Why NFPA 2112 should be important in my FR Clothing Program
Background

• Involved with the Flame Resistant Clothing market from the service, manufacturing and garment sides for over 20 years.

• Over the past 11 years worked closely with fortune 1000 companies as they look develop PPE programs within their Electrical Safe Work Practices to comply with NFPA70E/NESC and also Flash Fire programs for NFPA 2113.

• Developed and conducted over 250 educational and informational seminars on the Hazards of Arc Flash and Flash Fire for NSC, ASSE, VPPPA, NJATC, NECA, CAER and numerous other associations.
Objectives

• Understand what the test method ASTM 1930 measures vs real world
• Understand the relationship between NFPA 2112 and 2113
• Understand the value of UL certification
• Understand the concerns regarding rainwear
• Understand some of the do’s and Don’ts
SEC. 5. Duties

(a) Each employer --

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;
1910.132(d)(1)

- The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, likely to be present, the employer shall:

  1910.132(d)(1)(i)
  Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;

  1910.132(d)(1)(ii)
  Communicate selection decisions to each affected employee; and,

  1910.132(d)(1)(iii)
  Select PPE that properly fits each affected employee
The difference between NFPA® 2112 and 2113

- NFPA 2112 is the Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire. This standard outlines the various performance requirements and testing methods for both the FR fabric and FR garments that are needed to be considered in compliance with the standard. It also includes proper labeling and quality control requirements for the FR manufacturers. This is the standard most recognized in the flash fire industry and compliance with it is typically asked for by end users. Although meeting the performance requirements of NFPA 2112 is important, NFPA 2113 is needed to determine what kind of FR you should consider.

- NFPA 2113 is “Standard on Selection, Care, Use and Maintenance of Flame Resistant Garments for Protection of Industrial Personnel against Flash Fire.” NFPA 2113 provides greater detail on how to select proper FR garments. Chapter 4 speaks directly to Selection and gives guidance on Hazard Assessment, Selection of FR Garments and Purchase Specifications.
Industries Requiring FR Clothing

- Oil exploration
- Oil drilling
- Oil field services
- Oil refining
- Refinery services
- Chemical plants
The Benefit of FR Clothing

- Nomex® IIIA
- Cotton
- PolyCotton
Injuries and Fatalities do Happen


- OSHA reports more than 5,000 are injured in explosions and fires on the job each year.
2014, there were at least eight fatal oil and gas explosions in the United States.
• It is important to understand the difference between the ASTM 1930 test method for fabric and real world Flash Fires

• Many decision makers have been influenced to focus on the results of ASTM 1930 testing alone without fully understanding how to view the information

• Some manufacturers have attempted to “make up” a category “flash fire rated” that only focuses on ASTM 1930 test results
North Carolina State University

Thermal Protective Clothing Analysis System

Client: Mount Vernon Mills
Instrumented Manikin Results

NCSU

PyroMan™
3-Layer Skin Model

Burn Injury Prediction

<table>
<thead>
<tr>
<th>Exposure Time (s)</th>
<th>DAQ Time (s)</th>
<th>Time Step (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00</td>
<td>60.00</td>
<td>0.50</td>
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</table>

% 2nd Degree Burns 24.590
% 3rd Degree Burns  7.377
% Total Burn        31.97
Instrumented Manikin Results

THE UNIVERSITY OF ALBERTA
Protective Clothing and Equipment Research Facility
Flash Fire Facility

Monday, Feb 4 2008
Test Type: Flash Fire Simulation
Fabric: UltraSoft - 7 oz.
Series: Westex - REP 3
Exposure Time: 3.08 sec
Measurement Time: 60.00 sec
Second Degree Burn: 6.85%
Third Degree Burn: 6.80%
Total 2nd and 3rd Degree Burn: 13.65%
Burn Number: 01490
NFPA 2112 requires less than 50% predicted body burn
One requirement that warrants additional explanation is the manikin test requirement. This test involves placement of a flame-resistant garment on a manikin with exposure to a 3-second duration, 84 kW/m² (2.0 cal/cm² · sec) intensity engulfment “jet” fire. The test is used as a qualification of garment fabric performance, not the garment design, since a standard garment design is used for evaluating the fabric. The standard garment is a coverall with a front slide fastener (zipper) closure and no pockets. Flame-resistant garments with different designs are not evaluated using this test. Organizations should judge the performance of their garment designs by comparing their design with that of the standard garment design or conduct independent testing. Garment designs that provide different areas of body coverage, have different closure systems, or have pockets can demonstrate lesser or better performance than the standard garment design.
Flash Fires are Log-Normal Distribution

Approximate Time in seconds
Time Line

Rapidly moving flame front

Dispersed - dust, gas and/or vapor

Moves towards ignition source
Key differences between Flash Fires and ASTM 1930 testing in the lab

<table>
<thead>
<tr>
<th>Flash Fire</th>
<th>ASTM 1930</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It is a “flash” fire</td>
<td>• “jet” fire</td>
</tr>
<tr>
<td>• Duration varies</td>
<td>• 3 seconds</td>
</tr>
<tr>
<td>• Rapid moving flame front</td>
<td>• 360 degrees exposure</td>
</tr>
<tr>
<td>• Removed quickly once safe</td>
<td>• 60 seconds data collection</td>
</tr>
<tr>
<td>• Garment – pockets etc.</td>
<td>• Fabric – single layer</td>
</tr>
</tbody>
</table>
What does this mean?

Take our examples from ASTM 1930 testing – 32% BB and 14% BB

- If the actual exposure is not 3 seconds but may be less 1.5 sec
  - Cut the numbers in half
- If it is not 360 degree exposure but 180 degree
  - Cut the new numbers in half
- If we are not going to stay in that hot garment for 60 seconds but get out of it in 30 seconds
  - Cut the new numbers in half – what do you get
NFPA 2112 Standard

- Defines a “Flash Fire”
  - 2112 – Flash Fire - A Fire that spreads by means of a flame front rapidly through a diffuse fuel such as a dust, gas or vapors of an ignitable liquid, without the production of damaging pressure

- Defines minimum performance requirements to be independently Certified to be NFPA2112 Compliant
- Are promulgated by a committee of industry members
- Include a battery of test methods all of which must be passed
- Are continuously under review & revision
NFPA 2112

Standard on Flame Resistant Garments for Protection of Industrial Personnel Against Flash Fire

• What it is....

- A means of certifying fabrics & findings suitable for use in FR clothing to be worn as protection against possible flash fire exposure
• Vertical Flame Test 12 sec exposure, 2.0 sec max after flame, 4” max char length

• Oven Test 10% max shrinkage after 5 minutes in 500°F, no melting/dripping allowed

• Heat Transfer Performance (HTP): 6 cal/cm² with spacer; 3 cal/cm² without spacer

• ASTM F1930 Instrumented Manikin: 50% max body burn following 3 sec 2.0 cal/cm² exposure
NFPA 2112 Compliant

• Garments and components must be certified by a third party (i.e. Underwriters Laboratories)
• Annual inspection and testing of materials and components
• Annual audit of quality system
• The 3 F’s Fabrics, Findings and Facilities – with out the 3 F’s you have 1 F = Failure
What’s UL?

3rd party certifier that audits manufacturing facilities and conducts independent testing on products to assure compliance with appropriate industry standards.
So what does 3rd party certified mean to me?

• Based on what we know today – it gives you piece of mind that this garments meets or exceeds all the standards and tests available for the hazard
• You don’t need to choose NFPA 2112 certified garments but if you don’t why didn’t you?
• If you are not going to use NFPA 2112 What are you going to use?
Are all flame resistant fabrics and garments Independently Certified to be NFPA 2112 compliant? 

NO!

So Where can you look
NFPA 2112 Label Requirements

We are all too familiar with misleading claims but are you aware of misleading labels in FR garments? NFPA mandates strict labeling requirements and not everyone follows the rules. In addition to bearing the mark of the 3rd party certifier, these words and the edition of the standard must appear on the label of a certified garment:

"THIS FLAME-RESISTANT GARMENT MEETS THE REQUIREMENTS OF NFPA 2112-2012 STANDARD ON THE FLAME-RESISTANT GARMENTS FOR THE PROTECTION OF INDUSTRIAL PERSONNEL AGAINST FLASH FIRE”

Beware of subtle changes in wording on the label that claim to meet a portion of the standard. The following language does not meet the requirements of NFPA 2112:

"THIS GARMENT MEETS THE PERFORMANCE REQUIREMENTS OF NFPA 70E-2009, ASTM F1506-02ae1, NFPA 2112-2007."
4.1 General.

4.1.1 All flame-resistant garments that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified.

4.2.5.2 Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

4.1.6 Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard in any statements about their respective product(s) unless the product(s) is certified as compliant to this standard.
Required labeling

THIS FLAME-RESISTANT GARMENT MEETS THE REQUIREMENTS OF NFPA 2112 STANDARD ON FLAME-RESISTANT GARMENTS FOR PROTECTION OF INDUSTRIAL PERSONNEL AGAINST FLASH FIRE, 2012 EDITION.

Misleading Label

THIS GARMENT MEETS THE PERFORMANCE REQUIREMENTS OF NFPA 70E-2012, ASTM F1506-02ae1, NFPA 2112-2012.
THE GARMENT IS FLAM RESISTANT WARNING

THIS FLAME-RESISTANT GARMENT MEETS THE REQUIREMENTS OF NFPA 2112, STANDARD ON FLAME-RESISTANT GARMENTS FOR PROTECTION OF INDUSTRIAL PERSONNEL AGAINST FLASH FIRE, 2007 EDITION.

PROTECTIVE CLOTHING FOR PROTECTION OF INDUSTRIAL PERSONNEL AGAINST FLASH FIRE IN ACCORDANCE WITH NFPA 2112 2007 EDITION.

NFPA 2113 REQUIRES UPPER AND LOWER BODY COVERAGE.

THIS GARMENT RESISTS IGNITION WHEN EXPOSED TO FLAME OR ELECTRIC ARC AND WILL NOT CONTINUE TO BURN WHEN REMOVED FROM THE IGNITION SOURCE.

THIS GARMENT IS NOT DESIGNED FOR EXTENDED EXPOSURE TO FLAME OR HEAT OR FOR EXPOSURE TO CHEMICALS, NOT LIQUIDS OR STEAM. IT SHOULD NOT BE USED FOR FIRE ENTRY, FIRE FIGHTING OR OTHER ACTIVITIES INVOLVING EXTENDED EXPOSURE TO FLAME OR HEAT.

THE USER IS RESPONSIBLE TO DETERMINE THAT THIS GARMENT IS APPROPRIATE FOR THE INTENDED USE AND COMPLIES WITH ALL LAWS AND REGULATORY STANDARDS. THE USER ASSUMES ALL RISKS ASSOCIATED WITH THE USE OF THIS PRODUCT.

FR-INDUSTRIES SHALL NOT BE LIABLE FOR ANY LOSS, INJURY OR DEATH ARISING OUT OF THE USE OF THIS PRODUCT.

XL

88% COTTON 12% NYLON ARC RATING 10 ATPV FABRIC MADE IN CH / GARMENT MADE IN CH

ZIMPEX INC. BAKERS CA 93314

DO NOT REMOVE THIS LABEL ZIMPEX INC
Some Standards alone are not enough; some are just wrong

- **ASTM F2302** — 1.3 This specification does not pertain to applications where the conditions of potential flame contact or heat exposure are of an extended duration and/or are of a high intensity. Note 1—Examples include fire fighting applications, exposure to high energy electrical arcs and exposures in flash fires.

- **ASTM D6413** — 1.2 This standard shall be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled laboratory conditions and shall not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions.

- **NFPA 701** — Two distinct test methods differentiate fabrics of different densities. The test methods apply to textile materials used in interior furnishing for public occupancy buildings including curtains, window shades, draperies, table linens, textile wall hangings, as well as to fabrics used in the assembly of awnings, tents, tarps and other similar architectural fabric structures and banners. See more at: [http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=701#sthash.FcM0WGmG.dpuf](http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=701#sthash.FcM0WGmG.dpuf)
Be very cautious in Rainwear and Vests

Rainwear has specific standards for both Arc Flash and Flash Fire
FR Rainwear claims can and are very misleading
Do not jeopardize your safety and your FR/AR program by implementing non-compliant Rainwear and/or vests
Rainwear and vests that are marketed as FR should not be used in a Flash Fire – do your homework
Make sure to match the Rainwear to the hazard – for Arc Flash ASTM 1891 and they will have an ATPV and for Flash Fire ASTM 2733 better yet get raingear that is tested to both
The Benefit of Proper FR Rainwear
Proper Use of FR Garments

• FRC should be appropriate to the hazard
• Always the outermost layer
• Worn correctly; zipped, buttoned, etc
• All natural, non-melting undergarments
• Clean, no flammable contaminants
• Repaired correctly and removed from service when needed
Standard on Selection, Care, Use and Maintenance of Flame Resistant Garments for Protection of Industrial Personnel Against Flash Fire

Provides common sense protocol for issues like:

- Conducting a hazard assessment
- Selecting FR garments (specifications)
  - Upper & lower body coverage
  - Non-FR heraldry
- Properly using FR garments (Training)
  - Collars, sleeves, cuffs
  - Layering
- Care and Maintenance
  - Emblems and embroidery
  - Cleaning

NFPA 2113 in addition -
1.1 Scope.

- **1.1.1*** This standard shall specify the minimum selection, care, use, and maintenance requirements for flame-resistant garments for use by industrial personnel in areas at risk from flash fires or short-duration flame exposure that are compliant with NFPA 2112, *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire*. 
Organizations shall provide users with the instructions provided by the manufacturer on the care, use, and maintenance of flame-resistant garments, including any warning provided by the manufacturer.

5.1.2 Organizations shall instruct workers in the limitations, use, care, and maintenance of flame-resistant garments, including the use of undergarments or over garments.

5.1.3 For maximum protection, organizations shall require that flame-resistant garments be worn as described in the manufacturer’s instructions.

5.1.4 Flame-resistant garment collars shall be worn closed.

5.1.5 Sleeves and cuffs shall be worn down and secured.

5.1.6 Organizations shall require that protective neck, head, hand, and foot coverings be worn if the occupational hazard warrants their use.

5.1.7* Other personal protective equipment (PPE) shall be worn if determined as necessary from a review of the potential hazards to which workers are exposed from the hazard assessment.

5.1.8* Organizations shall not permit workers to wear non-flame-resistant clothing over flame-resistant garments.

5.1.9 Flame-resistant or non-melting undergarments (closest to the skin) shall be used. An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted.

5.2* Specific Requirements for Wearing Flame-Resistant Garments.

The organization shall define those facilities and areas of the workplace and tasks that require personnel to wear flame-resistant garments.
Do’s
Don’ts
What **could** be wrong here???
Always – rolled, tucked and buttoned!
Care

Essential to your PPE’s performance and life expectancy is caring for your garments

Objectives

• Be able to identify additives that cannot be used on your FR/AR garments
• To be able to understand and recognize the effect of stains and secondary accelerants on your FR/AR garments
1910.132(f)(1)

The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

1910.132(f)(1)(i) - When PPE is necessary;
1910.132(f)(1)(ii) - What PPE is necessary;
1910.132(f)(1)(iii) - How to properly don, doff, adjust, and wear PPE;
1910.132(f)(1)(iv) - The limitations of the PPE; and,
1910.132(f)(1)(v) - The proper care, maintenance, useful life and disposal of the PPE.

1910.132(f)(2) - Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.
6.1.1* Flame-resistant garments shall be kept clean.

6.1.2* New flame-resistant garments shall be washed or dry-cleaned at least once prior to their initial use.

6.1.3* Flame-resistant garments shall be cleaned in accordance with manufacturer instructions, or if cleaning instructions are not provided, in accordance with the recommendations provided in ASTM F 2757-09, Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing, or ASTM F 1449, Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing.

6.1.4 Flame-resistant garments shall be laundered or dry-cleaned with such frequency so as to prevent buildup of contaminants that reduce flame resistance.
• Important to read the manufacturers laundry instructions on the label
• Written care instructions are available for all employees.
• They can also be accessed at: http://www.bulwark.com/Safety-Care
The Top 3 –

1. Do not use chlorine bleach, peroxide or fabric softener
2. Do not wear if soiled with flammable contaminants
3. Retire garment if worn out
Soiled Garments

• Monitor the accumulation of secondary accelerants on your garments through out the day.
• After laundering make sure accelerants are removed. If your garments still have a hydrocarbon/petroleum odor a flammable contaminant may still be present, rewash the garment until the odor is gone. If flammable soils are not completely removed, the protective qualities of the garment may be compromised.
• Discoloration/stains alone are not an indicator of reduced protection
How Much is too much???
Laundering Guidelines -

• Wash FR/AR garments separately
• Turn FR/AR garments inside out both assist in color retention and appearance
• Use liquid detergent for best results
• Avoid the hottest temperature to reduce the impact of shrinkage
• For tough stains applying liquid detergent to the stain or stain remover and allow garment to soak
• Bulwark FR/AR garments can be dry cleaned for tougher stains
• Tumble dry on low setting and do not over dry
What can you Use??
The No’s
Important to Read the Label
Maintenance

Objectives

• Identify when garments need to be repaired and or replaced
• Understand proper repair process for your FR/AR Garments
Inspect garments daily –
• Check for holes, rips and tears
• Check for areas of heavy wear such as elbows and knees where the fabric may be worn thin
• Check the integrity of the seams
In general check the integrity of the garment and repair or replace accordingly
NFPA 2113 Inspection

7.1.1* The organization shall develop a systematic inspection program for all flame-resistant garments to confirm their serviceability.

7.1.2 The end user shall inspect flame-resistant garments for damage, soiling, or contamination after each use.

7.1.3 Inspections of flame-resistant garments shall be performed by the organization or the end user following each cleaning and following any use where there was potential for damage or contamination.

7.1.4 All flame-resistant garments shall be inspected by the organization or the end user for fabric or material damage.

7.1.4.1 The inspection shall include an examination of all components, including, if present, the outer shell, lining, interlining, wind/moisture barrier, hardware, wristlets, and reinforcements.

7.1.4.2 Damaged flame-resistant garments shall be immediately removed from service.

7.1.4.3 The decision to repair or retire the damaged flame-resistant garments shall be made by the organization.

7.1.5 All seams of the flame-resistant garment shall be inspected by the organization or end user for thread or seam damage as evidenced by skipped, broken, or missing stitches.

7.1.6 All hardware on the flame-resistant garment, including, but not limited to, zippers, buttons, snaps, and other fasteners, shall be inspected by the organization or end user for functionality.

7.1.7* The organization shall establish criteria for determining the extent of damage to a flame-resistant garment to warrant its removal from service for repair or disposal.
Inspecting Garments - General

- Evaluate fit
- Worn correctly: shirts are tucked in, sleeves are rolled down, cuffs are buttoned and shirts are buttoned up (second button from the top)
- Outermost layer is FR/AR
- Wear and tear - thin spots, holes, abrasions, rips, and/or tears, check for open seams
- No Alterations or modifications
- Not soiled with oils, greases and/or other flammable contaminants
- The easiest time to inspect FR/AR Clothing is just before you put it on in the morning
- However make sure that you are vigilant throughout the day to avoid common errors in proper wear
- Repair garments with like materials and FR threads
- If that is not possible retire the garment and replace
What to ask for:

• To see the UL Certification or other independent organization on that particular garment
• Specify only certified compliant garments are allowed on site
• Ask for the test data most fabric suppliers have data sheets with the most common test results
• Work with a proven supply chain
• Periodically police your program for compliance
Questions, Comments, Feedback?
Bulwark University
Thank You From Your Bulwark Team