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Understanding U.S. versus Canadian Standards for Flame-Resistant, Arc-Rated and High-Visibility Garments

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Overview

For employers and safety managers in the oil and gas, and the commercial electrical (non-utility) industries, operating in both the United States and Canada, a variety of standards govern the selection of personal protective equipment (PPE). While standards are often similar, they are not identical. A comparison of the most important differences can help inform important employer purchasing decisions as they seek to promote worker safety and compliance.

WHICH EMPLOYER GUIDELINES GOVERN UNITED STATES VERSUS CANADIAN STANDARDS?

In the United States, employers are responsible for providing employees with protection from workplace hazards. Employers responsibly discharge this duty by following the OSHA General Duty Clause:

> *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 likely to cause death or serious physical harm to his employees; (2) shall comply with occupational safety and health standards promulgated under this Act.*[1]

While OSHA determines the rule, it does not determine how employers should follow the rule. When assessing product suitability, employers look to standards established by the National Fire Protection Association (NFPA), ASTM International (ASTM) and the American National Standards Institute (ANSI).

The NFPA is a "global self-funded nonprofit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards" (NFPA.org). Its standards are updated on a well-defined five-year cycle. NFPA® standards 2112 and 70E, referenced in this paper, were updated in 2018.

ASTM sets more than 12,000 standards globally to help enhance product performance and ensure consumers are making confident, informed purchasing decisions (astm.org). ASTM standards are continually under review, with revisions issued when deemed necessary. ASTM F1506, referenced in this paper, was issued in 2019 as version 19a.

ANSI provides a framework for fair standards development and quality conformity assessment systems that affect almost every industry and 30 million professionals worldwide. Organizations such as the International Safety Equipment Association (ISEA) look to ANSI protocols for the writing and promulgation of their standards. ANSI/ISEA 107, referenced in this paper, was issued in 2015.

In Canada, employers must also provide employees with protections from workplace hazards. Employers discharge their duties by adhering to section 124 in Part Two of the Canadian Labour Code, which states that "Every employer shall ensure that the health and safety at work of every person employed by the employer is protected."[2]

Similar to the statutes of OSHA in the United States, the Canadian Labour Code determines the rule but does not determine how employers should follow the rule. When assessing product suitability, employers should look to Canadian standards development leaders: the Canadian General Standards Board (CGSB) and the Canada Standards Association (CSA Group).

Part of the Government of Canada, CGSB provides standards development and conformity assessment that support economic, regulatory, procurement, health, safety and environmental interests in the country. Updates to CGSB 155.20 have been infrequent. The edition referenced in this paper was published in 2017.

CSA Group is dedicated to "safety, social good and sustainability." It is an international leader in standards development, testing, inspection and certification. While CSA Group has no

1 Occupational Safety & Health Act [OSHA]. 29 USC §654 (1970).

2 Canada Labour Code [CLC]. Part II, Duties of Employers, §124 (RSC, 1985).

fixed schedule for updating its standards, CSA Z462 is routinely updated to match any changes made to NFPA® 70E. Both of these standards are referenced in the electrical arc flash section of this paper. The latest edition of CSA Z462, at the time of this writing, was published in 2018.

NOTE: Canadian provinces also have boards that develop their own regulations. These may take precedence over federal regulations if they are more stringent. Because this paper outlines the standards developed by CGSB and CSA Group only, purchasers should familiarize themselves with any applicable provincial regulations as well.

WHAT STANDARDS GUIDE FLASH FIRE PROTECTION?

In the United States, flash fire protection for non-utility oil and gas workers and those employed in commercial electrical fields is determined by compliance with NFPA® 2112: *Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*.

NFPA® 2112 component-recognized fabrics must

1. Meet minimum performance standards for vertical flammability, as well as for heat transfer performance (HTP), thermal stability and heat resistance
2. Demonstrate that flame resistant properties are durable to laundering
3. Result in no greater than 50% predicted body burn when tested on an instrumented manikin in a simulated flash fire exposure lasting 3 seconds. The vast majority of flame-resistant fabrics and garments sold to the oil and gas and the commercial electrical industries in the U.S. and Canada meet at least the 40% maximum required by CGSB, as noted below

Garments meeting NFPA® 2112 requirement must

1. Be certified compliant by an independent third party, whose mark must appear on the garment label. This is an important verification that fabrics and garments comply with the standard.
2. Meet certain design, labeling, and laundering criteria. For example, garments must be sewn using inherently flame-resistant thread and may not have metal components that would come in direct contact with the body. Labels must be durable to laundering and include a code that enables traceability.

In Canada, flash fire protection is determined by compliance with CGSB 155.20: *Workwear Protection Against Hydrocarbon Flash Fire*. This standard is comparable to NFPA® 2112, with a few important differences. Importantly, CGSB 155.20 fabrics and garments do not require third-party certification.

CGSB 155.20-compliant fabrics and garments must:

1. Meet minimum performance standards for vertical flammability, as well as for thermal protective performance (TPP) rather than for HTP, thermal stability and heat resistance
2. Demonstrate that flame-resistant properties are durable to laundering
3. Result in no greater than 40% predicted body burn when tested on an instrumented manikin in a simulated flash fire exposure lasting 3 seconds. As noted above, the vast majority of flame-resistant fabrics and garments sold to the oil and gas and the commercial electrical industries in the U.S. and Canada meet at least the 40% maximum required by CGSB

WHAT STANDARDS GUIDE ELECTRIC ARC FLASH PROTECTION?

In both the United States and Canada, there is an arc-flash protection standard for non-utility electrical workers. In the United States that standard is NFPA® 70E and in Canada it's CSA Z462.

NFPA® 70E requires PPE for arc flash protection to conform to applicable state, federal or local codes and standards, and lists ASTM F1506 as an example of a standard for arc-flash protective clothing. ASTM F1506 is the primary standard used throughout the U.S. for this application.

CSA Z462, on the other hand, specifically states that PPE shall comply with ASTM F1506.

Understanding U.S. vs. Canadian Standards

Both standards require the use of appropriate arc-rated clothing for any potential incident energy exposure above the threshold for a second-degree burn, which is 1.2 cal/cm^2.

ASTM F1506 sets the minimum performance standards for arc-flash rated (AR) protective clothing. This protective clothing is designed to provide thermal protection from exposure to the incident energy of an electrical arc-flash event. The potential incident energy for working on a specific piece of electrical equipment determines the required arc rating of the garment.

The standard defines garment arc rating as the value attributed to the material's performance after exposure to an electrical arc discharge using the ASTM F1959 test method. This rating is expressed in cal/cm^2 and is derived from the determined value of the arc thermal performance value (ATPV) or energy breakopen threshold (E_{bt}).

ASTM F1506 requirements:

1. Fabrics must meet minimum performance requirements for vertical flammability, breaking load and tear resistance
2. Fabrics must have an arc rating (ATPV or Ebt)
3. Fabrics must demonstrate that arc-flash-rated properties are durable to laundering
4. Garments must meet construction requirements, such as using inherently flame-resistant sewing thread, and no metal fasteners next to the skin
5. Garments must have specific labeling information including the arc rating (ATPV or Ebt), fabric identifier and tracking code

Both NFPA® 70E & CSA Z462 require the use of either the "incident energy analysis" method or the "arc flash PPE category" method to determine the arc rating for PPE worn while working with live electrical equipment.

When the incident energy analysis method is used, the PPE arc rating is required to be equal to or greater than the potential incident energy established for that equipment.

When the PPE category method is used, arc-flash hazards are divided into four categories. The type of PPE and the minimum arc rating are specified for each.

The same categories, clothing descriptions and minimum arc-rating requirements are used for both NFPA® 70E and CSA Z462.

PPE CATEGORY	CLOTHING DESCRIPTION	REQUIRED MINIMUM ARC RATING
1	AR shirt + AR pant or AR coverall	4 cal/cm^2
2	AR shirt + AR pant or AR coverall, plus face shield and balaclava or hood	8 cal/cm^2
3	AR shirt + AR pant or AR coverall, plus AR hood	25 cal/cm^2
4	AR shirt + AR pant or AR coverall or AR flash suit jacket and pants, plus AR hood	40 cal/cm^2

WHAT STANDARDS GUIDE HIGH-VISIBILITY PROTECTION?

High-visibility standards guide the selection of PPE that improves worker visibility during the day, in low-light conditions, and at night. The standards determine the colors and luminance of background materials, as well as how much of the body should be covered by retroreflective components.

NOTE: *High-visibility garments may also provide flash-fire or arc-flash protection. Refer to the standards documentation for details.*

In the United States and Canada, standards for high-visibility garments serve the same purpose but have different compliance requirements and use different modes of measurement.

In the United States, high-visibility PPE must be compliant with ANSI/ISEA 107: *High-Visibility Safety Apparel and Accessories*. This standard stipulates the use of fluorescent background fabric colors. It designates garments for various work environments by garment type and performance class, and notes that a combination of performance materials can be counted toward the minimum area requirements for background materials.

Understanding U.S. vs. Canadian Standards

Garment Type O refers to high-visibility garments designed to protect workers in off-road environments where struck-by hazards are operating at less than highway speed. All Type O garments fall into Performance Class 1 and provide the minimum level of visibility afforded by ANSI 107-compliant garments.

Garment Type R refers to high-visibility garments designed to protect workers exposed to struck-by hazards that approach at highway speeds along public roadways and temporary traffic control zones. These garments fall into either Performance Class 2 or Class 3, which provide incrementally greater visibility by using greater amounts of fluorescent background fabric and retroreflective striping.

Garment Type P refers to high-visibility garments used by emergency and incident responders and law enforcement personnel who are exposed to vehicular traffic along public roadways and temporary traffic control zones, but whose garments must also allow access to special equipment. Type P garments can also be labeled as either Class 2 or Class 3.

"Supplemental Items" are pants, overalls, shorts, rain pants and gaiters designated Performance Class E. These garments alone do not provide enough visibility to meet the requirements of ANSI 107, but when worn with a Class 2 or Class 3 garment, the overall classification of the ensemble is Class 3.

ANSI/ISEA 107 requires third-party certification for fabrics and trim, but garments made with third-party certified fabrics and trim may be self-certified by the manufacturer.

In Canada, high-visibility PPE must be compliant with CSA Z96: *High-Visibility Safety Apparel*. Whereas ANSI/ISEA 107 requires fluorescent background colors, CSA Z96 specifies fluorescent or "bright" background colors. It further specifies that there be retroreflective striping in an "X" pattern on the back of all high-visibility garments.

Although CSA Z96 classes are similar to those in ANSI/ISEA 107, CSA classes specify which parts of the wearer's body should be covered, as well as the minimum coverage area as measured in square meters.

The standard further denotes two levels of photometric performance, which correspond to the various apparel classes below. It also includes an allowance for an even lower photometric performance level called "Level FR." This level is exclusively used for Class 2 and Class 3 high-visibility apparel that is also flame resistant.

Class 1 garments require a reflective harness pattern or reflective stripes or bands over the shoulder(s) and around the waist. These retroreflective stripes can provide either Level 1 or 2 photometric performance.

Class 2 garments require full coverage of the upper torso, including the shoulders, with fluorescent or bright background material and incrementally more coverage of retroreflective striping than Class 1 garments. The retroreflective stripes can provide either Level 1 or 2 photometric performance.

Class 3 garments require the same Class 2 coverage, but also stipulate bands encircling both legs. These bands must be composed of combined-performance stripes, or a combination of retroreflective and background materials. Retroreflective striping used on Class 3 garments must provide Level 2 photometric performance.

Understanding U.S. vs. Canadian Standards

U.S. STANDARDS VERSUS CANADIAN STANDARDS AT A GLANCE

	COUNTRY	STANDARD	NOTES
Flash Fire	United States	NFPA® 2112	• Based on tests for vertical flammability, heat transfer performance (HTP), thermal stability and heat resistance • Max 50% predicted body burn • Requires third-party certification, an important compliance verification for purchasers
	Canada	CGSB 155.20	• Based on tests for vertical flammability, thermal protective performance (TPP), thermal stability and heat resistance • Max 40% predicted body burn • No third-party certification required
Arc Flash	United States	NFPA® 70E	• No longer requires explicit adherence to ASTM F1506, but rather must conform to applicable state, federal or local codes and standards, with ASTM F1506 as an example of a standard for arc-rated protective apparel
	Canada	CSA Z462	• Requires explicit adherence to ASTM F1506

	COUNTRY	STANDARD	NOTES
High Visibility	United States	ANSI/ISEA 107	• Garments categorized by "Types" according to workplace environment • Requires minimum areas of fluorescent-colored background material and retroreflective trim depending on garment type • Requires third-party certification for fabrics and trim, an important compliance verification for purchasers • Allows manufacturer to self-certify garments
	Canada	CSA Z96	• Garments categorized "Classes" which are defined by body coverage and minimum areas of background material and retroreflective trim • Allows fluorescent or bright colored background materials • Requires "X" retroreflective striping pattern on back of garment • No third-party certification required

WHAT ELSE DO EMPLOYERS NEED TO KNOW?

Each performance standard referred to in this paper is based on a battery of tests, which together provide a means of evaluating the protective capabilities of garments and the components they're made of. Be aware that some manufacturers may claim that a garment is fire resistant or arc rated based on a single test. Always look for certification to the standards listed here, as well as third-party certification on any garment claiming to be certified to NFPA® 2112 or fabrics and trims claiming to be certified to ANSI/ISEA 107.

Bulwark technical experts sit on multiple committees of the National Fire Protection Association and ASTM International where they participate with other voting members to create, update, and improve safety standards for flame-resistant and high visibility apparel. This apparel helps protect men and women working in jobs with potential exposure to thermal and struck-by hazards.

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To learn more about OSHA regulations, occupational hazard assessment, and FR outfitting standards, contact:

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