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Featured This Month . . . First Aid

On The Cover

First Aid is defined as the immediate emergency treatment for injury or sudden illness before regular medical care is available. Here, cardiopulmonary resuscitation is administered to a victim. Photography by James B. Lehman, NSC staff photographer; design by First Impression. (See "Technology Advances First Aid," beginning on page 51.)

Departments

Fire and Personal Protection

Fire injuries can be hideous in pain and difficult to heal. Personal protection has become quite advanced in efforts to mitigate heat and flame hazards.

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FIRE CAN MEAN BURNS and burns mean pain.

The pain from burns can be hideous, or in some cases the burn so traumatises the body that shock neutralises the pain—but such cases are often fatal.

The simplest solution, of course, would be to avoid fire. But fire, like electricity, is our sometimes unruly servant. In industry particularly, fire is a basic source of energy.

When the servant, fire, becomes unruly, the men who work with the servant leave the scene, but fire-fighters must enter the arena to get the unruly servant back under control, thus exposing themselves to possible injury and death.

As in so many cases, personal protective equipment is the first line of defense against the hazards of fire.

Both fire users and fire-fighters use personal protective equipment—but any similarity in the tasks of protection ends here.

Protecting the fire user is relatively simple and straight-forward. When protecting the fire-fighter, the safety professional is faced with a myriad of variables and strong demands—some of them conflicting.

Protecting the User

Traditionally, protection against heat, sparks, and fire of low intensity has been provided by garments of leather and asbestos.

Although such material has been replaced to some degree by space-age synthetics, the old standbys are still in common use.

Besides those hazards of heat, sparks, and fire, leather protective wear also protects against the hazards of hot splashes, limited impact forces, and infra-red and ultra-violet radiation.

When selecting such garments, look for quality of the leather, solidity of construction, and fastenings that forestall gaps in the protection. In addition, fasteners should be of a design that makes it easy to don and doff the garment.

Protective, and other garments worn by the worker, should be free of turned up cuffs and other projections, which could catch and retain hot metal, sparks, etc. Any pockets should have flaps that can be fastened shut.

Asbestos, and sometimes wool, can be used for protection against hot metal, radiant heat, and flame hazards of somewhat higher intensity. Some asbestos clothing is impervious to metal splashes up to 3,000 F (1,815 C).

Selection requirements for garments of asbestos and wool are much the same as those for leather, with the addition that metal fastenings be covered so that they do not become dangerously hot.

Foundrymen's leggings and aprons are probably the most common types of asbestos clothing.

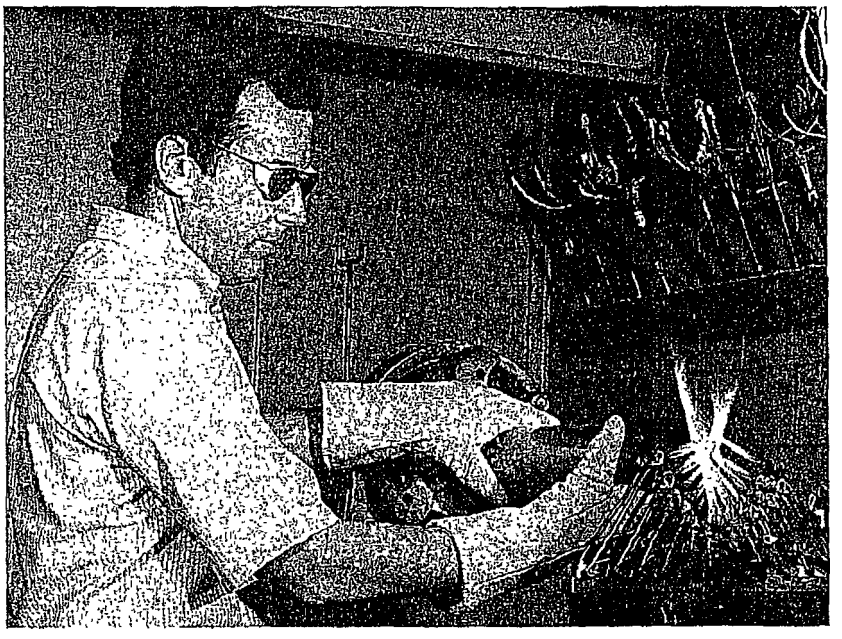
The leggings should completely encircle the leg from knee to ankle, and have a flare at the bottom to protect the instep. Again, the design of the leggings and fastenings should permit quick removal in case of an emergency.

Sometimes, the front of the leggings are reinforced to provide impact protection. The reinforcement is commonly made of fiber board.

Of more recent vintage is clothing that is reflectorized in some way to protect against radiant heat, flame, etc.

Such clothing of reflectorized fabrics are essential where extremely high ambient temperatures (2,000 F or 1,095 C) must be faced. Such situations include furnace and oven repair, coking, slagging, fire-fighting, and fire rescue.

Generally speaking, the outer coating of these garments reflects away most of the radiant heat and a



These work gloves, of Kevlar, were designed to resist flame and to protect against sharp edges. (Photo courtesy of Du Pont Company.)

liner insulates against the remainder and acts as a vapor barrier.

Some suits come as separates—trousers, coats, gloves, boots, and hoods. Others come as one-piece units, covering the body from head to toe.

In addition, others contain their own air supply to reduce heat further and to increase comfort.

Such high heat hazard suits come in two types: fire entry and fire proximity.

Fire entry suits, also called emergency suits, are used where temperatures exceed 1,000 F (535 C), such as kiln or furnace entry or moving through burning areas in fire-fighting.

Fire proximity suits provide less protection than fire entry suits and so are used in operations like slagging, coking, furnace repair work when working with hot ingots, and in fire-fighting when entering the flames is not required.

IMPORTANT: Never use a proximity suit when an entry suit is required.

One example of a more recently developed fiber used to replace leather and asbestos for low-intensity fire and heat protection is the synthetic, Nomex aramid, an inherently flame-retardant fabric.

Nomex welders' garments are available and include styles featuring the traditional cape sleeve, bib style, side or front closures, and lengths to the waist or knee.

Some models have solid, no-closure fronts to prevent gapping and incorporate Velcro closures in the back.

Similar type Nomex garments are available for protection in other heat-hazardous operations.

A similar fabric, Kevlar, is also in use on the industrial scene. According to the manufacturer, Kevlar 29 fabric is inherently flame-resistant, will not support combustion, and is useful over a wide range of thermal conditions.

For example, work gloves made of the fiber are said to begin to char at temperatures of 800 to 900 F (425 to 480 C) and will withstand short exposures to temperatures up to 1,000 F (535 C).

Sometimes, the hazards of exposure of flame and heat hazards of low intensity can be met with conventional work clothing—which has been made flame-retardant with commercial preparations.

Properly applied, such preparations will make work clothing highly flame-resistant without adding much to the weight or stiffness of the cloth.

Some commercial preparations must be reapplied after laundering. Others are designed to retain flame-retardancy through laundering.

In any event, clothing designed to protect against flame and heat, if not already distinctive in appearance, should be well-marked so that untreated clothing will not be used by mistake in a hot or fiery situation.

Protecting the Fire-Fighter

Consider the problems faced while protecting the fire-fighter from all the dangers he is exposed to—flame, extreme heat, frostbite, fatigue, excessive perspiration, unpredictable impact, situations that can deteriorate rapidly, calling for quick mobility, becoming obscured by smoke from potential rescuers, etc.

In addition to meeting all of the needs mentioned, protective apparel must also be reasonably economical, reasonably long-wearing, and easy to put on in a hurry.

Needless to say, the perfect set of turnout clothes isn't perfected as yet, and some authorities feel it never will be because meeting all the parameters is impossible.

> *As one authority put it: You cannot achieve the best of each and every one of these requirements (thermal protection, durability, tear strength, overall weight, visibility, water-absorption, color fastness, high-temperature-resistance, washability) in a single garment. There must be some compromises to obtain the best overall garment, which will meet the fire-fighters' routine needs and (also) provide a high level of protection in emergencies.*[1]

Nevertheless, with the proper use of available protective clothing, the fire-fighter probably is safer today than he ever has been.

Safety in the fire service has come a long way in a few years, and future prospects are encouraging. Organizations from the federal National Fire Prevention and Control Administration (NFPCA) to the NFPA are engaged in research and standards writing.

These fire-fighters turn out garments are designed to meet NFPA Standards. (Photo: Courtesy of Survivair, Division of U.S. Divers Company.

It is well that the picture is encouraging, because as far as the fire service has come, there is still a distance to go.

Available statistics indicate that fire-fighting is the most hazardous occupation of modern times—more dangerous than mining, construction, and police work.

As expressed by a fire surgeon:

> *In 1974, 100 fire-fighters sacrificed their lives during the performance of duty, while non-fatal injuries increased to 47.3 per 100 workers. If occupational diseases are included, the figure increases to 207—207 deaths related to fire-fighting during 1974! The life hazard attached to fire-fighting is much greater than that attached to police work. On the average, from 1965 through 1974 there were 86 deaths for every 100,000 fire-fighters, compared with 55 deaths for every 100,000 police officers.*[2]

Today, much of the discussion about turnout coats centers around

This welder's garment is made of 10-ounce, heavy-duty Nomex duck fabric. (Photo: Courtesy of Du Pont Company.)

those made of Nomex, a trademarked member of the aramid family of synthetic fibers.

Nomex's specifications, according to its developer, Du Pont, include:

- Non-meltability, but it will degrade rapidly at temperatures above 700 F (371 C);
- Its breaking strength at 482 F (250 C) is equivalent to 60 per cent of that at room temperature;
- Its breaking strength after exposure of 1,000 hours in dry air at 500 F (260 C) is about 65 per cent of that before exposure;
- Its stretch-resistance is about four times that of nylon 6-6, another synthetic fiber;
- Nomex has a higher resistance to beta and gamma radiation, X-rays, water, and steam at high temperatures than nylon 6-6;
- The length of Nomex is unaffected by changes in relative humidity.

The modern turnout coat could be said to come in two parts, which have four functions.

The outer part, or shell, is a flame-resistant synthetic fiber that acts as a heat reflector and barrier. Then a removeable liner acts as a vapor barrier, an insulating batting, and a lining fabric.

(NOTE: The removable liner leads many fire-fighters to belive it is meant for warmth only, and they tend to remove it in warm weather. They should be educated to the fact that this action will only expose them to greater burn hazards.)

In addition, the air spaces between the layers of material act as a further insulation against heat.

As noted, modern synthetic fabrics provide a great deal of flame protection—when used properly—but as even manufacturers point out[1], every fire coat has its failure point, particularly under sudden, catastrophic fire conditions.

Fire-fighters gloves are another area where work remains to be done.

OSHA spokesmen have said:

> *None of the gloves currently used by fire-fighters in the United States provide both adequate protection and function.*

They add:

> *For the most part, current standards emphasize construction parameters without addressing the fire-fighters' actual needs.*[3]

However, the same authors provide guidelines for what standards gloves should meet in the various hazard areas of: resistance to cut; resistance to puncture; resistance to heat penetration; resistance to wet heat penetration; resistance to cold; resistance to electricity; dexterity; resistance to liquids; comfort; resistance to flame; durability; drying; visibility.

As an example, the authors break down the "resistance to heat penetration" category into three levels of protection:

- Gloves used by engine-company fire-fighters should protect against relatively mild "routine" radiant exposures—from five to 60 minutes with a maximum air temperature of 140 F (60 C) and a maximum radiant flux of 399 Btu/ft²-hr (0.03 cal/cm²-sec;
- Gloves used by ladder-company fire-fighters should protect against a hazardous (entering a burning building while a fire is at its height) flux of 2,660 Btu/ft²-hr (0.2 cal/cm²-sec) for a 10-minute exposure;
- Gloves used by rescue-company fire-fighters should protect against an emergency flux of 33,192 Btu/ft²-hr (2.5 cal/cm²-sec) for a 10 second exposure.[3]

Most authorities seem to agree that fire-fighters should use the boot with all the safety options—steel toe cap, steel insoles, etc.

However, there are calls for improvements and options:

- Optional lengths or a feature whereby the taller fire-fighter could cut his boots down to suit his height[3,4];
- An option to wear six-inch (13.24-centimeter) leather work shoe for fighting brush fires in warmer climates, such as Southern California[5];
- Footwear that will provide better traction on ladders, wet surfaces, pitched roofs, and mountainsides[2,5];
- Footgear that is lighter in weight, less cumbersome, and less prone to lead to fungal infection.[2]

While it is true that today's fire-fighter is thought to have only about a 50-50 chance of escaping injury this year[1], is should be remembered that some 75 per cent of fire-fighters wear outmoded equipment, which is estimated to be unable to pass the children's sleepwear flammability test, and according to Molter many fire-fighters wear equipment improperly, if at all.

Modern fire protective equipment is made to be safer—and it's made to be worn. Ω

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