Tennessee Fire Chiefs Association
P.O. BOX 25052, NASHVILLE, TN 37202
WWW.TNFIRECHIEFS.COM

Awareness to Fire Fighter Cancer
White Paper

Primary Objectives:

The information contained herein assists firefighters by educating firefighters that every fire response has various toxic substances/properties which may enter the body either by inhalation from inappropriate respirator protection or through protected or unprotected ensembles that may attach to the dermal layer seeking ways to enter our body to create a threat to our immune system.

✓ What is Cancer

- How is the DNA damaged
- 2015 NIOSH Fire Fighter Cancer Study

✓ Kinds of Cancer in relation to firefighting

- Facts addressing each cancer
- Signs and symptoms
- Stages of cancer growth

✓ How are we exposed to cancer

- Permeation through personal protective equipment
- Off-gassing of personal protective equipment
- Fire behavior toxicity facts, “Is Carbon Monoxide monitoring really a good indicator for the determination of SCBA mask removal”

✓ How can we prevent cancer

- Limit/reduce toxic chemical exposures
- Recommendations for prevention of cancer post-fire decontamination
- Safe application recommendations for Incident Commanders, Fire Fighters & fire Ground Investigators
- NFPA 1851 recommendation chapters for personal protection equipment decontamination.

What is Cancer?

- ✓ **Occurs when abnormal cells divide without control and invade other tissues. Normal cells are the body's basic unit in life. Each cell divides and grows and knows when to stop.**
- ✓ **Deoxyribonucleic Acid (DNA) may become damaged, resulting in cell not dying when it should or growth not stopping when it should.**
  - **Abnormal DNA may have been inherited from a previous cell.**
  - **Mistake in the DNA passed on to another daughter cell when the first one divides, inherited from a mother or father (some cases the body is able to detect and correct the mistakes and repair them, but not always).**
  - **Environmental exposures (chemicals, sunlight, smoking, or a virus) can cause DNA molecules to change or cause them to die or modify cells to become cancerous.**
- ✓ **May result in a tumor, or a mass of cells.**
- ✓ **May be benign and spread and not be cancer, or be malignant or cancerous.**

2015 NIOSH Firefighter Cancer Study:

- ✓ **Study revealed limitation within previous research.**
- ✓ **Comprised of over 20,000 career firefighters with over 1300 cancer-related deaths and 2600 cancer incidence cases.**
- ✓ **Study was among the largest assembled for the purpose of firefighter research and the first with adequate statistical power for detailed examinations of exposure characteristics.**

Objective:

- ✓ **Examine exposure-response relationships between surrogates of firefighting exposure and select outcomes among previously studied U.S. career firefighters.**

Methods:

- ✓ **Comprised of all career (male) firefighters who were on active duty at least 1-year between the years 1950-2009.**
- ✓ **Incidence cases were defined as the first occurring primary invasive cancer matched (ex. Bladder cancer) among firefighters matched to at least 1 of 11 state registries (AZ, CA, FL, IL, MI, NV, NJ, PA, DC).**
- ✓ **Eight cancer outcomes (all-cancers, bladder, colorectal, esophageal, lung, and prostate, leukemia, and non-Hodgkin's lymphoma), and four non-cancers**

outcomes (COPD, ischemic heart disease, cerebrovascular disease, and alcohol-related cirrhosis.

- ✓ **Helped interpret effects from life-style related risk factors) were selected.**
- ✓ **Days accrued in firefighting assignments (exposed days), run totals (fire runs), and run times (fire hours) were used as exposure surrogates.**

Results:

- ✓ **Among 19,309 male firefighters eligible for the study, there were 1333 cancer deaths and 2609 cancer incidence cases.**
- ✓ **Significant positive associations between fire-hours, lung cancer mortality and incidence were evident.**
- ✓ **Similar relation between leukemia mortality and fire-runs was also found.**
- ✓ **Lung cancer associations were the same in cumulative exposure, however, the association with leukemia was reduced at higher exposure levels and greater for recent exposures.**
- ✓ **Significant negative associations were evident for exposure surrogates and colorectal and prostate cancers, suggesting a healthy worker survivor effect possibly enhanced by medical screenings.**

Conclusions:

- ✓ **Lung cancer and leukemia mortality risks were modestly increasing with firefighter exposures.**
- ✓ **Findings add to evidence of a casual association between firefighting and cancer.**

Kinds of Cancer in Relation to Firefighting:

- ✓ **University of Cincinnati is the largest comprehensive study to date (2006) investigating cancer risk associated with working as a firefighter.**
- ✓ **Researchers have determined that firefighters are significantly more likely to develop four different types of cancer than workers in other fields.**
- ✓ **Twice as likely to develop testicular cancer.**
- ✓ **Significantly higher rates of non-Hodgkin's lymphoma and prostate cancer.**
- ✓ **Greater risks for multiple myeloma.**

Mark Noble

- ✓ **Brain cancer patient 2002-2005**
- ✓ **Devoted time and energy to educate others about fire toxins.**
- ✓ **"We can see fire, building collapse, explosions and prepare for it, however, even deadlier is the invisible threat of toxins."**
- ✓ **His last message was delivered at his own memorial service.**
  His research of ten (10) specific cancers has helped educate inform of the health-related threats that firefighters are exposed to regularly.
- ✓ **Multiple Myeloma 2.25 times as likely, after 30 years, 10 times as likely as non-firefighters**
- ✓ **Multiple myeloma (also called Kahler disease or plasma cell myeloma) is a cancer that begins in the blood's plasma cells.**
- ✓ **Made in the bone marrow, plasma cells are a type of white blood cell that produces antibodies, which fight infection.**
- ✓ **Causes an excess of abnormal plasma cells that forms tumors in multiple locations throughout the bone marrow.**
- ✓ **Tumors begin to overcrowd the bone marrow and prevent normal reproduction of health blood cells.**

Non-Hodgkin Lymphoma: 2 times likely than non-firefighters.

- ✓ **Term lymphoma widely used to describe a diverse group of abnormal growth (neoplasm) of new tissue most often in the lymphoid tissue.**
- ✓ **Cancer that starts in cells is called lymphocytes, part of the body's immune system.**
- ✓ **Lymph system is composed mainly of lymphoid tissue, lymph vessels, and a clear fluid called lymph**
- ✓ **Lymphoid tissue includes the lymph nodes and related organs that are part of the body's immune and blood-forming systems such as spleen and bone marrow.**

Brain Cancer: 3.5 times as likely in firefighters with 10-19 years of experience.

- ✓ **Develops from cells within the brain**
- ✓ **Part of the nervous system (CNS), the brain is the control center for vital functions of the body, including speech, movement, thoughts, feelings, memory, vision, hearing and more.**
- ✓ **Primary brain tumors are classified by the type of cell or tissue the tumor affects and the location and grade of the tumor.**

- ✓ **Tumor cells may travel short distances within the brain, but generally won't travel outside the brain.**
- ✓ **When cancer develops elsewhere in the body and spreads (metastasizes) to the brain, it's called a secondary brain tumor or metastatic brain cancer.**
- ✓ **Metastatic brain tumors are more common than primary brain tumors. Some cancers that commonly spread to the brain including lung, colon, kidney and breast cancers.**

Bladder Cancer: 3 times as likely in firefighters.

- ✓ **Cancer that has spread through the lining of the bladder and invades the muscle wall and/or has spread to nearby organs and lymph nodes.**
- ✓ **Three (3) types of bladder cancer that begin in the lining of the bladder:**
    1. **Transitional cell carcinoma-most cancers begin in this phase and can be low grade transitional or high grade transitional**
    2. **Squamous cell carcinoma- flat cells that may form in the bladder after long-term infection**
    3. **Adenocarcinoma- glandular cells found in the lining of the bladder**

Kidney Cancer/Renal Cell Carcinoma: 4 times as likely in firefighters.

- ✓ **Begins in the kidneys and can start as one or more tumors in a single kidney. Less often, tumors form in both kidneys at the same time**
- ✓ **Single cell grows and divides to form two (2) cells and then these two form four (4). This process repeats again and again.**
- ✓ **Tumors can be detected once enough cancers cells are made.**
- ✓ **Some cancer cells may enter the bloodstream spreading from the kidneys to other parts of the body.**
- ✓ **New tumors may arise in other organs in which the cancer is metastatic. No matter where the cancer spreads, it will still be called renal cell carcinoma because it started in the kidney**
- ✓ **There are four stages of renal cell carcinoma. To determine the cancer stage, doctors will measure the tumor size.**

    - **Stage I-Tumor is found only in the kidney and is 7 centimeters or smaller**
    - **Stage II- Tumor is found only in the kidney and is larger than 7 centimeters.**

- **Stage III- Cancer may be found in the kidney, one nearby lymph node, an adrenal gland, the tissue around the kidney, or the main blood vessel of the kidneys.**
- **Stage IV- cancer has spread beyond the kidney and may be found in multiple nearby lymph nodes or other organs such as the intestines, pancreas, or lungs.**
- **Recurrent Renal cell Carcinoma- cancer that has returned after it has been treated-coming back in the kidney and/or in other parts of the body after first treatment.**

Prostate Cancer: 2 times as likely in firefighters.

- ✓ **Begins in the tissues of the prostate gland located just below the bladder and in front of the rectum.**
- ✓ **One of the mot treatable malignances if it's caught early.**
- ✓ **Prostate cancer grows slowly making active surveillance a treatment option. Routine screening has improved the early diagnosis**
- ✓ **Warning signs are not usually present when the disease first develops.**
- ✓ **Critically important for men at risk because of age, family history or lifestyle factors such as diet or obesity to be tested regularly.**
- ✓ **Warning signs include:**
  - **Need to urinate frequently, especially at night**
  - **Difficult to start urination**
  - **Weak or interrupted urine flow**
  - **Pain or burning when urinating**
  - **Blood in urine or semen**
  - **Pain or stiffness in lower back, hips or upper thighs**
- ✓ **Testing for prostate cancer includes:**
  - **Annual exams after age 50, unless there is a family history of disease, then screening should start at age 45**
  - **PSA, Digital Rectum Exam**
  - **CT's MRI, PET Scan, Ultrasound**
- ✓ **Stages of prostate cancer:**
  - **Stage I- Cancer is in the prostate only and too small to be felt in a digital rectum examination.**
  - **Stage II- Cancer is in the prostate only but larger than Stage I.**
  - **Stage III- Cancer has spread beyond the prostate to nearby tissue such as the seminal vesicles.**

- Stage IV- cancer has metastasized to other parts of the body often invading the bone, bladder, rectum, liver or lungs.

Testicular Cancer: 2.5 times likely in firefighters.

- ✓ Disease in which malignant cancer cells form in the tissues of one or both testicles.
- ✓ Almost all testicular cancers start in germ cell tumors called seminomas and non-seminomas (cells that form sperm or egg.
- ✓ They grow and spread differently, non-seminomas grow and spread faster than seminomas.
- ✓ Testicular tumors that contain both seminoma and non-seminomas cells is treated as non-seminomas.
- ✓ Signs and symptoms of testicular cancer
  - Swelling or discomfort in the scrotum
  - Painless lump or swelling in either testicle
  - Change in how the testicle feels
  - Dull ache in the lower abdomen or groin
  - Sudden build-up of fluid in the scrotum
  - Pain or discomfort in a testicle or in the scrotum
- ✓ Treatment for testicular cancer
  - Depends on the type and stage of the tumor
  - Once found, the first step is to determine the type of cancer cell by examining it under a microscope.
  - Next step is to determine the stage to see who far the cancer has spread to other parts of the body.
- ✓ Stages of testicular cancer:
  - Stage I- Cancer has not spread beyond the testicle.
  - Stage II- Cancer has spread to lymph nodes in the abdomen.
  - Stage III- Cancer has spread beyond the lymph nodes where it can be as far as the liver, lungs, or brain.
  - Testicular cancer is one of the most treatable and curable cancers.

Colorectal Cancer; 2 times as likely in fire fighters.

- ✓ Develops in the tissues of the colon and/or rectum slowly growing through some or all of its layers.
- ✓ Typically starts as a growth of tissue called a polyp. A particular type of polyp called an adenoma can develop into a cancer.

- ✓ **If the cancer begins in the colon which is the first four to five feet of the large intestine, it may be referred to as colon cancer. If the cancer begins in the rectum, which is the last several inches of the large intestine leading to the anus it is called rectal cancer.**
- ✓ **Methods that doctors use to describe the stage are in the Tumor, Node, and Metastases (TNM) system.**
    - **How large is the primary tumor and where is it located? (Tumor) Uses the letter or number 0-4 to determine depth in bowel lining.**
    - **Has the tumor spread to local lymph nodes (Node)**
    - **Has the cancer metastasized to other parts of the body such as the liver or lungs? (Metastasis)**

Liver Cancer: 2 times as likely in fire fighters.

- ✓ **Begins in the blood vessels of the liver and grows quickly.**
- ✓ **Typically diagnosed at an advanced stage.**
- ✓ **Secondary liver cancer develops when primary cancer from another part of the body spreads to the liver.**
- ✓ **Most liver metastases originate from colon or colorectal cancer. More than half of people diagnosed with colorectal cancer develop secondary liver cancer.**
- ✓ **Several types of liver cancer based on the type of cells that becomes cancerous.**
    - ***Hepatocellular carcinoma* (HCC) also called hepatoma. It is the most common type of liver cancer accounting for approximately 75 % of all liver cancers. Most cases are the result of infection with hepatitis B or c, or cirrhosis of the liver caused by alcoholism**
    - ***Fibro lamellar* HCC is a rare type that is typically more responsive to treatment than other types of liver cancer.**
    - ***Cholangiocinoma* occurs in the small, tube-like bile ducts within the liver that carry bile to the gallbladder**
    - **Accounts for 10-20 percent of all liver cancers.**
    - **Intrahepatic bile duct cancer begins in duct within the liver.**
    - **Extra hepatic bile duct cancer develops in ducts outside the liver.**
    - ***Angiosarcoma* accounts for about 1 percent of all liver cancers.**

- ✓ **Common Liver Cancer Symptoms:**
    - **Weight loss not associated with change in diet**
    - **Decrease in appetite or feeling of fullness after a small meal.**
    - **Nausea and vomiting not associated with other known conditions.**
    - **General weakness and/or fatigue that is persistent, on-going weakness or fatigue.**
    - **Fever that is unrelated to other conditions.**
    - **Pain occurring in the upper abdomen on the right side or near the right shoulder blade**
    - **Enlarged liver felt mass under the ribs on the right side.**
    - **Enlarged spleen felt as a mass under the ribs on the left side.**
    - **Abdominal swelling or bloating in the abdomen can occur as a mass forms.**
    - **Jaundice which appears as yellowing of the skin and eyes and occurs when the liver is not functioning properly.**
- ✓ **Liver Cancer Risk Factors:**
- ✓ **Average age at onset of liver cancer is 63 years**
- ✓ **Gender: Men are more likely than women to develop liver cancer by a ratio of 2 to 1**
- ✓ **Race and ethnicity: In the United States, liver cancer rates are highest in Asian Americans and pacific Islanders. White Americans have the lowest risks. Chronis infection with Hepatitis B virus (HBV) is the most common liver cancer risk factor. These infections lead to cirrhosis of the liver.**
- ✓ **Heavy use of alcohol.**
- ✓ **Smoking**
- ✓ **Arsenic, naturally occurring arsenic through drinking water.**
- ✓ **Exposure to certain chemicals. Exposure to vinyl chloride used in the making of plastics.**

Skin Cancer; 2 times as likely in firefighters.

- ✓ **Most common cancer in the United States. Results from an uncontrolled growth of abnormal cancerous cells in the skin.**
- ✓ **Can spread to other areas of the body if left untreated.**
- ✓ **The most easily treated cancers when caught early,, however, skin cancer that progresses to other areas or organs of the body is more difficult to treat and can be fatal**

- ✓ **Early detection and treatment usually results in complete eradication of the cancer cells and the prognosis for early skin cancer is generally very good.**
- ✓ **Skin cancer types are broken down into:**
    - **Basal cell carcinoma- most common and tends to spread slowly and easily treatable. Appears in various forms such as waxy or white bumps on the skin, or as a flat, scaly patches on the back or chest and usually brown in color.**
    - **Squamous cell carcinoma- usually appears as a nodule or growth that bleeds or crusts or as a sore that doesn't seem to heal, but easily treatable if caught early.**
    - **Melanoma- serious and potential deadly form of skin cancer that begins in the pigment cells of the skin and can eventually spread to other areas or organs of the body. Commonly appears on or near existing moles, though other areas of the skin can become affected.**
- ✓ **Skin Cancer Causes:**
    - **Ultraviolet light exposure**
    - **Use of tanning booths**
    - **Immunosuppression or impairment of the immune system which protects the body from germs or substances that cause an allergic reaction.**
    - **Contact with certain chemicals such as arsenic, hydrocarbons in tar, oils, and soot**
- ✓ **The following people are at the greatest risk of skin cancer:**
    - **Fair skin**
    - **Already treated for skin cancer**
    - **Numerous moles**
    - **Burns unrelated to sunburn**
    - **Basal cell carcinoma and squamous cell carcinoma more common in older people.**
    - **Melanomas are more common in younger people especially in the ages of 25-29 brackets.**

How Are We Exposed to Cancer:

Anatomy of fire smoke

Toxic composition of smoke varies from fire to fire and will be identified by the nature of materials burning, the temperature or BTU's within the

compartment, oxygen levels and ventilation (free burn or ventilation limited). The conditions of high temperature and low oxygen enhances degradation of synthetics, plastics and other components which quicken the chemical release therefore allowing these substrates to permeate through our personal protective equipment and into our skin commonly referred to as absorption.

Toxic materials generated by fire.

Substances generated by fire are broken down into three distinct classes that in their own peculiar way can harm firefighter during and after the fire. Special levels of protection are required during all phases of fire to prevent the exposure to the by-products of combustion.

Particulates

- ✓ **Size of the particulate is directly linked to their potential for causing harm.**
- ✓ **Small particles 10 micrometers of less penetrate the deepest part of the lungs such as the bronchioles and alveoli.**
- ✓ **Larger particles are filtered in the nose and throat.**
- ✓ **Smoke and haze 2.5 micrometers in diameter and smaller tends to penetrate into the gas exchange regions of the lungs**
- ✓ **Smoke is fuel with aerosolized H2O and hydrocarbons. These black droplets have the ability to encapsulate particulates to further target organs once entry into the body has been accomplished.**

Irritants, ***any such agent capable of causing irritation or inflammation of tissues***

- ✓ **From the incipient, growth, free-burn and decay stage fire produces many form of irritants which can have health-related effects on firefighters, investigators, home/business owner, and insurance adjusters Listed below are some common irritants which are very common at every fire:**
    - **Hydrochloric Acid**
    - **Sulfur dioxide**
    - **Oxides of nitrogen**
    - **Ammonia**

Asphyxiates/Toxicants

- ✓ **Asphyxiation, oxygen starvation of tissues. Chemicals such as carbon monoxide prevent the blood from carrying sufficient oxygen to the brain and other organs. As a result, the individual may lose**

consciousness, stop breathing, and die without artificial respiration and other means of elevating the blood oxygen level. Listed below are some common asphyxiates which are very common at every fire:

- **Carbon Dioxide**
- **Carbon Monoxide**
- **Hydrogen Cyanide**
- **Hydrogen Sulfide**

Toxic Permeation

Routes of greatest concern for entry of carcinogens into the bodies of firefighters are:

- ✓ **Through the lungs when firefighters do not wear or prematurely remove respiratory protection, especially during overhaul.**
- ✓ **Dermal absorption where toxicants are absorbed through the skin.**
- ✓ **Following the lungs, the skin is the body's second largest organ in area and it is highly absorptive.**
- ✓ **Some areas of skin are more permeable than others specifically the face, the angle of the jaw, neck, throat and groin.**
- ✓ **Skin's permeability increases with temperature and for every 5 degree increase in skin temperature, absorption increases 400%.**

Residual Off-Gassing

Structural firefighting ensembles and uniforms are absorbing materials that collect and filter fire behavior contaminants to a point of saturation in which the body is now the target. Our body tissue is a "*soft sponge*" that collects and therefore absorbs contaminants into the dermal layering. Upon completion of any fire, the firefighter leaving the positive pressure of smoke is now entering an atmospheric pressure of lesser amounts which allows the toxic collection to exit from our PPE into other locations such as our apparatus/vehicles, stations/homes, and with this we are continually breathing and absorbing this contamination.

Fire Behavior Toxicity Facts:

- ✓ **Typical fires involving high temperature destruction of plastics, foams, various species of wood, fabrics and other chemicals.**
- ✓ **Toxicity is at its worst after flame reduction, changing from flaming combustion to smoldering combustion.**
- ✓ **Toxic properties much greater than CO present with lower IDLH values**
- ✓ **Gases and particulates liberated from these burning materials often contain toxic, reactive, unhealthy chemicals that are both inhalation and skin absorptive hazards.**

- ✓ **Reality is …. *firefighters and fire investigators are exposed to these unknown varieties of toxic chemicals and particulates*.**

Occupational Safety &Health Administration (OSHA)
29 CFR 1910.134 Paragraph (d) (1) (iii) states;

"The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposure to respiratory hazards and an identification of the contaminants chemical state and physical form. Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be immediately dangerous to life and health (IDLH)".

- ✓ **Based on knowledge of the potential range of "unknown products" of combustion during a structure fire and with limited means of ability to evaluate respiratory hazards, it may be correct to say that all phases of a structure fire have the potential to produce an IDLH atmosphere.**
- ✓ **If this is the case, then the only remedy allowed by OSHA is an atmosphere-supplying respirator, meaning *"a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied air respirator (SAR) and self-contained breathing apparatus (SCBA) as found in 29 CFR 1910.134(b)(2)(i)".***
- ✓ **This negates the use of filter masks, as well as air purifying respirators, since neither provides breathing air from a source independent of the ambient atmosphere.**

National Fire Protection Association (NFPA) 1500
Standard on Fire Department Occupational Safety and Health Program 2013 edition

- ✓ **7.10.7 "When engaged in any operation where they could encounter atmospheres that are IDLH or potentially IDLH, or where the atmosphere is unknown, the fire department shall provide and require all members to use SCBA's that has been certified as being compliant with NFPA 1981, Standard on Open-Circuit Self Contained (SCBA) for emergency services".**
- ✓ **7.12.3.1 Air-purifying respirators shall be used only in non-IDLH atmospheres for those contaminants that National Institute of Safety & Health (NIOSH) certifies them against.**

Reference Information based upon studies from the State of Oregon, January 2006-February 2010.

- ✓ **Study gathered data on overhaul phase of 38 structure fires of varying types.**
- ✓ **Concluded that SCBA should be worn continuously during overhaul/investigation phase unless fire departments have the ability to purchase detection equipment to mon~~mon~~itor airborne hazards.**
- ✓ **Firefighters best protection and best practices should not be limited to CO detection and SCBA use**
- ✓ **Reference: A Study on Chemicals Found in the Overhaul Phase of Structure Fires using Advanced Portable Air Monitoring Available for Chemical Speciation.**
- ✓ **Results revealed that under permissible exposure levels (PEL), Time-weighted average (TWA) and IDLH, there were substantial chemicals that were below Carbon Monoxide levels, but had a higher IDLH concentration and also carcinogenic.**

International Agency for Research on Cancer (IARC)

- ✓ **Identify environmental factors that can increase the risk of human cancer.**
- ✓ **Interdisciplinary working groups of expert scientists review the published studies and evaluate the weight of the evidence that an agent can increase the risk of cancer.**

Include chemicals, complex mixtures, occupational exposures, physical agents, biological agents, and life factors. National health agencies can use this information as scientific support for their actions to prevent Remember this:
"The actions you take today will be the actions and responsibilities your family will be forced to live with tomorrow."

References:

Center of Disease Control Study of cancer among United States Firefighters
http://www.cdc.gov/niosh/firefighters/ffcancerstudy.html

Cancer Center of America
http://www.cancercenter.com/

Study on Chemicals Found in the overhaul phase of structure fires using advanced portable air monitoring available for chemical speciation.
http://www.oregon.gov/osp/sfm/documents/airmonitoringreport.pdf

International Agency for Research on Cancer
http://monographs.iarc.fr/ENG/Monographs/vol98/mono98.pdf

Identification of soils on firefighter turnout gear from the Philadelphia Fire Department
http://uknowledge.uky.edu/mat_etds/8/