OIL FIRES, PETROLEUM AND GULF WAR ILLNESS

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I. EXECUTIVE SUMMARY

The Gulf War, Operation Desert Storm (ODS) resulted in few direct casualties. However, returning veterans reported a number of symptoms including fatigue, skin rash, muscle and joint pain, headache, loss of memory, shortness of breath, and gastrointestinal problems. Collectively these symptoms and others became known as Gulf War illness. It was speculated the symptoms were a result of exposure to toxins during and immediately after the Gulf War.

Identified toxic exposures included the oil field fires, depleted uranium, and low levels of chemical warfare agents. The Gulf War toxic exposures are a vast and complex subject. This is a first overview report on the oil field fires and the relation to Gulf War Illness.

The oil field fires caused immense amounts of smoke and an oil rain or mist. The fires generated plumes of smoke that dropped to ground level during air inversions and still winds. Troop reports of battlefield operations in conditions of heavy smoke and petroleum rain verify the severity of the actual exposures to the oil field fires.

A telephone study of 10,051 ill Gulf War veterans found those reporting breathing or enveloped in oil fire smoke, 96%; within clear visual area of the oil fires, 90%; worked in, lived in, or made travel through the burning oil fields, 72%; and washed in water with an oily sheen,68%. Those having oily taste to their food were 66%, and those with oily taste to the drinking water were 65%.

The Army, through the Environmental Hygiene Agency (AEHA), did an air monitoring study and health risk assessment of the cancer and non-cancer risk to Gulf War veterans from exposure to the oil field fires. The AEHA found no adverse risk from this exposure.

The Army, through the Center for Health Promotion and Preventive Medicine (CHPPM, formerly the AEHA) did a second updated health risk assessment. This updated assessment utilized a computer program that integrated satellite photos of the oil fire smoke plume, troop unit location and oil well fire extinguishment to determine a unit exposure factor to the oil fire plume. This unit exposure was then utilized in a risk assessment to evaluate the cancer and non-cancer risk from the oil field fires. Once again, no adverse risk was found from the exposure.

A study was also done on the 11 ACR (Armorer Calvary Regiment) that deployed to the Persian Gulf on June 10, 1991 and returned to its Germany base on September 20, 1991. The 11 ACR was stationed 30 to 80 miles from the oil field fires during a time of high winds (Shamel winds) that dispersed the smoke plume from the fires and at a time 40% of the oil fires had been extinguished. The exposure of the 11 ACR to the oil fires would not be comparable to the combat troops in ODS. With a much more limited exposure to the oil fires, the 11 ACR reported major symptoms while in Kuwait of fatigue, burning eyes, eye irritation, trouble breathing, nose and throat irritation, and skin rashes. These symptoms have also been reported by ill Gulf War veterans.

Both Army health risk assessments omit two important toxic exposures, the particulate smoke and the oil rain. The health risk assessments also omit oil-contaminated water and food. Both smoke and petroleum as found in the Kuwait oil fires are known to be highly carcinogenic and toxic.

The Army air monitoring study, which was done May 5, 1991 through December 3, 1991, did not monitor air pollution equivalent to the exposures experienced by ODS combat troops. The Army air monitoring study was done during the hot, dry, windy summer months in Kuwait when the Shamel winds were blowing. The plumes from the oil fires rose to great heights and were dispersed by the winds. The ground level pollution monitored was minimal and consisted of blowing sand.

In contrast, the combat troop exposure to the oil fires occurred in the winter when air inversions and still winds were common. Reports from the field state the air was so thick with smoke that visibility was reduced to 10-15 feet, and the oil rain soaked the troops' uniforms. This condition was known as plume touchdown or fumigation, and led to smoke pollution concentrations 50% to 900% in excess of the significant harm level established by the U. S. Environmental Protection Agency (USEPA). The Army air monitoring study monitored only one plume touchdown on May 23, 1991. During this touchdown, smoke and particulate levels ranged from 924 $\upsilon g/m^3$ to 1842 $\upsilon g/m^3$ compared to a USEPA significant harm level of 600 $\upsilon g/m^3$. The World Health Organization found smoke and particulate levels of 5400 $\upsilon g/m^3$ immediately after the liberation of Kuwait.

Omission of the smoke and oil rain from the health risk assessments invalidates the conclusion of no significant cancer or non-cancer risk. The air monitoring done by the Army is invalid as an exposure measure for the combat troops for it was done under much different weather conditions than those experienced by the troops.

A study of the health of the oil field firefighters has been cited by government reports (Presidential Advisory Committee, DoD Environmental Exposure Report on Oil Well Fires), as showing a group with a higher exposure

to the oil field fires suffered no adverse health consequences. The firefighter study has never been published, lacks exposure data, lacks demographic data, and therefore is not a reliable study. In addition, the firefighter exposure conditions were not comparable to the actual combat troop exposure to the oil fires. The firefighters extinguished the oil field fires during the summer months where the Army air monitoring study found very low levels of air pollution, not in the winter months when the smoke plume hugged the ground.

Studies of professional firefighters in the U. S. have found smoke exposure leads to asthma, respiratory disease, and lung impairment. Occupational and animal studies of petroleum inhalation and skin exposure have found symptoms that include cancer, fatigue, asthma, breathlessness, headache, skin rash, immune suppression, memory loss and chemical sensitivity. All these symptoms have been found among the ill Gulf War veterans.

In conclusion, the oil fires and other petroleum exposures are a likely major causative factor in Gulf War illness. No research has been funded to accurately evaluate these toxic exposures. Immediate needs include:

- Review the literature and prepare a report on the toxicity and toxicology of the smoke and petroleum exposure from the Kuwait oil fires. This report should address the association between Gulf War symptoms and the oil fire exposures.

- Research and implement diagnostic protocols to detect residual soot, residual petroleum, and other clinical markers (loss of lung capacity) for veterans exposed to the oil field fires.

- Research and implement treatment protocols that attenuate and eliminate the symptoms resulting from exposure to the oil field fires.

- Develop and administer a self-reported oil fire exposure questionnaire for Gulf War veterans. This would assist in correlating exposure to symptoms reported and determined through diagnosis.

II. INTRODUCTION

The Gulf War resulted in veterans reporting numerous symptoms and ailments that have collectively been described as Gulf War illness. No single clinical definition of Gulf War illness has been developed. No single cause has been found for the symptoms expressed by the veterans.

The oil field fires were initially thought to be a possible cause of Gulf War illness. These massive fires caused exposure to soot and petroleum mist. The fires have been dismissed as a cause of Gulf War illness by all government agencies, including the IOM (Institute of Medicine), PAC (Presidential Advisory Committee), DoD (Department of Defense; Office of the Special Assistant, Defense Science Board), and the VA (Veterans Administration, VA Persian Gulf Scientific Panel). Is this the correct conclusion? Or, is there scientific evidence that the veterans' actual exposure to the soot, petroleum rain and other petroleum contamination is a causative factor in Gulf War illness? For many years it has been known that smoke and petroleum exposure cause many of the major symptoms of Gulf War illness, including asthma, skin rash, cancer, breathlessness, fatigue and immune suppression.

The government position on the oil fires is the result of incorrect analysis of the actual exposure to the oil fires and incorrect assessment of the toxicity of the soot and petroleum exposure. The government position cannot be supported when subjected to unbiased and knowledgeable analysis.

This paper will discuss the actual exposures to oil fire toxins, the toxicity of these toxins, and some of the symptoms likely to result from the exposure. This paper will also examine the government reports on the oil fires and the deficiencies in these reports that lead to the government conclusion that the oil fires are not a cause of Gulf War illness.

III. EXPOSURE

Iraq invaded Kuwait on August 2, 1990, leading to Operation Desert Storm (ODS), known as the Gulf War. As part of its defensive strategy, Iraq destroyed the Kuwait oil wells. This destruction was done by explosive charges attached to the well heads. In total, 730 wells were detonated with explosives. Of these, 656 wells ignited and burned with flames until extinguished. The remaining 74 wells gushed oil, forming burning lakes of crude oil. The first wells were destroyed in January 1991. These first wells, numbering 94, were believed both blown up by Iraqi troops as well as detonated by allied bombing.[1]

Initially the oil wells were under higher reservoir pressure, which varies depending upon the reservoir and the producing depth. The reservoir pressure, presence of natural gas in the oil, and nature of the destruction of the well head all determined the nature of the fire at the well head and the corresponding smoke plume. The oil fire plumes were black with soot and also contained

[1] Husain, Tahir. Kuwaiti Oil Fires: Regional Environmental Perspectives. Elsevier Science, Tarrytown, NY., 1995, p. 40

unburned oil that rained in droplets downwind. This oil rain together with soot coated the desert with a black, tar-like coating. Some wells had salt water in the burning oil that lead to a white plume rich in salts rather than soot.[2]

As the oil fires burned, reservoir pressure dropped, reducing plume height. Cones of carbon formed around some of the wells, affecting the combustion of the crude oil. The oil lakes also aged, with the volatile components having been burned off.

The greatest exposure to the oil rain and soot would have been when the oil wells were first destroyed by explosives and the reservoirs were at highest pressure. This was when the troops were operating in the oil fields in February and March 1991, a time of frequent air inversions that held the smoke plume on the ground. Reported exposures to the soot and oil rain include:

> There were ... days when the smoke [plumes] 'hugged' the ground and turned the sunlit, bright day into a dark of night. [We] traveled the 'coastal highway,' from Kuwait City down to Saudi Arabia ... and the petroleum-thickened air was so impregnated that we choked on oil while breathing through our doubled-up scarves ... we were forced to stop and clear the raw petroleum off vehicle windshields and our goggles constantly. At [times] on the highway the ... air was so thick our vehicle headlights could not penetrate the air further than 10-15 feet, and Marine escorts were needed to walk ... ahead of the vehicles to keep us on the highway.[3]

> [I] was in the center of the oil fires in Kuwait City with no capability of distinguishing the sun from the moon for the first 6 weeks after the liberation of Kuwait. [My] body was so oil and soot covered that a black watch band was camouflaged on [my] wrist. The scarf [I] wore around [my] face did not filter out the air borne debris. [My] spit looked like oil and when [I] sneezed [my] mucus looked like axle grease."[4]

> A number of troops reported significant short-term exposures to oil fire smoke, particulate matter and unburned oil. During these events, troops reported being soaked, at times with unburned oil.[5]

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[2] Hobbs PV, Radke LF. Airborne studies of the smoke from the Kuwait oil fires. Science 1992;256:987-991

[3] DoD(Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness, p.6.

[4] Statement of Herb Smith to the National Institutes of Health Gulf War Workshop, April 27-29, 1994

[5] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 41

In February 1991, Jackson spent three days outside Kuwait City, breathing smoky air. 'At high noon, it just turned pitch black with some lines of light on the horizon. When it was raining, it would be oil coming down.' Jackson said. ... Months later, he (Jackson) said, he began coughing up oily mucus. When he returned home in March 1991 after three months in the gulf area, he had nagging coughing spells.[6]

After this firefight (1st Marine Division in the Burgan oil field, February 25, 1991), the wind shifted and the billowing smoke from an estimated 500 burning oil wells settled over the battlefield. At high noon, troops in the 1st Marine Division could see only then feet in any direction and had to read their maps with flashlights. The soot and oil covered their clothing and burned their throats.[7]

A telephone study done on 10,051 sick veterans found:

Specific to the oil in the environment there, those breathing or enveloped in oil fire smoke was 96 percent; within clear visual area of the oil fires was 90 percent; worked in, lived in, or made travel through the burning oil fields was 72 percent; washed in water with an oily sheen was 68 percent. Those having oily taste to their food was 66 percent, and those with oily taste to the drinking water was 65 percent.[8]

The U. S. Army, as part of its ongoing effort to characterize exposure to the oil field fires, has developed a computer program that integrates daily satellite photographs of the oil fire smoke plume with unit location. This program found February 18 had the the highest level of modeled oil fire exposure. This was just prior to the start of the ground war on February 24. The program found:

Of the 3,900 units in ODS during February-October 1991, 3,327 units (85%) displayed exposure to oil well fires. The exposure was categorized by both the number of days and associated health risk levels. The number of exposure days... ranged from a high of 260 days to a low of 1 day. ... The UICs (Unit Identification Codes) displaying the highest modeled exposure days were Air Force units ... geographically located at the Kuwait International Airport, Kuwait. In general, these units were aligned near the major Kuwaiti oil field regions and were predominately downwind in relation to the superplume structure emanating from the northern oil fields. ... The greatest 1-day modeled risk (both cancer and non-cancer) occurred on 18 February 1991. On this day, the UIC with

[6] Williams TD. Civilians also trace illness to work in Gulf War. Hartford Courant, October 24, 1994.
[7] Allen TB, Berry CF, Norman P. CNN War in the Gulf. Turner Publishing, Inc. Atlanta, GA, 1991 p. 211
[8] Testimony of Debbie Judd, Presidential Advisory Committee Hearing of 11/07/95.

the highest risk levels were geographically located in the Al Minagish oil field region.[9]

It is obvious from the above that the U.S. troops in the Gulf War received a major exposure to toxins from the oil fires. This exposure consisted of smoke, oil rain, oil mist, and heavy oil vapors from the burning oil wells. The exact concentrations of smoke and oil rain in the air breathed by the troops have not been established. The Army did a lengthy study of air quality in Kuwait after the end of the Gulf War and during the period the oil well fires were extinguished.[10] This study found no significant air pollution from the oil fires. The study is flawed which will be discussed below. No study has been done on the oil rain, its composition and concentration in the air. This is a significant omission in gathering data on possible causes of Gulf War illness.

IV. TOXICITY

The toxicity of the oil field fires consisted of smoke and the oil rain. The smoke from an individual well consisted of fine soot. The unburned oil from the wells consisted of droplets, mist, and vapors. The toxicity from these exposures is:

- Soot of one micron or less size,
- Oil rain, which would be a "weathered" crude oil,
- Oil fumes and vapors which would be the more volatile compounds in Kuwait crude oil.

The toxicity and toxicology of fine particles and petroleum is a vast and complex subject. A brief overview of toxicity for soot and petroleum is below.

A. SOOT

The burning oil wells generated massive amounts of soot that rose as a plume above the oil wells. The plumes from individual wells merged to form a superplume that moved according to the prevailing wind direction and meteorological conditions. Prevailing winds are from the Northwest. When air inversion conditions occurred, the plume would touchdown to ground, leading to very high levels of soot at the breathing zone. This plume touchdown is referred

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[9] Environmental Surveillance Health Risk Assessment, No. 47-EM-7121-98, Kuwait Oil Fires, 1 October 1997-15 April 1998. U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD, Draft Report, June 28, 1998, p.68.

[10] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994.

to as fumigation. When plume touchdown occurred, visibility was limited to 10-15 feet and petroleum was raining from the sky.

In Kuwait, air inversions occur commonly in the winter months and rarely in the summer months. From May through September the Shamel winds blow, causing rapid dispersion of the plume and high levels of wind blown sand at the surface.

1. SOOT CONCENTRATIONS

Numerous scientific studies were done to characterize the plume, its composition and toxicity. These studies were performed by the US Interagency Air Assessment Team, independent scientific observers, and the U.S. Army. Important to the validity of these studies is whether the conditions monitored accurately reflect the actual exposures of the troops.

The most important and widely cited study, the one performed by the U.S. Army Environmental Hygiene Agency (Army study), does not reflect the actual exposures that occurred. The Army study found little air pollution and has been quoted as finding the air in Kuwait was about as polluted as the air in Houston and Philadelphia[11]. This statement seems impossible given the field reports of veterans of air pollution so severe you could not see more than 15 feet during broad daylight.

The first issue is the weather. Plume touchdown, as discussed above, created extremely high levels of soot and petroleum mist at ground level. This was a common occurrence during the Gulf War, and a rare occurrence during the air monitoring done by the Army. Dr. Jack Heller, primary author and the scientific director of the Army air monitoring efforts, has stated twice that the Army only monitored one plume touchdown during the 6 months the monitoring occurred.[12]

From an examination of Dr. Heller's data, plume touchdown occurred May 23, 1991. On this date, all air monitoring stations in operation recorded a maximum level of particulate matter.[13] The levels reported were:

Embassy (Kuwait City)	1842 $\upsilon g/m^3$
Jubayl (Saudi Arabia)	1715 $\upsilon g/m^3$
Military Hospital (Kuwait City)	1594 $\upsilon g/m^3$
Khobar Towers (Saudi Arabia)	1380 $\upsilon g/m^3$
KKMC (western Saudi Arabia)	924 $\upsilon g/m^3$

[11] Brown D. Washington Post. June 24, 1996

[12] Testimony of Dr. Jack Heller to National Institute of Health Workshop, The Persian Gulf Experience and Health, April 27-29, 1994 and to the Presidential Advisory Committee on August 6, 1996

[13] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994, p. B-3-7. Riyadh, Ahmadi and Camp Thunderrock monitoring stations were not operational on May 23, 1991, and therefore the maximum particulate concentrations were recorded at a later date.

These levels are to be compared to a significant harm level of 600 $\upsilon g/m^3$.[14] From examination of a regional map, it appears this plume touchdown followed the Persian Gulf coastline. For this reason, the farthest inland air monitoring station, KKMC, recorded the lowest particulate concentration. The above plume touchdown data is the only exposure data in the whole Army report that would correspond to the exposure levels reported by troops in the field that are cited at the beginning of this section.

Air pollution levels were reported by the World Health Organization who found particulate concentration of 5400 $\upsilon g/m^3$. [15] Other investigators reported particulate levels of 1014-2030 $\upsilon g/m^3$ under maximum fumigation conditions.[16] These particulate concentrations are again to be compared to a significant harm level of 600 $\upsilon g/m^3$.

The composition of the oil fire air pollution was predominately soot. However, the Army air monitoring study concluded the air pollution was predomiately sand. This conclusion occurred because the Army air monitoring was done during the summer when high winds and sand storms were common. As a result bothThe Presidential Advisory Committee (PAC) and DoD found:

> High levels of airborne particulate matter (and soot), . . . were observed frequently at several monitoring sites. Analysis of samples suggested particles were mostly sand-based materials; high levels of airborne sand particulates are typical for this region of the world.[17]
>
> Results of the PM_{10} sampling program indicated the following: 1) elemental carbon data obtained from analysis indicated that soot from the oil fire plumes was, in general, only a minor component, ~22%, of the PM_{10} mass; 2) sand based particles accounted for about 77% of the particle mass of most samples; and 3) although high levels were noted in particulate matter, these concentrations,

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[14] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994, p. B-15. Significant harm level from EPA pollution standard index (PSI) for classifying the health impact of urban air pollution. Air quality is considered hazardous if the PSI exceeds 300. If the PSI exceeds 600 there is the possibility of significant harm from breathing the air.

[15] Report of the WHO Meeting of Experts on the Atmospheric Part of the Joint U.N. Response to the Kuwait Oilfield Fires. Geneva, 27-30 April 1991, Draft.

[16] Al-Shatti KS, Harrington JM eds. The Environmental and Health Impact of the Kuwaiti Oil Fires: Proceedings of an International Symposium held at the University of Birmingham 17th October 1991. Institute of Occupational Health, The University of Birmingham, UK, 1992 p. 53

[17] Presidential Advisory Committee on Gulf War Veterans' Illnesses Final Report (Washington, DC: U.S. Government Printing Office, December, 1996), p. 100.

as noted previously, were considered to be within a range common to this area of the Middle East.[18]

In the above both the PAC and DoD minimize the impact of the oil fire soot on the air pollution in the Gulf and indicate the air pollution levels during the oil fires were no different than air pollution levels without the fires. This is not common sense, is based upon misleading data in the Army study, and is not supported by other field investigators.

The Harvard School of Public Health found on plume impact days the carbon content of the particulate air pollution was greater than 30% and ranged as high as 70%.[19] Hobbs and Radke found the oil fire plumes contained 20% to 48% soot for the black plumes.[20] Other investigators found carbon comprised around 50% of the particles at a number of sites.[21]

2. SOOT TOXICITY

The majority of the smoke contained particles sized between 0.1 and 1.0 microns. The black smoke, which contained predominately soot, contained particles with a mean diameter of 0.8 microns.[22]

Soot less than 2.5 microns penetrates to the deepest part of the lung, the alveoli. There it is retained until it can be cleared by the lung immune defenses. Particles of this size are retained in the lung for an extended period of time that can be as long as two years. The International Agency for Research on Cancer has examined soot carcinogenicity and found:

> Cohort studies of mortality among chimney-sweeps in Sweden and Denmark have shown a significantly increased risk of lung cancer. ... In addition to lung cancer, statistically significant excess mortality from esophageal cancer, primary liver cancer and leukaemia was found among chimney-sweeps in one study. ... There is *sufficient evidence* that soot is carcinogenic to humans.[23]

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[18] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 55

[19] Spengler JD. Harvard School of Public Health's Kuwait oil fires investigations. The Kuwait Oil Fires Conference, August 12-14, 1991, American Academy of Arts and Sciences, Cambridge, MA. Abstract only

[20] Hobbs PV, Radke LF. Airborne studies of the smoke from the Kuwait oil fires. Science 1992;256:987-991

[21] Al-Shatti KS, Harrington JM eds. The Environmental and Health Impact of the Kuwaiti Oil Fires: Proceedings of an International Symposium held at the University of Birmingham 17th October 1991. Institute of Occupational Health, The University of Birmingham, UK, 1992 p. 53

[22] Cofer WR, Stevens EL, et al. Kuwait oil fires: Compositions of source smoke. J Geo Res. 1991;97:14521-25

[23] IARC. 1985. IARC monographs on the evaluation of carcinogenic risks to humans. Vol. 35: Polynuclear Aromatic Compounds, Part 4, Bitumens, Coal-tars and Derived Products, Shale-oils and Soots. Lyon, France p. 236

3. FIREFIGHTER STUDIES

The soot from the oil field fires would be typical of that encountered by a firefighter in the course of firefighting work. The PAC and DoD have used "the firefighter study" to support their conclusion the oil well fires did not have any health impact on the troops. The PAC and DoD stated:

> Information has been gathered from 110 firefighters working for private companies in the Kuwaiti oil fields in 1991. Individuals were deployed for 28 day periods, working daily at the well heads without breathing-protection equipment. Most were over 30 years old and had 10 or more years experience fighting similar well fires, many of them in Kuwait and elsewhere in Southwest Asia. No cases of illness resembling those reported by Gulf War veterans were reported, nor have such complaints been observed among thousands of oil-well firefighters who have spent years experiencing similar exposures.[24]
>
> Often in occupational health, you turn to the highest exposed groups for a sense of what health outcomes you might be most likely to see in the extreme. In this case, the highest exposed group is that of the civilian firefighters, who worked 28-day stints at the well heads with no respiratory protection. Most were over 30 and had 10 or more years experience fighting similar oil well fires. Many of them in Kuwait and elsewhere in the Middle East. ... The physician who examined them before and after each tour of duty, found upon follow-up through 1994, no cases of illnesses resembling those reported by Gulf War veterans, nor had he observed such complaints in work among thousands of firefighters who had spent years with similar experiences.[25]
>
> Firefighters working in Kuwait to extinguish the fires also experienced short-term intense exposures. In general, these exposures were of similar or higher intensity and longer duration [than the troop exposure]. Medical screening studies were conducted at the University of Texas on approximately 110 firefighters from Adair Enterprises, Boots and Coots, and Wild Well Control. Crews worked 10-12 hours per day and on average spent approximately 105 days in Kuwait fighting the fires. Personal protective equipment was limited to flame-retardant suits, hard hats, and safety shoes (i.e., no respiratory protection). Firefighters

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[24]Presidential Advisory Committee on Gulf War Veterans' Illnesses Final Report (Washington, DC: U.S. Government Printing Office, December, 1996), p. 120

[25] Testimony of Dr. Lois M. Jollenbeck, staff, Presidential Advisory Committee hearing of July 9, 1996, p. 233

> averaged 10 years of experience with some having over 30 years of experience fighting similar type fires in the US and abroad. Results of the health screening studies indicated that: 1) no objective evidence exists of any significant illness; 2) there were no reports of symptoms similar to those reported by Gulf War veterans; and 3) there were no reports of any illness with a delayed onset.[26]

The "firefighter study" is an important study that is heavily relied upon by the PAC and DoD to conclude the oil fires were not a causative factor in Gulf War illness. The question is whether the study is valid and scientifically sound? The first issue is whether the exposure of the firefighters was comparable to that experienced by the troops. Important is **no** exposure data has been provided by Dr. Freidman, the author of the firefighter study. However, the Army study on air monitoring found the Kuwait air was cleaner than Houston and Philadelphia during the time the firefighters were in Kuwait. Therefore, relying upon the flawed Army study, it can be concluded that the firefighters were exposed to minimal levels of soot. This conclusion is supported by many observations that found the air clear in the oil fields and the smoke plumes lofting to great heights during the hot, windy summer months when the oil well fire fighting occurred.

Dr. Friedman also provides no scientific data to support his assertions regarding the health of the oil field firefighters. This study has never been published in a peer-reviewed journal. The only public information available on Dr. Friedman's study and methodology are: 1) one paragraph of telephone notes of a conversation between the DoD and Dr. Friedman, 2) one half page of telephone notes of a conversation between the PAC and Dr. Friedman, and 3) a 2 1/2 page fax to the PAC from Dr. Friedman with no scientific data or accurate methodology.

It was specifically recommended that accurate exposure data be kept on the oil field firefighters. The U.S. Public Health Service prepared recommendations for monitoring and analysis of the health impact of the Kuwait oil field fires.[27] This document was obtained through FOIA request from the Army Kuwait oil fire health effects working group that coordinated the Army study. The document was attached to minutes of the May 17, 1991 meeting of the working group. The document specifically recommends:

> The dose-response assessment; human data as well as animal and invitro studies is a critical aspect of risk assessment. Namely, the amount of exposure via various routes must be quantified so that acute and chronic risk can be estimated. Strategies and approaches should include:

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[26] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 65

[27] US Public Health Service Scope of Action Document for Kuwait prepared by The Kuwait Working Party, May 17, 1991

> **Identifying by time, place, duration of exposure, level of exposure,** various groups of individuals including **oil well fire fighters,** oil well workers, military personnel and citizens. (emphasis added)[28]

In sum, Dr. Friedman's firefighter study is not an adequate or scientific basis for dismissing the oil fires as a cause of Gulf War illness. If this study were of scientific merit, it would be published in a peer reviewed scientific journal.

Respiratory symptoms described as breathlessness, asthma, and respiratory disease have been found 17.5 to 21% of the ill Gulf War veterans.[29] Could smoke inhalation be a causative factor in respiratory symptoms? Studies on professional firefighters have found a direct correlation between smoke inhalation and respiratory impairment.

> The model of persistent inflammation with associated bronchial hyperresponsiveness, fundamental to our current understanding of asthma, should apply to the chronic inflammation seen after smoke inhalation. 'Reactive airway dysfunction syndrome' (RADS, also referred to as irritant-induced asthma) has followed smoke inhalation... Acquired progressive asthma and subclinical acute bronchial hyperresponsiveness have been well documented following smoke inhalation. Kinsella et al. evaluated 13 consecutive patients with suspected smoke inhalation and found increased airways hyperactivity within 3 days of injury. Although responsiveness to histamine improved over a 3-month period, reductions of FEV_1[30] and airways conductance persisted.[31]

> Occupational exposure to smoke may produce a wide range of pulmonary effects in firefighters, ranging from acute changes in lung function to increased mortality from nonmalignant respiratory disease. ... The investigators concluded that routine firefighting is associated with a high incidence of acute decrements of lung function. ... Analysis ... revealed that the change in airway responsiveness was greatest in those with moderate exposure and was not related to smoking or years of firefighting. Like Sheppard et al., these investigators concluded that routine firefighting is

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[28] Department of the Army, Office of the Surgeon General, Falls Church, VA, May 17, 1991 minutes of Kuwaiti Oil Fire Health Effects Working Group, reference 27, p. 19, attached to Col. Frederick Erdtmann's copy.

[29] Presidential Advisory Committee on Gulf War Veterans' Illnesses Final Report (Washington, DC: U.S. Government Printing Office, December, 1996), pp. 59, 62.

[30] FEV_1 is a measure of lung capacity and is forced expiratory volume in one second.

[31] Haponik EF. Clinical smoke inhalation injury: Pulmonary effects. Occupational Medicine. 1993;3:431-68, p. 444

associated with acute decrements in spirometric function and an acute increase in airway responsiveness.[32]

In summary, the smoke exposure of the troops was significant, and expected to be carcinogenic and toxic to the respiratory system and other organs. The exposure data obtained by the Army air monitoring study did not represent exposure conditions experienced by the troops in the battlefield. The Friedman firefighter study quoted and relied upon by the PAC and DoD is non-scientific, not peer reviewed or published, has no exposure information, and lacks the essential elements of a scientific study. Readily available scientific information and occupational studies have found soot carcinogenic, toxic, and a cause of asthma, respiratory cancer, and other disease. The Government has no scientific basis what so ever to conclude the smoke from the oil field fires is not a causative factor in Gulf War illness.

B. OIL RAIN

The smoke from the oil well fires was the air pollutant of greatest initial concern. Equally important as a toxic exposure was the oil rain from the oil fires. The oil well fires allowed significant amounts of oil to pass unburned through the flame zone, creating an oil rain downwind of the oil well fires.[33] In high-pressure wells, there was a high-speed jet of unburned crude in the middle or bottom edge of the fireball. Some wells did not ignite when detonated by the Iraqi army. These wells gushed crude oil to various heights depending upon reservoir pressure.[34]

The oil rain was Kuwait crude oil with the volatile components removed by combustion and evaporation in the oil well fire or in the air. The volatile components would be natural gas, and the lower boiling fractions that contain the VOCs (volatile organic compounds). These lower boiling fractions would correspond to the gasoline and kerosene fractions.

The oil rain was Kuwait crude oil with volatile components removed. The oil rain would correspond to a light lubricating oil fraction contaminated with soot. The heat of the oil well fires could cause thermal cracking of higher boiling compounds. Thermal cracking creates higher boiling aromatic compounds and lighter boiling compounds by breaking large petroleum molecules. Higher boiling aromatic compounds have consistently been linked with carcinogenicity and toxicity. Thus, the oil rain may have become more toxic from thermal cracking of the Kuwait crude in the oil fire heat.

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[32] Scannell CH, Balmes JR. Pulmonary effects of firefighting. Occupational Medicine. 1995;4:789-801

[33] Peter V. Hobbs, University of Washington, personal communication.

[34] Al-Shatti KS, Harrington JM eds. The Environmental and Health Impact of the Kuwaiti Oil Fires: Proceedings of an International Symposium held at the University of Birmingham 17th October 1991. Institute of Occupational Health, The University of Birmingham, UK, 1992 p. 15

The oil rain was large droplets near the oil wells and smaller droplets that rained as a fine drizzle for a distance of 50 km. from the fires.[35], [36] One account by a reporter in Kuwait City at the end of the battle describes the conditions as:

> It was 11:00 a.m., yet the darkness caused by the burning oil wells was like a moonless night. The photos I brought back show the black, hellish landscape-yet they cannot convey the **fine mist of oil particles that hangs in the air**, nor the deafening roar of the wildly burning wells.[37] (emphasis added)

Troops operating in the oil fire zone inhaled the oil mist and were covered with the oil rain. The DoD has stated:

> The most severe exposures to US troops from the oil well fires occurred when they were in proximity to the damaged or burning wells. During these incidences, troops were subjected to short-term exposures where they were **literally drenched in unburned oil and/or covered with fall-out** (i.e., soot, smoke, and other by-products of combustion) from the oil well fires.[38] (emphasis added)

The DoD further notes exposure to the crude oil was short in duration, lasting from a few hours to several days. Symptoms reported included coughing, shortness of breath, eye and throat irritation, and black mucous from the nose.

No study has been done on the composition or toxicity of the oil rain. This is a major omission, given the known widespread troop exposure to the oil rain and the known toxicity and carcinogenicity of the higher boiling petroleum fractions that would be expected to correspond to the oil rain.

Petroleum exhibits both toxicity and carcinogenicity. Exposure of the troops to the oil rain was through inhalation and skin absorption. The troops had other petroleum exposures from oil contaminated water and diesel fuel use as a dust suppressant. These other petroleum exposures, though an additional toxic burden, are beyond the scope of this paper.

Inhalation of high boiling petroleum oils such as the oil rain causes a progressive disease called lipoid pneumonia. The severity of the disease is a function of the amount of oil inhaled, the viscosity of the oil, and the aromatic content of the oil. The greater the amount of oil inhaled, the lower the viscosity of the oil, and the higher the aromatic content of the oil, the more severe is the disease.

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[35] Hobbs PV, Radke LF. Airborne studies of the smoke from the Kuwait oil fires. Science 1992;256:987-991, p. 988

[36] Stevens R, Pinto J, et. al. Chemical and Physical properties of emissions from Kuwaiti oil fires. Wat Sci Tech. 1993;27:223-33

[37] Canby TY, McCurry S. After the storm. Nat Geographic. 1991;August:4-35 p.35

[38] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 64

Petroleum in the lung acts as an irritant which cannot be removed by the normal defense mechanism of the lung, macrophagic action. Instead, the lung forms paraffinomas and granulomas around the oil droplets. Lipoid pneumonia can be a progressive disease which continues to reduce lung capacity long after the exposure to the petroleum ceases. Effectively, lipoid pneumonia can lead to a progressive emphysema.

Petroleum inhalation can lead to two forms of lipoid pneumonia. One form causes a circumscribed lesion similar to a tumor within the lung and is called lipoid granuloma or paraffinoma. Extensive loss of pulmonary function can occur with this type of lesion. A second form of lipoid pneumonia is diffuse pneumonitis in which oil droplets are spread throughout the lung. This type of lipoid pneumonia can be accompanied by bacterial infection.[39]

Lipoid pneumonia symptoms can range from occasional cough to severe, debilitating breathlessness and pulmonary illness. Commonly chest x-rays will not detect any lung changes to indicate the presence of lipoid pneumonia. Accurate diagnosis can only be made through lung biopsy or other invasive procedures. Advanced lipoid pneumonia can lead to permanent loss of lung capacity from fibrosis. Lung damage from lipoid pneumonia can vary from slight to severe with necrosis and hemorrhage.[40]

Inhaled petroleum with an aromatic content would be expected to partition in the lung. The aromatic portion of the oil is fat-soluble and would pass through the lung wall to be deposited in the adipose tissue. It also is possible some of the non-aromatic portion of inhaled petroleum would pass through the lung wall and be deposited from the blood in the spleen, lymph nodes, liver and kidneys. The aromatic and other petroleum fractions distributed throughout the body would cause systemic toxicity which expresses through many symptoms. A detailed discussion of petroleum toxicology is beyond the scope of this paper. An extensive literature review by the author has found petroleum exposure associated with the following symptoms:

cancer	skin rash	memory loss
fatigue	headache	immune
breathlessness	diarrhea	suppression
cough	weight loss	chemical sensitivity

[39] Palmer WG. 1990. Exposure standard for fog oil. Tech. Rep. 9010, ADA231714. U. S. Army Biomedical Research and Development Laboratory, Fort Detrick, Frederick, MD. p. 8

[40] Palmer WG. 1990. Exposure standard for fog oil. Tech. Rep. 9010, ADA231714. U. S. Army Biomedical Research and Development Laboratory, Fort Detrick, Frederick, MD. p. 8

Skin exposure to petroleum has been known for many years to cause skin cancer, rashes, eczema, acne, and dermatitis. The reaction of the skin to petroleum depends upon the composition, boiling range, viscosity and aromatic content of the oil. Aromatic content is a key toxicity parameter for petroleum; the higher the aromatic content, the greater is the toxicity. Aromatic compounds boiling between 500 and 1000° F. have been found highly carcinogenic.

Highly refined petroleum oils, called white oils, are used for lotions and skin creams. These highly refined oils have all aromatic compounds removed and as a result have low toxicity.

The potential for skin carcinogenicity and toxicity of the oil rain must be evaluated based upon its estimated boiling range, viscosity and aromatic content. As mentioned above, the source of the oil rain was Kuwait crude oil altered by heating in the oil fires. Reports of the oil rain forming a sticky coating on surfaces suggest it was similar to a lubricating oil in viscosity and boiling range. This is effectively a weathered crude, similar to that found in an environmental spill, and would contain a high level of aromatic compounds and asphaltic and resinous compounds.

Animal testing with Kuwait crude has found it carcinogenic.[41] The study was a lifetime mouse skin painting experiment using Kuwait, Louisiana, and shale oil crude. The Kuwait crude was a paraffinic crude with a high sulfur content. The composition and physical properties of the crude oils were not given. However, the article states the Kuwait crude was selected because it was used extensively in the United States. Kuwait has three major types of crude which are Ratawi, Burgan and Kuwait export.[42] Export crude has 2.5% sulfur and an API gravity of 31.4 A reasonable assumption is the crude used in the study would be export crude, and would be comparable to the crude composition given in the DoD report[43].

The study found the Kuwait crude produced carcinogenic tumors on 38% of the mice. This is to be compared with the Louisiana crude that produced tumors in 20% of the mice, and shale oil with tumors in 68-92% of the mice.

Another study examined carcinogenicity of a domestic Gulf Coast naphthenic crude and a foreign, high (2.54%) sulfur paraffinic crude. The foreign crude had a boiling profile and sulfur content similar to Kuwait export and likely was a Kuwait crude. In this study, the crudes were separated into fractions

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[41] Coomes RM, Hazer KA. Comparison of the carcinogenic potential of crude oil and shale oil. From: Proceedings of the Symposium, the Toxicology of Petroleum Hydrocarbons, MacFarland HN, Holdsworth CE, et. al. editors, American Petroleum Institute, 1982, pages 208-224

[42] Al-Shatti KS, Harrington JM eds. The Environmental and Health Impact of the Kuwaiti Oil Fires: Proceedings of an International Symposium held at the University of Birmingham 17th October 1991. Institute of Occupational Health, The University of Birmingham, UK, 1992

[43] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 106

that would approximate the gasoline, fuel oil, light lube oil, and heavy fuel oil fractions. The whole crude oil and each fraction were tested using standard mouse skin testing protocols. The whole foreign crude produced tumors on 56% of the mice. The higher boiling fuel oil fraction, which boiled at 700-1070° F, produced tumors in 87% of the mice.[44] The higher boiling fuel oil fraction would roughly correspond to the oil rain in composition and boiling range. Thus, a reasonable assumption is the oil rain was highly carcinogenic.

Domestic and wild animals in Kuwait suffered severe health effects from the smoke and oil rain. Observations reported just after the end of the war stated:

> Sheep, goats and camels grazing in the areas impacted by the burning wells have turned black from the falling drops of oil and have started to lose their fur and die. Many birds observed flying through the plumes are overcome by heat and fumes and fall to the ground.[45]

Inspection of sheep in a Kuwait slaughter house after the war found the sheep had lipoid pneumonia; there were massive clots in the lungs. Also observed were dark granulated livers and blood clots in the hearts.[46]

In summary, the oil rain would have caused a petroleum exposure from inhalation and skin absorption. The petroleum rain would be expected to cause lipoid pneumonia in the lungs, a progressive lung disease whose major symptom is breathlessness similar to asthma. The oil rain on the skin would be expected to cause rashes, dermatitis, and future cancers. Animal skin painting experiments on Kuwait crude have found it highly carcinogenic. Observations on livestock exposed to the oil field fires have significant health impacts, including severe lipoid pneumonia, and heart and liver disorders.

V. GOVERNMENT STUDIES AND REPORTS

Many government reports, hearings and studies have examined the toxic troop exposures in the Gulf War and the likely symptomatic outcome. The Gulf

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[44] Lewis SC, King RW, et. al. Skin carcinogenic potential of petroleum hydrocarbons. 2. Carcinogenesis of crude oil, distillate fractions and chemical class subfractions. From: Proceedings of the Symposium, the Toxicology of Petroleum Hydrocarbons, MacFarland HN, Holdsworth CE, et. al. editors, American Petroleum Institute, 1982, pages 185-195; boiling range diagram on p. 172.

[45] U. S. Environmental Protection Agency, Report to congress: United States Gulf Environmental Technical Assistance January 27-July 31, 1991, Under Public Law 102-27, Sec. 309, undated, Appendix F, Subappendix IV, p. 11

[46] Al-Shatti KS, Harrington JM eds. The Environmental and Health Impact of the Kuwaiti Oil Fires: Proceedings of an International Symposium held at the University of Birmingham 17th October 1991. Institute of Occupational Health, The University of Birmingham, UK, 1992, p. 80

War had many toxic exposures besides oil fire smoke and petroleum rain. In general, all toxic exposures save low level chemical warfare agents have been dismissed as a probable cause of Gulf War illness. This section will discuss the major government studies and reports, their validity, and accuracy regarding the oil fires. The following major government studies will be individually discussed.

- The U. S. Army Kuwait Fire Health Risk Assessment (Army study)[47]
- The U.S. Army Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires (CHPPM study).[48]
- The 11 ACR (Armored Calvary Regiment) health impact study[49]

A. U. S. ARMY KUWAIT FIRE HEALTH RISK ASSESSMENT

This assessment consisted of two parts; 1.) an air monitoring and soils contamination study done in Kuwait after the Gulf War and 2.) a health risk assessment for cancer and non-cancer impacts of the air and other pollution. The study is seriously flawed and its results are invalid. The Army study found no increased risk of cancer or other health outcomes from the oil field fires. The study suffers from the following flaws which invalidate its conclusions:

1. AIR MONITORING

The air monitoring which found the air as clean as the air in Philadelphia and Houston did not monitor similar conditions to those experienced by the troops. During the Army monitoring study, the Shamel summer winds were blowing and the climate was sunny, hot and dry. Air inversions were rare, and only one ground level air inversion that caused plume touchdown was recorded. In contrast, the troop exposure occurred in the winter months when air inversions and still days were common.

Reports from the troops of severe air pollution are consistent with the high levels of air pollution recorded during the one plume touchdown and the WHO monitoring done just after the war. The one plume touchdown monitored by the Army had smoke concentrations that exceeded the EPA significant harm level of

[47] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994.
[48] U.S. Army Center for Health Promotion and Preventive Medicine, Draft Final Report-Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires. April 1998
[49] Located in the U. S. Army Health Risk Assessment (Reference 43 above) as the Biological Surveillance Initiative (BSI)

600 $\upsilon g/m^3$ by a wide margin. The Army monitoring found plume touchdown concentrations of 924-1842 $\upsilon g/m^3$ on May 23, 1991. At the time of this plume touchdown, approximately 70 wells on fire and 17 gushing wells in the greater Burgan field had been capped, about 18% of the detonated wells.

The greater Burgan field was the source of the majority of the soot and oil rain, and consists of the Magwa, Burgan and Al Ahmadi oil fields, all located directly south of Kuwait City. The greater Burgan, one of the largest oil fields in the world, is estimated to have generated 90% of the oil lost from the destruction of the oil fields.[50] The greater Burgan would be expected to be the major source of the soot and oil rain exposure of the troops.

In summary, the pollution measured by the Army air-monitoring program did not reflect the exposure of the troops during and directly after Operation Desert Storm due to different weather conditions and different oil field fire conditions. The only air pollution data that may directly relate to the troop exposures are the data taken immediately after the liberation of Kuwait or during the one monitored plume touchdown on May 23, 1991.

2. HEALTH RISK ASSESSMENT

The Army used a risk assessment methodology developed by the EPA for superfund sites. Superfund sites are contaminated land areas that typically were municipal landfills and industrial disposal sites. Public exposure to toxins at superfund sites comes from:

- vapors given off from chemicals disposed in the site,
- windblown chemically contaminated soil and,
- drinking water contaminated with chemicals.

This methodology has never been used for assessing a health risk from massive air pollution consisting of smoke and oil rain. In order to use the methodology, the Army was forced to ignore the toxic smoke inhalation and the oil rain. The Army also ignored the oil contaminated drinking and shower water that was a common exposure of Gulf DoD personnel.

The Army examined the Gulf air for volatile organic compounds (VOCs) and found very low levels. One possible cause of this is the VOCs found in Kuwait crude oil were burned or rapidly evaporated in the oil field fire heat.

The Army examined the oil fire soot for polycyclic aromatic hydrocarbons (PAHs) commonly found as air pollutants in city air from auto exhaust and coal fired boilers and found low levels of these compounds. PAHs are of concern because they are known carcinogens.

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[50]Husain, Tahir. Kuwaiti Oil Fires: Regional Environmental Perspectives. Elsevier Science, Tarrytown, NY., 1995, Tables pp. 55-57 and calculations by author.

The Army examined the soot for heavy metals that are part of Kuwait crude (nickel, vanadium), or expected to be in the background air pollution or windblown sand (chromium, lead). None were significant as a cancer or non-cancer risk.

By using an inappropriate risk methodology, doing an air monitoring study that did not reflect actual exposures, and ignoring significant toxin exposures (soot and oil rain), the Army was able to conclude there was no significant cancer or non-cancer risk to the troops. As a result of these glaring and significant flaws in the Army study, the conclusions that there are no cancer or non-cancer risk are invalid.

B. U.S. ARMY ENVIRONMENTAL SURVEILLANCE HEALTH RISK ASSESSMENT

One recognized weakness of the Army air monitoring study, A. above, was that data were not collected during the stagnant air conditions of the winter months, February-April when the greatest troop air pollution exposure occurred. In addition, oil well fires were continuously extinguished during the air monitoring study, leading to continuously reduced oil fire pollution. As a result, it was felt there was an underestimation of the risk associated with the Army measured air pollution. [51]

Therefore, a second risk assessment was performed by U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM).[52] This assessment developed an exposure computer program that integrated daily troop locations, capping of oil well fires, and satellite photos of plume boundaries. From this data, the number of days a troop unit was exposed to the oil fire plume could be estimated. This was a rough exposure indication for it did not locate individuals within the plume, and most importantly, it could not predict contaminate concentrations within the plume boundary.[53] Satellite images would not indicate the specific location of air inversions and more importantly, plume touchdown. As noted above, plume touchdown and air inversions were the major meteorological factor in determining ground level smoke and petroleum rain concentration in the breathing zone.

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[51]DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 53

[52] U.S. Army Center for Health Promotion and Preventive Medicine, Draft Final Report-Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires. April 1998

[53]DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness. p. 72

The report presents satellite superplume boundaries on pages C-2 through C-4. No information is provided in the report on the computer modeled superplume boundaries. However, the DoD report on environmental exposure contains computer modeled superplume boundaries on pages 114-116.[54] A comparison of two days when both satellite and computer modeled superplume boundaries are available, April 11 and April 20, shows a major discrepancy between the satellite and computer modeled superplume. The computer-modeled superplume is larger by a factor of approximately 2. This is a major error and would under estimate troop exposure in the computer model by a factor of two.

The cancer risk levels were calculated for inhalation of metals, volatile organics (VOCs) and polycyclic aromatic hydrocarbons (PAHs) contained in the air pollution. To this risk was added the cancer risk from accidental ingestion and dermal exposure to soil contaminated with toxic metals. This cancer risk assessment suffers from the fatal flaws in A. above; it does not include the troop exposure to carcinogenic and toxic soot and oil rain.[55]

The report admits a major flaw in using the EPA superfund methodology which is:

> One of the most confounding uncertainties of this HRA (Health Risk Assessment) involves the application of USEPA's concept of carcinogenic risk. ... This assessment involves short-term exposures to carcinogens and the validity of the USEPA risk methodology is questioned. The current default risk method for carcinogens is lifetime based. **There is no current methodology for assessing carcinogenic risk from short-term exposures**.(emphasis added)[56]

Effectively the report is concluding the methodology used is not applicable to the cancer exposures experienced by the troops and therefore is invalid.

The non-cancer risk calculated by USACHPPM was caused by the inhalation of benzene. Once again, the health risk assessment has ignored the major non-cancer exposures which are soot and oil rain. These two exposures are known to cause asthma, breathlessness, bronchitis, impaired lung function, skin rash, dermatitis, and eczema.

The USACHPPM report concluded that:

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[54] DoD (Department of Defense). Environmental Exposure Report. Oil Well Fires. September 30, 1998 Interim Report. Investigation and Analysis Directorate of the Office of the Special Assistant for Gulf War Illness.

[55] U.S. Army Center for Health Promotion and Preventive Medicine, Draft Final Report-Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires. April 1998. p. 53

[56] U.S. Army Center for Health Promotion and Preventive Medicine, Draft Final Report-Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires. April 1998. p. 51

> The exposure and risk levels generated for each troop unit in this HRA were compared to levels determined to be safe by the USEPA. ... As can be seen from the following graphics, all troop unit excess cancer and non-cancer risk levels were below respective USEPA safe risk levels. In other words, the environmental exposures troop units received from oil well fires and other industrial sources in the Gulf region were not expected, by themselves, to cause health effects.[57]

In summary, this health risk assessment, though apparently more sophisticated with its computer database and modeling, has no more merit than the Army study. It omits the important cancer and non-cancer exposures of the troops, the oil fire soot and oil rain. Its conclusion of no adverse health risk is invalid because it ignores the actual exposures of the troops to known toxic agents.

C. 11 ACR (ARMORED CALVARY REGIMENT) HEALTH IMPACT STUDY

The 11 ACR was deployed from Germany to Kuwait on June 10, 1991 and returned to base on September 20, 1991. This cohort of 4700 soldiers was selected for study of the health impact of exposure to the oil well fires. The 11 ACR was stationed at Doha, 30 miles from the fires and Monterey, 80 miles from the fires.[58] No daily data on exposure of this unit to the oil field fire smoke and oil rain were kept. Self-administered symptoms and medical history questionnaires were given to a portion of the soldiers in the 11 ACR prior to, during and shortly after their deployment to Kuwait. A limited number, 355, filled out questionnaires while in Kuwait. These questionnaires had only one question on smoke exposure, and it is unknown if it related to the oil field fires. The exposure question asked was: "If you have had a job where you were exposed to any of the following substances (smoke) since arriving in Kuwait, please write down the kind of job and check off how severe the exposure was."[59] Exposure was rated as mild, moderate or severe.

The results of the questionnaire found 52.3% reported a smoke exposure with 9.0% mild, 27.0% moderate, and 16.3% severe exposures reported.[60] Two-thirds reported the oil fire smoke more severe than expected and 41%

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[57] U.S. Army Center for Health Promotion and Preventive Medicine, Draft Final Report-Environmental Surveillance Health Risk Assessment, Kuwait Oil Fires. April 1998. Executive Summary, p.2

[58] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994. p. F-2-2

[59] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994. p. F-2-135

[60] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February, 1994. p. F-2-44

reported having been within a mile of an oil fire at some time. Significant symptoms reported while in Kuwait included fatigue, burning eyes, eye irritation, trouble breathing, nose and throat irritation, and skin rashes. Noticeably increased symptoms included digestion, urination, and bowel movements (predominately diarrhea). Other minor symptoms included sleeping, concentration, breathing, and prolonged exercise. Several symptoms, not identified, were significantly associated with proximity to the oil fires.[61]

Other medical testing, including pulmonary function testing, medical record surveillance and personal diaries provided no useful information. The pulmonary function tests could have provided very useful information to correlate lung impairment with smoke exposure. However, the predeployment pulmonary function tests were not properly done. The medical records in field were destroyed in an ammunition fire at Doha. Only 6 personal diaries were kept which made this information too small of a database to achieve any meaningful significance.

The 11 ACR study, though lacking precise exposure data and necessary lung function tests, does show symptoms of Gulf War illness occurred in this study group. This group was deployed months after hostilities ceased, and when in average 40% of the oil fires had been extinguished.[62] The 11 ACR was stationed 30 to 80 miles from the oil field fires. Thus, the smoke and oil rain exposure of the 11 ACR would not be at all comparable to that experienced by troops involved in the liberation of Kuwait. As a result, this study has limited usefulness in understanding the oil fire contribution to Gulf War illness.

VI CONCLUSION

Eight years have passed since the successful liberation of Kuwait by coalition forces. The Gulf Registry of ill veterans approaches or surpasses 100,000 veterans of that war. On December 5, 1991, Congress required the Secretary of Defense to:

1. Establish and maintain a special record relating to members of the Armed Forces who, as determined by the Secretary, were exposed to the fumes of burning oil in the Desert Storm Theater of Operations during the Persian Gulf Conflict, and

[61] U.S. Army, Environmental Hygiene Agency, Final Report: Kuwait Oil Fire Health Risk Assessment, 5 May- 3 December, 1991, Report No. 39-26-L192-91, February. 1994. pp. F-7 & F-8

[62] Husain, Tahir. Kuwaiti Oil Fires: Regional Environmental Perspectives. Elsevier Science, Tarrytown, NY., 1995, Tables pp. 55-57 and calculations by author.

2. Submit to the Congress the results of all ongoing studies on the health consequences (short- or long-term) of members of the Armed Forces who were exposed to the fumes of burning oil in the Desert Storm Theater of Operations during the Persian Gulf conflict. This report should also address the need for any additional studies relating to this exposure.[63]

Many studies and reports have been produced by the DoD and other government agencies, all of which find no relationship between the oil fires and Gulf War illness. As shown above, the primary reports contain serious flaws and therefore cannot support the conclusion they advance. These primary reports have been relied upon by the PAC and DoD to conclude the oil fires pose no adverse risk to Gulf War veterans.

In truth, a large body of scientific evidence exists that links smoke and petroleum inhalation and ingestion to many of the symptoms of Gulf War illness. It would not be unreasonable to assume that half of the veterans with Gulf War illness symptoms have the oil fires as a primary cause of the symptoms. This is a simple and obvious conclusion given the reported exposures of the troops, the limited air pollution monitoring done immediately after the liberation of Kuwait, and the symptoms reported by Gulf War veterans.

The DoD needs to acknowledge the oil fires and petroleum exposures constitute a significant cancer and non-cancer risk to the exposed Gulf War veterans. An in depth toxicological evaluation needs to be done on the petroleum and soot exposures to relate reported symptoms to reported exposures. This toxicological evaluation should be independently done to avoid DoD bias, which is clearly evident in the reports done to date. Diagnostic and treatment protocols are needed to detect petroleum and smoke products in a veteran's body. Treatment protocols that address the continuing toxicity of smoke and petroleum metabolites need to be developed. The current scientific literature has research studies that indicate promising diagnostic and treatment procedures. These research areas need to evaluated for applicability to the veterans' oil fire toxic exposure in the Gulf War. A self-reported questionnaire on smoke and petroleum exposure needs to be developed and administered to correlate exposure with associated symptoms.

The circle comes to a closure when the oil fires, which were the original impetus for the Gulf War registry and research efforts, are acknowledged and receive the research identified above that they properly deserve.

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[63] Public Law 102-190 passed December 5, 1991

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