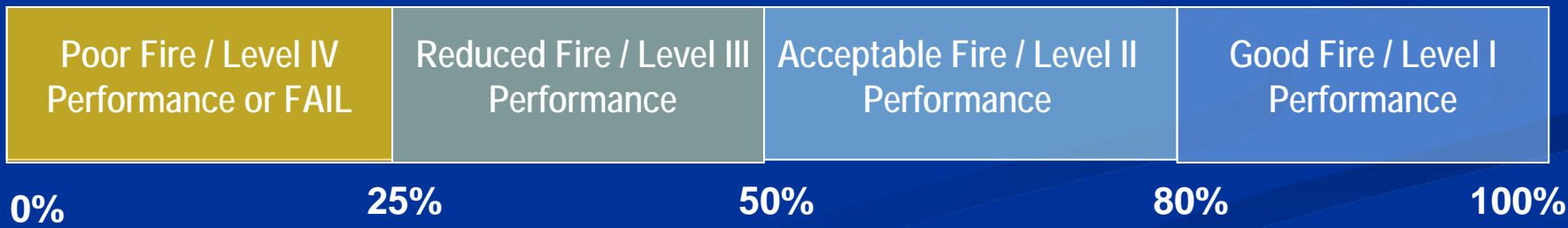
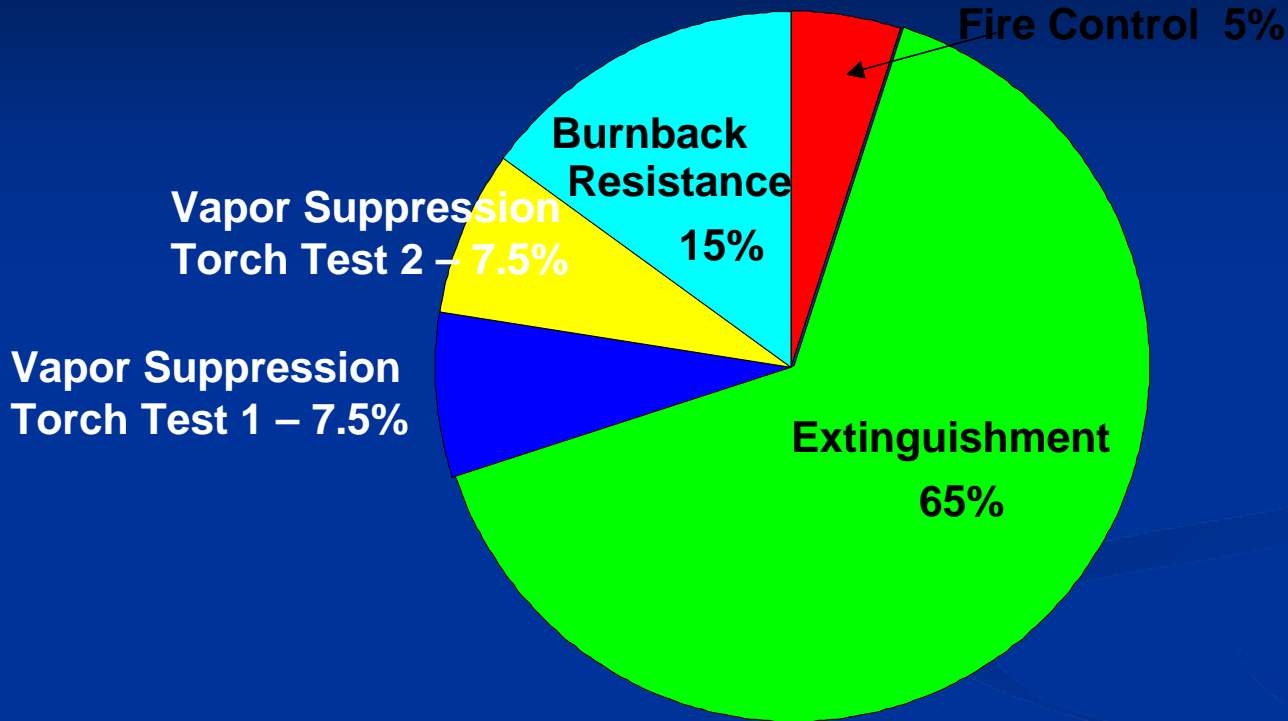
Semi-Aspirating Monitor Application 3.74 lpm/m² Rate



Schematic of LASTFIRE test sequence



Relative Importance of LASTFIRE Test Fire Performance Criteria (Developed from poll of end users)



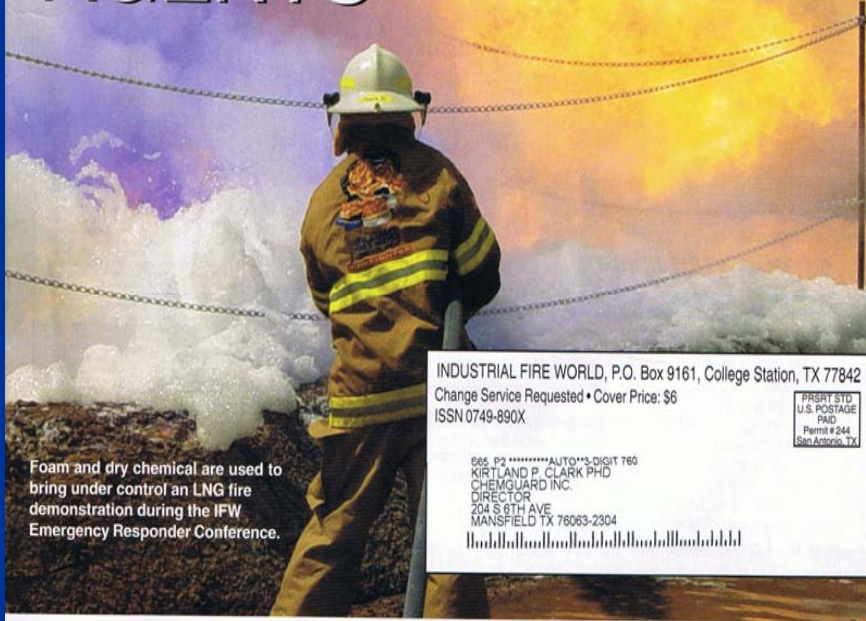
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FOAM & OTHER EXTINGUISHING AGENTS



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KIRTLAND P. CLARK PHD
CHEMGUARD INC.
DIRECTOR
204 S 6TH AVE
MANSFIELD TX 76063-2304



Foam and dry chemical are used to bring under control an LNG fire demonstration during the IFW Emergency Responder Conference.



Photos by David White

Flames rise inside Chemguard's test building in Mansfield, TX. Chemguard Brings LASTFIRE Testing to U.S.

PRODUCT PERFECT



Consultant Richard Coates times the effectiveness of the Ultraguard 3% x 3% in live fire tests.

20 INDUSTRIAL FIRE WORLD

In August, the last thing on the mind of most Texans is building a fire indoors. The temperature in Mansfield, Texas, home to fire suppression foam manufacturer Chemguard, averages 96 degrees F that time of year. Last year was significantly above average. Still, Chemguard needed to build an indoor fire in a round 50 square foot pan several feet deep in heptane.

Required as part of an international test protocol, a fire like this would typically have been built in a far more frigid climate than Texas, said Dr. Kirtland Clark, Chemguard's Vice President of Research and Development.

"This is the first time these fires have been run indoors," Clark said. "It's also the first time the fires were run at atmospheric temperatures of 100 degrees and above. All the other fires have been done in the U.K. or in northern Norway."

Even the fuel temperature and water temperature used were higher than what is normally indicated in the LASTFIRE tests. As if that was not enough, some of the tests were conducted with the overhead door of the massive test building shut tight.

All this simply added another hurdle that the Chemguard AR-AFFF product, Ultraguard 3% x 3%, easily cleared. Eleven batches of fire fighting foam totaling 50,000 gallons were approved for sale to a Middle Eastern country who ordered the testing as a condition of purchase.

LASTFIRE (Large Area Storage Tank Fire Protocol) was developed as a test to assess the capability of a foam to achieve the special performance characteristics relevant to large storage tank fire fighting. The test serves as a standard for this severe application and has been included as a requirement in foam concentrate procurement specifications by major international oil companies.

Richard Coates with U.K. based Resource Protection International, a consulting firm specializing in fire and explosion management, provided third party supervision of the cradle-to-grave testing process. Coates formerly served as the Chief of Fire Protection for BP Corporation.

Typically, manufacturers test their products by submitting samples to a separate location where testing is conducted. However, in this case, the entire production process was monitored by Coates at one location. He sampled the foam as it came out of the blender, pulling out the batch that was tested on the fire. At no time was the material outside his ability to control.

The fire test burns were conducted by Chemguard's senior and very experienced foam chemist, Randy Hendricksen, who himself checked every aspect of the tests from initial blending to the detailed laboratory analysis of every separate batch, Coates said.

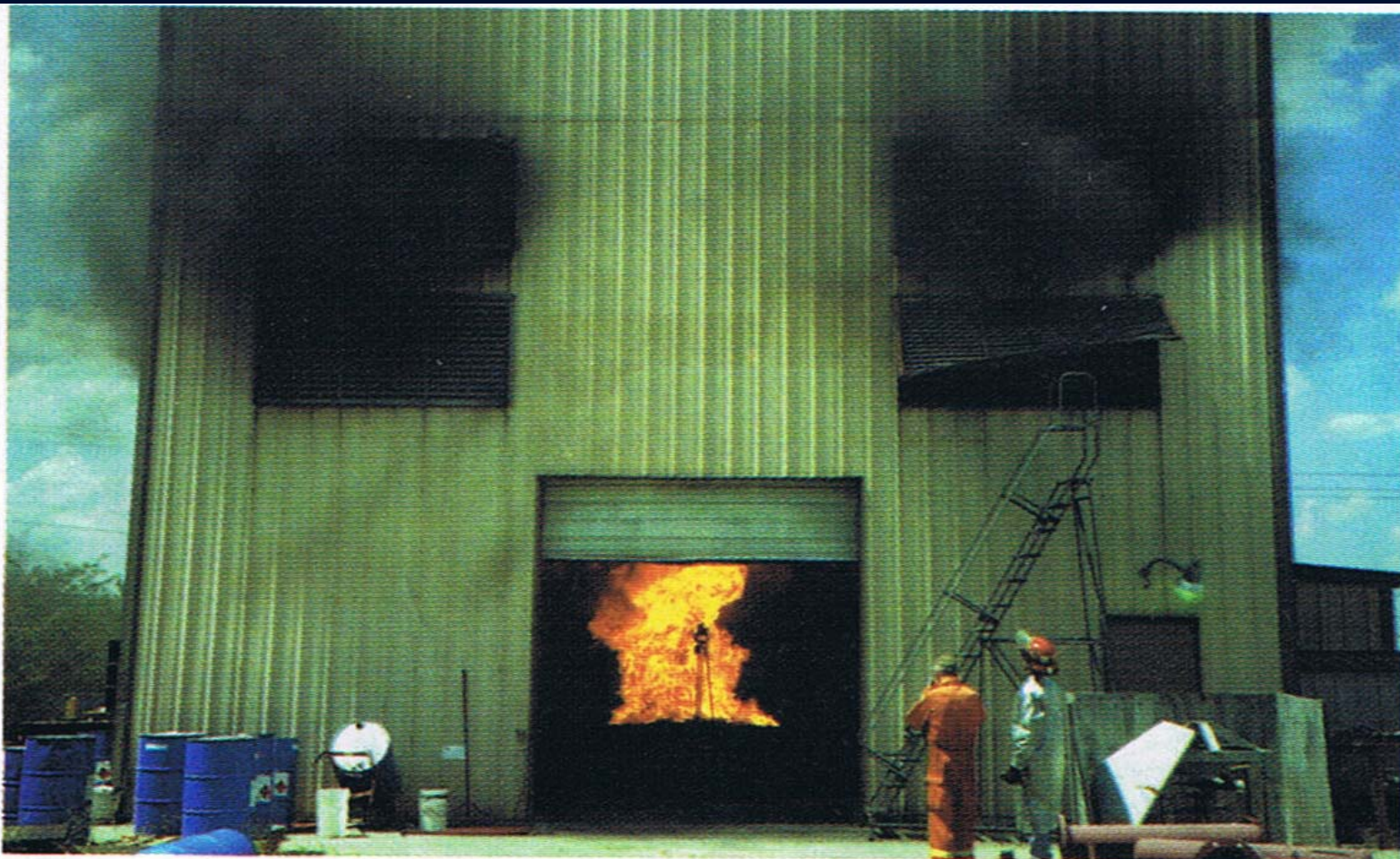
"Randy is a consummate professional," Coates said "It was no surprise that while I was at the plant over two weeks, Randy received telephone calls from people both in and outside the USA requesting technical advice on foam and their chemical products."

The actual test is conducted under equally rigorous conditions. A separate LASTFIRE test is conducted for each of the three categories of nozzles used - aspirated, semi-aspirated and a system nozzle that is the equivalent of a foam chamber/pourer. First, the pan is ignited and allowed to burn for three minutes. From a fixed position, a stream of foam is shot into the center of the burning pan for

LASTFIRE Testing of CUG (3X3) Production August 2006

What is meant by “Product Perfect”?

- 11 Consecutive batches of CUG were produced and tested under Resource Protection International (RPI) monitoring by Richard Coates.
- Tests were run indoors with and without the overhead door open.
- Tests were run in Texas in August while ambient temperatures were as high as 110F.
- 30 of 33 tests were Good/Level I and 3 tests were high Acceptable/Level II.



Photos by David White

Flames rise inside Chemguard's test building in Mansfield, TX.

Chemguard Brings LASTFIRE Testing to U.S.



Consultant Richard Coates times the effectiveness of the Ultraguard 3% x 3% in live fire tests.

LASTFIRE RESULTS – ASPIRATED NOZZLE

11 Batches of CUG (3x3) Verified by Richard Coates of RPI

Tap Water and Time in Seconds from Foam On



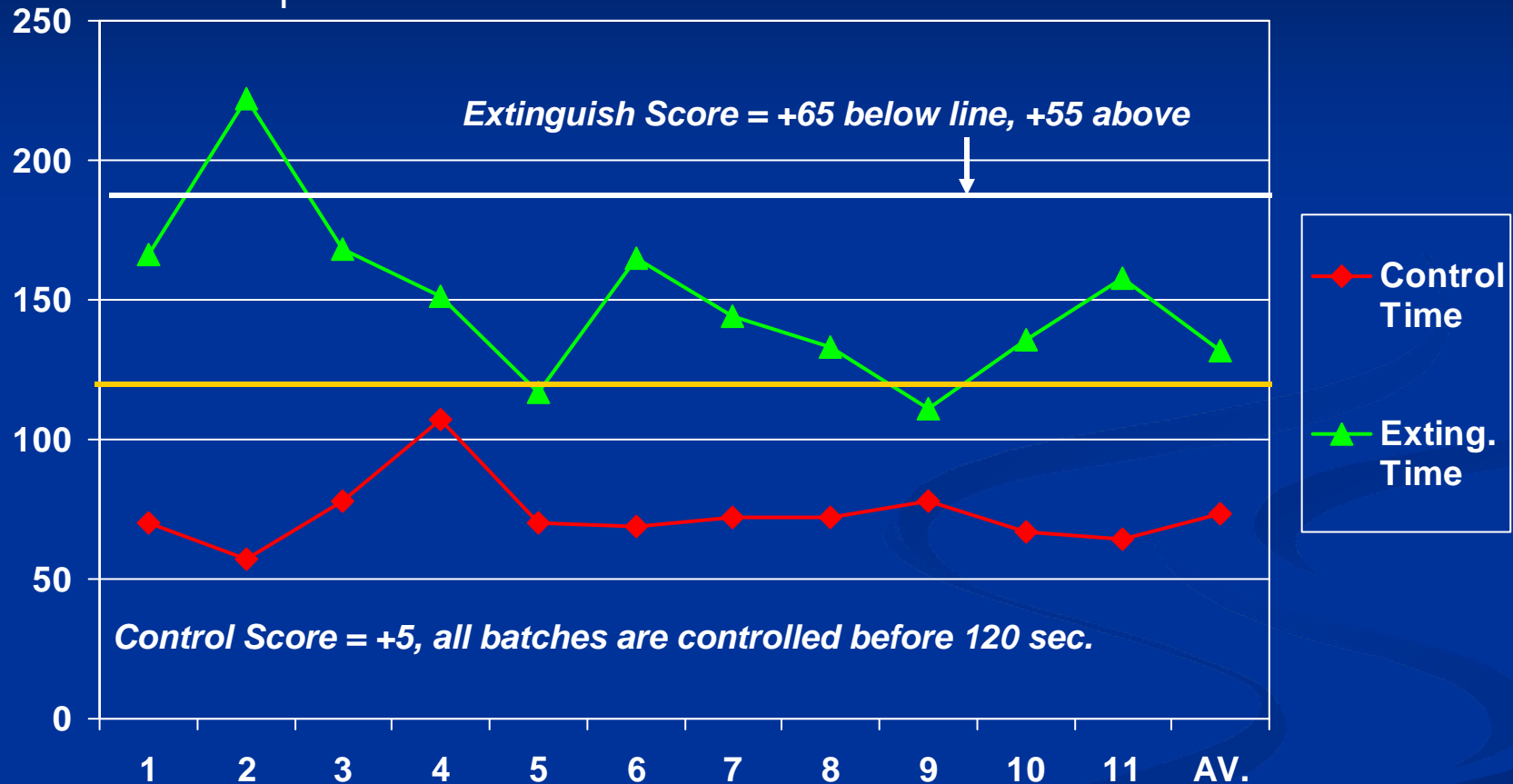
For Exting. and Control all 11 Batches = 70 points, the maximum

Total Score: 10 = 100% and 1 = 97.5%, Average = 99.8%

LASTFIRE RESULTS – SYSTEM NOZZLE

11 Batches of CUG (3x3) Verified by Richard Coates of RPI

Tap Water and Time in Seconds from Foam On

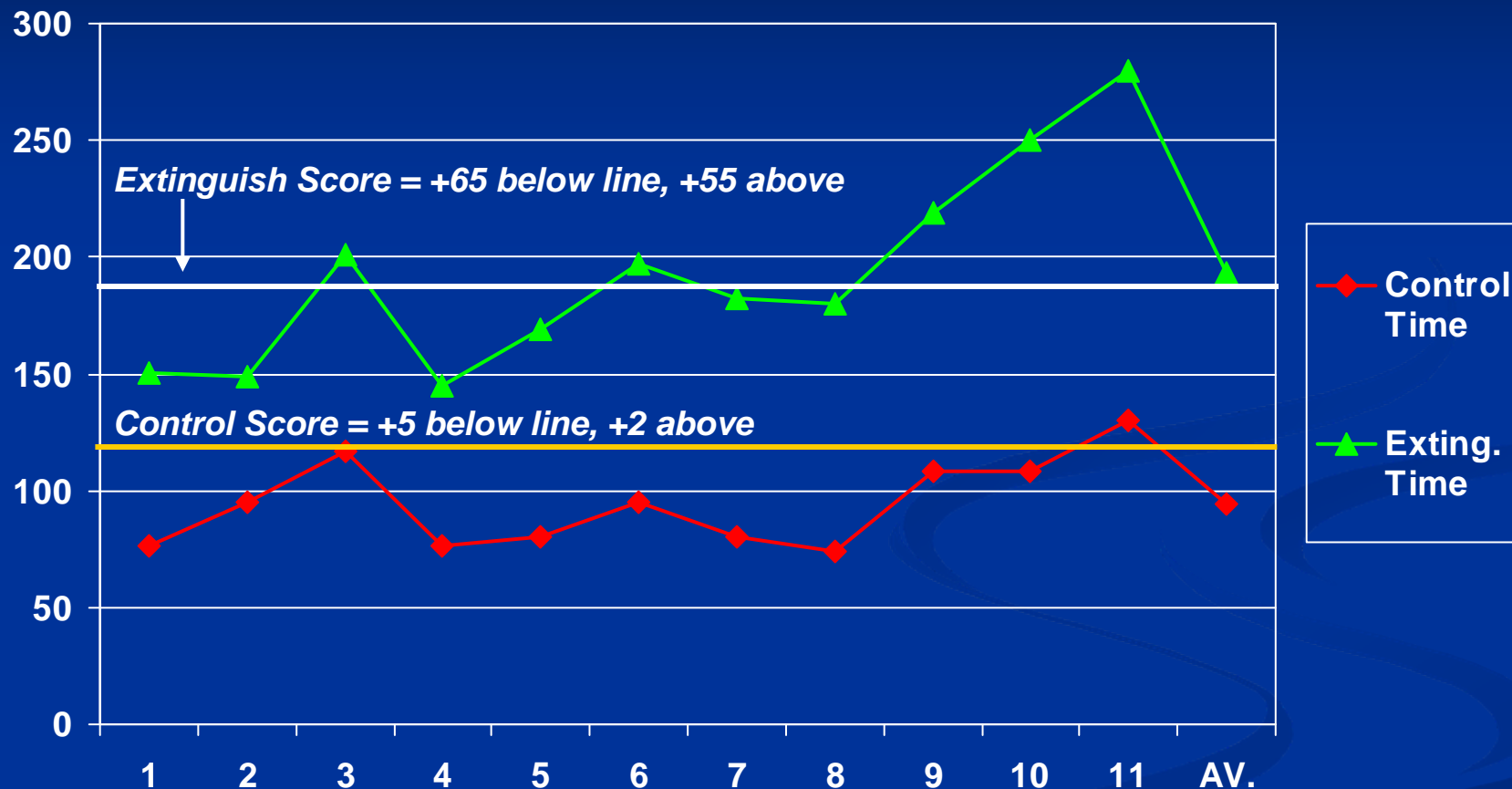


For Exting. and Control 10 Batches = 70 and 1 Batch 65 points

Total Score: 1 = 100%, Lowest 2 = 75%, Average = 85.6%

LASTFIRE RESULTS – SEMI-ASPIRATED NOZZLE

11 Batches of CUG (3x3) Verified by Richard Coates of RPI
Tap Water and Time in Seconds from Foam On

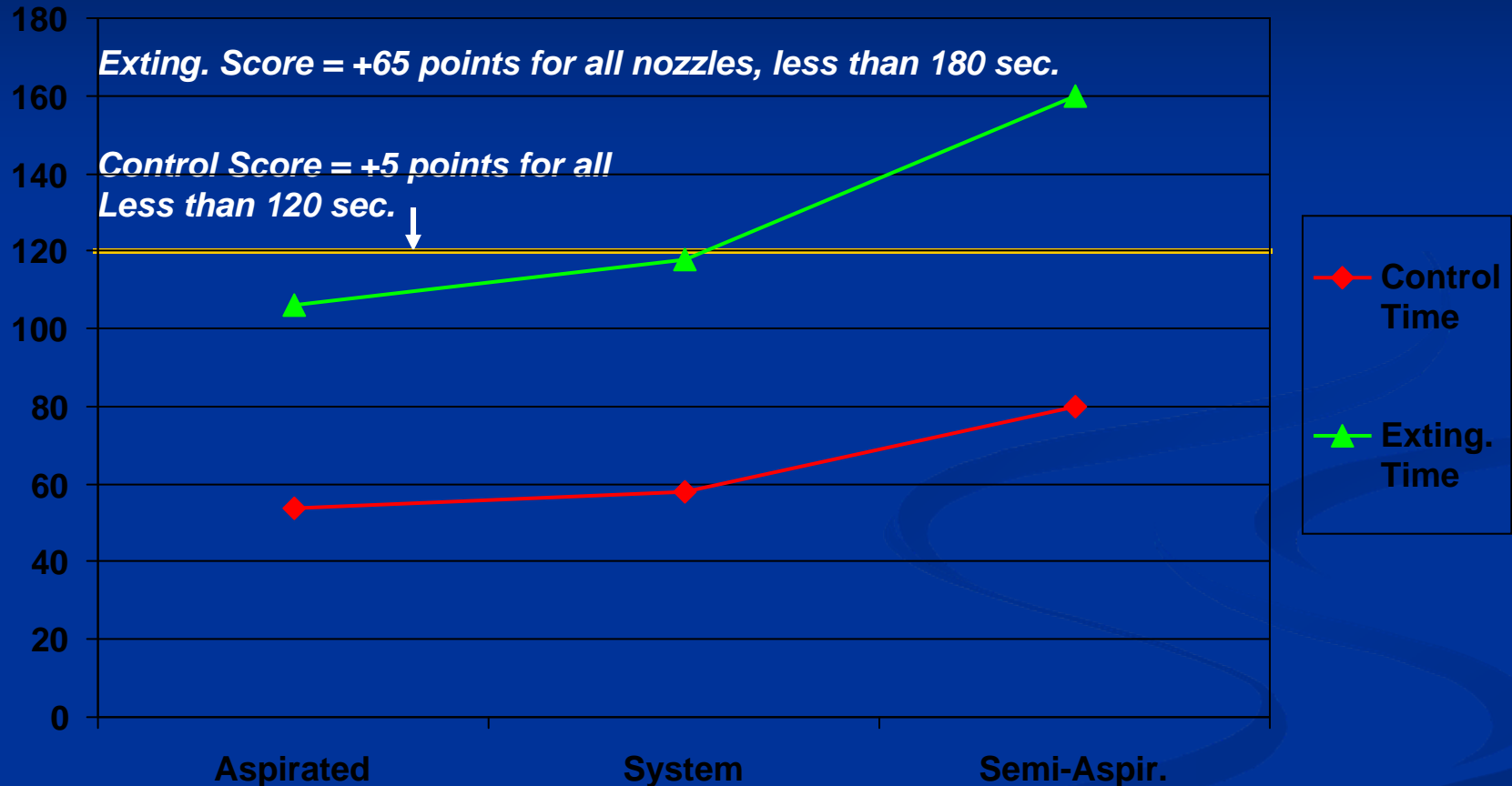


For Exting. and Control Batches 6 = 70, 4=60 and 1 =57 points

Total Score: 7 = 100%, Lowest 1 = 85%, Average = 95.8%

LASTFIRE RESULTS – SEA WATER

Batch 4 of CUG (3x3) Verified by Richard Coates of RPI
Time in Seconds from Foam On



For Exting. and Control Batch 4 = 70 points, the maximum
Total Score: Aspir. = 100%, System = 100%, Semi-Aspir. = 95%

LASTFIRE Testing of CUG (3X3) Production

Results of the 33 LASTFIRE Tests:

- Average: Semi-aspirated 85.6 Good/Level I
- Aspirated 99.8 Good/Level I
- System 95.8 Good/Level I
- All 33 fires 93.7 Good/Level I

Chemguard Recommends Ultraguard For Large Tank Fire Protection

Performance in LASTFIRE

- In Norway, Ultraguard rated **GOOD** with all three LASTFIRE monitors with **Tap Water**.
- Only 3 other multipurpose products performed as well.
- In Norway, only one product passed LASTFIRE with Salt Water and then only with one monitor not all three.
- In Mansfield, TX, Ultraguard rated **GOOD** with all three LASTFIRE monitors with **Salt Water**.
- **Only Ultraguard has performed GOOD in both Tap and Salt Water.**

Chemguard Chemical R&D

Using Chemguard and Ciba Chemical technology:

- Chemguard has invented a new method of extinguishing Class B nonpolar and polar fires covered under US Patent 7,011,763.
- FluoroSurfactant Free Foams are claimed based on specified high molecular weight fluoropolymers (HMWFP) which extinguish fires as effectively as AFFF/AR-AFFFs.
- Fires are extinguished due to HMWFP stabilization of foam bubbles to heat and hot fuel, not by film formation
- When used with fluorosurfactants, HMWFPs allow the formulation of fluorine efficient AR-AFFF agents.

Chemguard Chemical R&D

Using technology from US Patent 7,011,763 and Chemguard FP-5100 series fluoropolymers:

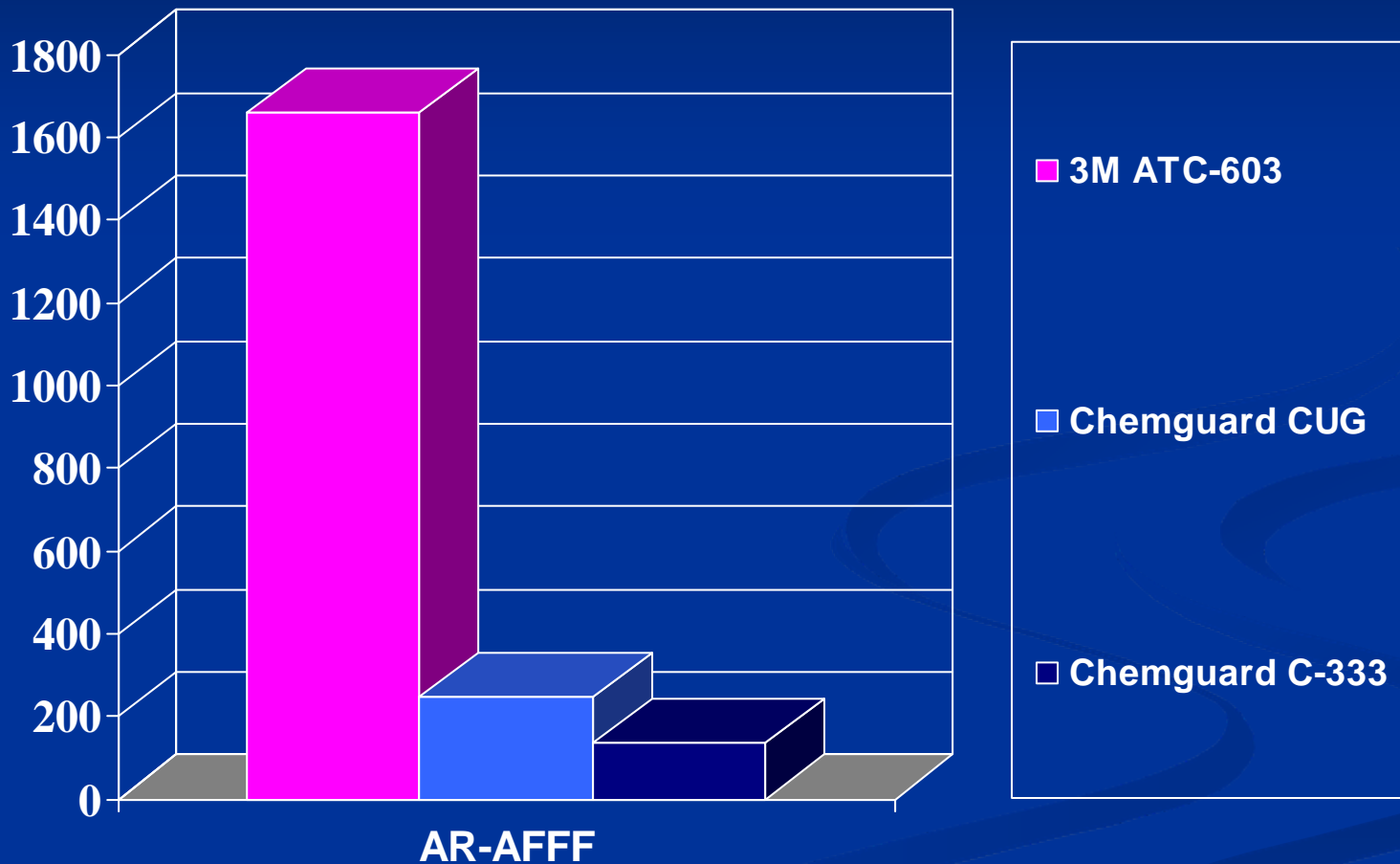
- **Ultraguard** was developed having exceptional UL162 and LASTFIRE performance, with 54% fluorine as HMWFP and total 0.5%F.
- **Chemguard C-333** was developed having exceptional UL162 performance, with 83% fluorine as HMWFP and total 0.2%F.

Chemguard Chemical R&D

Is there any environmental advantage to using HMWFP technology?

- **Yes**, because of the effectiveness of the HMWFPs in stabilizing foam bubbles, much lower fluorine levels provide exceptional fire performance.
- **Yes**, the US EPA considers high molecular weight polymers as a generic class as having less potential for negative environmental impact.

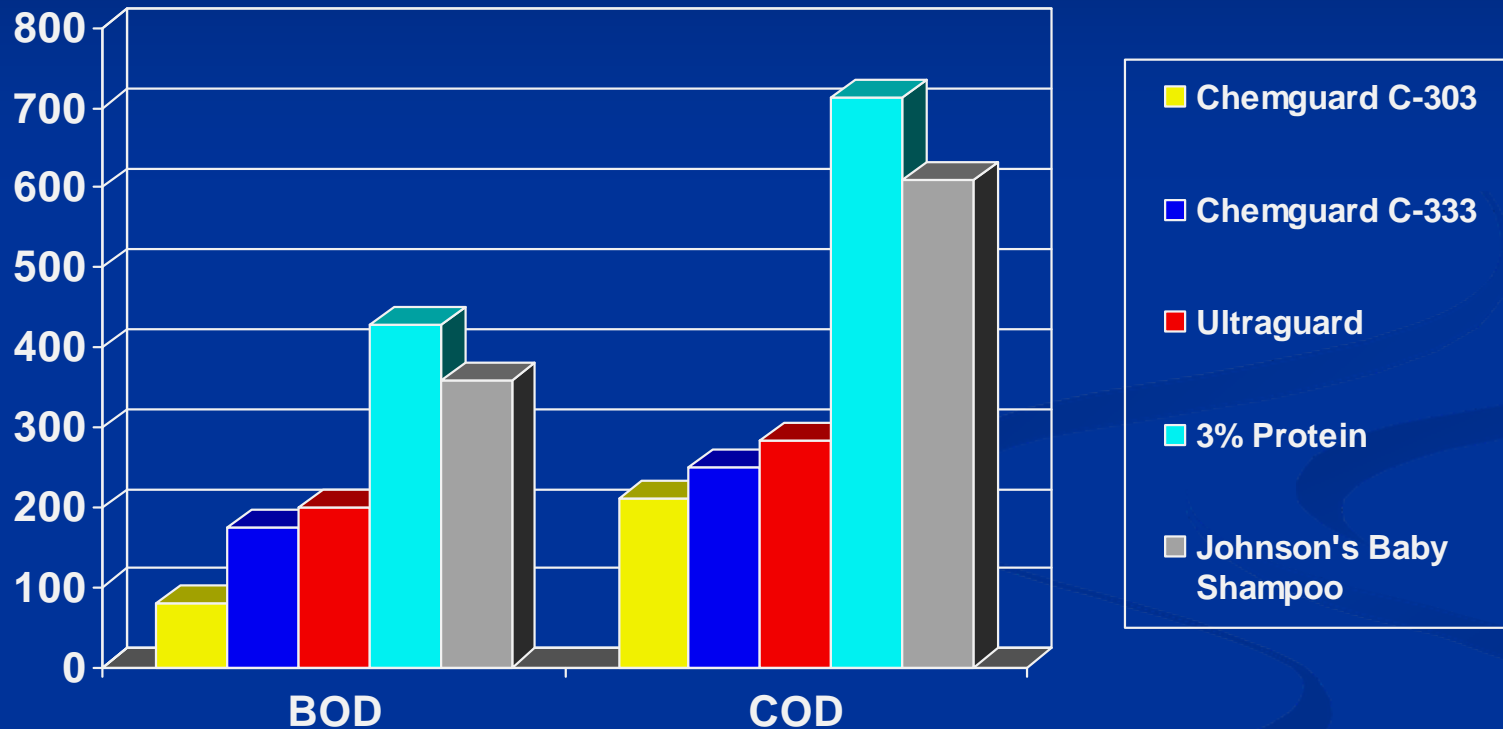
Grams of Fluorine Used on 1,000 ft² Fire at 0.10 Rate for 5 min. Chemguard AR-AFFF Products, Based on Fluorine Assay



Environmental Impact

Analysis by Lancaster Laboratories, Lancaster, PA

BOD₂₀, COD₂₀ as gm/l



Environmental Impact

Analysis by Lancaster Laboratories, Lancaster, PA

BOD₂₀/COD₂₀ as Percent, TOC as gm/l

