Technical Handbook of Personal Protective Equipment

Section 1.4 Hand Protection

Introduction

The first thing you do when you see your newborn baby is to reach out with your hands and touch, usually the baby's hand. It is your hands that allow you to connect with this new little human. These same hands allow typing of these words and give you the ability to earn a living. Are hands worth protecting? Of course they are! But do we know how to select the correct protection? What follows will provide a comprehensive guide in glove selection.

Hand Protection is one area which requires much debate, discussion and trial before a purchase decision can be made, it is not as cut and dried as perhaps Hearing Protection may be.

Historically, the South African market, has like many others worldwide, become predominantly concerned with the use of leather gloves, cotton gloves and PVC gloves. While these gloves certainly still have a very important place in our market, it is only in the last four years, that we have seen the local market evolve and mature somewhat with regard to the selection of Hand Protection. Due to a lack of information, misinformation or even a misinterpretation of information consumers have been incorrectly led to believe that the above mentioned gloves were sufficient to cover all their needs. Thanks to the internet, customer training and other mediums, customers have now been made aware that there are in fact standards which need to be adhered to with regards to the manufacturing of Safety Gloves, and that these requirements will differ from application to application (mechanical to chemical), and to a large degree determine the correct application where the glove should be used. While it can be argued that the standards themselves are not that demanding and in many cases do not even represent instances of what might actually occur in the workplace, the point is this, they are consistent and fair and exactly the same for all gloves.

Customers are now spoilt for choice when it comes to hand protection products, and yet this choice itself may cause even further confusion, if one is not comfortable with the standard involved (even a basic understanding) and the application for which the glove will be used. The purpose of this section therefore is to ensure that as much information about hand protection standards (Mechanical, Chemical and other), is transferred not just to members of SAPEMA, but also to members of partner associations (SAIOH, IoSM and Safety First Association), end-users and to anybody or institution who is involved in the procurement, manufacturing or use of hand protection products in southern Africa. We trust that you will find the information useful and informative and will enable you to make more informed decisions in the future. Please note that for your information we will be referring to the European Norms (EN) and standards in this section, and will be referring specifically to the following:

- EN388: Mechanical Protection
- EN374:1 Terminology and Performance Requirements (Chemical Protection)
- EN374:2 Penetration Resistance (Chemical Protection)
- EN374:3 Permeation Resistance (Chemical Protection)

Detailed technical information follows below.

The Hand *our most useful tool*

The first thing you do when you see a newborn baby is to reach out and touch, usually the baby's hand. Hands allow you to connect with this new little human. This same hand allows typing of these words and gives you the ability to earn a living. Are hands worth protecting? Of course we do, but do we know how to select the correct protection?

The hand is one of the most complex tools and one accident in three involves it. The hand has such unique attributes and is an essential part of the human body; it must be adequately protected when exposed to hazards which can seriously damage it. To protect your hand, you will need to assess:
• **Hazard** - Potential to do harm
• **Risk** - Likelihood that your hands may be harmed
• **Consequence** – Severity or degree of injury sustained

This tool is exposed to numerous hazards

- Thermal hazards
- Mechanical hazards & vibrations
- Chemical hazards
- Radioactive contamination
- Microorganisms
- Electric current
- Incomparable dexterity and touch sensitivity
- Ionizing radiations

UNDERSTANDING THE CE MARKED PRODUCTS

CE marked products are categorized by the EN directive for personal protective equipment (89/686/EEC). The CE marking certifies that a product has met EU consumer safety, health or environmental requirements but is not a standard in itself. It forms a part of the requirements of the relevant EN standard. The CE marking is a mandatory European marking for certain product groups to indicate conformity with the essential requirements set out in European Directives. In order to use the CE mark on a product the manufacturer must draw up a Declaration of Conformity (DoC) in which the manufacturer attests conformity with all relevant NADs (New Approach Directives) and takes sole legal responsibility. In some instances a NAD may require a Notified Body to issue a Certificate of Conformity in order to verify performance of the product or constancy of the production process (Factory Production Control) for example.

The DoC must include: manufacturer's details (name and address etc); essential characteristics the product complies; any European standards and performance data; if relevant the identification number of the Notified Body; and a legally binding signature on behalf of the organization.

PPE directive as applicable for Protective Gloves

Category I (SIMPLE DESIGN)

Simple design protecting the user against MINOR RISKS
• Superficial mechanical aggressions (gardening, dirty jobs, sports…)
• Low toxicity cleaning agents (dishwashing, cleaning jobs) for professional use
• Heat below 50°C, non-dangerous shocks, non extreme cold, for professional use

Type of Certification: Declaration of conformity issued by the manufacturer (with no external controlling body) and is reliant on the manufacturers declaration

Category II (INTERMEDIATE DESIGN)

Every glove that is not covered by Category I, Category III or is excluded is certified in "Category II"

Type of Certification: Issue of CE declaration by an authorized controlling body

Category III (COMPLEX DESIGN)

Complex design against mortal risks or risks that can irreversibly affect the health of the user
PPE giving greater protection against risks which may cause death or severe and / or permanent injury

- gloves against electrical risks
- hot environments at 100°C or higher
- cold environments at –50°C or colder
- limited protection against chemical attack or ionizing radiations

EN: Standards and Performance

EN 420 Essential requirements for protective gloves

- Ergonomic/Comfort: construction, sizing, dexterity
- Innocuousness: material used is not toxic or harmful to the user ie. Leather gloves must have Chromium VI content less than the limit of detection
- Glove Marking: each glove shall be marked. Individually packaged gloves shall have markings on the packaging as well as on at least one of the gloves
- Packaging/Leaflet: The information leaflet is compulsory, and shall accompany the PPE on the market. The end-user is entitled to find such information with the gloves he buys.

EN 388 Mechanical Hazards

			
Dipped Nitrile Coated Handling Glove	**Dipped PVC Coated Handling Glove**	**Chrome Leather Handling Glove**	**Pigskin Handling Glove**

Please note the pictures shown above are purely illustrative, and do not offer any endorsement for a given brand.

Statistics prove mechanical hazards are the most common causes of hand injuries in industry. They account for 60% of all reported accidents to hands. Mechanical risks in the workplace are often a combination of several different hazards. Tests are performed on a portion of the glove, taken from the palm section of the glove

Consequences:

- cuts to the skin, tendons and nerves,
- punctures
- skin abrasion
- skin irritation (rubbing),
- fractures, sprains.

Examples of applications:

- Handling sharp objects such as glass or metal parts,
-Handling sharp objects, wire strands
-Handling cardboard boxes wooden pallets
-Handling small components, assembly of sharp engineering parts
-Warehousing, machine part handling, moving of heavy loads

Protection against general mechanical risks is symbolized by a pictogram and accompanied by four numbers (each number gives the level of performance obtained according to the corresponding test). The higher the number on the glove, the higher can be the expected performance of the glove in that particular test. Importantly these tests serve only to indicate a measure of resistance to the possible risks. These products are in no way able to be rendered cut-proof or abrasion-proof, but to simply offer an element of resistance.

A B C D

The numeric performance level indicator (above) is A, B, C or D and is derived as follows:

A **ABRASION RESISTANCE** (0 to 4) Number of cycles

1	2	3	4
100	500	2000	8000

Please note that the glove would actually have to achieve for example at least 500 cycles in this test, in order to achieve a level 2 for abrasion. 495 Cycles would still result in a level 1. The reason for this variance between the various levels is due to the following:

- Building in a tolerance to ensure that there is an understanding that not every glove will perform to exactly the same level and results may vary within acceptable limits
- The gradual deterioration of the abrasive material being used therefore increasing the cycles will compensate for this

B **BLADE CUT RESISTANCE** (0-5)
Index

1	2	3	4	5
1,2	2,5	5,0	10,0	20,0

This test is not as clear as the previous test, as it makes use of three tests and then mathematically calculates a result by way of an algorithm. First a standard material is tested, then the cut resistant material in question and finally the standard material again. All tests are performed using the same cutting blade, which may deteriorate during the three tests. The result is obtained by dividing the result of the Test material (required cut resistant material) by a mean average of the two tests performed on the standard material. However if the cut resistant material is so good that it reduces the sharpness of the blade significantly, then obviously the second standard test result will be skewed, affecting your overall result. However, it is fair and constant and the same for all gloves. This is again offset by the variance in test results, which help compensate for this effect

C **TEAR RESISTANCE** (0-4)
Newton's

1	2	3	4
10	25	50	75

A fairly simple test wherein a portion of the material being tested is clamped and a force is applied to see what the resistance of the material is when it comes to tearing. Again a tolerance is built in to allow for a variance in results of gloves being tested

D **PUNCTURE RESISTANCE** (0-4)
Newton's

1	2	3	4
20	60	100	150

The same machine is used here to test for the amount of resistance the glove material offers with regards to punctures. This test has also come under question as the needle being used is relatively broad, which means it covers a wider surface area and as such would find it harder to penetrate the material. In real life situations, the material may be faced with a thinner object (wire strand) which may penetrate far more easily. Again we are reminded of the consistency of the test and the tolerance for a variety of comparable test results

EN 374 Protective Gloves against Chemical and/or Micro-Organisms

			
PVC Liquid Handling Gauntlet	**Rubber Liquid Handling Gauntlet**	**Liquid Handling Gauntlet**	**PVC Liquid Handling Gauntlet**

Please note the pictures shown above are purely illustrative, and do not offer any endorsement for a given brand.

Where there is a possibility of personnel being exposed to harmful or toxic materials Risk Assessment MUST be done. It is essential Risk assessments are conducted by suitably trained competent staff. Glove manufacturers can assist and advise personnel doing these risk assessments on the most appropriate hand protection when all mechanical hazards and chemical rates have been assessed.

Consequences:

- chemical burns,
- skin irritations,
- allergic dermatitis,
- major organ damage,
- carcinogenic effects.

Examples of applications:

- cleaning jobs (detergents, disinfectants, solvents, diluted caustics),
- mixing or transferring concentrated chemicals from containers,
- diluting concentrated chemicals,
- handling chemical-coated parts,
- hazmat- Hazardous Material

EN 374-1: Terminology and Performance Requirements

Part 1 of EN374 deals with the following:

1. Scope
2. Normative references
3. Terms and Definitions
4. Method of Testing
5. Performance requirements
6. Markings
7. Information supplied by Manufacturer

1. Scope

- Part one of this standard deals with the requirements for gloves to protect the user against chemicals and/or micro-organisms and the definition of the various terms used in this standard (complete)
- Should be used in conjunction with EN420 (see page 3 above)
- This portion does not specify requirements for protection against any mechanical hazards

2. Normative References

This standard refers at various points to other EN standards in the appropriate portions of the text. These additional references are as follows:

- EN374-2: Determination of Resistance to Penetration
- EN374-3: Determination of Resistance to Permeation
- EN388: Protective Gloves against Mechanical Risks
- EN420: General requirements for gloves

3. Terms and Definitions

The following terms and definitions are explained:

- Protective glove material
- Protective gloves against micro-organisms
- Degradation
- Penetration
- Permeation
- Test chemical
- Breakthrough time

4. Method of testing

Details of the following tests are explained:

- Penetration: EN374-2
- Permeation: EN374-3

5. Performance requirements

The following performance requirements are detailed:

- Minimum liquid proof length
- Penetration
- Permeation

Time (Measured breakthrough time)	Protection Index
➢ 10 min	Class 1
➢ 30 min	Class 2
➢ 60 min	Class 3
➢ 120 min	Class 4
➢ 240 min	Class 5
➢ 480 min	Class 6

- Mechanical characteristics

6. Markings

The appropriate markings in accordance with EN420 shall be used and will be as follows:

EN 374-2

XXX

EN374-3

7. Information supplied by the manufacturer

The information supplied, shall be in accordance with EN420 and shall include amongst other information:

- The list of Chemicals against which the glove was tested
- Contact details for additional information
- Warning that results do represent the actual results or performance which can be expected in the workplace due to other factors

EN 374-2 : Determination of Resistance to Penetration

Penetration can be defined as the movement of a chemical, micro-organism or substance through a glove on a non-molecular level ie. Through imperfections in the construct of the glove such as porous material, poor seam quality, pin holes, poor dip quality etc.

Air leak test as per the table below

Nominal glove thickness - mm	Air pressure - kPa
$e \leq 0{,}3$	0.5
$0{,}3 < e \leq 0{,}5$	2.0
$0.5 < e \leq 1{,}0$	5.0
$e > 1{,}0$	6.0

Water leak test

Ambient water is filled into inside of glove (minimum 1000ml) for a period of 2 minutes.

Although they do not have any denomination, we can say that:

• If a glove is liquid proof according to EN 374-1, but with no other pretention or checking of the chemical resistance, or not passing the level specified for the second case, it will bear the pictogram 'liquid proof' or 'basic chemical protection', but still with questionable chemical resistance.

EN 374-3 : Determination of Resistance to Permeation by chemicals and/or micro-organisms

Chemicals are tested for the time it takes to permeate through the glove in a controlled "test cell" and the breakthrough time is recorded.

Permeation can be defined as the breakthrough by a chemical, micro-organism or substance of the glove material on a molecular level. This involves three stages: Absorption, Diffusion, Desorption

• If a glove is liquid proof and has a level of performance in the permeation test (according to EN 374-3) of at least 2 (> 30 minutes) for at least 3 of the chemicals listed below, then the « Erlenmeyer flask » pictogram can be used. It shall be accompanied with the standard number and the code letters of the chemicals for which the level 2 at least has been obtained (thus there can be up to 12 letters).

Code	Chemical	Class
A	Methanol	Primary alcohol
B	Acetone	Ketone
C	Acetonitrile	Nitrile compound
D	Dichloromethane	Chlorinated paraffin
E	Carbon Disulphide	Sulphur containing organic compound
F	Toluene	Aromatic Hydrocarbon
G	Diethylamine	Amine
H	Tetrahydrofurane	Heterocyclic and Ethereal compound
I	Ethyl Acetate	Ester
J	N-Heptane	Saturated hydrocarbon
K	Sodium Hydroxide 40%	Inorganic base
L	Sulphuric Acid 96%	Inorganic mineral acid

Thermal hazards

Thermal risks due to high temperatures or fire are causing mainly immediate accidents. The awareness is high in this field and PPE are spontaneously requested and worn by operators. Hazards induced by low temperatures are often combined with a wet environment therefore it is essential to wear insulated liquid proof gloves.

Consequences:
- thermal burns,
- dermatitis,
- skin cancer,
- frostbite and chilblains,
- skin peeling in contact with frozen surfaces,
- reduced blood circulation,
- increased risk of muscular-skeletal disorders.
- handling of liquid gas,

Examples of applications:
- fire-fighting,
- handling hot parts,
- extracting rubber type or thermoplastics from moulds,
- welding, foundry works, thermoforming,
- removing food from ovens or rotisseries,
- driving vehicles outside,
- outdoors jobs in cold weather,
- job in cold rooms.

EN 511 Protective Gloves against COLD

A B C

COLD RESISTANCE -50ºC

FLEXIBILITY 10 000 cycles @ -20oC

A CONVECTIVE COLD

Performance	ITR (m2 . ^{0}C/W)

Level 1	0.10 ≤ ITR < 0.15
Level 2	0.15 ≤ ITR < 0.22
Level 3	0.22 ≤ ITR < 0.30
Level 4	0.30 ≤ ITR < ~~

The levels are determined by the measured Thermal Insulation (ITR) of the hand.

The levels are an indicator of the gloves ability to protect against general convective cold in a working environment.

B CONTACT COLD

Performance	R (m2 . ^{0}C/W)
Level 1	0.025 ≤ R < 0.050
Level 2	0.050 ≤ R < 0.100
Level 3	0.100 ≤ R < 0.150
Level 4	0.150 ≤ R < ~~~

The levels are determined by the test ISO 5085-1 @ 6.9kPa

The levels are an indicator of the gloves ability to protect against contact cold in a working environment.

B WATER IMPERMEABILITY

Performance	30 minutes
Level 1	Pass EN 344
Level 2	Pass EN 344
Level 3	Pass EN 344
Level 4	Pass EN 344

Determines if the glove is liquid proof.

EN 407 THERMAL RISKS (HEAT & FIRE)

A B C D E F

A BURNING BEHAVIOUR (6.3)

	1	2	3	4
After Flame (sec)	≤ 20	≤ 10	≤ 3	≤ 2
After Glow (sec)	~	≤120	≤ 25	≤ 5

Flame burning behaviour in seconds.

B CONTACT HEAT (6.4)

	1	2	3	4
Contact Temp °C	100	250	350	500
Threshold Time sec	≥ 15	≥ 15	≥ 15	≥ 15

The contact time at varying temperatures for 15 seconds

C CONVECTIVE HEAT (6.5)

	1	2	3	4
Heat Transfer sec	4	7	10	18

The heat transmission through the glove materials or material assemblies in seconds

D RADIANT HEAT (6.6)

	1	2	3	4

Heat Transfer sec	5	30	90	100	The measured ability of the glove (back) to repel radiant heat.

E SMALL SPLASHES MOLTEN METAL (6.7)

	1	2	3	4	
Droplets	≥ 5	≥ 15	≥ 25	≥ 35	The determination of behavior of the glove on impact of small splashes of molten metal before the glove deteriorates.

F LARGE QUANTITIES MOLTEN METAL (6.8)

	1	2	3	4	
Mass g	30	60	120	200	The determination of behavior of the glove on impact of small splashes of molten metal before the glove deteriorates.

Note:
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