

Protective Apparel for Laboratory Safety



Presented by: **Loka Mistretta**
Higher Education Strategic Markets
Cintas Corporation

Common Laboratory Hazards

- **Chemical Hazards**

- *Pure and mixtures*
- *Corrosives, Flammables, Toxins,*
- *Pyrophorics*

- **Chemical Reactions**

- **Biological Hazards**

- *Viruses, bacteria, animals*
- *Plants & Genetically modified organisms*

- **Waste Handling / Disposal**

- **Fire / Explosive Hazards**

- **Airborne Hazards**

- *Particulates*
- *Gases, vapors*
- *Aerosols*

- **Nanoparticles & Nanomaterials**

- **Physical & Mechanical Hazards**

- *Heating and cooling devices*
- *Instrumentation*
- *Steam, pressure*
- *Moving equipment*

Most common reported accidents involve fire, explosions, chemical & thermal burns, cuts, absorption or inhalation of chemicals¹.

¹<http://www.dartmouth.edu/~chemlab/info/safety/hazards.html>

Common Laboratory Hazards

- **Chemical** *Fire is the most common serious hazard that one faces in a typical laboratory.*
 - *While proper procedures and training can minimize the chances of an accidental fire, laboratory workers should still be prepared to deal with a fire emergency should it occur. In dealing with a*
 - *laboratory fire, all containers of infectious materials should be placed into autoclaves, incubators,*
 - *refrigerators, or freezers for containment.*
 - *Small bench-top fires in laboratory spaces are not uncommon. Large laboratory fires are rare.*
- **Chemical** *However, the risk of severe injury or death is significant because fuel load and*
- **Bio** *hazard levels in labs are typically very high. Laboratories, especially those using solvents*
 - *in any quantity, have the potential for flash fires, explosion, rapid spread of fire, and high toxicity of*
 - *products of combustion (heat, smoke, and flame).*
 -
- **Waste handling / Disposal**
 - *OSHA Laboratory Safety Guidance*
- **Fire / Explosive Hazards**
 - *Moving equipment*

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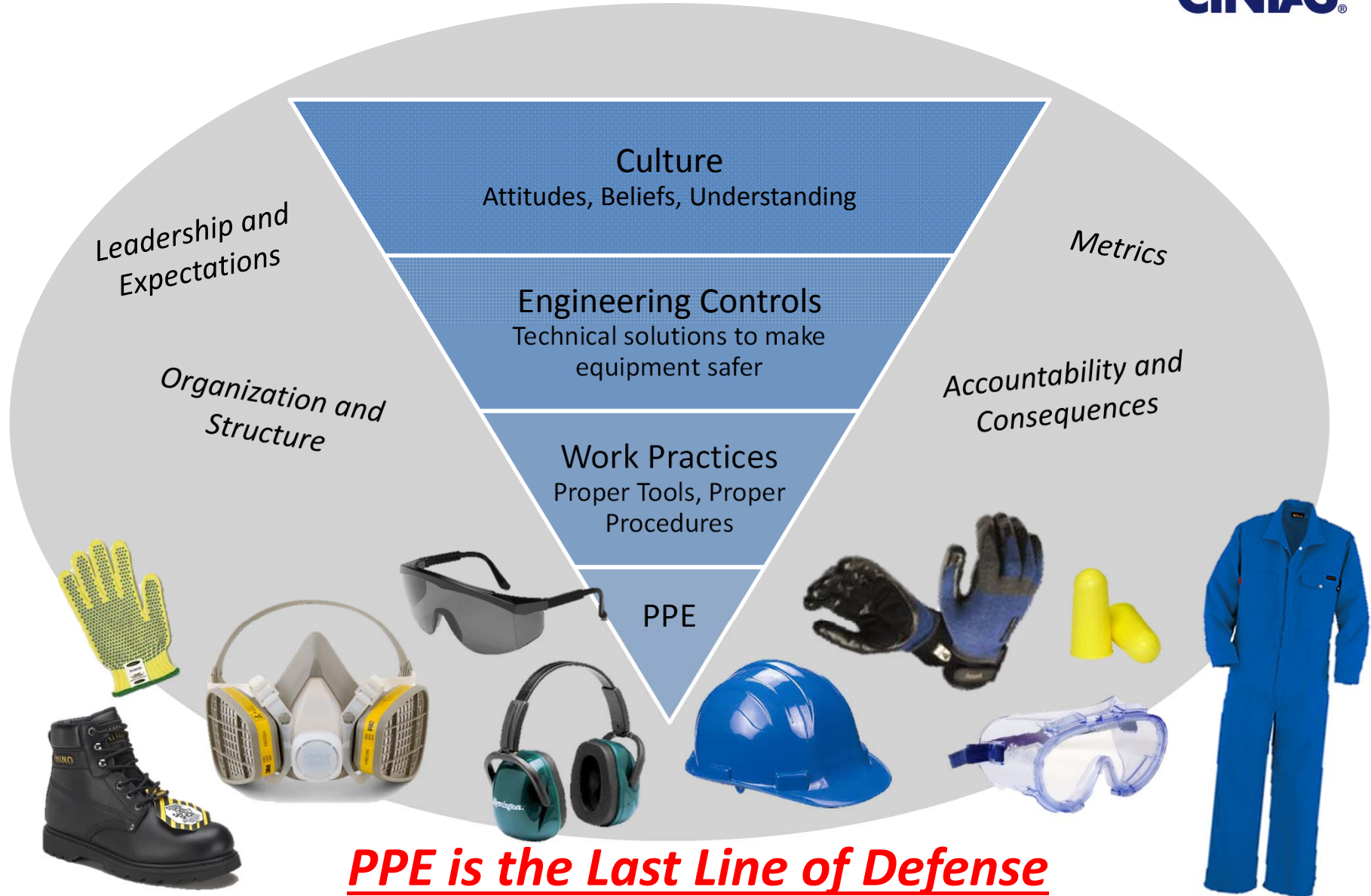


Common Lab Flammable Liquids

Classifications of Some Commonly Used Flammable and Combustible Liquids

Class I-A Flammable Liquids		Class I-B Flammable Liquids	
Acetaldehyde Ethylamine Chloroethane Ethyl Ether Ethyl Mercaptan Isopropylamine 2-Methylbutane Propylene Oxide Tetramethylsilane Trichlorosilane		Acetone Acetyl Chloride Acetonitrile Benzene Cyclohexane 1, 2- Dichloroethane Diethylamine Ethyl Acetate Ethyl Alcohol >50% Gasoline	
Class I-C Flammable Liquids		Class II Combustible Liquids	
Amyl Acetate Azidotrimethylsilane 1-Butanol Chlorobenzene Dicyclopentadiene Ethylenediamine Hydrazine Methyl Isobutyl Ketone	2-Methyl-1-Propanol Morpholine Nitromethane 2,4-Pentanedione 1-Pentanol Propyl Alcohol Styrene Trichloroethylene	Acetic Acid > 80% Acetic Anhydride Boron Trifluoride Etherate Cyclohexanone Decane Diesel (Fuel Oil No. 2) N,N-Dimethyl Formamide Dimethylaminoethanol	Formaldehyde Formic Acid Kerosene 2-Methoxyethanol 3-Methyl-1-Butanol Propionic Acid Thiophenol WD-40® Lubricant
Class III-A Combustible Liquids		Class III-B Combustible Liquids	
Acetophenone Aniline Benzaldehyde Benzoyl Chloride Benzyl Bromide Benzylamine Butyric Acid Diethyl-Pyrocaborate Dimethyl Sulfate	N,N-Dimethylacetamide Dimethylsulfoxide Ethanolamine Hexyl Alcohol 2-Mercaptoethanol 1-Methyl-2-pyrrolidinone Nitrobenzene 1-Octanol Phenol	p-Anisaldehyde Benzyl Alcohol 2-Bromoethanol Diethanolamine Ethylene Glycol Formamide Glycerol Hexadecane Hexanoic Acid	Hydraulic Oil (generic) Methyl Salicylate Mineral Oil (generic) Oxalyl Chloride Polyethylene Glycol Transformer Oil (generic) Triethanolamine Triton X® Tween 20®

Safety Program Hierarchy of Control



History

Before we start, let's look back at the history of how we got here.



Los Angeles Times

FELONY CHARGES FILED

Against UC and a UCLA chemistry professor after fatal lab fire!

“Felony charges have been filed against the University of California and a UCLA chemistry professor in connection with a laboratory fire that killed a staff research assistant three years ago. On Tuesday, the Los Angeles County district attorney's office charged Harran and the UC regents with three counts each of willfully violating occupational health and safety standards, resulting in Sangji's death. Harran and UCLA are accused of failing to correct unsafe work conditions in a timely manner, to require clothing appropriate for the work being done and to provide proper chemical safety training. An arrest warrant was issued for Harran, 42, who faces up to 4 1/2 years in state prison, according to a district attorney's spokeswoman.



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Recent Incidents in Academic Labs

- U.S. Chemical Safety Board accident investigation at Texas Tech University
- Recent incidents reported at Yale, Northwestern and UCLA
- Laboratory Safety Institute Virtual Memorial Wall lists five deaths in academic labs since 2001¹

Report faults professor, UCLA in death of lab assistant
Cal/OSHA says Sheri Sangji was not properly trained to handle the chemicals that killed her. The university criticizes the findings.

January 21, 2012 | UCLA professor to stand trial in death of assistant in lab fire
Professor Patrick Harran is ordered to stand trial on felony charges stemming from a fire that killed staff research assistant Sheharbano Sangji more than four years ago.

April 26, 2013 | By Kim Christensen, Los Angeles Times

January 10th, 2011 • 05:01
Explosion from aqueous hydrogen peroxide and acetic anhydride

By Jyllian Kemsley • Posted in Accidents, **CSB Investigates Lab Explosion at Texas Tech University**

The U.S. Chemical Safety Board (CSB) released a report on Jan. 7 explosion that severely injured a student at Texas Tech University.

Laura Walter

Life on NBCNEWS.com

Yale student dies in chemistry lab accident

'True tragedy': Girl's hair pulled into piece of machine-shop equipment

Recommend 0

¹ <http://www.resources.labsafetyinstitute.org/MemorialWall.html>



Local

6 injured in chemistry classroom fire at Woodson High in Fairfax

A chemistry demonstration at a Fairfax County high school went out of control Friday morning, with a flash of flame engulfing a group of students, leaving two with serious burns and also sending three others to the hospital.



Current Scenario

So, what guidelines are in place today to address this hazard:

- Regulatory Compliance
- Institutional Policies



UCLA Lab Prosecution Enforcement Agreement

The following Personal Protective Equipment (PPE) policy shall be considered the minimum standard to apply at all times while working or occupying any laboratory area:

Laboratory coats, or equivalent, are required to be worn while working on, or adjacent to, all hazardous chemicals, biological or unsealed radiological materials. These laboratory coats must be appropriately sized for the individual and be buttoned to their full length.



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UCLA Lab Prosecution Enforcement Agreement

Flame resistant laboratory coats shall be worn when working with pyrophoric materials OR flammable liquids. Cotton (or other non-synthetic material) clothing must also be worn during these procedures to minimize injury in the case of a fire emergency.



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UCLA Lab Prosecution Enforcement Agreement

Each department or research unit shall be responsible for providing professional laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by staff members at private residences or public laundry facilities. Any clothing that becomes contaminated with hazardous materials must be decontaminated before it leaves the laboratory. Employees shall not bear the cost of any required PPE.



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Cal/OSHA 8 CCR 3320 Hazard Assessment

- ❑ Employers are required to **assess** the workplace for hazards that will require PPE
- ❑ This assessment **documented**
- ❑ **Select** PPE that will protect the worker from the hazards identified
- ❑ **Communicate** assessment and selection decisions
- ❑ **Train** researchers on the PPE
- ❑ Select PPE that properly **fits** each lab worker
- ❑ **Use** the PPE
- ❑ **Maintain** the PPE

Important Regulations and Industry Standards

- **Flash Fire – NEW Update- 2015 NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals**
- **An expanded scope and new chapter to help protect students and staff in school laboratories.**
- **Chapter 6- Fire Protection - Section (6.6) addresses Flame Retardant Clothing**
 - (6.6.1)-The provisions of 6.6.2 through 6.6.5 shall apply to all new and existing laboratories
 - (6.6.2)- Fire-retardant lab coats shall be worn where pyrophoric reagents are used outside the inert atmosphere of a glovebox.
 - (6.6.5)- Fire-retardant clothing shall meet the requirements of NFPA 2112.
 - (A 6.6.2) Fire-retardant lab coats should be considered when handling flammable liquids and other hazardous materials that are easily ignited.
 - (6.4.4)- Wear natural-fiber clothing on legs and feet



FR Clothing Standards for Flash Fires





- NFPA 2112 – provides minimum FR garment requirements for industrial flash fire protection
- NFPA 2113 – provides guidance for FR garment selection, care, use, and maintenance



These standards are the starting point for protection.




Key Industrial FR Standards and Test Methods

NFPA 2112: *Standard for Industrial FR Garments*

-  **Minimum** requirement for a garment to be considered FR
-  Design, construction, and evaluation of garments
-  7 Primary tests, only 1 garment test (ASTM F1930)
-  Primarily for garment manufacturers, not end-users






NFPA 2113: *Selection Care, Use, and Maintenance of FR Garments*

-  Perform fire / exposure hazard assessment
-  Must meet NFPA 2112 minimum standard
-  Primarily for end-users



ASTM F1930: *Thermal Manikin Evaluation Test Method*

-  **Minimum** threshold to qualify fabrics to NFPA 2112
-  Result is a predicted body burn injury %
-  Does not specify the hazard



Beware of garments that claim FR certification through NFPA701 or ASTM D6413 – standard for textiles and drapery!



Product Selection

Here is the coat that we are seeing most widely adopted.



Flame Resistant Lab Coat

KNEE LENGTH 4.5oz NOMEX
(worn directly over street clothes)

SIDE PASS THRU
(access to inner clothing)

LARGE POCKETS
(double-stitched)

KNIT CUFF
(for comfort and safety)

SNAP CLOSURE
(for quick release)



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FR Considerations

Fabric

- Protection:
 - Non-synthetic underlayers
- Efficacy
- Particle Shedding
- Static Dissipation
- Sensitivity To Oxidizers
- Appearance/Durability
- Comfort:
 - Air Permeability
 - Moisture Movement
 - Weight

Garment

- Comfort:
 - Design/Ergonomic
 - Fit/Tailoring
- Functionality:
 - Size range
 - Snap closures
 - Knit cuffs
 - Pass-through reinforced pockets
 - High-closing collar
 - ISO 9001 Certification



Nomex.



Types of FR Fabrics

There are two basic types of FR fabrics, and they respond differently when exposed to heat and flame.

Fabric Type

Response

Chemically Treated

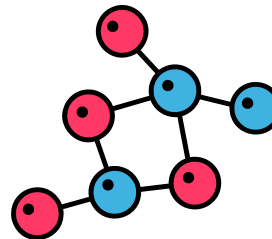
Ex: Indura® Ultrasoft®, Banwear®, Dale Antiflame®



FR chemicals are “activated” by intense heat, producing char and gases that inhibit combustion.

Inherent

Ex: NOMEX®, KEVLAR®, PBI®,



DNA of the fiber does not support combustion.

Flame Resistant (FR) Clothing

Thermal Manikin - 6 cal/cm² (3 s @ 2 cal/cm²s)

For Age Group 30 to 39 Years

Conditions

ASTM F-1930

3 s Exposure

Heat Flux 2 cal/cm²s

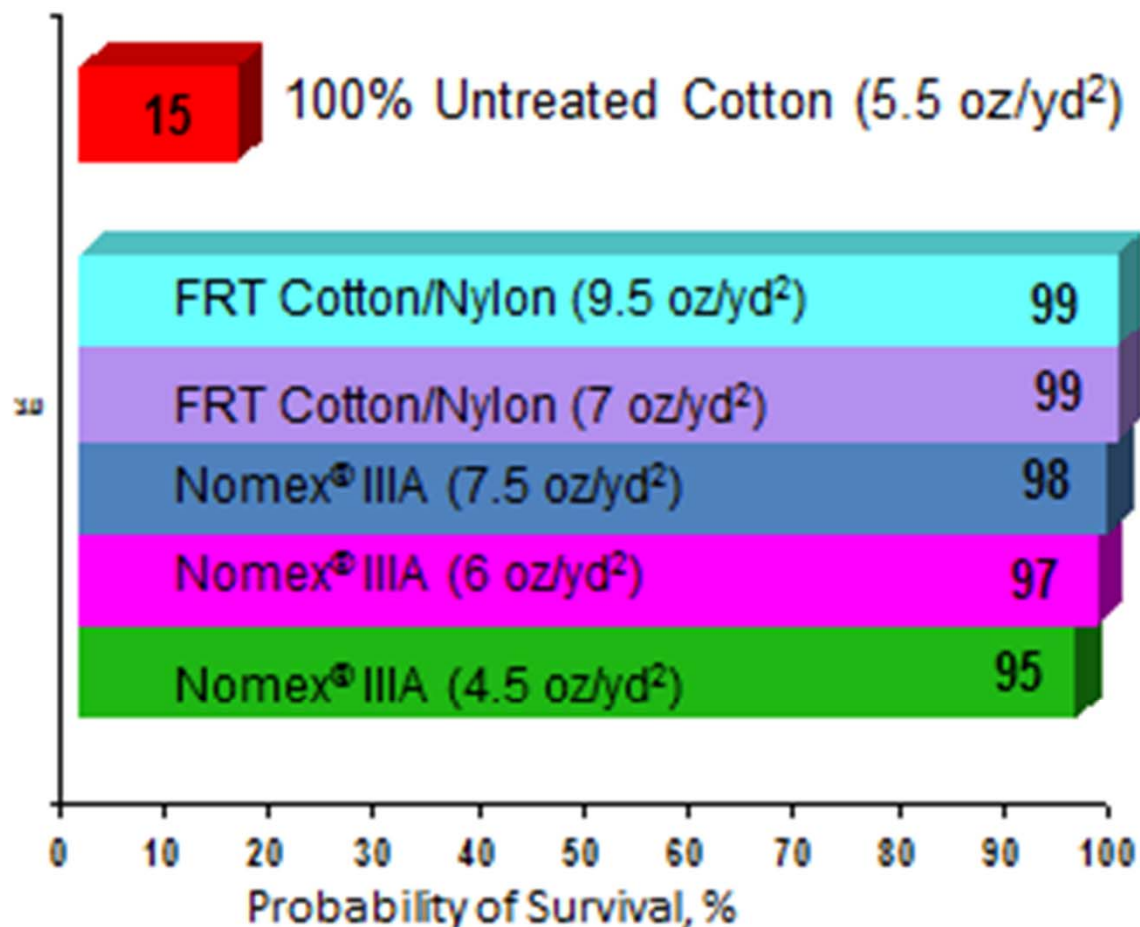
Average of 3 Data Points

Coveralls Tested

1X Home Laundering

100% Cotton Underwear

Based on Applying
Predicted Burn Injury
Results to Probability of
Survival Data: American
Burn Association
(1991-1993 Study)



Flame Resistant (FR) Clothing

Thermal Manikin - 8 cal/cm² (4 s @ 2 cal/cm²s)

For Age Group 30 to 39 Years

Conditions

ASTM F-1930

4 s Exposure

Heat Flux 2 cal/cm²s

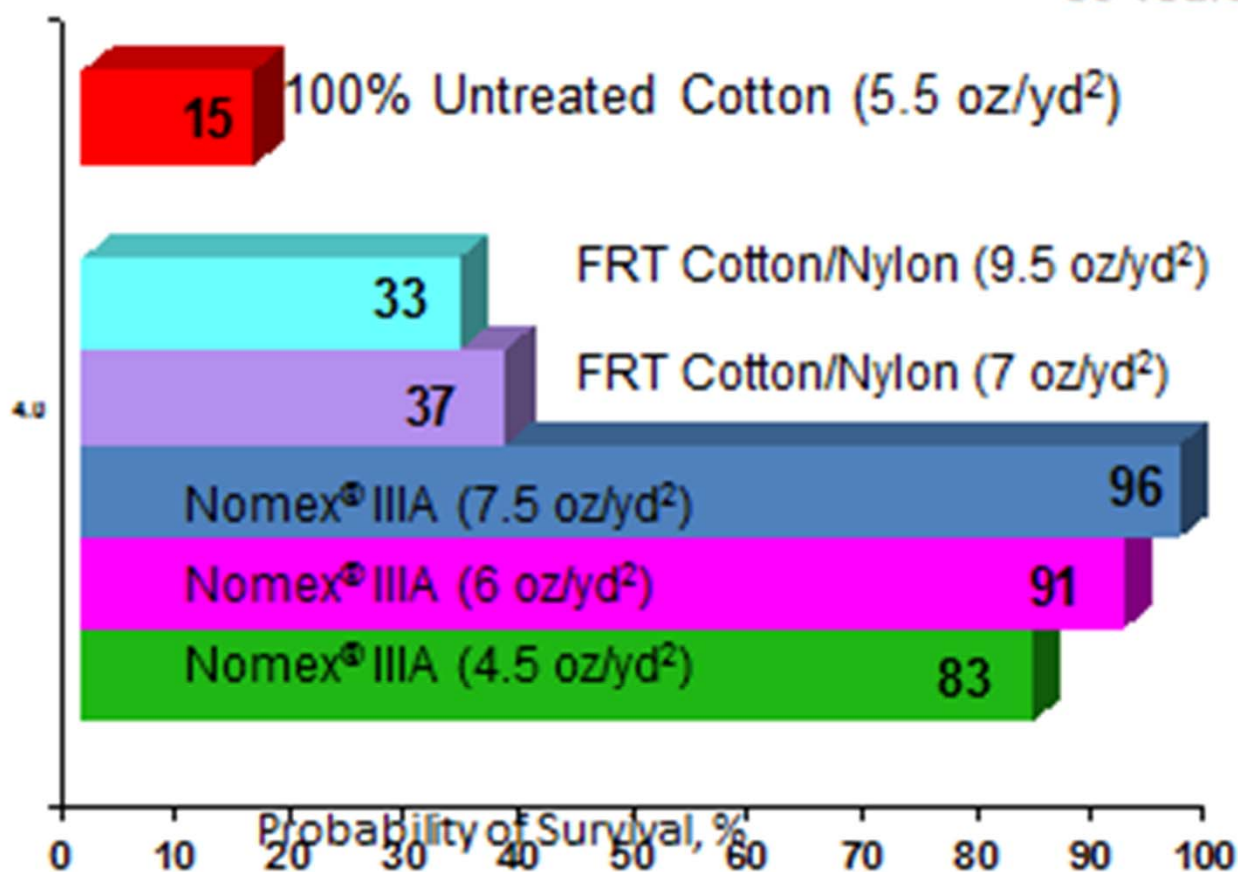
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thermoman demo--all 3 together.mp4



FR Clothing Guidelines for Use (NFPA 2113)

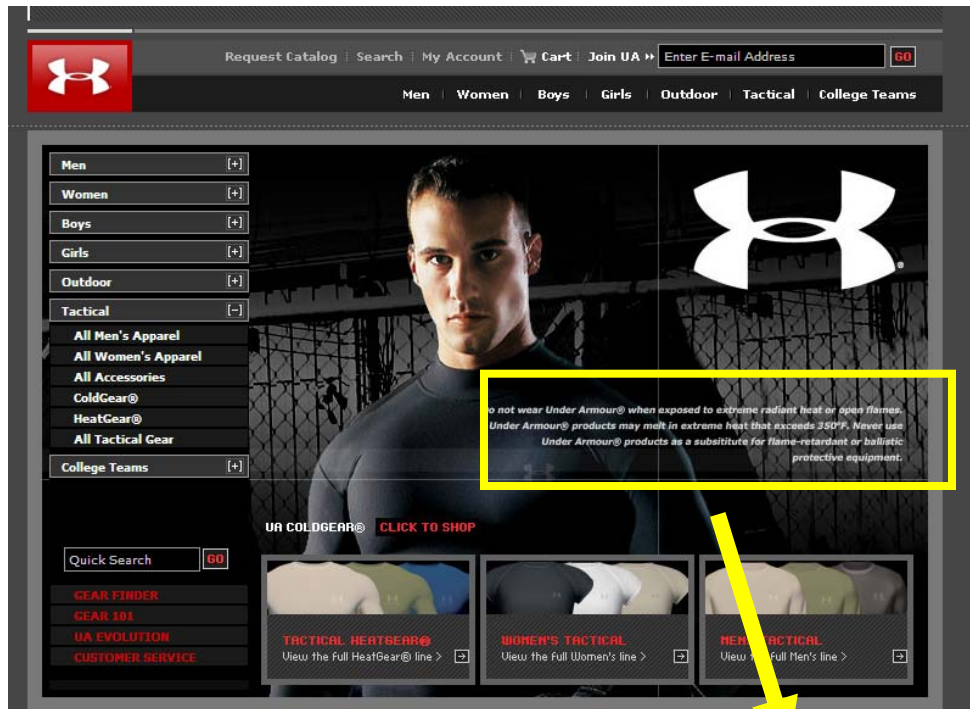


- Good functional fit for protection and comfort
- Free of flammable contaminants
- Undergarments should not contain meltable fibers (i.e. polyester, nylon)
- Outerwear must be FR



Layering

Materials That Melt Can Compromise Performance



In Extreme Heat polyester under garments can melt, increasing the severity of burn injuries.

Do not wear Under Armour® when exposed to extreme radiant heat or open flames. Under Armour® products may melt in extreme heat that exceeds 350°F. Never use Under Armour® products as a substitute for flame retardant or ballistic protective equipment.

Current Scenario

To address the trends in the regulatory environment, most universities have or are in process of implementing institutional policies.

- Must wear a lab coat and safety glasses in a lab
- Must wear an FR lab coat in defined environments



Care and Maintenance of PPE



- **Federal Register / Vol. 79, No. 70 / Friday, April 11, 2014 / Rules and Regulations (Page 184 - 187)**
 - The OSH Act and the PPE standards at 1910.132 and 1926.95 make the **employer**, not the employee, responsible for the care and maintenance of PPE.
 - OSHA stresses that 1910.132(a) and (b) and 1926.95(a) and (b) require **employers** to properly maintain FR and arc-rated clothing required by this final rule.
 - These provisions make PPE maintenance the responsibility of **employers**, not employees. OSHA believes that it is the **employer's** responsibility to ensure proper maintenance of PPE.

*Standards recommend the use of a professional laundry service



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Care and Maintenance of PPE



- **Federal Register** / Vol. 79, No. 70 / Friday, April 11, 2014 / Rules and Regulations (Page 184 - 187)
 - The responsibility for maintaining PPE rests squarely with the **employer** under existing OSHA standards.
 - The Agency is not prohibiting home laundering of FR and arc-rated clothing. However, to comply with 1910.132 or 1926.95, **employers** cannot simply instruct employees to follow manufacturers' instructions.
 - If **employers** rely on home laundering of the clothing, they must train their employees in proper laundering procedures and techniques, and **employers** must inspect the clothing on a regular basis to ensure that it is not in need of repair or replacement.

*Standards recommend the use of a professional laundry service



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Current Scenario

What programs are in place today to meet these requirements?

- Most common is purchase and ??? on washing/upkeep
 - On campus laundry
 - Dry cleaner
 - One person makes a laundromat run
 - On your own





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Lab Coat Program Options

Complete Care

Enhanced Care

Purchase

NO UPFRONT CAPITAL COST

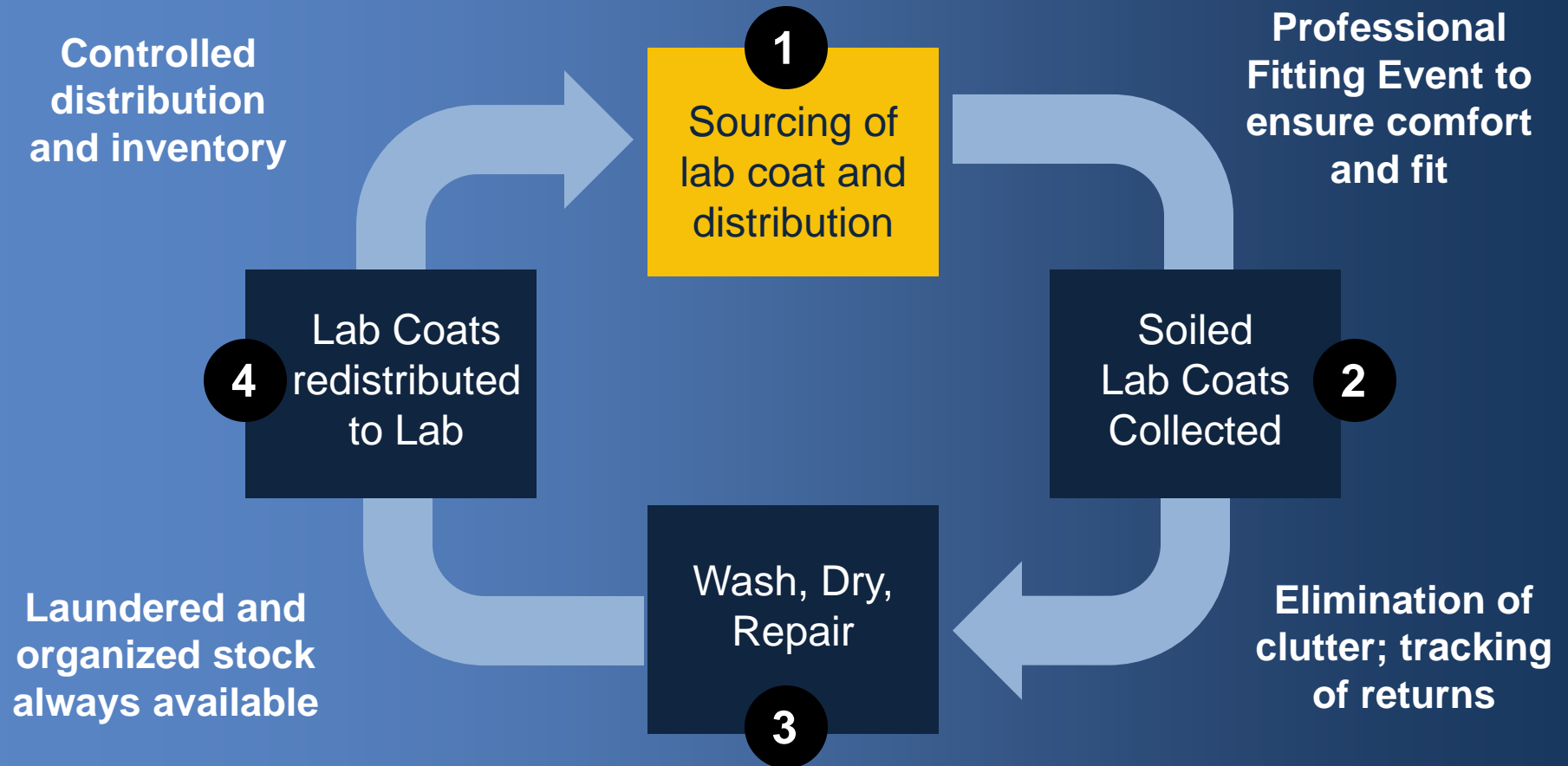
Weekly Laundering	Weekly Laundering	Weekly Laundering
Weekly Inspection	Weekly Inspection	Weekly Inspection
Repairs	Repairs	Repairs
Delivery	Delivery	Delivery
Size Changes	Size Changes	Size Changes
New Orders/Replacements	New Orders/Replacements	New Orders/Replacements
Tracking Report	Tracking Report	Tracking Report
Management of Program	Management of Program	Management of Program
On-Hand Inventory	On-Hand Inventory	On-Hand Inventory
Initial Fitting	Initial Fitting	Initial Fitting

- Supplier Responsibility
- Employee Responsibility
- Company Responsibility

***Hybrid**-Enhanced Care or Purchase with Wash Programs are also available



Holistic Lab Coat Solution



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Additional Thoughts

- We have focused on Flash Fire Hazard, but issue of care and maintenance of PPE continues to come up—recent AALAC accreditation visit
- Must have a plan to address how lab coats should be laundered and cared for
- Culture Change



Cal/OSHA 8 CCR 3320 Hazard Assessment

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Use the PPE

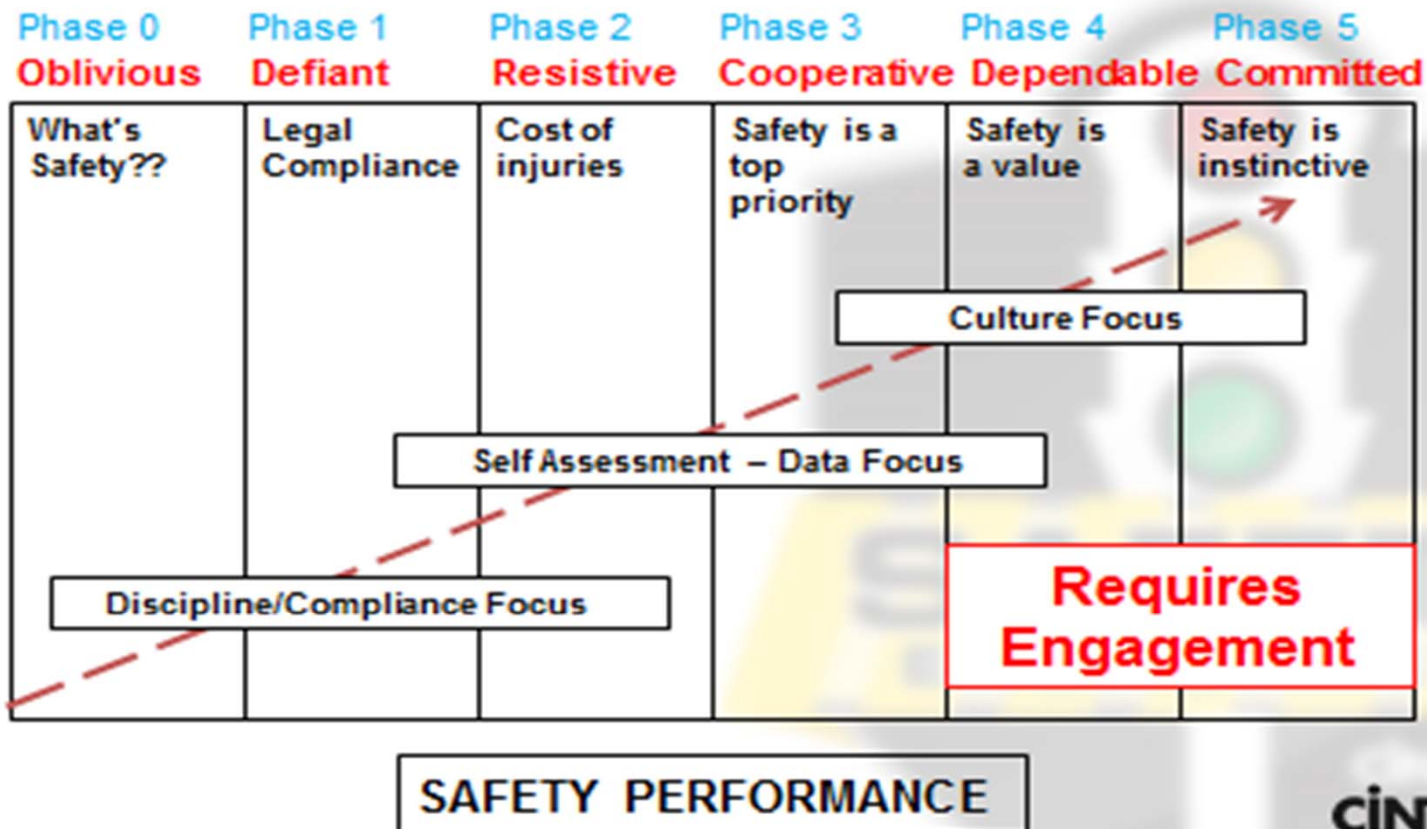
- Maintain** the PPE



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The Evolution of Safety Engagement



Current Scenario

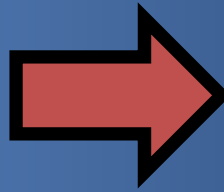
We have to reduce the obstacles and “make it easy” for the wearer.

- **Coat isn't comfortable** → what coat is being sourced? What is the process to properly fit the wearer?
- **Coat is dirty** → what is the process for the coats to be cleaned?
- **No coat available or in my size** → what is the process to ensure that each person has a coat that fits when they need it

We group these into three categories that must be addressed to “make it easy” on the wearer: **Available, Functional, and Comfortable.**



Clean, Safe, and Readily Available



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Q & A

**Thank You – If I can be a resource to you in the future,
please don't hesitate to reach out to me!**

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