Thank you for your service to our country and for your participation in the Gulf War Oil Well Fire Smoke registry. During the Gulf War, the retreating Iraqi forces set fire to more than 750 oil wells. Between February 2, 1991 and October 29, 1991, the oil well fires burned causing a decrease in the air quality over a majority of the country of Kuwait and a dramatic decrease within the immediate vicinity of the fires.

On December 5, 1991, Public Law 102-190 was passed requiring the Secretary of Defense to establish and maintain a record relating to members of the Armed Forces who were exposed to the smoke/fumes\(^1\) from burning oil wells. Section 734 of this law and Section 704 of Public Law 102-585 requires a means of calculating exposures to DoD service members deployed to the Gulf War theater who were exposed to oil well fire smoke.

**THE MAXIMUM RISK ESTIMATE FOR A GULF WAR SERVICE MEMBER**

Based on an assessment of estimated chemical exposures resulting from the oil well fire smoke:

- The maximum increased risk for getting cancer (over a lifetime) for any Gulf War service member is 0.0000026%.
- For non-cancer effects, the hazard index is 0.002.

These are lower than the safe thresholds set by the U.S. Environmental Protection Agency (EPA).

**EXPOSURE ASSESSMENT**

To determine the oil well fire smoke exposure, atmospheric modeling data from the National Oceanic and Atmospheric Administration (NOAA) Air Resources laboratory were used for over 40,000 grid points (15 kilometer spacing) throughout the theater on a daily basis. Using EPA risk assessment methods, the daily exposures were calculated to provide an overall risk to oil well fire smoke. Based on the Public Law, the assessment only calculated inhalation exposures from oil well fire smoke. The Public Law did not address exposures to liquid crude oil or other potential Gulf War exposures.

Due to the data limitations outlined below, an assessment was conducted that assumed an individual was located with the unit having the highest exposure value on each day for the entire timeframe the oil well fires were burning. Your actual oil well fire smoke exposure is expected to be lower because it is very unlikely that an individual was with each unit that had the highest daily exposure value for the entire time period the fires were burning. This assessment provides the maximum oil well fire smoke exposure for an individual. Therefore, more accurate unit location data or a veteran’s unit association will not increase the calculated exposure.

\(^1\) Fumes are composed of particles formed during the combustion of a solid material. Smoke is composed of a mixture of fumes, vapors, and gases. The terms fumes and smoke are used interchangeably.
EXPOSURE ASSESSMENTS LIMITATIONS

During the Gulf War, there was not a central repository of individual or unit locations, therefore unit locations were re-constructed after the operation ended by manually examining over 5 million paper records. All units do not have complete locations for each day of the operation or for each day the oil well fires were burning.

An individual is assigned to their unit’s location. Often individuals were not with their unit’s headquarters or the unit split into multiple tactical elements. These data limitations can cause inaccurate locations for individuals. Due to these limitations, all Gulf War service members are provided with a maximum estimated exposure.

WHAT DOES THIS MEAN TO YOUR HEALTH?

Due to exposure to the oil well fire smoke, your chance of getting cancer has increased by 0.0000026%, which means if a billion people had the same exposure, 26 people may get cancer because of the exposure. For non-cancer effects, the concentration of chemicals in the air was well below levels that the EPA consider safe.

It is possible personnel experience short-term coughing, eye irritation and increased mucous production during days when the plume made ground level impacts. Chronic long-term health effects are not anticipated with such exposures. This assessment is for a group population and does not consider individual susceptibility such as those who had asthma or other pre-existing conditions.

This assessment only assessed smoke; it does not include ingestion of soot or dermal exposure to oil and other petroleum products and meets the intent of Public Laws 102-190 and 102-585. It also does not include any other exposures associated with the Gulf War.

Additional medical consultative assistance is available from the Army Public Health Center’s Environmental Medicine-Clinical Consult Service at usarmy.apg.medcom-phc.mbx.emp@mail.mil or 410-436-2714.

ADDITIONAL INFORMATION

Enclosure 1 describes the methods used to determine exposure to oil well fire smoke. Enclosure 2 shows a comparison of excess cancer and non-cancer risk levels from the exposure assessment to the EPA values.

For specific questions regarding your oil well fire smoke exposure, please contact the Registry staff at usarmy.apg.medcom-phc.list.gulfwarfires@mail.mil

Additional information on Gulf War exposures can be found on GulfLINK at http://www.gulflink.osd.mil/vet_help/help.jsp.

Veterans Affairs also maintains a web site for Gulf War related exposures at http://www.publichealth.va.gov/exposures/gulfwar/sources/index.asp
1. AUTHORITY.
   a. Public Law 102-190, Section 734, Registry of Members of the Armed Forces Exposed to Fumes of Burning Oil in Connection with Operation Desert Storm.

2. BACKGROUND.
   a. Public Law 102-190 requires the Secretary of Defense to establish and maintain a record relating to members of the Armed Forces who were exposed to the fumes of burning oil wells. Section 734 of this law and Section 704 of PL 102-585, requires a means of calculating exposures to DOD military and civilian personnel deployed for Operation Desert Storm/Desert Shield and who were exposed to oil well fires smoke. This includes the length of time of the exposure, the circumstances of each exposure to the fumes of burning oil, and the locations in the Operation Desert Storm Theater of operations. The U.S. Army Public Health Center was assigned this mission of determining the exposure of Persian Gulf veterans to the fumes from burning oil well fires as an adjunct to the troop registry requirement.
   b. Since 1992, the Army Institute of Public Health (AI PH) has provided health risk assessment information and data on the exposures to the smoke from the 1991 Kuwait Oil Well Fires from Operation Desert Storm.
   c. The U.S. Armed Services Center for Unit Records Research (USASCURR) was charged with determining the locations of all troop units on a daily basis for the period of time the oil well fires were burning (February through November 1991). The USASCURR Troop Movement Database was constructed by examining all existing Gulf War records, such as troop unit logbooks and situation reports that contained daily troop-unit location data by latitude and longitude. Over 5 million records were examined. The individual personnel in each troop unit were determined from the Defense Manpower Data Center's (DMDC) Persian Gulf Registry. In addition to containing a list of individuals in each troop unit, this registry contains the dates when an individual entered and left the theater of operation. This data was used to determine the length of time when an individual may have received oil well fire smoke exposure.
   d. To determine the oil well fire smoke exposure an individual received, the PHC enlisted the aid of the National Oceanic and Atmospheric Administration (NOAA), Air Resources Laboratory (ARL) to assist in the exposure modeling effort. The PHC used the output from the NOAA HY-SPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectories) model, in conjunction with their AVHRR (Advanced Very High Resolution Radiometer) satellite images to determine where the oil well fire smoke plume impacted troops on a daily basis and at what concentration. HY-SPLIT was able to estimate the concentrations of individual oil well fire smoke contaminants at the breathing zone level (2 meters) for 40,000 points (15 kilometer grid spacing) throughout the theater. To make the model more accurate the following information was used; (1) ground level air sampling results (2) data from air sampling flights through the smoke cloud (3) chemical composition of the oil (4) number of oil wells burning and (5) estimated amount of chemicals coming out of the burning wells. The PHC Troop Exposure Assessment Model (TEAM) used model exposure data, standard U.S. Environmental Protection Agency (USEPA) toxicity factors (i.e., reference dose/concentration and cancer slope factor), and risk assessment methods and calculated an individual troops' exposure and resultant health risk. Figures 1, 2, and 3 show an example for May 20, 1991 of the modeled, satellite, and merged oil well fire smoke plumes determined. Exposure levels and risk from the various compounds coming from the oil well fire smoke were then estimated. Finally, service members in each unit were identified (Figure 6) so individual risk levels could be determined based on time in theater, and estimated exposure to the oil well fire smoke.

Figure 1. Modeled Plume Boundary for 20 May 1991.
Figure 2. Satellite Plume Boundary for 20 May 1991.

Figure 3. Plume Features for 20 May 1991.
Figure 4. Base Map with Unit Locations

Figure 5. Base Map with Unit Locations and Merged Plume Data
EXPOSURE ASSESSMENT.

Figure 6. Base Map with Unit Locations and Merged Plume Data Identifying Individuals
a. Oil Well Fire Smoke Exposure. The assessment of oil well fire smoke exposure was based on four factors: · Exposure to known or suspected carcinogenic compounds in the oil well fire smoke and the risk from that exposure (excess cancer risk), · Exposure to non-carcinogenic compounds in the oil well fire smoke and the risk from that exposure, · Exposure to particles in the oil well fire smoke and the risk from that exposure, and · The number of days exposed to oil well fire smoke. These exposure levels were then compared to USEPA national standards to determine the extent of risk they pose to the individual.

b. Excess Cancer Risk. Excess cancer risk from a particular environmental exposure such as the oil well fire smoke, is defined as the extra risk of getting cancer from that exposure alone. This risk is in addition to the risk of cancer from other sources. This included such things as smoking, diet, excess sun, or other environmental exposures. The excess cancer risk caused by exposure to the oil well fire smoke was determined by evaluating the air concentration of the compounds that cause cancer against a USEPA toxicity factor (cancer slope factor). The risk from all the cancer causing compounds in the oil fire smoke, for all the days the person was exposed were added together to determine the total excess cancer risk. This risk is the additional chance of getting cancer from oil well fire smoke exposure, such as one in a million. This means if one million people received this exposure then, potentially one person may develop cancer. The chart showing the individual service members cancer risk also shows the range of risks for all exposed troop units and compares them to the USEPA risk limits of one in ten thousand (1E-04) to one in a million (1E-06).

c. Non-Cancer Risk. Exposure to certain compounds causes health effects other than cancer. These compounds, called non-carcinogens, may affect the function of organs and systems in the body. One major difference between exposure to carcinogens and non-carcinogens is that the effects caused by non-carcinogens stop when the exposure stops. To determine the hazard from environmental exposure to non-carcinogenic compounds in oil well fire smoke, a method similar to that used for carcinogens was applied. The air concentration of the compound was evaluated by comparing it to a USEPA toxicity value called the reference concentration. The reference concentration is the amount of a chemical that a person can be exposed to in the air for their entire lifetime without a bad health effect. These reference concentrations are set to protect sensitive subpopulations (i.e. the elderly, children in schools, daycare centers, etc.). Oil well fire smoke exposures in the Persian Gulf were for much shorter periods (days to weeks) and affected generally healthy service members. To determine the impact of many non-carcinogenic chemicals in the oil well fire smoke, the value obtained when each non-carcinogen was evaluated were added together to obtain the hazard index for the total exposure. The USEPA limit for exposure to non-carcinogenic compounds is a Hazard Index of 1. The chart showing the individual service members non-cancer hazard index also shows the range of hazard indices for all exposed troop units and compares them to the USEPA limit of 1. A hazard index of 1 or less means there is no risk of health problems, while an index greater than 1 means there is the potential for health problems. However, a hazard index greater than 1 does not mean an individual will have a health problem because the system is meant to protect sensitive individuals, such as older people or children.

d. Total Suspended Particulate (TSP) Exposure. In addition to chemical compounds, the oil fire smoke contained small particles of carbon material (total soot) that could be inhaled. The total quantity of all the particles from the oil well fire smoke is known as total suspended particulates (TSP). The USEPA National Ambient Air Quality Standard for TSP is 75 micrograms per cubic meter of air (annual standard) and 260 micrograms per cubic meter of air (daily standard). These standards were withdrawn in 1986 in favor of a standard for small particles that get deeper into the lungs. However, we are still using the TSP standard because this is the only data the oil well fire smoke model produced. It is not applicable to use the annual standard in evaluating the veteran’s TSP exposure because there was not a long enough exposure period. However, the daily standard is appropriate and was used to evaluate the veteran’s TSP exposure because it is the only U.S. standard available to evaluate TSP exposures.

*Fumes are composed of particles formed during the combustion of a solid material. Smokes are composed of a mixture of fumes, vapors, and gases. In this appendix, the terms fumes and smokes are used interchangeably.
Oil Well Fire Smoke Maximum Estimated Exposure Risk

Potential Risk of Developing Cancer from Gulf War Oil Fire Smoke (compared to USEPA Risk Limits)

- **HIGH**
  - 100% chance

- **MODERATE**
  - 1 in 10,000
  - 1 in a million (EPA’s Level of Concern)

- **LOW**
  - 26 in a billion
  - 1 in a trillion

This means that if a billion people had the same exposure, 26 people may get cancer because of this exposure. Currently there are 6 billion people on earth.
Potential of Developing Non-Cancer Illness from Gulf War Oil Fire Smoke (compared to USEPA Indexes)

Dividing your exposure by the USEPA’s most protective standard derives your non-cancer index. A value less than 1 is considered safe for exposure to compounds that cause health effects other than cancer. All U.S. Gulf War veterans are well below the index of 1.