

# A Review of the Scientific Literature As It Pertains to Gulf War Illnesses

**VOLUME 6**

**OIL WELL FIRES**

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*Prepared for the Office of the Secretary of Defense*

**National Defense Research Institute**

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## **BACKGROUND**

When the Iraqi army withdrew from Kuwait, it left the Kuwait oil fields in flames. Over half of the more than 1000 oil wells were burning, a most spectacular and unforgettable sight. The sheer magnitude of the fires caused concern about potential global effects, including alteration of worldwide weather patterns and a drastic increase in acid rain. Fortunately, these concerns proved excessive; the fires were extinguished much sooner than originally anticipated or thought possible. Although the fires could be detected by sensitive instruments several thousand miles from the Persian Gulf, the global catastrophe many predicted did not occur. The fire characteristics were such that the plumes were not energetic enough to pierce into the upper atmosphere and cause long-term climatic changes.

Because of the proximity of U.S. troops, concerns about the effects of the fires on them were also high. Burning crude oil produces a wide range of pollutants such as carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxides, volatile organic compounds (VOCs) (e.g., benzene), polycyclic aromatic hydrocarbons (PAHs) (compounds such as anthracene that form during the incomplete combustion of organic substances), hydrogen sulfide, acidic gasses (e.g., sulfuric acid), and soot. Several of these pollutants have been linked with short- and long-term illnesses, including upper-respiratory ailments and a variety of cancers.

The geographic and climatic characteristics of the Gulf region exacerbated the hazard posed by the pollutants. Most of the area is desert, and the sandy soils of the region are a boundless source of particulate matter, some of which is very fine. The region is subject to high winds, especially in the spring, that stir up large amounts of fine sand dust endemic to the region. Not only does the particulate matter pose a health risk in its own right, but it could also serve as a carrier for the airborne pollutants generated as a by-product of the oil fires.

Particles smaller than 2.5 microns<sup>1</sup> pose a special threat because they can penetrate deeply into the lungs, and recent studies have found strong associations between fine particles and premature death and morbidity from cardiopulmonary diseases when compared with larger particles.

## MONITORING EFFORTS

No systematic environmental monitoring took place in the region from the initial deployment in August 1990 until May 1991. To determine the extent of the health hazard of the oil fires to U.S. forces and others, several monitoring teams were sent. The team from the U.S. Army Environmental Health Agency (USAEHA), presently known as the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), carried out the most extensive series of measurements, monitoring both air and soil pollution. From May until December 1991, the USAEHA team collected about 4000 samples. When the team began its sampling, only about 8 percent of the fires had been put out, and the team continued its work until after all fires were extinguished. The team sampled soil and air at eight sites in Kuwait and Saudi Arabia, primarily in locations with large concentrations of U.S. personnel.

In addition to the USAEHA team, several other groups carried out environmental sampling. These efforts were not as comprehensive as those of the USAEHA team. For example, one project measured particulate matter in Bahrain from late July to early August 1991. The U.S. Environmental Protection Agency (EPA) sent a team of experts to monitor oil-fire emissions during March 13–20 and March 24–27 when most fires were still burning. Another tested for polycyclic aromatic hydrocarbon compounds and trace metals at ground level and inside smoke plumes. The measurements taken by these other groups confirmed the data taken by the USAEHA team.

## HEALTH EFFECTS STUDIES

Studies were conducted during the Gulf War to assess possible health effects due to emissions from the Kuwait oil well fires. VOC levels in the blood of U.S. personnel in Kuwait City were measured in May 1991 and found to be equal to or lower than a control group residing in the U.S. Similar measurements on firefighters working in the oil fields in October 1991 yielded levels about 10 times higher than the control group. No difference in genotoxicity was found between soot brought from Kuwait and air particulates isolated from Washington, DC.

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<sup>1</sup>A micrometer or micron is 1/1,000,000 of a meter.

Specimens from the lungs, liver, kidneys, and blood and urine samples of Kuwaiti feral cats were examined. Except for minimal changes in the larynx, no lesions were found that could be attributed to breathing smoke from the oil well fires or associated with hydrocarbon inhalation.

Several self-reported health surveys were conducted on Gulf War veterans. Symptoms questionnaires were completed before, during, and after deployment by the 11th Armored Cavalry Regiment based in Fulda, Germany. The symptoms that appeared during their stay in Kuwait but were not experienced before were headache (55 percent), lightheadedness (48 percent), fatigue or weakness (45 percent), skin rashes (41 percent), and diarrhea (42 percent). About 35 percent of those who did not usually cough or have phlegm first thing in the morning before deployment reported the symptom after arriving in Kuwait. Symptoms were associated with reported proximity to the oil well fires, and their incidence generally decreased after soldiers left Kuwait.

The Navy's self-administered symptoms questionnaires were completed by three groups of U.S. Marines. The group that had the longest exposure and was located closest to the oil fires reported a higher rate of gastrointestinal episodes, respiratory symptoms, and burning and red eyes. The prevalence of wheezing, coughing, runny nose, and sore throat for each group decreased with increased distance from the fires. Smokers reported more complaints than nonsmokers.

The Iowa Persian Gulf Study reported a significantly higher prevalence of self-reported symptoms among military personnel deployed during the Gulf War compared with those on active duty at the same time but not deployed to the Gulf. Larger differences between Gulf War and non-Gulf War veterans were observed for National Guard and Reserve components. Results from this study on the prevalence of symptoms of airway disease indicate a statistically significant rate difference of 2.3 percent for asthma and bronchitis between Gulf War and non-Gulf War military personnel.

## **RESULTS**

The concentrations of VOCs, polycyclic aromatic compounds, metals, and criteria pollutants were much lower than initially presumed, considering the magnitude of the fires. The mean-concentration measurements of these pollutants are consistent across studies. The maximum concentrations measured in the Persian Gulf region are virtually the same levels found in suburban locations in the United States, lower than those found in large urban centers in the United States, and much lower than the U.S.-recommended occupational levels.

The data show that the concentration of the pollutants present in the environment as a consequence of the oil well fires fell below the exposure limits for

hazardous substances in the workplace recommended by the National Institute of Occupational Safety and Health, Occupational Safety and Health Administration, or American Conference of Governmental Industrial Hygienists. For example, the mean benzene concentration measured in Ahmadi, Kuwait, was  $7.8 \mu\text{g}/\text{m}^3$ ; this compares to the ACGIH occupational standard of  $1600 \mu\text{g}/\text{m}^3$  for an 8-hour-day, 40-hour-week workshift. One who smokes two packs of cigarettes a day inhales about  $1200 \mu\text{g}$  of benzene, compared to  $150 \mu\text{g}$  a day of ambient benzene inhaled by nonsmokers in Ahmadi. In most cases, the ambient air concentrations of pollutants in areas where military and civilian personnel were located were found to be orders of magnitude lower than those in occupational settings in the United States and similar to ambient levels.

The levels of pollutants measured in the Gulf were much lower than those that are known to cause short- or long-term health effects. The intensity of the fires made combustion relatively efficient, and the presence of coarse particles in the clouds assisted in removing other pollutants from the smoke plumes.

The health surveys conducted during the oil fires indicate increased symptoms and an association between prevalence of complaints and proximity to the fires. No data confirm, however, that those symptoms were indicators of disease.

Particulates are another story. Measurements at all monitoring sites show that particulate concentrations were much higher than ambient levels in the U.S. The high density of atmospheric particles did not result from the oil fires; rather, it is characteristic of the region itself. Comparison of measurements taken in 1991 and in 1994, when the fires had long been extinguished, show similar average values. Results of the relatively few measurements of particle size indicate that there was a significant amount of particles in the size range that can have an effect on the respiratory system of sensitive subgroups, e.g., smokers, or those who have a history of asthma or bronchitis. Thus, U.S. troops could have been exposed for several months to concentrations of fine particulate matter (smaller than  $2.5 \mu\text{m}$ ) that exceed U.S. air-quality standards. Although some personal communications indicate increased respiratory complaints among the indigenous population during the oil fires, no epidemiological studies or evidence of health effects were found in the peer-reviewed literature.