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Briefing Report to the Chairman, Legislation and National Security Subcommittee, Committee on Government Operations, House of Representatives

January 1992

INTERNATIONAL ENVIRONMENT

Kuwaiti Oil Fires–Chronic Health Risks Unknown but Assessments Are Under Way

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Resources, Community, and
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The Honorable John Conyers, Jr.
Chairman, Legislation and National
Security Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

On April 23, 1991, you requested that we review the adequacy of an April 3, 1991, report entitled Kuwait Oil Fires: Interagency Interim Report. The interagency team, which was led by the Environmental Protection Agency (EPA), included members from EPA, the Department of Health and Human Services' Public Health Service, and the Department of Commerce's National Oceanic and Atmospheric Administration. Grave concerns had been raised by U.S. officials in Kuwait that the pollution from the fires could cause severe acute health effects, including death. The team was sent to address those concerns and spent 2 weeks during March 1991 in Kuwait and Saudi Arabia.

Specifically, you asked us to address the report's findings that (1) there was no significant acute health risk from the pollution levels to people with normal respiratory capacity and (2) more data are needed to determine long-term health risks. On September 20, 1991, we briefed your staff on the results of our review of the interagency interim report. This briefing report formalizes the information we presented during our briefing and also includes updated information. As agreed with your office, a separate report is being prepared on the adequacy of measures being taken to safeguard the health of U.S. troops from this pollution event.

In summary, we believe the interagency team's findings were reasonable, given that the scope of the study was limited, the teams's findings and conclusions were qualified, and

the team recognized the need for more data to determine long-term health risks. Additional monitoring has been done, and the preliminary results indicate that Kuwait's air quality has generally been within established standards except that levels for particulates were high. The fires are now out and both the Army and EPA have initiated actions, which we endorse, to assess the long-term health risks, including those from the particulate levels.

INTERAGENCY TEAM'S MAJOR FINDINGS

The team stated in its report that while only a limited assessment was possible, it did not find significant quantities of pollutants of concern that would cause severe acute or chronic health effects except for high levels of particulates.[1] Concerning acute effects, the team did not consider the high particulate levels to be life threatening. Concerning chronic effects, the team's report stated that the preliminary analysis of the high levels of particulates did not reveal any chemicals at levels of concern but recognized that more data are needed to determine the long-term health effects.

However, the report did caution that the team's monitoring findings and information from interviews with medical personnel suggested that susceptible subpopulations, such as individuals with asthma and chronic obstructive lung disease, could experience exacerbation of their symptoms. At the same time, though, the report noted that the situation did not appear to be life threatening under the existing exposure conditions. More importantly, the report stated that long-term health effects could not be determined because of insufficient data on the populations exposed, the composition of the smoke plume, the impact of resultant oil pools, and long-term meteorological patterns.

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[1]The team monitored for sulfur dioxide, hydrogen sulfide, and particulates, which have the potential to cause significant acute health effects. A combination of high sulfur dioxide and particulate levels has been cited as a cause of increased mortality in some air pollution episodes, such as in London, England, in 1952. The team also analyzed the emissions for pollutants such as volatile organic compounds, polycyclic aromatic hydrocarbons, and metals, many of which are suspected or confirmed carcinogens associated with long-term health effects.

In our view, the interagency team's assessment and the subsequent report findings that the levels of pollutants would not cause severe acute health effects were reasonable, given that

-- the team's immediate objective was to determine whether the pollution levels could cause death and whether precautions should be taken;

-- the report's assurances (1) were qualified, (2) recognized the potential for changes in the assessment because of weather conditions, and (3) called for a range of protection measures and follow-up assessments that were subsequently agreed to by the international community; and

-- our comparison of the preliminary monitoring results with established pollutant standards--including the monitoring by the interagency team and tests conducted by the Kuwait Environmental Protection Department, the French, the Norwegians, an EPA/National Aeronautics and Space Administration team, and others--indicates that air quality in the Kuwaiti area has generally been within such standards except for particulates.[2] In a few other instances, pollution levels were also above established standards and therefore of concern, but the levels detected generally would not be considered life threatening.[3]

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[2]We compared the air-monitoring data reported by the interagency team and others with existing EPA National Ambient Air Quality Standards. For those pollutants for which ambient air standards do not exist, we compared the levels with the National Institute for Occupational Safety and Health's or the American Conference of Governmental Industrial Hygienists' workplace exposure limits. For some of the chemicals, there are no standards. The results of our comparisons are discussed further in sections 4 and 5.

[3]Some intermittent peak readings were above the levels for some of the standards. For example, some sulfur dioxide readings of less than an hour made near the fires by the interagency team exceeded the level for the 24-hour National Ambient Air Quality Standard, and two sulfur dioxide readings of approximately 8 and 12 hours made by the French team also exceeded the level for the 24-hour ambient air standard. None of these readings, however,

(continued...)

The extent of long-term health risks to U.S. personnel that were exposed to the pollution remains an unanswered question. Some of the pollutants found, such as polycyclic aromatic hydrocarbons, are likely human carcinogens. The U.S. Army is preparing a risk assessment to define the potential risks to the troops that may have been exposed to the pollution, including the particulate matter, during their assignments in Kuwait and Saudi Arabia. In addition, EPA is developing a health research and environmental management plan to assess the health and ecological impacts in the Persian Gulf from the oil fires and spills. The plan will identify health research needed, including a component to assess risks to U.S. personnel exposed to air pollution in the Gulf. Once funded, such an effort would take at least 2 years to complete, according to an EPA official.

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In conducting our review, we examined records at EPA, the Department of State, and the National Oceanic and Atmospheric Administration pertaining to the interagency team's visit to Kuwait and U.S. activities to assist Kuwait in dealing with the air pollution. We also interviewed officials at these agencies and at the Public Health Service, as well as individual team members, regarding the EPA report and U.S. activities in Kuwait. Finally, we obtained reports and analyzed monitoring data collected by other U.S. agencies, foreign governments, and others who visited Kuwait.

We discussed the facts presented in this report with EPA, which is responsible for coordinating U.S. activities in the Gulf; officials from the National Oceanic and Atmospheric Administration whose responsibilities included coordinating additional air monitoring in Kuwait; and officials from the U.S. Army Environmental Hygiene Agency who monitored the air at troop locations in the Gulf. However, as you requested, we did not obtain written agency comments on a draft of this report. Our review was performed in accordance with generally accepted government auditing standards.

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[3](...continued)
exceeded the 10-hour workplace exposure limit of 2 parts per million for sulfur dioxide established by the National Institute for Occupational Safety and Health.

As agreed with your office, we plan no further distribution of this briefing report until 30 days from the date of this letter. At that time, we will send copies to the Administrator of EPA, the Secretaries of the Army, Commerce, and State, and other interested parties and make copies available to others upon request. If you or your staff have any questions concerning this briefing report, please call me at (202) 275-6111. Other major contributors to this briefing report are listed in appendix I.

Sincerely yours,

Richard L. Hembra
Director, Environmental Protection
Issues

CONTENTS

ABBREVIATIONS

CO	carbon monoxide
EPA	Environmental Protection Agency
GAO	General Accounting Office
H_2S	hydrogen sulfide
mg/m^3	milligrams per cubic meter
NAAQS	National Ambient Air Quality Standards
ng/m^3	nanograms per cubic meter
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NO_2	nitrogen dioxide
NO	nitric oxide
NO_x	nitrogen oxides
O_3	ozone
PAH	polycyclic aromatic hydrocarbon
PM_{10}	particulate matter of 10 microns or less
PM_{15}	particulate matter of 15 microns or less
ppb	parts per billion
ppm	parts per million
SO_2	sulfur dioxide
SO_4	sulfates
TSP	total suspended particulate
ug/m^3	micrograms per cubic meter
VOC	volatile organic compound

SECTION 1

OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

-- Assess the adequacy of the interagency report's findings that (1) there was not a significant acute health risk from the pollution levels to people with normal respiratory capacity and (2) more data are needed to determine long-term health risks.

SCOPE AND METHODOLOGY

-- Reviewed records at the Environmental Protection Agency (EPA), the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and the Department of State to obtain information on team and U.S. activities, objectives, and approaches to addressing the impact of the oil well fires on air pollution in the Persian Gulf area.

-- Interviewed officials at EPA, NOAA, the Department of State, and the Department of Health and Human Services' Public Health Service to obtain their views and perspectives on the interagency report and the team's approach and conclusions.

-- Interviewed team members regarding the team's approach and rationale for air monitoring and the conclusions reached concerning the potential health effects from the fires' pollution.

-- Reviewed information obtained from EPA, the Public Health Service, and the U.S. Army Environmental Hygiene Agency relating to health effects of pollutants of concern and applicable standards.

-- Obtained preliminary air-monitoring data collected by other U.S. agencies, foreign governments, and others who had visited Kuwait and compared the monitoring results with existing ambient air standards. For those pollutants where ambient air standards do not exist, such as volatile organic compounds (VOCs), some metals, and polycyclic aromatic hydrocarbons (PAHs), we compared the levels with the National Institute for Occupational Safety and Health (NIOSH) or the American Conference of Governmental Industrial Hygienists (ACGIH) workplace exposure limits, which are 10- and 8-hour time-weighted-averages, respectively. However, as discussed in section 6, a detailed analysis of the data is needed to determine long-term health risks to those exposed to such pollutants.

-- Information presented in this report from preliminary monitoring results was reviewed by an EPA scientist and a Public Health Service doctor for any results that might pose health concerns. To ensure that we have presented the monitoring results accurately (see sec. 5), we also arranged for an EPA air-monitoring expert to review our presentation of the data.

-- Because the necessary information was not included in the air-monitoring data we obtained, we did not review the quality assurance and quality control procedures used in sampling, collecting, and analyzing the data. Such procedures, including using spiked samples and collocating sampling equipment, are used to ensure the precision, accuracy, completeness, representativeness, and comparability of the data.[1]

-- While we attempted to determine the status of the implementation of the recommendations contained in the interagency report, we did not attempt to determine the effectiveness of implementing the recommendations, including validating the models used to develop a forecasting capability.

-- Contacted three environmental groups--The National Toxics Campaign Fund, Greenpeace, and Friends of the Earth--and experts from Harvard's School of Public Health who have made public statements on the levels of pollution from the oil well fires to obtain their air-monitoring data. The National Toxic Campaign Fund provided us with a report on its monitoring.

-- Our work was primarily carried out between June and September 1991.

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[1]Spiked samples are samples that contain a known substance at a predetermined concentration and are used to determine the accuracy of the measurements. Collocated sampling is used to evaluate the precision of the air samples by comparing samples taken at the same locations.

SECTION 2

BACKGROUND

During its occupation of Kuwait, the Iraqi army sabotaged the bulk of Kuwait's oil fields. As table 2.1 shows, 798 oil wells were sabotaged--611 were set on fire, 79 were gushing, and 108 were damaged. These fires, which were north and south of Kuwait's major populated area of Kuwait City, produced an enormous amount of smoke and other pollutants.

Table 2.1: Number of Oil Wells Sabotaged

	Number of Wells			
Field	On fire	Gushing	Damaged	Intact
Ahmadi	60	3	18	4
Bahra	3	2	0	0
Burgan	290	25	30	66
Khashman	0	0	1	1
Magwa	98	6	24	12
Minagish	27	0	8	0
Raudhatian	62	3	6	4
Sabriyah	38	4	9	2
Umm Gudair	27	3	12	2
Wafra	6	33	[a]	15
Total	611	79	108	106

[a]Data not available.

Source: NOAA.

In response to this situation, the Saudi Arabian government requested U.S. technical assistance to assess the health impact on the population. Concerned with the impact of the pollution on U.S. citizens and troops, the U.S. Embassy in Saudi Arabia concurred with this request and requested that a team be sent to Kuwait to assess the potential health effects of the fires.

An interagency team was formed and sent to the Gulf on March 10, 1991, to monitor the air, to determine if there was an acute health threat from exposure to some of the substances thought to be emitted from the burning wells, and to identify other by-products produced from burning oil wells. According to team members, there was concern that the fires could be emitting toxic gases at levels that could cause severe acute health effects and, in particular, death.

The team comprised eight staff from EPA, the Public Health Service, and NOAA. According to the team leader, the members were

selected because of their experience and expertise in air monitoring, health effects research, investigating emergency releases, meteorology, and studying the health effects of toxic air pollutants. The team performed its air monitoring over the period March 13-27, 1991.

The team conducted real-time monitoring at 15 locations in Kuwait--5 at the wells or in the smoke plumes in order to get the highest possible readings and 10 away from the wells and in or near populated areas to determine the levels of exposure to the population. The team also monitored the air at three locations in Saudi Arabia. The team's real-time monitoring was limited generally to 10 to 20 minutes to cover as many sites as possible.

The team reported that on the basis of its limited assessment and under the existing exposure conditions, it did not detect high levels of pollutants that would likely cause immediate severe health effects in populations of healthy individuals. The team did detect high levels of total suspended particulates (TSPs) but reported that a preliminary analysis of the particulate matter did not reveal any chemicals of concern.

The team reported that it could not ascertain the long-term health effects because of the lack of data on population exposure, weather patterns, and composition of the oil smoke plume. The report recommended additional testing and analysis of the particulate matter for other toxic materials, continued air monitoring, establishment of an early warning health advisory system, and the development of a forecast capability based on modeling to predict the movement of smoke plumes and compute concentrations of pollutants created by the fires.

Table 2.2 identifies pollutants of concern as well as the health effects resulting from short- and long-term exposure to these pollutants. The table includes EPA's National Ambient Air Quality Standards (NAAQS) and Saudi Arabia's Meteorology and Environmental Protection Administration standards. The Saudi Arabian standards have been referred to by EPA and others for comparison with the pollution levels from the Kuwaiti oil fires.

The team was also concerned about the levels of VOCs, metals, and PAHs. Many of these pollutants are suspected or confirmed carcinogens. In addition, some of the pollutants can become attached to particulate matter. Particulates of 10 micrometers or less are considered to pose the greatest hazard, since particles of this size can be deposited deep in the lungs.

Table 2.2: Health Effects Associated With Six Pollutants in Crude Oil Smoke Emissions and Relevant Standards

Substance	Short-term effect	Long-term effect	Standard[a] ug/m^3 (ppm)	Average period
SO_2	Respiratory irritant	Chronic bronchitis such as shortness of breath	US 365(0.14) 80(0.03) SA 800(0.28) 400(0.14) 85(0.03)	24 hrs. 1 yr. 1 hr. 24 hrs. 1 yr.
Particulates:	Respiratory irritant, some studies indicate high levels may result in death	Damage to lung tissue, contributing to chronic respiratory disease and premature mortality		
TSP			US 260[b]	24 hrs.
PM_{10}			US 150 50	24 hrs. 1 yr.
PM_{15}			SA 340 80	24 hrs. 1 yr.
H_2S	Low concentrations act as a respiratory irritant. High levels create poisoning that causes unconsciousness and death	Unknown	SA 200(0.14) 40(0.03)	1 hr. 24 hrs.
NO_2	Eye and lung irritation	Lung dysfunction, labored breathing, cough	US 100(0.053) SA 660(0.035) 100(0.053)	1 yr. 1 hr. 1 yr.
O_3	Headache, coughing, dryness of the throat, loss of lung function	Lung inflammation, permanent scarring of lung tissue, loss of lung function	US 235(0.12) SA 290(0.15)	1 hr. 1 hr.
CO	Reduces the blood's oxygen-carrying ability, causing headache, nausea, dizziness, and death at high levels	Unknown	US/SA 40,000(35) 10,000(9)	1 hr. 8 hrs.

Note: "US" indicates U.S. NAAQS, and "SA" indicates Saudi Arabian standards.

[a]Units are in micrograms per cubic meter (ug/m^3) and parts per million (ppm). Parts per million are in parentheses.

[b]TSP was the indicator pollutant for the original particulate matter standard and is used here for comparative purposes. New standards were promulgated in 1987 using particulate matter of 10 microns or less (PM_{10}) as the new indicator pollutant.

SECTION 3

INTERAGENCY APPROACH TO ASSESSMENT

APPROACH TO AIR MONITORING AND SAMPLING

-- According to team members, the team approached the assessment in a manner similar to what would have been done in the United States to determine immediate health risks in an emergency situation.

-- The team monitored and sampled air for the combustion products that it expected to be associated with oil well fires, as shown in table 3.1.

-- The team used real-time monitoring generally over a 10- to 20-minute period and also took air samples that were sent to the United States for analysis. The latter approach tended to confirm the results of the real-time monitoring for sulfur dioxide (SO_2) and VOCs, according to the report.

-- The team used equipment that was readily available, was transported easily, and could operate with a battery or other portable power source, as electric power was not available at that time and sites were often remote.

Table 3.1: Pollutants Monitored

Real-time monitoring	Air sampling
SO_2	SO_2
Total VOCs	VOCs--specific compounds
TSPs	PAHs
H_2S	Metals
	Inorganic acids
	Formaldehyde

AIR SAMPLING AND MONITORING LOCATIONS

The real-time monitoring in Kuwait was done at 5 sites at the wells or in the plumes and at 10 sites away from the wells and in or near populated areas, including the U.S. Embassy in Kuwait City and the Al Ahmadi Hospital, about 15 miles south of Kuwait City. The real-time monitoring in Saudi Arabia was done at the Saudi Arabian Meteorology and Environmental Protection Administration in

Dhahran, the U.S. Embassy in Riyadh, and a location near Khafji. The air sampling was done at 10 sites, including 9 where the real-time monitoring was done.

SOME LIMITATIONS OF THE INTERAGENCY TEAM'S WORK IN KUWAIT

The number of air-sampling sites was limited because unexploded mines around some of the wells created concerns for the safety of the team and because of difficulties in arranging transportation to the wells. Additionally, the sampling time at the sites was limited because of the team's desire to test at as many sites as possible in the limited time available, as well as the safety and transportation considerations. Nevertheless, the team considered the monitoring adequate to determine the immediate health effects of the fires.

The pollution levels were affected by the existing weather conditions, which the team recognized could change. Therefore, the team recommended continued monitoring and the establishment of an early warning system to detect any buildup of pollutant levels.

Concentrations of particulate matter equal to or less than 10 microns in size (PM_{10}) were not determined, as the team did not have the necessary equipment readily available. Additional testing of the particulate matter also was needed to better define what toxic materials may be associated with the particulates. The team recommended additional equipment and further testing of the particulates. This was followed up with a PM_{10} monitoring program using portable PM_{10} monitors.

The team's assessment of the extent of respiratory problems related to the smoke was based on limited interviews and records examination. The team proposed additional health surveillance and risk assessments.

SECTION 4

POLLUTION LEVELS AND ACUTE HEALTH EFFECTS NOT AS SEVERE AS ANTICIPATED

On the basis of information from the Department of Energy and reports from the Gulf, team members expected to find high levels of pollutants, such as SO_2 and hydrogen sulfide (H_2S), being emitted from the oil well fires that could cause toxic effects. However, the interagency team reported that except for TSPs, it did not detect significant levels of pollutants of concern and did not consider the levels of TSPs to be life threatening under the existing exposure conditions. The report did note, however, that susceptible people, such as those with asthma and chronic obstructive lung disease, may experience exacerbation of their symptoms and that health warnings were warranted for these people.

The Public Health Service's Assistant Secretary for Health/Science and Environment has also commented on the significance of the pollution levels being observed in the Gulf. In commenting on our presentation of the monitoring data by others (see sec. 5), he stated that on the basis of available data, there has been no sustained elevation of medically significant pollutants; thus, the likelihood of acute health effects was remote.

Table 4.1 summarizes the results of the team's real-time monitoring at the 18 sites in Kuwait and Saudi Arabia as reported in the interagency report. According to team members, the results reported for the March 13-20, 1991, period were the highest readings observed over a 10-minute period at the sites. The results for each pollutant reported for the March 24-27 period are averages of readings observed at the sites. For particulates, the monitoring period ranged from 15 to 32 minutes, and for the remaining pollutants, the monitoring period was 10 minutes.

Table 4.1: Summary of Interagency Team Real-Time Air-Monitoring Results

	Results of monitoring for the indicated periods[a]			
	March 13-20, 1991		March 24-27, 1991	
Pollutant	Median	Range	Median	Range
TSPs	145.0000	10 - 5,400.000	276.0000	34 - 935.000
SO_2	1.0000	0 - 2.000	1.5000	0 - 2.000
H_2S	.0125	0 - .042	.0025	0 - .003
VOCs	.8000	0 - 2.500	.4500	0 - .600

[a]Units are in parts per million, except for TSPs, which are in micrograms per cubic meter. Medians are based on the nonzero readings at the various sites.

With respect to the March 13-20 monitoring, the interagency report observed that the highest readings were at the well sites in the plume. According to the report, the only elevated levels in the populated areas were TSPs, with the highest reading being 480 micrograms per cubic meter at the Saudi Arabian Meteorology and Environmental Protection Administration in Dhahran. The report concluded that the March 24-27 monitoring results were similar. It noted that the highest TSP reading occurred at the Al Ahmadi Hospital. At the hospital, a 20-minute average reading of 935 micrograms per cubic meter was recorded, and the single highest peak reading was 1,160 micrograms per cubic meter.

In commenting on the TSP levels, the medical experts on the team stated that these readings were intermittent and, as such, would generally not be considered life threatening. Team members also said that the area naturally had some of the highest particulate levels in the world because of blowing desert sand, thus making it difficult to determine the oil fires' effect on particulate levels.

The real-time monitoring also showed high SO_2 levels of 1-2 parts per million (ppm) at seven sites, but the report noted that these levels should be viewed with caution. Some of the team members had more sensitive monitors on their persons at every site where they tested for SO_2, and these monitors indicated levels of SO_2 below the NAAQS, according a team member. Also, another team member told us that data obtained from Kuwait and Saudi Arabia on SO_2 levels, as well as the analysis of air samples, also showed lower levels.

In this regard, the report showed that SO_2 air samples were taken at five sites on the same day as the real-time monitoring. An analysis of eight air samples taken at these five sites showed

SO_2 levels ranging from none to 0.67 ppm. While these levels were lower than indicated by the real-time monitoring, the levels of four samples (0.17 ppm, 0.20 ppm, 0.23 ppm, and 0.67 ppm) exceed the level of the 0.14-ppm 24-hour NAAQS. If sustained for 24 hours, these levels would have exceeded the standard. The remaining four air samples showed levels below the level of the 24-hour SO_2 standard. The readings exceeding the level of the standard were taken in oil fields. According to the medical experts on the team, while some of the levels did exceed the 24-hour NAAQS level, the readings were intermittent and, as such, would generally not be viewed as life threatening.

The report also showed that for the 17 sites where there was real-time monitoring for SO_2, 20 readings showed zero levels of SO_2. According to a team member, however, because of the detection level of the monitors used, these levels should have been shown as less than 2 ppm, the detection level. But as discussed above, the more sensitive monitors did not show any readings for SO_2 that were above the level of the NAAQS.

Similarly, the report also showed 15 zero readings for H_2S and 18 zero readings for VOCs. According to a team member, these readings should have been shown as less than 0.001 ppm and 0.5 ppm, respectively--the detection level of the monitors.

As discussed above, in addition to the real-time monitoring, the team also took air samples, which it sent back to the United States for analysis. (See table 3.1 for the substances analyzed.) The team again concluded that on the basis of the limited number of samples analyzed, the major concern seemed to be the particulate matter.

According to a team member, in assessing the air sampling and monitoring results with respect to acute health effects, he looked at the levels detected in terms of EPA NAAQS when applicable. For those substances for which there were no NAAQS, he used the NIOSH and the ACGIH workplace exposure limits, which are 10- and 8-hour time-weighted-averages, respectively.

For some of the substances, however, there are no standards. In these cases, according to the team member, he looked at similar substances for which there were standards. He commented that the VOCs and PAHs were generally at very low levels. With respect to the metals, he also commented that there were no standards for the metals detected. However, he observed that these metals were of the type found in sand particles and were not thought to be harmful.

In addition to the air sampling and monitoring, two team members, on a limited basis, assessed whether there had been increased adverse health occurrences that might have been associated with the oil well fires. According to the members,

they interviewed medical personnel, talked to U.S. and Kuwaiti troops, and reviewed health records. One of these members said he visited 3 to 5 medical sites and 1 major hospital and talked to about 30 Kuwaiti soldiers who were encamped in an oil field and about 30 to 50 U.S. soldiers at various locations.

One of the team members said he found that for the most part, the military personnel were experiencing little adverse health effects. He also found that civilians with existing respiratory problems were experiencing elevated health problems, such as asthma episodes and chronic bronchitis, and that healthier people were experiencing periods of mild eye irritation from the smoke.

One member told us that the team did not find a great number of people seeking medical aid but observed that there were far fewer civilians in Kuwait after the war than before. Both members stressed that it was difficult to determine if there were significant increases in respiratory problems because of the lack of baseline data. According to one of the members, some of the records had been destroyed, and others could not be retrieved because of the lack of electrical power to run computer-stored data.

GAO COMPARISON OF MONITORING RESULTS WITH STANDARDS

Our comparison showed that SO_2 levels identified by the team through an analysis of air samples exceeded the levels of the EPA NAAQS for SO_2 in four cases in nonpopulated areas but did not exceed the NIOSH or ACGIH 2-ppm workplace exposure limit. Levels detected at the remaining sites did not exceed either the NAAQS or the workplace exposure limits.

The team's real-time monitors at seven sites recorded SO_2 levels that would have exceeded the 24-hour NAAQS if sustained that long. However, team members believe the readings were less because more-sensitive monitors did not detect SO_2 at levels above the standard.

The H_2S levels detected by the team's real-time monitoring exceeded the level of the Saudi Arabian 24-hour standard in two cases and would have exceeded the standard if sustained that long. The levels, however, did not exceed the NIOSH or ACGIH workplace exposure limits.

Of the 28 real-time monitoring readings taken for TSPs, the levels detected would have exceeded the levels of the 1971 24-hour TSP standard of 260 micrograms per cubic meter (ug/m^3) in 12 cases if sustained that long.

VOCs and PAHs detected by the team through an analysis of air samples did not exceed the NIOSH or ACGIH workplace exposure

limits for those substances for which they have been established. We were unable to identify standards for 10 of the 25 VOCs and two of the three PAHs detected. None of the inorganic acids detected by the team exceeded the workplace exposure limits. The level of formaldehyde detected at one of the oil wells (0.020 ppm), however, was higher than the NIOSH exposure limit (0.016 ppm) but was below the ACGIH exposure limit (1 ppm). According to one of the medical experts on the team, the level detected would not cause severe acute health effects.

SECTION 5

MONITORING BY OTHERS GENERALLY SHOWS LOW POLLUTION LEVELS, WITH SOME EXCEPTIONS

In addition to the U.S. interagency team, a number of U.S. and international teams have been sent to Kuwait to perform air and ground monitoring. Also, the Kuwait Environmental Protection Department and the U.S. Army Environmental Hygiene Agency have been monitoring air in Kuwait since late March and early May 1991, respectively.

To get an indication of the air quality in the Kuwaiti area, we compared the monitoring results with EPA's NAAQS or with Saudi Arabia's ambient air standard in the case of H_2S. For those pollutants where ambient air standards do not exist, such as VOCs, metals, and PAHs, we compared the levels with the NIOSH or ACGIH workplace exposure limits, which are 10- and 8-hour time-weighted-averages, respectively. While this type of comparison provides an indicator for short-term exposure levels, a more detailed analysis is needed to determine long-term health risks, especially in the case of carcinogens.

Caution must be exercised in comparing the monitoring results with the standards because, in many cases, the actual monitoring time was less than the time on which the standard was based. For example, the NAAQS for SO_2 is 24 hours, while the actual time the French monitored for the pollutant varied from 3 to 16 hours.

Furthermore, caution must be exercised in comparing the results of the various monitoring efforts because much of the monitoring was done during different time periods; the length of monitoring time differed; and, in some cases, locations where monitoring was performed differed. Also, the types of pollutants monitored by the teams varied.

The following pages of this section include some of the preliminary information from groups that have collected air-monitoring samples in the Gulf region since the war ended. Because the necessary information was not included in the data we obtained, we did not review the quality assurance and quality control procedures used in sampling, collecting, and analyzing the data and therefore could not make any comment about the data's validity.

KUWAIT ENVIRONMENTAL PROTECTION DEPARTMENT

The Kuwait Environmental Protection Department has had two continuous monitoring stations--Mansoriya, located in Kuwait City, and Reqa, located South of Kuwait City--in operation. The monitoring stations generally record readings every 5 minutes. Table 5.1 summarizes the results of the 3-month period April-June 1991 at the two stations for some of the pollutants of concern.

The data are summarized by the monthly mean reading and the 5-minute maximum reading for the month.

Table 5.1: Kuwait Environmental Protection Department Monitoring

	April		May		June	
	Mean	Max	Mean	Max	Mean	Max
	ppm					
Mansoriya monitoring station:						
SO_2	0.003000	0.038	0.002000	0.020	0.002000	0.017
H_2S	0.000087	0.011	0.000048	0.007	0.000180	0.026
CO	0.643000	7.280	0.254000	7.900	1.000000	33.110
NO_2	0.012226	0.496	0.012000	0.070	0.016000	0.287
O_3	0.003000	0.015	0.001000	0.013	0.002000	0.038
Reqa monitoring station:						
SO_2	0.016000	0.022	0.010000	0.038	0.002000	0.022
H_2S	0.000050	0.006	0.000117	0.003	0.000059	0.005
CO	0.492000	32.370	0.615000	30.062	0.669000	44.820
NO_2	0.019000	0.167	0.021900	0.186	0.017000	0.317
O_3	0.017000	0.161	0.007000	0.015	0.007000	0.138

GAO Comparison of Monitoring Results With Standards

None of the 5-minute maximum readings for SO_2 at the two stations reached the level (0.14 ppm) of the 24-hour NAAQS for SO_2. In the case of H_2S, all of the 5-minute maximum readings were below the Saudi Arabian 24-hour ambient air standard of 0.03 ppm. For nitrogen dioxide (NO_2), none of the monthly mean readings exceeded the level (0.053 ppm) of the 1-year NAAQS.

The carbon monoxide (CO) maximum reading for the Mansoriya station in June and the CO maximum readings in April and May at the Reqa station approached the 1-hour NAAQS of 35 ppm. The CO maximum readings at Reqa in June exceeded the 1-hour NAAQS of 35 ppm. However, we could not determine from the data if the standard was actually exceeded because the maximum readings are based on 5-minute readings. The detailed data that would show the length of time the maximum reading exceeded the NAAQS were not available.

In the case of ozone (O_3), none of the 5-minute maximum readings at the Mansoriya station exceeded the level (0.12 ppm) of the 1-hour NAAQS. For the Reqa station, the 5-minute maximum readings in April and June exceeded the level of the O_3 NAAQS. However, as stated above, the detailed data were not available to determine the length of time the 5-minute maximum readings exceeded the level of the NAAQS.

In addition, EPA documents show that the CO, H_2S, NO_2, and O_3 mean readings at the Mansoriya station in April, May, and June 1991 were less than the readings for the same periods in 1990. The maximum readings in 1991 were also less than the 1990 readings for these pollutants, with the exception of the CO maximum reading in June 1991 and the NO_2 maximum reading in April and June 1991. The SO_2 mean and maximum readings for the periods were slightly greater in 1991 than in 1990. Data were not available to make a similar comparison for the Reqa station.

Kuwaiti PM_{10} monitoring at three locations--Jahra, Mansoriya, and Reqa--for approximately 26 days in May 1991 show ug/m^3 mean levels of 479, 513, and 451, respectively. All of these readings exceed the PM_{10} 24-hour NAAQS of 150 ug/m^3 and the Saudi Arabian 24-hour standard of 340 ug/m^3 for PM_{15}.

AIR POLLUTION MEASUREMENTS BY THE TEAM FROM FRANCE

Using a monitoring van, the French team measured pollution from the burning oil wells in Kuwait at eight different sites during the period March 26-April 6, 1991. Five of the sites were located either in Kuwait City or its suburbs to determine the pollution levels experienced by Kuwait's population. The other three sites were located in the middle of the oil fields in the immediate vicinity of the smoke plumes to determine the maximum level to which personnel working in the oil field were exposed.

The team monitored for SO_2, CO, nitric oxide (NO), NO_2, PAHs, VOCs, O_3, and black smoke--TSPs. Because of logistical needs and equipment problems, not every pollutant was monitored at every site. Also, since the monitoring van had to rely on a portable electric generator, the maximum monitoring time was 18 hours without servicing. As a result, the duration of monitoring periods ranged from 3 to 16 hours.

Table 5.2 presents the mean, average maximum, and maximum 5-minute readings of some of the monitoring results that were summarized in the French report for 14 monitoring periods at 8 sites.

Table 5.2: Summary of French Monitoring in Kuwait, in ug/m^3

Pollutant	Mean	Maximum average	Maximum 5 minute
O_3	40	96	126
SO_2	159	495	2,911
CO	1,058	4,813	8,576
NO	17	77	227
NO_2	28	54	78
Black smoke	373	818	[a]

[a]Data not included in the French report.

GAO Comparison of Monitoring Results With Standards

The overall SO_2 mean reading is below the level of the 24-hour NAAQS of 365 ug/m^3. The French report does show that the average readings at two of the sites did exceed the level of the standard. Both measurements were done in less than 24 hours, however. On April 3 the average for a 7-hour, 50-minute SO_2 reading at the Kuwaiti international airport was 495 ug/m^3 in the plume. Another reading exceeded the level of the standard on the night of April 3-4, when a smoke plume touched the ground at the "New English School," where the team took many of its readings. During this episode, a peak 5-minute SO_2 reading of 2,911 ug/m^3 was observed, with the 12-hour average for SO_2 being 472 ug/m^3.

The readings for O_3, CO, and NO_2 did not exceed the NAAQS. The readings for the black smoke did exceed the 1971 24-hour NAAQS for TSPs of 260 ug/m^3. There is no NAAQS for NO. The levels, however did not exceed the NIOSH 10-hour exposure limit of 40,000 ug/m^3.

AIR POLLUTANT MEASUREMENTS BY THE NORWEGIAN INSTITUTE FOR AIR RESEARCH

The Norwegian delegation monitored at Umm Quasr, Iraq, because of health concerns expressed by a Norwegian medical unit stationed there. This site is located in the United Nations-controlled zone at the Kuwaiti and Iraqi border. This was about 100 kilometers from the largest field of oil fires in northern Kuwait. The closest fires were within 50 kilometers. The monitoring period was from May 15 to June 17, 1991. Sulfur dioxide and soot (particulates) were monitored continuously. Four PAH samples were taken. Table 5.3 shows the concentrations for SO_2 and particulates.

Table 5.3: Air Pollution Measurements by the Norwegian Institute for Air Research, in ug/m^3

Substance	24 hour concentrations Average	Range
SO_2	11.5	5 to 36
Particulates	43.3	8 to 400

The Norwegian report stated that strong conclusions could not be drawn because of limited data collected during a period of favorable weather conditions. However, during the period when wind blew from the south and southwest, soot concentrations exceeded the World Health Organization's 24-hour guideline of 125 ug/m^3 by a factor of three.

The report stated that the PAH samples' total concentrations ranged from 207 to 412 nanograms per cubic meter (ng/m^3). It noted that the PAH concentrations were lower than in the industrialized areas of Norway.

GAO Comparison of Monitoring Results With Standards

The SO_2 readings were well below the level of the 24-hour NAAQS of 365 ug/m^3. The high particulate 24-hour average of 400 ug/m^3 did exceed the 1971 TSP NAAQS of 260 ug/m^3. The report data show that the PAH analysis identified 23 PAHs. Naphthalene accounted for about 45 to 60 percent of the PAH concentrations found. The naphthalene levels in the four samples ranged from 94 ng/m^3 to 228 ng/m^3 (0.094 to 0.228 ug/m^3). The NIOSH 10-hour exposure limit for naphthalene is 50,000 ug/m^3.

BRITISH METEOROLOGICAL OFFICE REPORT

A British Meteorological Office research aircraft made seven flights into the Kuwaiti oil fire smoke plume during the period March 22 to April 2, 1991. The office's report presents peak concentrations of SO_2, O_3, and nitrogen oxides (NO_x) measured by the aircraft 100 kilometers from Kuwait. The peak readings were 1 ppm for SO_2, 0.08 ppm for O_3, and 0.05 ppm for NO_x.

The report cautions against direct comparisons of the effects of SO_2 and smoke in Kuwait with those produced by similar concentrations in London in the 1950s, as the results may be misleading. In London, fog was a problem, and water droplets containing sulfuric acid were produced. In the dry air in Kuwait, this was much less of a problem, according to the study.

GAO Comparison of Monitoring Results With Standards

The 1-ppm peak SO_2 reading exceeded the level of the 24-hour SO_2 NAAQS of 0.14 ppm but was under the NIOSH workplace exposure limit of 2 ppm. The 0.08 ppm for O_3 was below the 0.12 ppm 1-hour NAAQS. There is no short-term NAAQS for NO_x. The report did not give any average readings.

MONITORING BY THE U.S. DEPARTMENT OF COMMERCE'S NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

The team collected smoke samples in the Al Maqwa oil field in Kuwait on May 15, 1991. The first set of samples was collected about 3 meters above ground at a location that was not in the plume but near the oil field. The second set of samples was collected in the plume created by a well and pool fire at a height of about 1 meter. The plume samples were collected for about 20 minutes. Table 5.4 presents the particulate levels and the PAH concentrations found in the particulates.

Table 5.4: National Institute of Standards and Technology Monitoring

Pollutant	In plume	Near oil field
Particulate matter (estimated mg/m^3)	21.0	.6
PAHS in nanograms per milligram:		(less than)
Phenanthrene	100.0	2.3
Anthracene	30.0	1.0
Fluoranthene	76.0	1.0
Pyrene	84.0	1.0
Benzo(a)anthracene	28.0	1.0
Chrysene	34.0	1.0
Benzo(b)fluoranthene	17.0	1.0
Benzo(k)fluoranthene	9.0	1.0
Benzo(e)pyrene	21.0	1.0
Benzo(a)pyrene	19.0	1.0
Perylene	5.8	1.0
Indeno(1,2,3,cd) pyrene	13.0	1.0
Benzo(ghi)perylene	15.0	1.0

GAO Comparison of Monitoring Results With Standards

The particulate levels found are greater than the 1971 NAAQS for particulates. The levels found for phenanthrene, anthracene, pyrene, chrysene, and benzo(a)pyrene do not exceed the NIOSH 10-hour exposure limits. We were unable to find exposure limits for the remaining PAHs.

NATIONAL TOXICS CAMPAIGN FUND STUDY

The National Toxics Campaign Fund reported that it found five chemicals in three air samples it took at Al Jubayl, Saudi Arabia, on May 15, 20, and 21, 1991. The duration of each air sample was 2 hours.

Table 5.5: National Toxics Campaign Fund Measurements, in ug/m^3

	Sampling dates		
Chemical	May 15,1991	May 20, 1991	May 21,1991
1,4-dichlorobenzene	0.46	0.41	0.54
1,2-dichlorobenzene	0.20	0.26	0.22
Diethyl phthalate	2.59	0.25	0.18
Dimethyl phthalate	0.49	a	0.40
Naphthalene	0.52	0.53	0.46

[a]None.

According to the report, all three samples showed levels of 1,4-dichlorobenzene that exceeded the Massachusetts' annual ambient average limit of 0.18 ug/m^3. While under the annual ambient average limit of 81.74 ug/m^3, the levels of 1,2-dichlorobenzene in all three samples exceeded the U.S. median urban concentration of 0.11 ug/m^3, according to the report. The report did not identify limits for the other three pollutants monitored. The naphthalene level, however, was under the median U.S. level of 1.26 ug/m^3.

GAO Comparison of Monitoring Results With Standards

None of the levels exceeded the workplace exposure limits established by either NIOSH or ACGIH. Neither NIOSH nor ACGIH, however, had exposure limits for 1,4-dichlorobenzene. According to an EPA official, these compounds are constituents of cleaning compounds, not combustion products. Also, the Al Jubayl area is where U.S military equipment and vehicles were being cleaned and sanitized prior to their return to the United States.

NATIONAL SCIENCE FOUNDATION STUDY

The National Science Foundation put together a program involving 35 scientists from 7 U.S. universities, the National Center for Atmospheric Research, NOAA, and the National Aeronautics and Space Administration. Among the goals for this group were to characterize the emission rates of smoke particles and trace gases from the Kuwaiti oil fires. Readings were taken in the smoke plume by two research aircraft, one operated by the National Center for Atmospheric Research and the other by the University of Washington. Readings were taken from May 16 through June 12, 1991, in the first phase of the air monitoring.

A preliminary report presented some comments on the emissions identified. For example, it reported that peak concentrations of O_3, NO_x, and CO in the smoke plumes were below the threshold limits adopted by the U.S. Occupational Safety and Health Administration's standards for maximum allowable workday exposure. The SO_2 peak concentrations occasionally exceeded the threshold limits--the report did not provide specific numbers. The report also said that particles in the smoke close to the fires reached 100,000 per cubic centimeters of air and could pose a significant health hazard.

EPA/NATIONAL AERONAUTICS AND SPACE ADMINISTRATION IN-PLUME POLLUTANT MEASUREMENTS

Twenty-two plume gas and particle samples were taken over Kuwait's oil fields on seven helicopter flights. Black, white, and super plume samples were taken. Five ground-level samples were also collected in Kuwait City and near the Al Wafra and Al Burgan oil fields. The monitoring period was from July 28 to August 8, 1991. Sampling by helicopter was performed between 8 and 10 a.m. Sampling times were between 0.5 and 30 minutes.

Table 5.6 presents the results of the monitoring for SO_2, sulfates (SO_4), calcium, chloride, and potassium.

Table 5.6: Air Pollutant Measurements From Helicopter Flights in the Plume, in ug/m^3

Plume samples	SO_2	SO_4	Calcium	Chloride	Potassium
July 7, 1991: Black smoke	6	5.1	2.4	5.3	0.6
August 2, 1991: Black smoke	133	9.3	[a]	[a]	[a]
August 3, 1991: Black smoke	169	114.0	6.0	15.0	[a]
August 5, 1991: Black smoke	12	25.0	34.0	[a]	5.4
August 6, 1991: Super smoke	49	18.0	8.7	10.0	1.6
August 7, 1991: White smoke	319	630.0	415.0	3,220.0	62.0
August 8, 1991: Super smoke	26	10.0	1.2	9.0	0.3

Note: In addition to the sample contents identified in table 5.6, the team reported low or no levels of 11 other chemicals. Also, ground-level air samples, including both indoor and outdoor, were taken during the period July 28-August 7, 1991. These samples covered the same 16 chemicals, and the levels were low.

[a]Data not provided in report.

GAO Comparison of Monitoring Results With Standards

None of the SO_2 levels exceeded the 24-hour NAAQS of 365 ug/m^3. We could not find exposure limits for SO_4, calcium, chloride, or potassium.

U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY MONITORING

The U.S. Army Environmental Hygiene Agency's monitoring began around early May 1991 and was scheduled to run until early December. Monitoring sites were established at 10 locations--6 in Kuwait and 4 in Saudi Arabia. One site in Kuwait was shut down after about 2 weeks, and as a result, only limited data were collected.

The Army monitored for VOCs, TSPs, PM_{10} particulates, metals, O_3, PAHs, nitrates, SO_4, NO_2, SO_2, and acid gases. The monitoring was for 24-hour periods every 3 to 4 days. The air samples were sent to laboratories in the United States for analyses.

The following tables are the Army's summarization of preliminary monitoring results for the period early May through July 1991 for the sites located in both Kuwait and Saudi Arabia. The data have not gone through full quality control/quality assurance checks.

Table 5.7: Acid Gases and VOC Concentrations in Kuwait, in ug/m^3

Pollutant	Camp Freedom	Military Hospital	Doha	Kuwait City	Al Ahmadi Hospital
Nitric acid:					
u	NA	4.6	3.9	6.7	5.0
95%	NA	7.4	5.2	13.8	7.5
Sulfuric acid:					
u	NA	6.6	8.7	3.9	17.2
95%	NA	13.2	11.5	6.6	25.1
VOCs:					
Benzene					
u	4.7	1.1	5.5	3.3	9.1
95%	10.5	2.1	7.5	5.9	11.3
Toluene					
u	18.0	3.4	20.4	26.1	23.1
95%	42.7	3.8	36.7	48.2	31.3
Ethylbenzene					
u	4.5	1.1	5.9	4.0	17.9
95%	11.3	1.3	11.9	6.4	29.9
m,p-xylene					
u	12.4	2.7	21.9	10.2	49.1
95%	28.9	3.0	49.3	16.0	83.7
o-xylene					
u	5.4	1.4	9.7	4.2	16.0
95%	13.7	1.9	22.9	6.7	23.9
1-heptane					
u	54.8	2.0	8.8	8.5	55.6
95%	155.3	2.4	12.4	15.9	94.0
n-propylbenzene					
u	1.3	2.2	2.1	1.0	3.9
95%	3.3	0.3	4.6	1.2	5.0

Note: u = Mean (average 24-hour reading for the number of days that measurements were taken, which can vary by pollutant). 95% = The upper value at the 95-percent confidence interval, as reported by the U.S. Army Environmental Hygiene Agency. NA = Data not available because analysis was not complete for the particular pollutant.

Table 5.8: PM_{10} and TSP Concentrations in Kuwait and Levels of Trace Metals on the Particles, in ug/m^3

Pollutant	Camp Freedom	Military Hospital	Doha	Kuwait City	Al Ahmadi Hospital
PM_{10}:					
u	204.100	470.000	284.700	349.700	280.600
95%	245.800	735.300	330.900	474.700	349.500
Cadmium					
u	0.002	0.006	0.003	0.004	2.130
95%	0.003	0.009	0.004	0.006	2.420
Chromium					
u	0.008	0.039	0.018	0.025	0.015
95%	NA	0.068	0.025	0.032	0.030
Nickel					
u	0.016	0.054	0.029	0.042	0.021
95%	0.021	0.159	0.039	0.058	0.027
Lead					
u	0.176	NA	0.094	0.199	0.123
95%	0.310	NA	0.139	0.282	0.165
Vanadium					
u	0.010	0.037	0.019	0.027	0.029
95%	0.015	0.068	0.023	0.036	0.039
Zinc					
u	0.024	0.062	0.065	0.047	0.053
95%	0.037	0.097	0.080	0.059	0.081
TSPs:					
u	615.100	738.600	NM	562.900	NM
95%	1,194.800	1,175.400	NM	751.800	NM
Cadmium					
u	0.003	0.006	NM	0.005	NM
95%	0.005	0.009	NM	0.006	NM
Chromium					
u	0.024	0.047	NM	0.038	NM
95%	0.043	0.069	NM	0.051	NM
Nickel					
u	0.027	0.079	NM	0.063	NM
95%	0.053	0.126	NM	0.089	NM
Lead					
u	0.208	0.391	NM	0.312	NM
95%	0.326	0.704	NM	0.437	NM
Vanadium					
u	0.029	0.042	NM	0.036	NM
95%	0.043	0.067	NM	0.048	NM
Zinc					
u	0.075	0.081	NM	0.083	NM
95%	0.106	0.113	NM	0.100	NM

Note: u = Mean (average 24-hour reading for the number of days that measurements were taken, which can vary by pollutant). 95% = The upper value at the 95-percent confidence interval as reported by the U.S. Army Environmental Hygiene Agency. NA = Data not available because analysis of the monitoring was not complete for the particular pollutant. NM = No measurements taken at sites.

Table 5.9: VOCs and Acid Gas Concentrations in Saudi Arabia, in ug/m^3

Pollutant	Al Khobar	Al Jubayl	Riyadh	King Khalid Military City
Nitric acid:				
u	10.50	8.90	4.44	2.66
95%	15.44	12.89	5.86	3.41
Sulfuric acid:				
u	13.72	8.90	4.06	1.54
95%	17.70	11.78	5.91	2.08
VOCs:				
Benzene				
u	3.53	2.19	1.26	1.23
95%	4.72	3.28	2.44	1.79
Toluene				
u	13.31	3.79	9.77	2.68
95%	16.98	5.42	15.63	3.59
Ethylbenzene				
u	3.37	1.27	2.07	1.47
95%	4.14	1.72	3.17	2.26
m,p-xylene				
u	8.69	3.11	6.16	2.80
95%	10.58	4.24	9.51	4.09
o-xylene				
u	3.29	1.16	2.14	1.94
95%	3.96	1.58	3.23	3.06
1-heptane				
u	4.04	1.79	1.55	1.01
95%	5.09	2.51	2.34	1.47
n-propylbenzene				
u	0.94	0.26	0.44	1.23
95%	1.16	0.36	0.65	2.36

Note: u = Mean (average 24-hour reading for the number of days that measurements were taken, which can vary by pollutant). 95% = The upper value at the 95-percent confidence interval as reported by the U.S. Army Environmental Hygiene Agency.

Table 5.10: PM_{10} and TSP Concentrations in Saudi Arabia and Levels of Trace Metals on the Particles, in ug/m^3

Pollutant	Al Khobar	Al Jubayl	Riyadh	King Khalid Military City
PM_{10}:				
u	277.280	NA	NA	NA
95%	356.560	NA	NA	NA
Cadmium				
u	0.004	NA	NA	NA
95%	0.005	NA	NA	NA
Chromium				
u	0.029	NA	NA	NA
95%	0.044	NA	NA	NA
Nickel				
u	0.029	NA	NA	NA
95%	0.045	NA	NA	NA
Lead				
u	0.425	NA	NA	NA
95%	0.503	NA	NA	NA
Vanadium				
u	0.018	NA	NA	NA
95%	0.025	NA	NA	NA
Zinc				
u	0.146	NA	NA	NA
95%	0.208	NA	NA	NA
TSPs:				
u	376.200	NA	NA	NA
95%	455.110	NA	NA	NA
Cadmium				
u	0.005	NA	NA	NA
95%	0.010	NA	NA	NA
Chromium				
u	0.020	NA	NA	NA
95%	0.029	NA	NA	NA
Nickel				
u	0.029	NA	NA	NA
95%	0.048	NA	NA	NA
Lead				
u	0.356	NA	NA	NA
95%	0.466	NA	NA	NA
Vanadium				
u	0.019	NA	NA	NA
95%	0.028	NA	NA	NA
Zinc				
u	0.161	NA	NA	NA
95%	0.270	NA	NA	NA

Note: u = Mean (average 24-hour reading for the number of days that measurements were taken, which can vary by pollutant). 95% = The upper value at the 95-percent confidence interval as reported by the U.S. Army Environmental Hygiene Agency. N/A = Data not available because analysis of the monitoring was not complete for the particular pollutant.

GAO Comparison of Monitoring Results With Standards

The PM_{10} levels that the Army measured in Kuwait and at the one site in Saudi Arabia were above the 24-hour NAAQS of 150 ug/m^3. Although not directly comparable, the PM_{10} mean levels at the Kuwaiti military hospital site and the site in Kuwait City also exceeded the 24-hour Saudi Arabian particulate matter of 15 microns or less (PM_{15}) standard of 340 ug/m^3. The TSP levels measured exceeded the 1971 NAAQS of 260 ug/m^3 at all of the sites where particulates were measured.

With the exception of lead and particulates, there are no NAAQS for the other pollutants measured by the Army. The NAAQS for lead is a maximum quarterly average of 1.5 ug/m^3. None of the mean or upper levels reported exceeded this level. While the Army's 24-hour mean or upper limit readings are not directly comparable to the 10-hour NIOSH exposure limits because of the time differences, none of the pollution levels exceeded the exposure limits. We were unable to find exposure limits for cadmium and n-propylbenzene.

SECTION 6

LONG-TERM HEALTH RISKS ARE UNKNOWN

In the report the interagency team stated that it could not determine the long-term health effects of the Kuwaiti oil fire pollution because of insufficient data on the populations exposed, the composition of the smoke plume, and long-term weather patterns.

Pollutants of concern for the long-term health effects included VOCs, PAHs, and metals, many of which are confirmed carcinogens and can become attached to particulates. The team did some monitoring for these pollutants and generally found low levels. Had they found high levels as anticipated, according to team members, they would have been able to say more about the possible long-term effects.

In testimony before the Gulf Pollution Task Force, Senate Committee on Environment and Public Works, on October 16, 1991, the Director of EPA's Gulf Task Force stated that for the next 6 months, the task force would be addressing specific needs identified by the field team and scientific contacts in the region. The Director further stated that one of the areas being studied is determining long-term human health effects. He specifically stated that "This is a logical carry over from the initial acute health assessment made in early March by the Interagency Air Assessment Team. More data need to be collected and these data must be thoroughly analyzed to assess the potential threats to those exposed."

At this same hearing, the Deputy Assistant Secretary for Health Science and the Environment, Public Health Service, stated that although measurements of air pollutants from the Kuwaiti oil fires are still not complete enough to fully evaluate the potential long-term health effects, he expects no large increase in respiratory tract or lung cancer from the low levels of exposure and the relatively short duration (less than 1 year) of exposure experienced in Kuwait.

As of late November 1991, no agency or organization had completed an assessment outlining what all of the monitoring results mean in terms of long-term health risks. Most of the data collected by ground and aircraft monitoring subsequent to the initial interagency team effort have been widely dispersed among the organizations that performed the monitoring. In August 1991 the National Center for Atmospheric Research was designated to archive the measurement data from the Kuwaiti oil fires. Data from this effort, however, will probably not be available until early 1992, according to a NOAA official.

The Army is preparing a risk assessment for the troops that were deployed in the Gulf on the basis of its monitoring and health

data collected. The risk assessment is not expected to be completed until sometime in 1992.

EPA is also developing a health research and environmental management plan that will include a component to assess the risks to U.S. troops and civilians exposed to air pollution in the Gulf. The thrust of the plan is to assist Gulf countries in assessing health and ecological impacts, establishing terrestrial and Gulf water environmental management, and reestablishing Kuwait's health care system. As of late November the plan had not been approved by the Administrator. Once the plan has been approved and funded, according to the Chief Scientist of the EPA Gulf Task Force, it would probably take about 2 years to complete the risk assessment. Recommendations had not been made on how to fund the plan.

The Public Health Service has also developed a plan of action that identifies a broad range of public health issues, strategies, and approaches that should be addressed to explore the acute and chronic risks from the fires. The plan has been provided to the Kuwaiti government for its consideration. The plan outlines general steps necessary to carry out risk assessment and risk management of the health effects of the fires. For example, it outlines steps to measure the contaminants, determine who has been exposed, and the nature and extent of the exposure.

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