

Safety

GUIDE



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ARC FLASH

hazard





"Arc Flash" hazard

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"Arc Flash" hazard

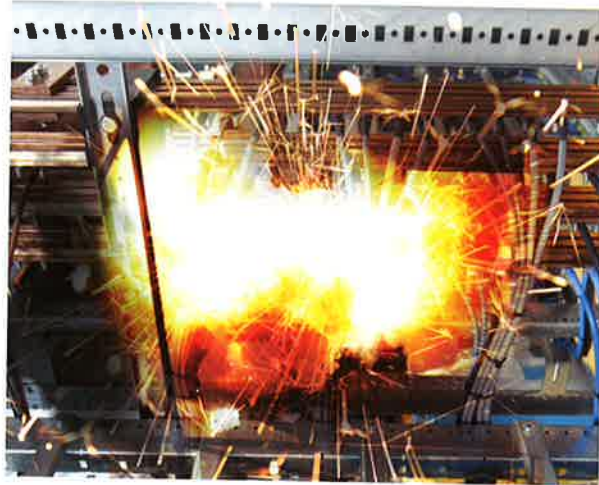
What is an "arc flash"? What produces it?

WHAT IS AN "ARC FLASH" AND HOW IS IT PRODUCED?

The phenomenon

An **"Arc Flash"**, occurs when an electric arc appears as a result of a short circuit in a high or low voltage electricity facility. It can also occur in certain conditions* through the **ionisation of gases** present that then create an electrical connection between the conductors with different currents.

In either case, there is an explosive release of energy accompanied by a significant release of heat.



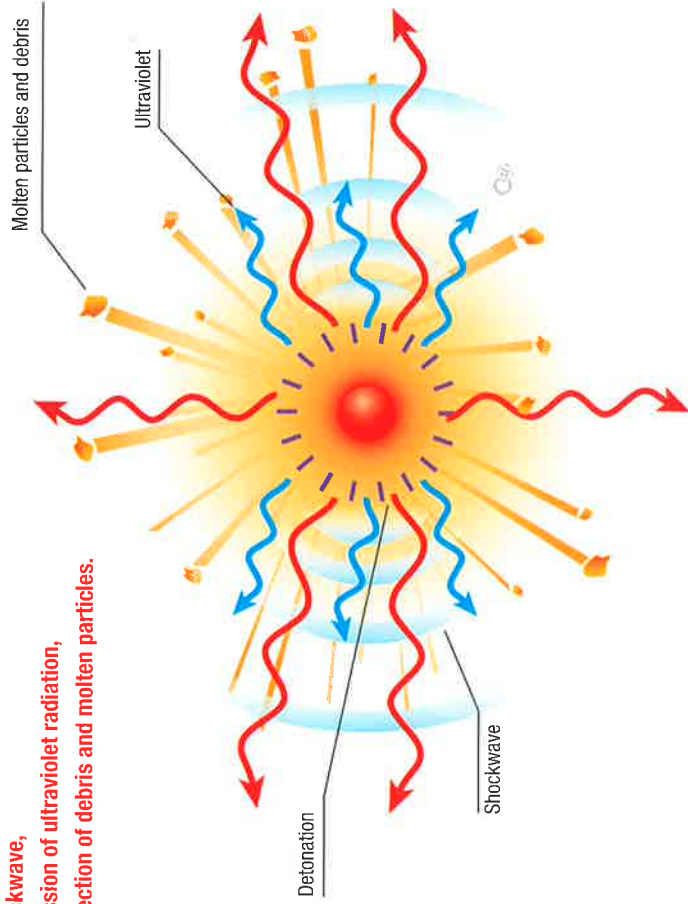
IMPORTANT

The energy of the arc flash depends on the voltage of the installations as well as the intensity of the short circuit, which can reach several thousand amps and a temperature in the region of 20,000 °C.

* High level of suspended fine particles, for example.

As with an explosion, and as well as the high level of heat released, an arc flash produces the following additional effects:

- detonation,
- shockwave,
- emission of ultraviolet radiation,
- projection of debris and molten particles.



Conditions for risk of "Arc Flash" occurring

An "Arc Flash" can occur during works close to bare live parts, actions to operate or commission load breaking devices for power installations and in various other situations:

- fault at the installation,
- dilapidated installation or load breaking device,
- operator error,
- other...

Of course, this all depends on the configuration of the installation and in any case a precise risk assessment must be performed for those parts considered to pose a hazard (chapter 4).





"Arc Flash" hazard

THE CONSEQUENCES OF AN "ARC FLASH"

Contrary to conventional wisdom, there is not generally direct contact in the case of an arc flash, and the current does not actually pass through the body, since the electric energy released is transformed almost instantly into an explosive emission of heat energy.

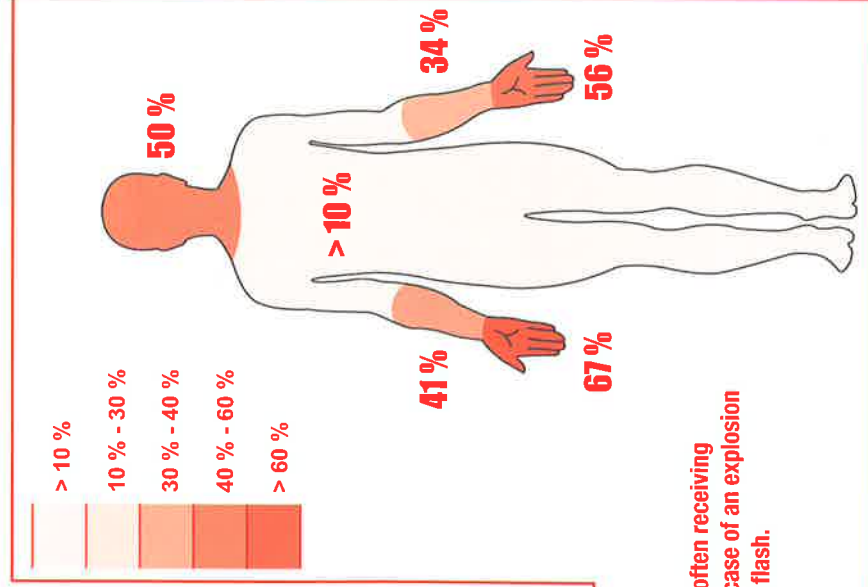
For an unprotected operator, the consequences of a direct explosion can cause serious injuries.

Generally, the most common injuries are burns to the face, eyes, upper limbs and particularly the hands.

If clothes catch fire, other parts of the body can also be affected.

The pressure shockwave that follows the explosion can also cause problems to the eardrums and present a risk of being thrown by their force.

It is thus essential to be protected in situations that present a risk.



Areas of the human body most often receiving 2nd or 3rd degree burns in the case of an explosion without protection from the arc flash.

REGULATION CURRENTLY IN FORCE FOR PROTECTION FROM ARC FLASHES, IN FRANCE, EUROPE AND AROUND THE WORLD

Currently, regulations for employees are not harmonised, and we can see significant differences between regulations in place in France, Europe and the rest of the world.

Three basic principles

To protect people from electric hazards (electric shock and short circuit) as per decree 1118 from 22 September 2010:

- ① Work with power off after commissioning
- ② If voltage present in the vicinity: move out of touch by
 - Distancing
 - Obstacle (door, rigid screen, etc.)
 - Insulation (e.g. Safety sheet)
- ③ Work with voltage on when it is technically impossible or dangerous to work without voltage present.





"Arc Flash" hazard

a- In France



In France, the Labour Code establishes the employer's obligations related to electric hazards.

Article L 4121-1 specifies that it is the employer's responsibility to perform a risk analysis for workers exposed to electric hazards.

As part of the evaluation of electric risk inherent in their activity and their establishment, they specify the suitable means for protection.

"Art. R. 4121-1. - The employer specifies, and maintains up to date in a single document, the results of the risk evaluation for the health and safety of the workers.

- The employer must take protective measures and provide appropriate instructions to workers.

"Art. L. 4121-3. - This evaluation includes an inventory of the risks identified in each of the work units for the company or establishment.

The articles of the Labour Code regarding electrical hazards were updated with the passing of several decrees, including decree 2010-1118 from 20/09/2010 relating to operations on electrical installations and in their vicinity as described in standards NF C 18-510: 2012

Today

NF C 18-510 lays down a requirement for the wearing of work clothes to protect from the effects of an arc flash and face protection with characteristics described in annex C without, however, specifically mentioning "Arc Flash" type equipment.

IMPORTANT

Without being officially mandatory, the use of "arc flash" protection as a means of protection results from the risk analysis performed at the installation in question.



b- Europe

For Europe, as per the stipulations of European standard EN 50110-1, the head of the electrical installation is obliged to evaluate the electric risks and define the measures for protection against the effects of the ARC FLASH.

"6.1.1 The work procedures include 3 different procedures: working without voltage, working with live voltage, and working close to bare parts with live current. All of these procedures are based on the use of measures to protect against electric shocks and/or the effects of short circuits and arcs."

The dangerous phenomenon of arcs is covered under standard EN 501101 in annex B.6 **"People working in the vicinity of electrical installations are exposed to arc flash hazards [...]** effective protection is required"

Under this framework, arc flash protective clothing must comply with the requirements of the following standards: **IEC 61482-2** (Standard specifying the clothing for protection against the temperature effects of the arc flash hazard) product standard specified in chapter 4.



c- In the rest of the world

Outside of France and Europe, standards and practices in North America predominate with the "OSHA" (Occupational Safety and Health Administration) regulations.

They clearly stipulate that all employers must protect their employees from the effects of arc flashes.

NFPA* 70 E standard 70 E makes it mandatory to perform a risk analysis and to use protection where required against the thermal effects of arc flashes.

Clothing and equipment used against the thermal effects of the arc must comply with the ASTM or ANSI standards.

* (National Fire Protection Association).

Category of arc flash protective clothing as defined by NFPA 70 E

Category		Minimum capacity of protection against arc flash
1		4 cal/cm ²
2		8 cal/cm ²
3		25 cal/cm ²
4		40 cal/cm ²



"Arc Flash" hazard

EVALUATION OF HAZARD AND MEANS OF PROTECTION

Evaluation

All employers are responsible for performing an electric risk analysis (Labour Code). This responsibility covers all hazards of an electric origin in the environment worked in, including the appearance of an arc flash.

ATTENTION

The risk evaluation must be performed by the employer. They may use the services of an organisation specialising in the field.

IMPORTANT

If the dangerous phenomena due to arc flashes cannot be eliminated, then appropriate measures should be taken with the use of specific equipment protecting against the arc flash hazard. One of the reference standards in the risk analysis field is IEEE 1584.

The evaluation of the risk of the appearance of an arc flash depends on the power as well as the configuration of the installation and requires precise analysis of the different equipment forming it, including:

- The evaluation of electric parameters on the site involving a prior investigation of the installation
- a data analysis
- recommendations for points of the installation potentially at risk of an arc flash, resulting in a calculation of the protection level.

The analysis of the installation involves:

- Understanding the one-line diagram of the network and its characteristics.
- Understanding all the characteristics of all of the breaker units, all consumers, all transformers, all cables, etc., that are present on the installation.
- Finding all the points where an arc flash may occur.
- Calculate, for all of these points, the thermal level required.

Levels and means of protection

To be able to precisely specify the level of protection required and thus the appropriate clothing, the protection level must be calculated in relation to the occurrence of the arc flash.

Elements that the protection level calculation depends on include:

- The maximum default current value (Icc).
- The nominal phase/earth voltage at the risk points identified by the evaluation.
- The time for protective supply cut-off (fuse or breaker).
- The distance from the source of arc to the receiving surface.
- The distance between the worker and the arc.

Level of energy released by the arc

The energy released by an arc flash is expressed in cal/cm² or in kJ/m².*.

Reminder:

- 1 cal/cm² is equivalent to the exposure to a lighter flame on a finger for one second.
- Energy of just 1.2 cal/cm² causes a 2nd degree burn to human skin.

* kJ/m² is the official unit, but the predominant use is in cal/cm².

Level of risks evaluated by European countries

In Europe, some countries including Germany, have adopted the Arc Protection Classes (APC) defined by the IEC 61482-1-2 test method: determination of the class of protection against the arc hazard from materials and clothing using a constrained directed arc (known as the box test).

Class 1: test 4 kA / 500 ms at 30 cm.

Class 2: test 7kA / 500 ms at 30 cm.



Example of test on helmet with face mask





"Arc Flash" hazard

Signage

After analysis, some test organisations apply labels warning of the risk of arc flash hazard at identified locations. This is not yet an obligation in France, but it is common practice in the industry.

For countries that have adopted NFPA70E, it is essential that this is displayed.

Example of display as per NFPA 70 E, 2015 version

 WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
25.1 9 ft 7 in	Cal/cm ² at 18 inches Flash Hazard Boundary
208 VAC 42 in 0 in	Nominal System Voltage Limited Approach Boundary Restricted Approach Boundary
Bus: MSB Prot.: Max Trip Time: 2 sec. Equipment Name:	

Signage in line with NFPA 70 E

Electrical equipment such as switching cabinets and industrial control boards that require testing and maintenance must have a sign stating:

- nominal voltage
- the arc distance
- the incident energy in the case of an accident corresponding to the working distance
- The EPI category (1,2,3, or 4)

The owner of the electrical equipment is responsible for the signage posted on the installation and its readability.

Means of protection

For protection from the arc flash hazard, the operators must be wearing clothing that protects them from the thermal effects of the arc.

The clothing must comply with standard **IEC 61482-2**

Standard of specifications of clothing protecting against the thermal effect of an arc flash.

The characteristics of protective clothing (protection of the head, face, hands and body) are specified in line with 2 test methods described in test standards:

IEC 61482-1-1

Free arc flash test method, including the American test method. Result expressed in cal/cm², Equipment from 4 to 100 cal/cm².



IEC 61482-1-2

Test method called the Box Test, the arc is directed. Characterised into 2 classes corresponding to the energy levels:
Classe 1 = basic protection
Classe 2 = reinforced protection

Under the EPI European directive, Arc Flash equipment is classed under Category III (fatal risk).

This means that all manufacturers have the obligation to ensure the product is tested by an approved European laboratory:

- The name of the laboratory must be published in the official journal and on the European NANDO website.
- Following testing: the laboratory supplies a type examination certificate.

In order to have the right to manufacture, the manufacturer must be audited at regular intervals by a laboratory that is recognised by Europe:

- The laboratory confirms that the level of quality examined once is repeatable 1,000, 10,000 times... by the manufacturing chain.
- The name of the laboratory that supplies the CE mark must be identified on the clothing labels.

Table of norms or standards

	France / Europe		International		USA	
Clothing for protection against thermal effects of arc flash hazard	NF EN 61482-1-1 (ATPV test) NF EN 61482-1-2 (BOX TEST)		IEC 61482-2 (Product standard) IEC 61482-1-1 (ATPV test) IEC 61482-1-2 (BOX TEST)		ASTM F1506 (Product standard) ASTM F1959 (Test standard)	
Protecting the face against thermal effects of arc flash hazard	GS-ET-29				ASTM F2178	
Gloves protecting against thermal effects of arc flash hazard					ASTM F2675	
Face protection for UV from arc flash	NF EN 170				ANSI Z87.1	
Face protection for physical impact from arc flash	NF EN 166				ANSI Z87.1	

Laboratory identification number





"Arc Flash" hazard

EQUIPMENT RANGE

Insulating gloves
for protection from
"Arc Flash"

EN 60903 / IEC 60903



IEC-61842-1-2 class 2
(Box: 7kA/30 cm)



Range of composite
insulating gloves
offering protection
from effects of an
"Arc Flash".
Classed 00 to 4.



CGM range

Nomex III ® inner gloves

EN 407
EN 420



CG-37



Fire protection

Face screen (12 cal/cm²) and helmet with face screen



KIT-ARC-01



MO-180-ARC range



ASTMF2178

ATPV 4 and 12 cal/cm²
IEC 61482-1-2 / GS-ET-29
Class 2



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Examples of Class 1 clothing



IEC 61482-2
12 cal/cm² class 1

Handling
overall
SJ-12

NFPA 70E



IEC 61482-2
12 cal/cm² class 1



Basic suit
MV-105

NFPA 70E / ASTM



IEC 61482-2
Suit with hood
(12 cal/cm²)
Class 1



KIT-ARC-12-J

NFPA 70E / ASTM



IEC 61482-2
Class 1 overall,
trousers, suit
kit (12 cal/cm²)
Class 1



KIT-ARC-12-C



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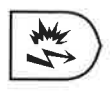


"Arc Flash" hazard

Examples of Class 2 clothing

Suit and hair kits (25, 40, 65, 100 cal/cm²)

NFPA 70E / ASTM
IEC 61482-2



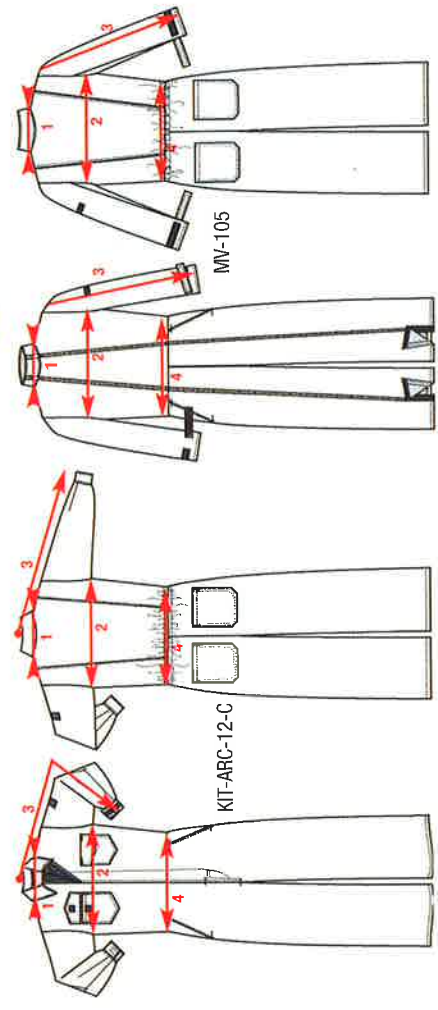
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SIZES OF CLOTHING AND ACCESSORIES (POCKETS, FASTENINGS, ETC.)

Suit

How to take your measurements:

- 1. Neck
Neck circumference.
- 2. Chest
Measure around the chest under the arms.
- 3. Length of sleeves
From middle of back of neck to the shoulder and down to the wrist.
- 4. Waist
Waist circumference.



Waist	S	M	L	XL	2XL	3XL
Neck	16"	18"	20"	21"	23"	24"
cm	40.5	45.75	51	53	58.5	61
Chest	47"	51"	55"	59"	63"	67"
cm	119	129.5	140	150	160	170
Sleeve length	33.5"	35"	36"	37"	38"	39"
cm	85	89	91.5	94	96.5	99
Waist circumference	33"	35"	38"	42"	44"	48"
cm	84	89	96.5	107	112	122
Stretched waist circumference	37"	39"	43"	46"	48"	50"
cm	94	99	109	117	122	127



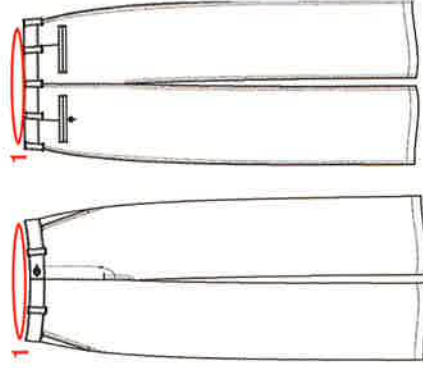
"Arc Flash" hazard

Trousers (KIT-ARC-12-JP)

How to take your measurements:

1. Waist

Waist circumference.



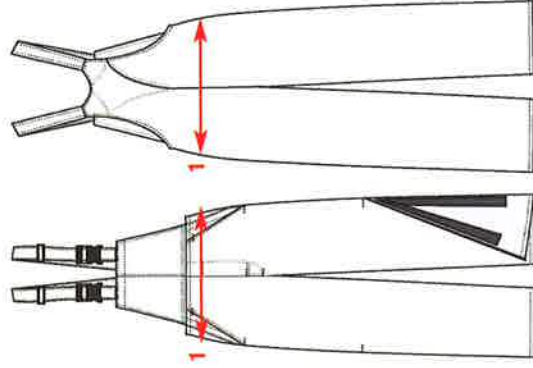
Waist	32	36	40	44	48
	S	M	L	XL	2XL
Waist circumference	33.5"	37.5"	41.5"	45.5"	49.5"
cm	85	95	105.5	115.5	125.7

Overalls (KIT-ARC-25...100)

How to take your measurements:

1. Waist

Waist circumference.



Waist	S	M	L	XL	2XL	3XL
Waist	36"	39"	42"	45"	48"	51"
cm	91.5	99	106.5	114	122	129.5

Short jacket (KIT-ARC-12-JP and KIT-ARC-25...100)

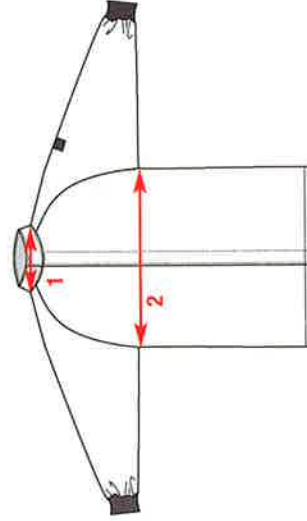
How to take your measurements:

1. Neck

Neck circumference.

2. Chest

Measure around the chest under the arms.



Waist	S	M	L	XL	2XL	3XL
Neck	19"	20"	21"	22"	23"	24"
cm	48	51	53	56	58.5	61
Chest	48"	52"	56"	60"	63"	66"
cm	122	132	142	152.5	160	167.5
Overall height	32"					
cm	81					

Suit with hood

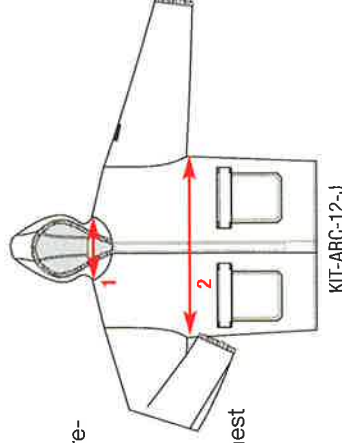
How to take your measurements:

1. Neck

Neck circumference.

2. Chest

Measure around the chest under the arms.



Handling overall
SJ-12

Waist	S	M	L	XL	2XL	3XL
Neck	19"					
cm	48					
Chest	46"	50"	54"	58"	62"	66"
cm	117	127	137	147	157.5	167.5
Clothing height (KIT-ARC-12-J)	32"					
cm	81					
Clothing height SJ-12	49"					
cm	124					



"Arc Flash" hazard



TECHNICAL ASSISTANCE



WEIGHT AND COMPOSITION

Description	Weight	Composition	
		Outer layer	Inner layer
Suits 12 cal/cm ²	305 g/m ²		Ultrasoft 88% cotton / 12 % nylon
Suits 25 cal/cm ²	542 g/m ² 16 oz/yd ²	88% cotton 12 % nylon	88% cotton 12 % nylon
Suits 40 cal/cm ²	746 g/m ² 22 oz/yd ²	88% cotton 12 % nylon	88% cotton 12 % nylon
Suits 65 cal/cm ²	644 g/m ² 19 oz/yd ²	100 % kevlar	visible : 93 % meta-aramid, 5 % paramid, 2 % anti-static. Intermediate ; 67 % nomex, 33 % kevlar
Suits 100 cal/cm ²	746 g/m ² 22 oz/yd ²	100 % kevlar	visible : 93 % meta-aramid, 5 % paramid, 2 % anti-static. Intermediate ; 67 % nomex, 33 % kevlar



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