

CHEMICAL EXPOSURE SUITS

... new exposure suits,
offer greater protection
for rescue personnel



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The firefighter's job encompasses more than extinguishing fires and rescuing victims. He is frequently called upon to perform emergency work which may or may not be related to a fire situation. Entering a hostile environment containing poisonous gases and dangerous chemicals is one type of emergency situation that mandates the use of protective gear exceeding the capabilities of the usual firefighter's clothing.

Given this requirement to enter hazardous situations, New York Fire Department Rescue Companies are equipped with fully encapsulated chemical exposure suits, designed to afford the firefighter greater protection than the standard turn-out gear. Exposure suits not only afford protection for the member in a toxic atmosphere (gaseous state), but also when the member is required to handle corrosive materials in a liquid state.

Chemicals Encountered. Some of the most commonly encountered hazardous materials that our Rescue Companies have had to contend with include: acetic acid, anhydrous ammonia, benzoyl peroxide, chlorine, hydrofluoric acid, hydrogen peroxide, nitric acid, picric acid, sodium cyanide, sodium hydrosulphite, and sulphuric acid.¹ As formidable a list of chemicals as this may be, it only represents a small portion of the hazardous chemicals, and combinations of chemicals, that may be encountered by our firefighting forces. It clearly indicates the importance and necessity of securing reliable protection for our members.

EVALUATING SUITS IN USE

In 1976, the Fire Department undertook the task of evaluating exposure suits in use at the time, with the intention of refining the suit to ensure maximum protection. At that time, there were two types of chemical exposure suits used in the Department, neither of which proved satisfactory. As these suits aged, they tended to dry out and become brittle, thereby allowing cracks to form in the material. Such a condition, of course, negates the safe use of the suit.

As a starting point, Rescue Companies were required to forward a report describing their suit inventory (quantity, manufacturer, size, age, whether serviceable or unserviceable), and the chemical encountered when the suit was used. Recommendations were solicited concerning:

- Fit of suit.
- Use of mask.
- Vision allowed by mask facepiece.
- Use of boots.
- Use of gloves.
- Problems of obtaining a good seal.
- Areas of leakage.
- Adequacy of suit durability.
- Use of handi-talkie.

PROBLEMS ENCOUNTERED

When all of the reports were consolidated and evaluated, a picture emerged indicating significant problems which appeared to be common to all the suits in use. They included:

The Hood. Since both suits in use utilized a hood that was separate from the suit, the possibility of leaks existed. A complete seal, with either of these suits, was almost impossible.

Foot Protection. Foot protection was insufficient. F.D.N.Y. boots could not be worn over the suit for

1. Definitions of these chemicals can be found in the *Fire Protection Guide on Hazardous Materials*, 7th Edition, 1978, National Fire Protection Association International, Boston, Mass.

added protection. Instead, shoes were worn on the inside. That method, however, only tended to make that area of the suit more susceptible to tears and abrasion wear.

Glove Protection. Glove protection was accomplished two ways. One suit utilized a separate glove that was attached to the suit by means of a plastic insert. This was not a desirable method because 1) the glove could easily be lost, and 2) the plastic had a tendency to crack, preventing a good seal of the suit.

The other suit employed an attached glove, which was deemed the most desirable method as long as the glove did not become separated from the wristlet.

The Facepiece. Only the Wilson (old type Scott) facepiece was compatible with the exposure suit. It was too difficult to fit the Scott-O-Rama facepiece into the hood opening, and the seal was ineffective. At this time, the regular Scott mask was also being phased out and being replaced by the new Scott 4.5. This was an opportune time to integrate the facepiece and the exposure suit as one complete unit.

Leakage. Areas of leakage occurred at points of wear, such as the elbows, knees, armpits, crotch, and neck. Leaks also occurred around the seal of the mask facepiece. Some attempts at providing a better seal were accomplished by the use of vaseline around the facepiece. Although this procedure improved the condition, it did not cure it.

It became apparent that a one piece suit, with reinforcement of the stress points, was the answer to all these problems.

After evaluating the problems and recommendations voiced by the wearers of the exposure suits, the Chief of Department expressed his concern for the safety of our firefighters. He directed PANDOR to research a new suit that would resolve all of the aforementioned problems. A committee was formed consisting of Captain William C. Anderson (retired), R.1; Battalion Chief Donald J. Burns, 8th Batt. (then captain, PANDOR); Captain Frank R. Ciavarella, Safety Div.; Captain George M. Foy, M.S.U. (retired); and Captain Alexander W. Santora, Research and Development.

After considerable inquiry, it was learned that only one manufacturer, East Wind Industries Incorporated, was interested in changing the design of their suit in order to incorporate the features that the members of Rescue Companies deemed necessary for a safe and efficient suit.

MASK WORN UNDER SUIT

As was previously mentioned, the most efficient method of eliminating the possibility of leaks was to design a one piece suit. One manufacturer offered a one piece suit that required the user to wear his mask under the suit. This approach presented three major safety hazards.

1. When the suit is worn over the mask, the air gauges cannot be seen. If the wearer is operating where there are loud noises, he may not hear the alarm. And, since he cannot see his gauge, he may run out of air while still in a toxic atmosphere.²

2. In an emergency situation, it would be difficult to institute emergency procedures on the mask system. Wearing the mask under the suit would mean that, in order to reach the bypass valves, either an opening in the suit would have to be provided, or the suit would

have to be removed. This procedure, of course, would not be feasible in a toxic atmosphere.

3. With the mask worn in this manner, it would be impossible to wear the firefighting turnout coat over the suit. And, as it is expected that the firefighter may also be operating in a fire area, he runs the increased risk of burning holes in the suit. He would then not only be exposed to the toxic atmosphere, but to burn injuries as well.

MASK WORN OUTSIDE OF SUIT

Designing the suit so that the mask can be worn on the outside not only eliminates the above mentioned disadvantages, but has, by its very nature, distinct advantages.

1. When the air cylinder becomes expended, it can be readily replaced without removing the suit.

2. The amount of time lost from standby position to actual operation is greatly reduced. The suit is fully donned, and the firefighter totally enclosed, except that the mask regulator is not attached to the facepiece. This standby time-saving factor is extremely critical for the rescue of a person who may be trapped in a chemically contaminated atmosphere.

PROTOTYPE DESIGNED

With both East Wind Industries and the Fire Department committee working in conjunction, a prototype chemical exposure suit was designed. Suggestions from both East Wind and the committee were incorporated in the suit.

The new suit has the 4.5 Scott facepiece built in, so that when a firefighter dons the suit, his facepiece is already in place.

The old vs. the new! The old exposure suit on the left had a separate hood, gloves that tucked into wristlets, and a Wilson facepiece. The new suit on the right features hood and gloves that are an integral part of the suit. The new suit also has splash guards, worn over the boots to prevent puddling within the boots.

Photo by J. Shanus, F.D.N.Y. Photo Unit



2. For an illustration of this problem, the reader is referred to Jacksonville, Florida: Tank Car Hazard, by Steve Garnaas, Firehouse Magazine, October, 1978.



Photo by J. Shanus, F.D.N.Y. Photo Unit



Photo by J. Shanus, F.D.N.Y. Photo Unit

Left: Members of rescue company display features of the new suit. 1. Webbing on top rear of hood to obtain a snug fit of facepiece. 2. Remote air supply, utilizing a quick disconnect air inlet. 3. Zipper pull for chest dump valve. Right: After donning the mask (without attaching the regulator to the facepiece), member will be in standby position. Zipper pull for arm dump valve is indicated by arrow 4. Note: Lineman's gloves (outer shell) or work gloves can be worn over suit gloves for better protection.

It is designed so that the firefighter's boots can be worn on the outside of the suit, to prevent tears, rips, and abrasions in those areas.

Gloves are molded into the suit for protection against skin contamination. The lineman's gloves (outer shell), or work gloves can be worn over the suit gloves for further protection against wear or puncturing.

A splash guard was incorporated into the leg of the suit. With the boots down, and the splash guards pulled over the boots, the possibility of a liquid puddle forming in the boots is eliminated. With the boots pulled up, firefighters can walk through hot embers without fear of burning holes in suit.

This suit is constructed from nylon cloth, coated with twelve layers of butyl rubber. It should be remembered that this suit is designed for chemical hazard protection, not fire protection.

AIR SUPPLY & HANDI-TALKIE

A remote air supply, employing a quick disconnect air inlet, may be used with the East Wind suit for purposes of cooling and prolonged operations. The suit was designed with an integral air distribution system capable of operating with approximately 15 psig, and delivering approximately 96 liters of air per minute.

At present, our rescue companies have two 300 cubic foot air cylinders on their apparatus. They will, in the near future, receive 400 feet of low pressure hose to supply air to remote areas. Using this umbilical cord type system, one man could operate for one hour and forty minutes, or two men could operate for fifty minutes. And, although members will be operating from the remote source, they will still wear the Scott 4.5 air system as an emergency back-up device.² Other suits that were studied offered only either one of the two air supply systems.

The new exposure suit allows the member to wear a handi-talkie outside the suit in the same manner as

with the old type suits. One suit that was investigated required that the air supply and the handi-talkie be worn inside the suit. That arrangement makes it difficult, if not impossible, for the operator to depress the handi-talkie button in order to transmit a message. This problem is not encountered with the new suit. In fact, in repeated field tests with the new suit, communications were considered to be quite good.

SERVICEABILITY TEST & MAINTENANCE

Two acceptance tests are recommended to evaluate the suit's serviceability.

Test 1. (Performed after each use.)

1. Attach suit to a 10-15 psig air source. (Note: Opening in the facepiece for the attachment of the regulator must be sealed.)
2. Fill suit with air until it is inflated and rigid.
3. Adjust the two dump valves to keep air flowing into the suit at 10-15 psig for five minutes. (Dump valves are for the positive escape of air, and to prevent the suit from ballooning.)
4. Suit should stay reasonably rigid and not deflate.

Test 2. (Performed when there is doubt after administering Test 1., or, when conditions permit, for additional confidence.)

1. Have a member don the suit.
2. Attach suit to external air supply of 10-15 psig and open dump valves. (This may be done with or without use of Scott mask.)
3. Have member walk into coarse shower, or spray with hoseline. Keep water on for three minutes.
4. Dry the suit on the outside. Have member remove the suit. The presence of more than five ounces of water in the suit is unacceptable.

Due to the impracticality of Test 2, greater emphasis should be placed on Test 1.³

Maintenance After each use, the suit should be immersed in soapy water and thoroughly washed. After washing, it should be hung up to dry with the zippers open. Drying may take a complete day. The suit

2. When operating with the remote air supply, the dump valves on the suit should be opened to prevent the suit from ballooning. If it becomes necessary to revert back to the Scott system, the dump valves must be closed before entering a hazardous area.

3. To ensure adequate product performance, both tests were conducted by the Fire Department prior to final acceptance of the suits.



Photo by J. Shanus, F.D.N.Y. Photo Unit

Ready for chemical emergency, Fr. William Gregor (co-author) demonstrates use of turnout coat as it is worn over exposure suit.

(Explosion, Fire, & Collapse contd. from page 9.)

Photo Unit. The F.D.N.Y. Photo Unit was special-called to the scene and assigned the task of photographing the entire collapsed structure. Photos were also ordered taken of the specific areas of construction that might have contributed to the explosion. Photos of this nature, in many instances, can be used by investigative personnel.

Operating tactics, tools and heavy equipment used in the rescue were also photographed with the thought that they could be used to great advantage in the preparation of bulletins of operating procedures, training lectures, and a general review and critique of the entire operation.

CONCLUSION

The fire was declared under control at 1221 hours;

may be turned inside out if necessary. Test 1 should be performed when the suit is dry. To aid in the next donning, talc may be used inside the suit.

The suit should be visually inspected every 90 days. At that time, it should be aired out and, if warranted, talc added.

LIMITATIONS AND RECOMMENDATIONS

Since the wearer of the exposure suit may have to trust his life (or the life of a subsequent wearer) to the protection it affords, reasonable care should be exercised.

Storage The suit is easily punctured, so it must be stored in a suitable compartment on the apparatus, away from heat. Avoid scratching the facepiece. A convenient solution would be to store the suit in a Scott mask carrying case.

Gloves The gloves are made of untreated butyl rubber, and are not designed for rough handling. Extra protection is afforded by wearing the outer shell of the lineman's gloves over the exposure suit gloves.

Boots The use of firefighter's boots over the exposure suit booties may prove uncomfortably tight. If so, the wearing of a larger size boot is suggested.

Immersion The suit is designed for protection against gases and splashes. It is not designed for immersion, and although it affords some protection in this area, it should not be relied upon for this purpose.

CONCLUSION

After many modifications of the prototype, the Fire Department ordered twenty-four new chemical exposure suits; six for each Rescue Company. These suits were issued on September 10, 1980, as per Department Order #123.

The combined time and effort expended by all parties in reaching a successful solution to the chemical exposure suit problem is certainly justified. The final product that is the result of those efforts will, doubtless, prove far superior to its predecessors. Members using this suit may have every confidence that they are being afforded better protection. ▲

just one hour after the arrival of the first unit. However, the careful and painstaking search for possible victims, conducted by this Department, continued for thirty-six hours.

When the Fire Marshal's investigation was completed it was determined that the explosion was caused by an accumulation of gas in the building. As of this writing, the source of that gas has not been definitely established and is the subject of litigation.

In closing, a word about the firefighters who operated at this alarm. Despite the fact that, ultimately, no persons were found trapped in the devastated building, the men of this Department operated with dedication, bravery, and concern, often placing themselves in great danger. Once again they have proved themselves the "Bravest." ▲

FDNY BOUNDARY MAPS STILL AVAILABLE!

It's not too late! We still have a small supply of these map sets in stock. So . . . anyone interested in acquiring a set of F.D.N.Y.

Boundary Maps, plus a Unit Location Chart (see original offer, 1st Issue, 1980, page 23) can still do so—but hurry, we're running low—by sending a \$6.00 check or money order to W.N.Y.F. Maps, 110 Church Street, N.Y., N.Y. 10007.