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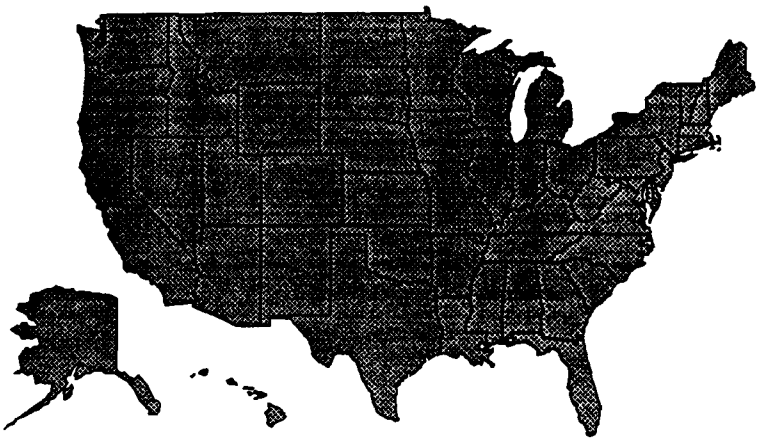
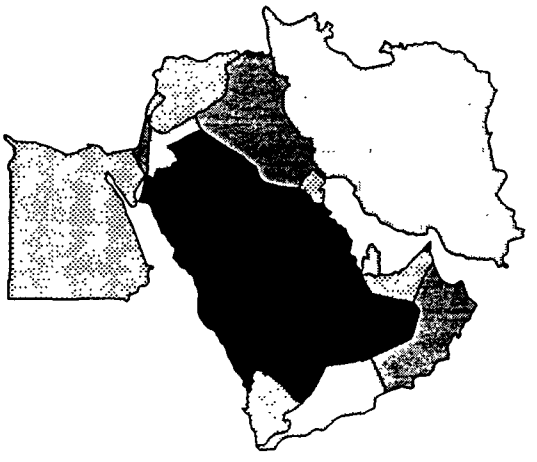


United States Gulf Environmental Technical Assistance



From January 27 – July 31, 1991

Under Public Law 102–27, Section 309

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PURPOSE

This report has been prepared pursuant to Public Law 102-27, Section 309 (b)(1), Persian Gulf Environmental Technical Assistance of the Dire Emergency Supplemental Appropriations for Consequences of Operation Desert Shield/Desert Storm, Food Stamps, Unemployment Compensation Administration, Veterans Compensation and Pensions, and Other Urgent Needs Act of 1991.[1]

The Environmental Protection Agency has prepared this report in coordination with the Central Intelligence Agency, the Department of Commerce, the Department of Defense, the Department of Energy, the Department of Health and Human Services, the Department of the Interior, the Department of State, the Department of Transportation, the National Aeronautics and Space Administration, and the National Science Foundation.

The report describes U.S. government technical assistance activities in the Gulf and the U.S. role within the overall international environmental response framework. The primary focus of this report is the U.S. contribution, including U.S. government expenditures, to the international effort to provide technical assistance in the Gulf region. In addition, the report briefly addresses the activities of other governments, international organizations, and non-governmental organizations.

[1]A copy of the relevant portion of the public law is located in Appendix E.

FOREWORD
By William K. Reilly

Just over a year ago, the Iraqi invasion of Kuwait and the environmental atrocities that followed shocked the world. During the conflict and as Iraqi forces withdrew, they deliberately released millions of barrels of oil into the Gulf and systematically ignited or damaged over 700 oil wells. Coastal areas were mined, power stations, desalination plants, and sewage treatment facilities were rendered inoperable, and the detritus of war was littered over the Kuwaiti landscape. The magnitude of environmental destruction has been tragic.

For a time, the consequences of this environmental catastrophe aroused fear worldwide that the fire plumes from Kuwait's oil wells could affect global climate. Fortunately, preliminary analysis by U.S. scientists and technical researchers from other countries have found that global climate effects seem unlikely under current conditions.

The United Nations International Action Plan comprises the core of a worldwide response, and the United States has played a pivotal role in developing and implementing major components of this U.N. Plan. We can take pride in the U.S. contribution to the environmental response efforts, where U.S. agencies, at the request of the Kuwaiti and Saudi governments, have joined forces to provide technical and scientific support to the countries in the region in responding to the disaster. The United States Interagency Assessment Team (USIAT) was on scene within days of the first oil discharge. This team included representatives from the Coast Guard, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, and the Army Corps of Engineers. This Team operated in the Gulf area as hostilities continued, focusing on environmental assessment, mitigation, and related efforts to protect the desalination plants from oil contamination. Our emergency response team coordinated the first air pollution sampling soon after Kuwait City was liberated by coalition forces.

I visited the Gulf in early June, at the direction of President Bush to assess the environmental consequences of the war and witnessed first-hand the assistance efforts and monitoring work underway by U.S. scientists and experts from other countries. It was evident that clean-up and restoration of the Kuwaiti infrastructure would be a daunting task. Both the United States and international organizations have made great progress in repairing damaged systems. The U.S. Army Corps of Engineers, for example, has done exceptional work in restoring crucial services, including power, water, and transportation. The National Oceanic and Atmospheric Administration has helped restore meteorological monitoring capabilities. Efforts by U.S. and international crews to extinguish the fires have been remarkable -- as of October 1, over 500 wells have been controlled -- and oil has been recovered from the Gulf in unprecedented amounts.

Although response efforts to date have been monumental, there are many problems still to tackle. Studies of possible long range effects on human health, wildlife, and the environment must get under way. The Gulf coastline needs attention, especially the marshes, migratory bird nesting areas and marine species affected by the oil discharges. The environmental effects on the fragile desert ecosystem from the oil fires and the oil lakes will have to be assessed and remedied where possible. Solid and hazardous waste issues will be challenging the country's capabilities for years. To augment efforts of the United Nations and governments of the Gulf region, the United States is continuing to provide scientific expertise and technical assistance on these and other matters, as additional requests for assistance are made and resources permit.

In the aftermath of the environmental disaster we have witnessed in the Gulf region, it is worthwhile to learn all that we can from this experience. There would be no greater sin than to fail to understand the lessons this scourge can teach us -- lessons in ecological vulnerability, in techniques of recovery, in measuring health impacts, and in assessing human and environmental exposure. If we do this, then at least we will be better prepared, at home and abroad, to address future environmental emergencies. In their intentional origin and in their size, the oil fires and releases in the Gulf were unique. But lesser chemical accidents and oil spills have a dreary, almost routine familiarity, making U.S. experience a valued resource, not just here but throughout the world. Making that experience available, as we have in the Gulf, is one of the most welcome and benign expressions of U.S. foreign policy.

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PREFACE

This report describes United States government participation in the international response to the Gulf oil discharges and oil fires in Kuwait from January 27 (the departure of the first U.S. team) through July 31, 1991. Chapter 1 summarizes the international framework under which the U.S. response effort has been conducted. This section includes information on the participation of international organizations including the United Nations Environment Programme, the International Maritime Organization, the World Meteorological Organization, the World Health Organization, and the Regional Organization for the Protection of the Marine Environment.

Chapter 2 focuses on United States government activities in response to the discharge of oil into the Gulf and to the oil fires in Kuwait. This chapter includes information on the initial response by the U.S. Interagency Assessment Team and subsequent international coordination of assistance efforts. It also covers assessment and remediation of the discharges and restoration efforts. The oil fires portion of the chapter addresses emergency assistance by the U.S. Interagency Air Assessment Team, and long-term air quality assessment, including studies designed to characterize the aerial plume and update models for use in predicting possible health threats caused by changes in air quality. This chapter also focuses on U.S. efforts relating to health, hazardous and solid waste, water, and environmental remediation and restoration issues.

The appendices provide additional documentation of topics addressed in the report. Appendix A is a summary of the major preliminary findings of the U.S. governmental agencies that participated in the response. Appendices B and C illustrate U.S. government agency roles and responsibilities. Appendix D contains a roster of all U.S. government employees who went on official travel to the Gulf region to participate in oil discharges and oil fires response efforts. Appendix E contains section 309 of Public Law 102-27. The remaining appendices contain documents and studies providing supplemental information to this report.

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LIST OF ACRONYMS

ARAC	Atmospheric Release Advisory Capability
ARAMCO	Arabian American Oil Company
CDC	Centers for Disease Control
CIA	Central Intelligence Agency
DNA	Defense Nuclear Agency
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOS	Department of State
EPA	Environmental Protection Agency
FWS	Fish and Wildlife Service
GEMS	Global Environmental Monitoring System
GRAMP	Gulf Regional Air Monitoring Program
HEAL	Human Exposure Assessment Locations
HHS	Department of Health and Human Services
IIAT	International Interagency Assessment Team
IMO	International Maritime Organization (UN)
IOC	Intergovernmental Oceanographic Commission (UNESCO)
KFUPM/RI	King Fahd University of Petroleum and Minerals/Research Institute (Saudi Arabia)
KPC	Kuwait Petroleum Company
KWP	Kuwait Working Party
LiDAR	Light Detection and Ranging
MEPA	Meteorology and Environmental Protection Administration (Saudi Arabia)
MOPP	Mission Oriented Protective Posture
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCWCD	National Commission for Wildlife Conservation and Development
NICT	National Incident Coordination Team (EPA)
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team (U.S.)
NSF	National Science Foundation
OPRC	International Convention on Oil Pollution Preparedness, Response, and Co-operation, 1990
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PM_{10}	Particulate matter less than 10 microns in diameter
ROPME	Regional Organization for the Protection of the Marine Environment
SLAR	Side Looking Airborne Radar
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UW	University of Washington
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USCG	United States Coast Guard

USIAAT	United States Interagency Air Assessment Team (oil fires)
USIAT	United States Interagency Assessment Team (oil discharges)
VOC	Volatile organic compound
WHO	World Health Organization (UN)
WMO	World Meteorological Organization (UN)

EXECUTIVE SUMMARY

o This Report to Congress describes the United States government contribution to response efforts to the environmental crises in the Gulf caused by the actions of the Iraqi forces. The international community immediately responded to requests from Gulf nations for assistance with these crises, and the United States has played a leading role in these response plans due to its scientific and technical expertise. As these international efforts continue, the United States will provide assistance as additional requests are made and resources permit.

o This was unlike any environmental situation previously experienced. Models for a disaster of this scale and complexity were not available to guide the international response to this situation. The international environmental community and the U.S. government extrapolated from previous experiences with environmental destruction to respond to these disasters in the Gulf.

o Disasters of this nature and magnitude require responses from the international community. The United Nations responded rapidly to technical assistance requests from the Gulf region. The United Nations Environment Programme worked with other international organizations to set up a framework to coordinate the technical assistance response effort.

o The United Nations technical organizations developed action plans for atmospheric monitoring and modeling, environmental remediation and restoration, oil discharge response, health effects, guidance, and training. Technical organizations include the World Meteorological Organization, the World Health Organization, the Intergovernmental Oceanographic Commission, the International Maritime Organization, and the Regional Organization for the Protection of the Marine Environment have developed plans to address components in the overall international framework.

o The U.S. government has actively participated in the development and implementation of distinct components of the international action plans. The Department of State has assisted Departments and Agencies with international logistical support and coordination among the regional governments. The U.S. National Response Team (a permanent organization with representatives from 15 U.S. Departments and Agencies) provided technical assistance, guidance, and training to the Saudi Arabian government to respond to the oil discharges. The Department of Transportation supplied U.S. Coast Guard personnel and equipment to the Gulf nations following the oil discharges and received assistance from the Department of the Interior, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency. The Department of Defense is conducting health monitoring studies regarding exposure to the pollutants and the effect on U.S. troops deployed to the Gulf region and providing logistical support in the theater for domestic agencies. The National Oceanic and Atmospheric Administration in the Department of Commerce, the Department of Defense, the Department of Energy, the National Science Foundation, and the Environmental Protection Agency have been involved in characterizing the smoke plumes and analyzing the effects from the oil fires. The Department of Health and Human Services has been working with the Kuwaiti Ministry of Public Health to determine the acute health risks from the exposure to the air pollution produced by the oil well fires. Extinguishing and controlling the fires and gushers has been the responsibility of the Kuwaiti government and private companies.

o Several U.S. scientific missions went to the Gulf from May through July to gather data from the smoke plume so that the impact of the smoke on human health and the environment could be estimated. Data from these air and ground monitoring missions are still being analyzed.

o Preliminary data from the various missions have shown generally consistent findings, but further work, including peer review, needs to be completed. Also, preliminary findings are subject to change as further analyses are conducted. The data clearly do rule out the "nuclear winter" scenario, however, and indicate that the most environmental damage will likely be confined to the Gulf region. Further, carbon dioxide emissions from the oil fires are not likely to have an important impact on global climate. The medium and long-term effects of the fires and oil discharges on human health and the environment are under review and study; to date, monitoring of hospital records, including emergency room surveillance, has not indicated an acute health impact.

CHRONOLOGY OF MAJOR EVENTS IN 1991 RELATING TO THE GULF OIL DISCHARGE AND KUWAIT OIL WELL FIRES

DATE	EVENT
January 19-30	Iraqi forces initiated several oil discharges into the Gulf from Kuwait and Iraq.
January 24	The Saudi Arabian government formally requested assistance from the U.S. government through the U.S. Ambassador to Saudi Arabia.
	Action took place to establish and dispatch an appropriate assistance team.
January 27-28	The U.S. Government Interagency Assessment Team (USIAT), led by the U.S. Coast Guard (USCG), traveled to Saudi Arabia to provide technical assistance for the oil discharge response.
January 29	The Saudi Arabian Meteorology and Environmental Protection Administration (MEPA) established an Eastern Province regional office in Dhahran, Saudi Arabia to coordinate response efforts.
February 5-6	A United Nations Environment Programme (UNEP) meeting was held in Geneva, Switzerland to develop an interagency action plan.
February 6	The Saudi Arabian government requested USCG to provide an HU-25 Falcon aircraft with AIREYE oil surveillance capability to assist in the oil discharge response. Air crews began receiving training and preparing equipment for operations within Saudi Arabia.
February 15-17	The Iraqi Army systematically ignited oil wells in Kuwait.
February 16	U.S. Environmental Protection Agency's (EPA) Emergency Operations Center (EOC) staff and EPA's National Incident Coordination Team (NICT) began to coordinate U.S. interagency response activities to the oil well fires.
February 16-20	Members of Congress visited the Gulf region to inspect damage resulting from oil discharges.
February 20	The first HU-25 AIREYE overflight was conducted.
February 26 - 27	The Regional Organization for the Protection of the Marine Environment (ROPME) sponsored a meeting, in Bahrain, to review information on marine and air pollution and to coordinate response efforts.
February 28	Kuwait City liberated; cessation of hostilities in the region.
Late February	Oil was reported leaking from facilities at Al Bakr and Sea Island Terminal (Mina Al Ahmadi) at an estimated rate of 1,500 to 6,000 barrels per day.
	The U.S. Army Corps of Engineers began efforts to assist in reconstruction of power, water, and transportation systems in Kuwait.
March	The Gulf Pollution Disaster Fund was established under the auspices of the International Maritime Organization (IMO) for restoration projects.
March 10	The U.S. Interagency Air Assessment Team (USIAAT) was deployed to Gulf to provide technical assistance in response to the oil fires.
March 11 - May	The USIAAT conducted air sampling, health surveys, and aerial reconnaissance surveys of the fire plumes.
March 14-18	A U.S. Senate delegation traveled to the Gulf region to observe environmental damage.
March 15	UNEP Governing Council adopted an international plan of action in response to environmental effects of the oil discharges and fires.
March 21	The Department of Health and Human Services (HHS) issued a Preliminary Health Advisory related to burning oil wells in Kuwait.

DATE	EVENT
March 27	Two of three continuous monitoring stations in Kuwait City were reactivated and began collecting air quality data from the oil fire plumes.
March - present	The National Oceanic and Atmospheric Administration (NOAA) began on-site presence in the Gulf region to provide logistical and scientific support to air sampling missions.
April	The Shoreline Cleanup Committee convened and issued a preliminary report.
April 3	EPA released the preliminary Interagency Interim Report on the Kuwait Oil Well Fires.
April 5	DOE sponsored a workshop for federal research laboratories to identify new and innovative technologies and equipment to control oil well fires.
April 10	The President signed the Dire Emergency Supplemental Appropriations for the Consequences of Operations Desert Shield/Desert Storm, Food Stamps, Unemployment Compensation Administration, Veterans Compensation and Pensions, and Other Urgent Needs Act of 1991.
April 22	The Army chaired a Tri-Service work group to evaluate health effects of oil smoke on Department of Defense (DOD) personnel.
Late April	Leaking oil terminals at Al Bakr and Mina Al Ahmadi no longer are considered a threat to the environment.
April 26	U.N. Interagency Office was established in Kuwait.
April 27	The USIAT performed its final AIREYE overflight of the oil discharges.
April 27-30	The World Meteorological Organization (WMO) held an international conference in Geneva, Switzerland to address atmospheric issues related to the oil fires and develop an air monitoring and modeling program.
May 1	DOD's U.S. Army Environmental Hygiene Agency (USAEHA) sent a team to collect samples and to monitor health effects. Samples were sent to laboratories at Aberdeen Proving Grounds, MD.
	The World Health Organization (WHO) and WMO agreed to collaborate on air monitoring investigation.
May 6	EPA released the complete Interagency Interim Report on the Kuwait Oil Well Fires including compiled data, preliminary analyses, and proposed future programs.
May 14-16	DOC's National Institute of Standards and Technology (NIST) sent a team to perform ground-based source term (oil well fire) characterization measurements.
May 16-June 12	The National Science Foundation (NSF)-led research aircraft from the National Center for Atmospheric Research (NCAR) and the University of Washington (UW) conducted air sampling and plume monitoring.
May 23	WMO Deputy Secretary General briefed Gulf countries on WMO plans.
May	UNEP and Intergovernmental Oceanographic Commission signed an MOU to take the lead on assessment and analysis of extent of damage from oil discharges.
May 31	The Kuwait Working Party released "The U.S. Public Health Service Scope of Action Document."
May 31-June 5	EPA Administrator Reilly visited the Gulf region on a mission to observe the environmental damage and inspect cleanup efforts.
June	Elements of the 11th Armored Cavalry Regiment received baseline medical surveillance screening prior to their tour in Kuwait.
June 20	An Intelligence Community Staff report was released.
July	The Department of Energy (DOE) sponsored aircraft air monitoring program began their characterization of the plume to measure pollutant transformation/removal rates.

DATE	EVENT
July 31	EPA and National Aeronautics and Space Administration (NASA) Langley Research Center began DOE funded experiments using helicopter based sampling to characterize the emissions from the oil well fires at and near the sources.
	USIAT returned to the United States.

1. BACKGROUND

In the aftermath of the Iraqi invasion of August 1990, Kuwait and its neighboring states have faced a major environmental disaster as a result of hundreds of oil fires and several massive oil discharges into the Gulf. Iraq began releasing oil into the Gulf in January 1991; in February, the retreating Iraqi army ignited or damaged over 700 oil wells after systematically placing explosives around each one.

As Kuwait was being liberated, the scale of the environmental damage became clearer. Kuwait had to extinguish the fires, and Saudi Arabia and other potentially affected countries had to mitigate the effects of the oil discharges on their territories and in the waters of the Gulf. In addition, assessments had to be made of the potential acute and chronic effects on human health and the environment. These assessments were made more difficult because most Kuwaiti scientific centers had been destroyed, facilities were stripped of equipment, and health institutions were crippled, leaving the country without adequate means to measure, sample, or monitor human and environmental effects, and project future problems.

At the requests of the governments in the region, the international community responded quickly to provide assistance. The United Nations (UN) took the lead in establishing a framework for coordinating international efforts and a system for responding to requests for technical assistance, assessments, and health and environmental monitoring in the Gulf region.

INTERNATIONAL FRAMEWORK

The United Nations Environment Programme (UNEP) General Council, which was meeting at the time of the Iraqi invasion in August 1990, expressed its concern about the environmental damage that could result from the onset of hostilities. On January 26, 1991, the UNEP Director General called a meeting under UNEP sponsorship to bring together various UN agencies, with their diverse capabilities, so that the UN system could respond to requests for environmental assistance from member governments. The meeting took place in Geneva, Switzerland, on February 5-6, 1991. Some UN organizations had already begun working with member states affected by the conflict. The International Maritime Organization (IMO), in particular, had already taken the lead in coordinating the international response to the oil discharges, and laid the foundation for the broader issues covered by UNEP.

United Nations Environment Programme

UNEP took the initiative to begin coordinating international activities in response to health, atmospheric, and environmental impacts of the oil discharges and oil fires. These activities included efforts conducted by member governments under the auspices of various UN agencies, such as IMO and the World Meteorological Organization (WMO), as well as the activities of the UN agencies themselves. In order to carry out this function, UNEP maintained an office in Kuwait for several months at the headquarters of the Regional Organization for the Protection of the Marine Environment (ROPME), an organization created under the UNEP Regional Seas Program to protect the Gulf environment. ROPME is beginning to take over the coordinating role for the international responses.

The February 5-6, 1991 UNEP meeting helped serve as a catalyst for the development of action plans to monitor the air quality in the areas affected by the smoke plumes from the oil fires. A subsequent meeting was held in March 1991, where a UN Interagency Action Plan was developed. WMO called a meeting in Geneva, April 27-30, 1991, where a comprehensive action plan was developed. The "Report of the WMO Meeting of Experts on the Atmospheric Part of the Joint U.N. Response to the Kuwait Oil Fires," which addressed atmospheric and meteorological concerns, also contained an overall work plan for assessing and monitoring the air quality in the Gulf region.

The WMO air monitoring work plan recognized the need to obtain data at different times and locations in order to predict the long and short-term effects of the smoke on human health and the environment. This

priority scheme became the "WMO Plan," which is the framework under which the international community, including the United States, is currently responding to regional requests for assistance.

The air monitoring effort was linked with the need to determine the impact of the smoke pollution on the health of the population. The World Health Organization (WHO) took part in the April meeting and was active in the development of the international air monitoring project which, in conjunction with WMO, outlines the basic response to the environmental and health situation created in the Gulf region.

In addition to IMO, WMO, and WHO, several other international organizations have been actively involved in responding to requests for assistance from the Gulf governments. The Intergovernmental Oceanographic Commission (IOC) made an important contribution to the oil discharge response, as did ROPME. IOC is preparing a long-term study on the effect of the discharges on coastal areas. ROPME has developed a plan outlining activities concerning the assessment and rehabilitation of the region's marine environment.

International Maritime Organization (IMO)

Together with the Saudi Arabian government and other Gulf state governments, the IMO played a key role in organizing international assistance and laid the foundation for the broader issues covered by UNEP. The basis for the IMO action was the recently negotiated International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990. Responding to the oil discharges in the Gulf was the first major test of the OPRC Convention. Almost immediately after the report of the oil discharges in the Gulf, the IMO began marshalling resources and coordinating emergency response in accordance with the Convention. IMO coordinators were situated in Saudi Arabia and Bahrain, and they served as technical experts and advisors to the Gulf states. These IMO representatives were instrumental in briefing the representatives of other international organizations and in expediting the rapid assimilation of the UNEP and other international organizations into the environmental response.

World Meteorological Organization (WMO)

The WMO has remained a focal point for the air monitoring effort since the Geneva meeting in April 1991, and the development of the WMO plan. The WMO plan addresses two issues: 1) air sampling and monitoring of the plume at various altitudes, and 2) data analysis, coordination, and modeling for local, regional, and global predictions.

The U.S. contribution to the monitoring effort, which has consisted of fixed wing aircraft, helicopter, and ground-based air monitoring and model forecasts of plume transport and dispersion for flight planning and mission support. This has all taken place within the context of the WMO plan.

World Health Organization (WHO)

In addition to its work with WMO, WHO has developed an international air monitoring effort. The WMO/WHO plans outline the basic framework for response to environmental and health effects in the Gulf region. WHO has also developed a World Health Response report in conjunction with the Ministry of Public Health in Kuwait. This report addresses the status of health care in Kuwait and includes a plan of action for Kuwait. The plan outlines several major objectives, including the restoration and restructuring of the Kuwaiti health care system, surveying and monitoring for health effects from current environmental problems, and restoration of systems to prevent community health impacts. It also addressed the need for equipment and supplies, disease prevention and control, drugs, diagnostic facilities and blood banks, community education, and a management and coordination system. All of these systems in Kuwait had been damaged or destroyed as a result of the Iraqi invasion.

Intergovernmental Oceanographic Commission of UNESCO (IOC)

At its Assembly meeting in March 1991, the Intergovernmental Oceanographic Commission of UNESCO (IOC) adopted a resolution calling for a number of measures to assist the Gulf region. These include establishment of a special research and monitoring program, establishment of a working group, and assistance to the region to re-establish the oceanographic infrastructure damaged by the war. The April UN Interagency Action Plan called for the IOC to address matters relating to the coastal and marine environment. In May 1991, the IOC signed a memorandum of understanding with UNEP to provide an assessment and analysis of the extent of damage to coastal and marine ecosystems, analyze the impact of the oil discharges on living marine organisms, and analyze the types and concentrations of various pollutants exchanged between the atmosphere and ocean in the region. Short and long-term strategies have been developed. Implementation of these strategies are underway in coordination with other UN and international organizations.

Regional Organization for the Protection of the Marine Environment (ROPME)

ROPME has coordinated various international activities concerning the oil discharges into the Gulf. In February 1991, a meeting was held in Bahrain to develop an international plan to coordinate efforts of the Gulf States in the region, as well as regional and international environmental agencies in the assessment of the marine, atmospheric, and terrestrial environmental damage. The objective of this meeting was to develop remedial measures for the restoration of the environment. ROPME continues its role in international activities in response to the oil discharges, coordinating with UN agencies.

UNITED STATES GOVERNMENT ROLE

The United States has participated in and continues to contribute to fulfill aspects of the UN Interagency Action Plan where its expertise and specialized experience can be most beneficial to the region. The U.S. has been actively involved in all stages of the UN Plan, responding to scientific and special response requests, and participating from the start in the development of international plans and activities. The U.S. has equipment and scientific experts, and has made available special response, technical assistance, and scientific teams to assist regional governments and scientists in the response, assessment, and monitoring of environmental effects and impacts facing the region from the oil discharges and oil fires. In consultation with U.S. Ambassadors in the region, U.S. agencies are cooperating to fulfill specific aspects of the international plan as expertise and resources allow. Efforts are being coordinated through the Environmental Protection Agency (EPA), the Department of State (DOS), the National Oceanic and Atmospheric Administration (NOAA), and interagency work groups.

U.S. response efforts have focused on the most serious and immediate needs - providing assistance concerning the oil discharges and responding to the problems associated with the oil fires. The U.S. has also provided Saudi Arabia with supplementary monitoring equipment, and Kuwait with monitoring equipment to replace equipment destroyed or removed; obtained air monitoring data at different altitudes through ground measurements, fixed wing aircraft, and helicopter flights; and assessed various aspects of the health and environmental situation in the region.

With regard to activities of the intelligence community, the Intelligence Community Staff prepared and submitted a report to Congress, dated June 20, 1991, that addresses the activities and concerns of the U.S. intelligence community. The report conveys findings of the Intelligence Community Task Force established expressly to evaluate the capabilities of National Foreign Intelligence Program assets to contribute to U.S. government activities addressing the nature, impact, and extent of environmental damages resulting from oil fires and discharges in Kuwait and Saudi Arabia.

2. UNITED STATES GOVERNMENT ACTIVITIES

This chapter focuses on United States government activities in response to the oil discharges and oil fires in the Gulf region. The first section of the chapter describes the U.S. technical assistance provided by the U.S. Interagency Assessment Team (USIAT), an oil discharge response group sent to the Gulf region in January 1991. In the region, the USIAT assisted in the establishment of a system to characterize the extent of the discharges, and helped set priorities for response, containment, and remediation. This portion of the chapter also focuses on the international response to the oil discharges.

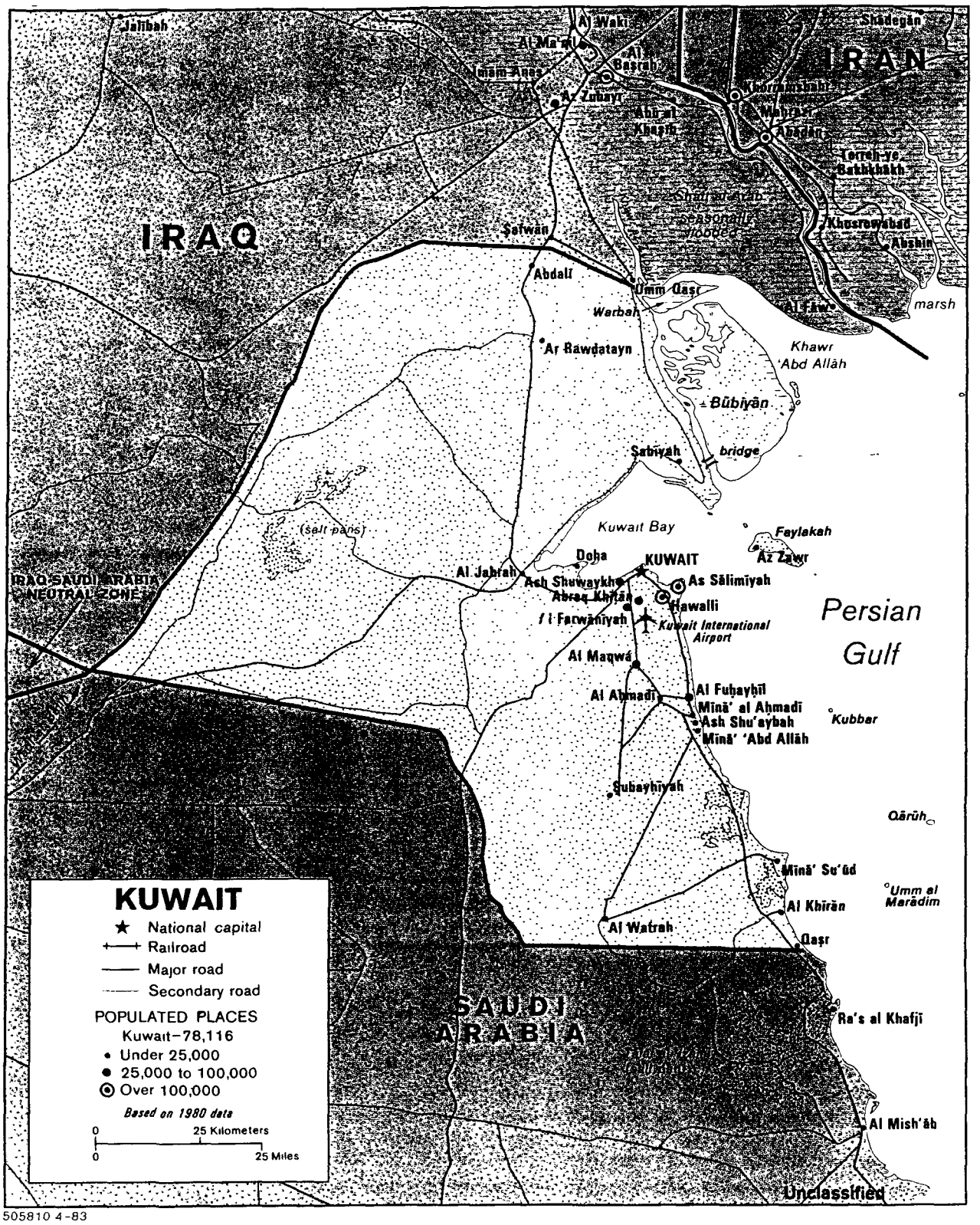
The second section of the chapter addresses the response to the oil fires in Kuwait. The U.S. Interagency Air Assessment Team (USIAAT) traveled to the region in March 1991, to provide technical assistance and assess potential health and environmental effects of the fires. The USIAAT examined existing monitoring networks and continued providing in-country assistance while international organizations were creating a comprehensive monitoring and modeling program. Since emissions from the oil fires have had the potential of causing acute health effects, much of the monitoring and modeling was designed to obtain indications quickly about these potential acute impacts. This section of the chapter also addresses U.S. assistance regarding hazardous and solid waste and water systems in Kuwait.

OIL DISCHARGE RESPONSE

Introduction

In late January 1991, the Iraqi government ordered a series of oil discharges from facilities and vessels in both Kuwait and Iraq. These actions took place as part of the Gulf War and were probably done to slow or prohibit an amphibious landing of coalition forces in Kuwait and Saudi Arabia. Between January 19 and 30, the following events occurred during hostilities:

- Crude oil cargos of tankers anchored off Mina Al Ahmadi in Kuwait were pumped into the Gulf;
- Crude oil began to be pumped into the Gulf through the Single Point Mooring Buoy and Sea Island Terminal at Mina Al Ahmadi;
- Coalition aircraft released smart bombs that stopped much of the oil flow from the facilities at Mina Al Ahmadi;
- Crude oil was discharged from a tanker near the Mina Al Bakr export terminal in Iraq;
- Crude oil was discharged from the Mina Al Bakr terminal in Iraq;
- The refinery at Mina Abd Allah was damaged resulting in a discharge of refined product; and
- Crude oil cargos were pumped off tankers anchored in the channel northeast of Bubiyan Island into the Gulf.


IRAQ
IRAN
SAUDI ARABIA
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Persian Gulf
Kuwait Bay
KUWAIT
Kuwait International Airport
Khawr 'Abd Allāh
Būbiyān
Warbah
Umm Qaṣr
Ar Rawḍatayn
Abdalī
Ṣafwān
Al Jahrah
Doha
Ash Shuwaykh
Abraq Khīṭān
As Sālimīyah
Hawalli
Al Farwānīyah
Al Maqwá
Al Aḥmadī
Al Fuḥayḥīl
Mīnā' al Aḥmadī
Ash Shu'aybah
Mīnā' 'Abd Allāh
Ṣubayḥīyah
Al Watrah
Qaṣr
Mīnā' Su'ūd
Al Khīrān
Ra's al Khafjī
Al Mish'āb
Qārūh
Umm al Marādim
Kubbar
Faylakah
Az Zawr
Khusrowabad
Abshin
Al Fāw
marsh
Shādegān
Jalībah
Al Wakī
Al Ma'qil
Al Baṣrah
Imām Anas
Az Zubayr
Abū al Khaṣīb
Khorramshahr
Mahrazī
Abādān
Torreh-ye Bakhkhākh
Shatt al Arab
seasonally flooded
(salt pans)
KUWAIT
National capital
Railroad
Major road
Secondary road
POPULATED PLACES
Kuwait–78,116
Under 25,000
25,000 to 100,000
Over 100,000
Based on 1980 data
0 25 Kilometers
0 25 Miles
Unclassified

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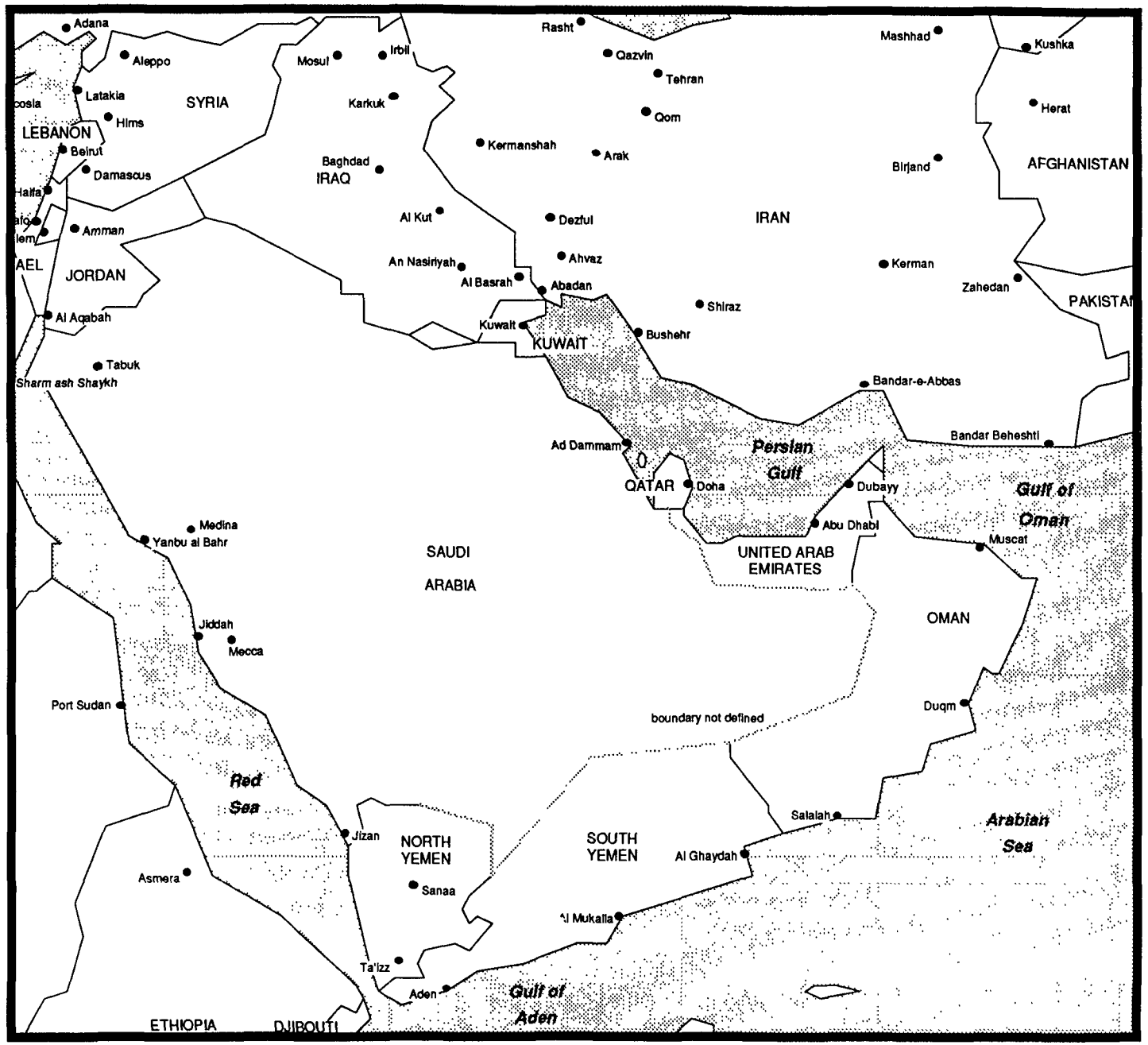
Adana
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Damascus
Amman
JORDAN
Al Aqabah
Tabuk
Sharm ash Shaykh
Mosul
Irbil
Karkuk
Baghdad
IRAQ
Al Kut
An Nasiriyah
Al Basrah
Abadan
Kuwait
KUWAIT
Rasht
Qazvin
Tehran
Qom
Kermanshah
Arak
Dezful
Ahvaz
Shiraz
Bushehr
IRAN
Mashhad
Kushka
Herat
Birjand
AFGHANISTAN
Kerman
Zahedan
PAKISTAN
Bandar-e-Abbas
Bandar Beheshti
Ad Dammam
QATAR
Doha
Persian Gulf
Dubayy
Abu Dhabi
UNITED ARAB EMIRATES
Gulf of Oman
Muscat
OMAN
Duqm
Medina
Yanbu al Bahr
SAUDI ARABIA
Jiddah
Mecca
Port Sudan
Red Sea
Jizan
NORTH YEMEN
Sanaa
Asmera
boundary not defined
SOUTH YEMEN
Salalah
Al Ghaydah
Arabian Sea
Al Mukalla
Ta'izz
Aden
Gulf of Aden
ETHIOPIA
DJIBOUTI

Estimates of the entire amount of oil discharged range between six and eight million barrels, or up to 30 times the size of the 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska (which was approximately 250,000 barrels or 11 million gallons). The main oil slick was probably between 0.5 to 3 million barrels. Most probably, the emulsification process and the deposition of sand increased the bulk of the oil and that which was not recovered eventually sank. The damage assessment task is an ongoing process, and it will take months or years before the effects of the discharges are fully determined.

The bulk of the oil discharged from the multiple sources between January 19 and 30 merged, and together with additional refined oil discharged from a small refinery attacked during the Battle of Khafji in Saudi Arabia, formed a massive slick that slowly worked its way down the coast of Saudi Arabia, nearly coating the coast from Khafji to Abu Ali Island. It is likely that some of the oil discharged from the Iraqi locations took a different trajectory and went undetected until late February 1991, due to lack of access to the northern Gulf because of the war; this oil dispersed into the Gulf, and no known impacts were reported except on offshore islands. When access to the northern Gulf became available at the end of the war, and military operations permitted, it was possible to investigate the magnitude of the remaining free floating oil there.

U.S. Interagency Assessment Team Discharge Response

On January 24, 1991, the Saudi Arabian government formally requested technical assistance from the U.S. ambassador to Saudi Arabia. The request for U.S. assistance was due to the U.S. expertise in handling a massive spill such as the *Valdez* spill and was an action consistent with the recently signed International Maritime Organization (IMO) convention entitled the International Convention on Oil Pollution Preparedness, Response, and Co-operation, 1990 (OPRC). The Department of State referred the Saudi request to the National Response Team (NRT). In the United States, the NRT has the responsibility for developing and implementing the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). EPA and the United States Coast Guard (USCG) (Chair and Vice-Chair, respectively, of the NRT) quickly identified NRT member agencies critical to the response. The NRT agencies worked actively to assemble an assessment team capable of managing the environmental response issues that might have to be addressed. The selected members of the initial assessment team were located all across the country. The level of activity required to select representatives to proceed into a combat zone for environmental concerns was monumental, yet a team was quickly assembled, briefed, and departed via USCG aircraft for the Gulf area. Underlying rapid departure of the USIAT were the logistical and administrative aspects associated with travel to the Gulf. This was further complicated by the bulk of these activities taking place over a weekend when support services were not readily available. On January 27, three days after receiving the request, the USIAT departed for Riyadh, Saudi Arabia, and arrived in Saudi Arabia on January 28.

During this period, the oil slick continued to move southward. In addition to the Saudi government, the governments of Bahrain, Qatar, and the United Arab Emirates also issued formal requests for the USIAT to visit their countries and assist in the preparation of response strategies.

The initial USIAT was led by the USCG and consisted of representatives from EPA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Army Corps of Engineers (USACE). It was later augmented to include a non-governmental response expert (the president of the Spill Contractors' Association of America), a representative from the Department of Energy (DOE), a representative from the U.S. Fish and Wildlife Service in the Department of the Interior (DOI), and an additional USCG liaison officer to the lower Gulf States. While deployed, the USIAT was supported by its parent agencies and the NRT. Various components of the USIAT, as necessary, maintained a presence in the Gulf region until the end of July 1991.

The NRT determined that the USIAT's mission should not be to clean up the discharges, but to assess the magnitude and impact of the discharges on Saudi Arabia, to advise Saudi government representatives, to recommend appropriate response strategies and techniques, and to train local responders. As regional governments and other organizations implemented recommended cleanup programs, the USIAT's role became one of discharge monitoring and evaluation; participating on the International Interagency Assessment Team;

and later, documenting IMO sponsored projects in the field. Various USIAT members also served on the Saudi Arabian Meteorology and Environmental Protection Administration (MEPA) Planning Committee and the King Fahd University of Petroleum and Minerals/Research Institute (KFUPM/RI) Science Committee to assist MEPA with shoreline assessments, determine cleanup priorities, establish wildlife rescue and rehabilitation centers, ensure the implementation of proper cleanup techniques, and develop practical shoreline rehabilitation programs to put into place after the spill had dispersed. The USIAT also tracked and evaluated (e.g., discharge size, type and thickness of oil) offshore free-floating oil in the Gulf and leaking oil in Kuwait.

Responding to an oil discharge in a war zone posed many logistical problems. The level of pressure involved in working in a war zone was stressful, intense, and hampered response activities. For example, personnel were required to carry gas masks at all times and full Mission Oriented Protective Posture (MOPP) gear when making field trips. This equipment was necessary to protect oil spill response personnel from the constant threat of SCUD attacks, and the possibility of nerve or biological agents being carried in the warheads. Open water skimming operations were extremely hazardous. Many of the impacted waters were laden with mines, both submerged and floating on the surface. These pressures, and the inability to secure the source of the oil discharges, further complicated the response effort.

The environmental response activities associated with the Gulf discharges were truly unique. At no point in history has there ever been a mobilization of oil spill response forces within a war zone. Further evidence of this hostile environment was the issue of travel restrictions throughout Saudi Arabia. Access to waterfront facilities was difficult. Security check points and the requirement of specific identification encumbered travel to incident sites. Communications were equally difficult since much of the data normally readily available during an oil discharge, such as weather information, discharge trajectories, and aircraft arrival times, were classified information during the continuation of Operation Desert Storm. Access to necessary data was difficult since the military operations personnel were not used to dealing with a massive oil discharge during wartime operations.

International Response and Coordination

As the magnitude of the discharges became more apparent, many countries began sending experts to help Saudi Arabia cope with it. Experts quickly arrived from France, the Netherlands, Norway, Spain, and the United Kingdom. The experts were integrated into both the USIAT and Saudi Arabian response organization as advisors. Collectively the advisors became known as the International Interagency Assessment Team (IIAT). Due to the early arrival, operational experience, and organizational skills of the USIAT, the USIAT Team Leader continued to serve as principal advisor to the MEPA Vice-President/On-Scene Coordinator, and leadership of the IIAT, consistent with the OPRC, was passed to the IMO representative.

USIAT members established a computer data base to catalog and quickly evaluate the offers of commercial cleanup contractors and private vendors from around the world. More than 500 offers were processed by the end of February 1991. Several proposals suggested new technologies such as in-situ burning and bioremediation. These technologies were referred to the Scientific Committee at KFUPM/RI for evaluation and recommendations for potential use. A key output of the Scientific Committee was development of a protocol for testing various cleanup techniques.

The USCG Marine Environmental Protection Division acted as the initial clearinghouse for national and international offers of assistance. The coordination of this effort was eventually passed to IMO representatives in London for coordination with IMO representatives in the Gulf area. In addition, the USIAT became the IIAT, with USCG as the lead for the U.S. personnel. As offers of help began to arrive from governments around the world, IMO established a Coordination Center in London to screen and categorize offers received. During the first few days of the emergency, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Japan, the Netherlands, New Zealand, Norway, Poland, Spain, Sweden, the United Kingdom, the United States, and the Union of Soviet Socialist Republics all offered assistance.

As MEPA began its response, resources from both international governmental and private organizations began to arrive. The first of several planeloads of oil collection booms from Japan arrived on February 6,

1991. Norway sent offshore boom, skimmers, and equipment operators. The Dutch donated some equipment and sent several other planeloads of shoreline cleanup equipment.

In March 1991, the Gulf Pollution Disaster Fund was established and IMO received donations of $4.5 million from governments worldwide. Additionally, Luxembourg donated $500,000 in equipment. IMO's use of these funds was for the protection and cleanup of environmentally sensitive areas. Some IMO sponsored projects include cleanups at Karan Island (one of the main Green Turtle egg laying locations in the Gulf), Safaniya Bay, Gurmah Island, Kuwaiti oil sources at Al Ahmadi Refinery, Musharrabah Salt Marsh, and Musallamiyah Bay.

Assessment of Discharge Impacts

Following the 1983-84 *Nowruz* spill in the Gulf of approximately 1.5 million barrels of oil, Saudi Arabia developed a National Oil Spill Contingency Plan in which Saudi ARAMCO, the oil company owned by the Saudi government, had the responsibility for oil spill response. In the interim and prior to the war, a new Saudi Arabian Oil Contingency Plan had been developed. In this new plan, the authority for oil spill response was transferred to MEPA. The responsibilities for oil spill response were delegated to the President of MEPA, and the Vice President of MEPA was designated as the National Oil Spill Coordinator. This new plan went into effect shortly before the Gulf invasion began. This left MEPA with little time to develop the spill response expertise needed to manage one of the world's most catastrophic oil discharges. The vice-president and staff of MEPA, Saudi ARAMCO officials, and representatives of the key industrial facilities had met throughout January to discuss roles and assess the discharge response actions. Saudi ARAMCO and the Royal Commission for Jubayl and Yanbu had response actions underway at their own facilities.

Characterizing the Extent of the Discharges

When the USIAT members arrived in Saudi Arabia on January 28, 1991, the leading edge of the discharge was south of Ras Al Khafji, the scene of the first ground action of Operation Desert Storm. They relied on Department of Defense (DOD) satellite imagery to provide initial indications of the overall extent of the slick.

The USIAT advised the Saudis of the need for accurate daily overflight data and constant tracking of the position of the oil slick. They recognized that they would not have access to the entire spill due to military operations and airspace restrictions in the northern Gulf region. On January 30, using U.S. Navy aircraft, U.S. and Saudi observers implemented daily overflights. The initial extent of observation for the overflights was limited to areas south of Ras al Mishab and covered only the slick's leading edge. Eventually, Saudi observers became fully trained and Saudi aircraft and personnel performed most of the coastal flights. Saudi Civil Defense helicopters were used frequently to conduct daily overflights of the Saudi coastline. These overflights provided the best means of tracking free floating oil and the daily observations from this flight helped to confirm on-shore sightings.

It was evident from the outset that detailed mapping of the discharges and affected areas within the Gulf was necessary to mount an effective response. Visual overflight and satellite data were unable to provide the needed coverage, due to cloud cover, airspace restrictions, and other military and weather hindrances. On February 6, 1991, the Saudi government requested the USCG to provide its HU-25 Falcon AIREYE oil surveillance capability. AIREYE is an aerial surveillance information gathering and recording system installed in certain USCG aircraft. AIREYE is composed of side looking airborne radar (SLAR) and infrared and ultraviolet scanners. The SLAR provides film recordings of the exact position and nature of the discharges. The U.S. provided two HU-25 Guardian Aircraft equipped with AIREYE oil surveillance systems and a USCG Aviation Detachment (CG AVDET) to support the two HU-25's. The aircraft and support crews operated out of Manama Airport in Bahrain.

The first AIREYE overflight was conducted on February 20, 1991. By February 27, 1991, two daily overflights were being conducted with different grid patterns flown on each flight both to confirm and provide redundant data. At this point the coalition forces had achieved air superiority and there was safer access to airspace for these overflights. There was still a significant concern over aircraft safety from missiles and other hostile fire. Additionally, a Navy C-12 was used weekly to supplement and verify the SLAR flights' information. This was a vital asset to improve the usefulness of the Kuwaiti and Saudi coastlines visual surveillance. Navy SH-3s also flew two sorties for the USIAT and provided the best visual observations of the spill sources in Kuwait. NOAA interpreted oil observation data from human and remote sensing platforms. These data were incorporated into a NOAA computer model that was used to validate and predict future movements of the slick. The combination of SLAR images and computer modeling became the basis for managing the spill response. When the war ended, reliable information for the entire Gulf area became available, and the MEPA On-Scene Coordinator was able to manage the response more accurately. AIREYE operations were ceased on April 27, 1991, after most of the free-floating oil had washed up on the shorelines along the Gulf.

Throughout March and April 1991, several facilities in Kuwait continued to leak oil, including the offshore terminal at Mina Al Bakr in the northern Gulf, and another at the Sea Island Terminal in the vicinity of Mina Al Ahmadi. Leakage from these terminals was estimated at between ten and several hundred barrels per day. The more significant problem was the continued leakage from the Mina Al Ahmadi refinery complex. The flow from the facility varied greatly from day to day. On one overflight a Saudi ARAMCO official estimated that between 1,500 and 6,000 barrels were being discharged per day.

Establishing Priorities

Other initial undertakings of the USIAT were to assist Saudi Arabia in the development and implementation of an organizational structure capable of addressing all aspects of the massive discharges, and to establish an operations center from which to direct the response. Due to the wartime situation, USIAT members planned around a worst-case spill scenario in which there would be a response effort consistent with the battlefield conditions. This process had to include the immediate development and implementation of a complete response infrastructure. After an initial assessment it became apparent that while Saudi Arabia was well prepared to deal with routine facility discharges, the magnitude of the current discharges completely overwhelmed its response capabilities. The MEPA Vice-President/On-Scene Coordinator immediately requested further planning assistance from the USIAT, and was ready to implement all recommendations consistent with available resources. Drawing on experience gained from the *Exxon Valdez* response, including the USCG Catastrophic Spill Plan and the response organization for catastrophic discharges developed by the USCG's Marine Environmental Protection Division, the USIAT assisted in developing an organizational structure. MEPA adopted the basics of the recommended structure in early February 1991.

The first implementation step was the development of an overall national response strategy. Due to the requirements of supporting the war effort, Saudi Arabia needed to establish the following response priorities:

- Protect high-priority industrial facilities and oil refineries (absolutely necessary to support the needs of the coalition forces);
- Protect environmentally sensitive areas;
- Recover oil in strategic offshore locations to minimize shoreline impact; and
- Remove oil from shoreline areas to prevent it from continuing its movement down the coast.

Due to the magnitude of the spill and the lack of funding and equipment, a priority ranking system was developed for facilities and environmentally sensitive areas. The MEPA On-Scene Coordinator established a national list, and the limited available equipment was moved to high priority sites to protect them from the advancing oil discharges. The top priority was strategic booming and cleanup of shoreline areas to protect key

facilities. According to the Saudi Arabian Oil Contingency Plan, industrial facilities were responsible for the protection of their own facilities.

The desalination plant at Jubayl was the primary facility to protect in Saudi Arabia. This plant is the largest in the world, producing more than 200 million gallons of water daily, and provides the Saudi capital of Riyadh with 80 percent of its water. The USIAT assisted in developing a protection plan for the facility, including diversionary booming around the mouth of the inlet areas, containment booming, and oil recovery skimmers at several locations within the basin. The desalination plant operators lacked adequate equipment to protect it and requested that MEPA provide additional equipment. As donated foreign equipment became available, it was shipped to the desalination plant until the equipment demands were met; additional equipment was shipped to the next priority site.

Discharge Response and Containment

The fundamental goal of all initial operations was the recovery of free floating oil. According to Saudi ARAMCO, Martech (a U.S. contractor from Alaska) was collecting 25,000 barrels per day of free floating oil from Manifah Bay until mid-April 1991. Lesser amounts were collected after mid-April because much had been cleaned up already, and the oil was becoming increasingly viscous. Throughout the response, the majority of Saudi ARAMCO's equipment was deployed to protect desalination plants, power plants, and oil facilities as the Saudi contingency plan required. The migration of the oil resulted in only one threatened industrial facility in northern Saudi Arabia, since the majority of their facilities are located well below Abu Ali Island, the southern extent of the oil impact. The shape of the island, prevailing on-shore winds, and an adjacent reef prevented any large amounts of oil from passing Abu Ali Island and moving far enough south to impact these facilities.

The primary shoreline remedial response took advantage of natural collection areas. The natural collection points were determined by winds and currents that forced the oil into large pools for collection. These collection points were enhanced through the construction of berms and jetties. Trenches were also dug into the shoreline to collect oil in the incoming tide. The combination of enhanced natural collection points and the collecting trenches optimized the shoreline cleanup effort. Pumps of every description were then used to recover the collected or pooled oil. Due to the massive amount of oil that collected along the shoreline areas, the limited equipment available had little effect. By the time the USCG departed Saudi Arabia at the end of July, reports indicated that about 1.4 million barrels (approximately 58.8 million gallons, in comparison to the entire *Exxon Valdez* spill of 11 million gallons) of oil had been recovered from the water and pumped into pits onshore for natural separation and further recovery.

Three skimming vessels under contract to Saudi ARAMCO were deployed in the offshore skimming operations in an attempt to remove as much oil as possible prior to its washing up on a shoreline. The largest skimming vessel, the Norwegian Al Wassit, recovered more than 100,000 barrels of an oil/water mixture during its first 30 days of operation. (The vessel's captain reported encountering oil slicks as thick as six inches that emitted strong vapors for up to three weeks after the discharge.) Two smaller skimming vessels were also effectively deployed offshore. Skimming operations were very slow due to the constant threat of striking a mine.

Shoreline Removal Operations

During March and April 1991, the Royal Commission for Jubayl and Yanbu, using American and Dutch contractors, made progress removing free floating oil in the Abu Ali area. Saudi ARAMCO had already taken protective measures around all critical water intakes to coastal oil-producing, hydroelectric, and desalination facilities, especially around the desalination plant in Jubayl. Saudi ARAMCO also had a small cleanup operation in progress in Manifah Bay using an American subcontractor.

Once the top priority sites were protected from advancing oil, MEPA provided assistance to several secondary facilities that were in the direct path of the migrating oil and closer to the discharges. For example, a

dike was constructed across the mouth of an inlet pond that provided salt water for a Saudi communications station desalination plant in the Ras az Zawr area.

The bulk of the discharge was located along the shoreline between Safaniya and Abu Ali Island. Tarballs were found along the beaches. Where impact was heaviest, the oil mixing with the sand formed asphalt (about a foot thick in some places). Three of the most heavily affected areas in the Gulf region were Al Musallamiyah Bay, Dawhat Manifa, and Dawhat Ad Dafi. These areas include salt marshes, mangrove swamps, and inter-tidal creeks and streams. MEPA, Saudi ARAMCO, and the Royal Commission all share responsibility for the cleanup of these areas.

In late-March 1991, MEPA signed contracts with both Crowley Maritime Corporation and Bechtel to begin the necessary cleanup operations. After signing the contracts, the MEPA Vice-President called for the reactivation of the Planning Committee, a small, high-level advisory group that would determine future discharge response strategies. The committee developed an organization to incorporate the roles of the IIAT, IMO, Bechtel, and Crowley. The Planning Committee, which included representatives from the USIAT, IMO, and countries such as the Australia, Germany, Japan, the Netherlands, and the United Kingdom, also developed a process to conduct shoreline assessments and develop a priority list for cleanup.

Potential for Further Impacts

Oil that had been collecting in land pools as a result of the damaged Ahmadi, Magwa, and Burgan oil fields in Kuwait was identified as a major potential threat to the Gulf waters. Many of these wells and pools were less than four miles from the coast. Saudi scientists at KFUPM/RI estimated that oil was accumulating at the rate of 100,000 barrels per day for every million barrels per day of oil lost from the damaged oil fields.

By the end of April 1991, these sources were no longer considered to be a threat. This conclusion was based on observations made by USCG personnel during a Navy SH-3 helicopter overflight and NOAA representatives who visited these facilities from land. By that point, virtually no significant amounts of free-floating oil remained in the Gulf and that there were no more substantial threats to the coastline of Saudi Arabia. At that juncture, IIAT and MEPA shifted their focus from emergency response to shoreline remediation.

Environmental Remediation

The Saudi coastline has several wetlands, saltmarshes, mudflats, and mangrove swamps in the intertidal zones which provide habitats and nesting areas to many migratory and native birds, including the flamingo and the endangered Socotra Cormorant. The Gulf is the only area in the world where this cormorant lives. Some areas in the Gulf are also home and nesting site to Green Turtles, dugongs (Gulf cousin of the manatee), and active coral reef systems. Due to the remoteness of these areas and the lack of response equipment, many sensitive areas were not protected and thousands of birds were casualties of the discharges.

Efforts to respond to and mitigate the damage to the coastal ecosystem began while the oil was still moving southward. Wildlife rescue projects were established at Jubayl, Tanaqib, and Ras Tannurah, funded by the Royal Commission, and staffed by volunteers. Several hundred birds have been rehabilitated at these facilities. In April 1991, a Shoreline Cleanup Committee, consisting of representatives from the IIAT, MEPA, the National Commission for Wildlife and Conservation Development (NCWCD), Crowley Maritime Corporation, and Bechtel, was convened.

Based upon a preliminary Bechtel report on the location of sensitive areas, a proposed response method was developed for each section of impacted shoreline. The focus of that assessment was to:

- Determine and rank sensitive areas -- NCWCD
- Provide a listing of cleanup methods available -- USIAT

- Recommend cleanup methods -- Crowley
- Develop a list of priority areas and recommend cleanup techniques including required secondary measures -- USIAT
- Obtain approval from MEPA for preliminary action -- Bechtel
- Conduct a field trip to verify accuracy of list, and expand the list when necessary -- All
- Submit final list to MEPA for approval -- Bechtel
- Conduct cleanup according to list and funds available -- Crowley
- Determine whether shoreline cleanup meets appropriate standards -- Shoreline Action Team (a subset of the full committee)

The U.S. Fish and Wildlife Service provided valuable input to the Saudi government regarding setting priorities for key environmentally sensitive areas included in the national priority ranking list.

A Shoreline Action Team was established to determine priority sites for remediation purposes. The team was composed of members from IIAT, Bechtel, Crowley, the European Economic Commission, KFUPM/RI, MEPA, and NCWCD. The team drew upon many response and cleanup methodologies that were pioneered during the *Exxon Valdez* spill in Alaska. The team took a seven-day trip in May to assess the coastline and covered approximately 600 miles of shoreline. One hundred and twenty-seven sites were recommended for review. As a result, the group produced a computer data base which will ultimately be used as a means to direct shoreline remediation and to make financial decisions. Decisions on additional shoreline remediation efforts are under consideration by the Saudi Arabian government. When the USIAT completed all its tasks it was recalled to the United States on July 31, 1991.

Environmental Restoration

The Intergovernmental Oceanographic Commission (IOC) is taking the leadership role for the short-term and long-term research on the impact of the oil spill, cleanup response, remediation, and restoration work focusing on the effects of the spill and the ecology of the area. Their efforts are being coordinated under the UN Interagency Plan of Action.

OIL FIRES RESPONSE

Introduction

The retreating Iraqi army set fire to or damaged over 700 oil wells, storage tanks, refineries, and facilities in Kuwait. The most recent estimate from the Kuwait Petroleum Company indicates the following:

Total Damaged or on Fire	Total Fires	Total Controlled[2]	Total Remaining Uncontrolled
749	610	441	308

As of September, 1991

The majority of fires were centered in the Al Burgan oil field south of the Kuwait City airport.

U.S. Interagency Air Assessment Team Response

Emergency Response

The United States participated in the oil fires response at the request of the Saudi Arabian government. The Saudi government requested U.S. technical assistance in addressing potential health and environmental effects of the fires. The U.S. Embassy in Saudi Arabia concurred with this request, and voiced additional concerns about the potential health effects of the fires on the U.S. troops in the region and American citizens residing in the Gulf countries. The Kuwaiti government expressed similar health concerns. The USIAAT consisting of representatives from EPA, the National Oceanic and Atmospheric Administration (NOAA), and the Department of Health and Human Services/Centers for Disease Control (HHS/CDC) was convened, and deployed to Saudi Arabia and Kuwait on March 10, 1991. This team was assisted by representatives of the USCG, DOD, and DOE already in Saudi Arabia assisting in response to the oil discharges. No contingency plan existed to guide atmospheric monitoring and health assessment programs.

With the assistance of the Saudi and Kuwaiti governments, the USIAAT conducted air sampling, health surveys, and aerial reconnaissance surveys of the fire plumes from March through May 1991. The USIAAT's primary objective was to obtain preliminary, short-term data on the emissions from oil well fires at a variety of locations, in order to:

- Determine if hydrogen sulfide, sulfur dioxide, and particulate matter -- three toxic pollutants which might be expected to come from burning oil wells -- were posing an acute health threat;
- Identify and quantify the gaseous and particulate by-products being produced from the burning oil wells;
- Determine if materials associated with the fires could affect geographic areas where people might be exposed; and
- Assess the potential extent of the health effects related to the emissions from the fires and related aspects of the Kuwaiti and Saudi health services infrastructure.

Samples were obtained directly from the Kuwait oil fields, as well as from Kuwaiti and Saudi Arabian locations where embassy officials, U.S. troops, and U.S. citizens were working and residing. Additionally, the

[2] "Controlled" includes extinguished/capped fires, capped "gushers," and repaired leaking wellheads.

USIAAT interviewed health officials to evaluate the extent of acute respiratory problems related to smoke exposure.[3]

The invasion and occupation of Kuwait caused the departure of large numbers of health care professionals and disabled the health care system. In addition to the work of the USIAAT, DOD developed a plan to bring in food, water, and medical supplies to Kuwait after its liberation and to restore the Kuwait governmental infrastructure, including the public health system. Subsequently, HHS assigned two officers to explore options for restoring the public health system and advise the Kuwaiti government and the public health service on a variety of issues ranging from sanitation to health services.[4]

Initially, the regional governments provided the USIAAT with air monitoring information covering the past several years in Saudi Arabia, Kuwait, and Bahrain. These data provided a useful baseline for evaluating the emissions from the oil fires. The USIAAT concurred with the Saudi government's view that the Saudi public and private sector air monitoring systems would need to be supplemented with support and technical assistance. The Kuwaiti air monitoring system also had to be supplemented, especially due to the initial lack of electricity in Kuwait City and the disruption of Kuwait's governmental and scientific infrastructure.

The USIAAT also completed the following activities with the cooperation and support of the host governments:

- Collected and analyzed meteorological observations and reviewed existing monitoring data[5];
- Produced daily forecasts and recorded visual observations of the smoke plume;
- Installed a ground-based sampling network of portable equipment at 15 to 20 locations to measure PM_{10} (particulate matter less than ten microns in diameter), determined the ratio of the less than ten micron particles to total particulate load, and undertook limited organic analyses.[6]

The USIAAT's preliminary findings (in February and March) were as follows:

- Limited sampling did not reveal the existence of high concentrations of sulfur dioxide or hydrogen sulfide near the burning wells or in populated areas in the path of the oil well fire emissions.
- High levels of total particulate matter were found in the air from ground-based monitoring.[7]
- The results of the monitoring findings and health interviews with medical personnel in the affected areas suggested that susceptible population groups, such as individuals with asthma and chronic obstructive lung disease, might experience exacerbation of their symptoms. Special health concerns, warnings, advisories, and precautions seemed clearly warranted for

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[3]EPA released the initial assessment in an Interagency Interim Report of April 3, 1991. EPA released the compiled data in May (Appendix G).

[4]HHS "Status Report of Public Health in Kuwait as of March 21, 1991," can be found in Appendix H.

[5]Plume observations were obtained via satellite daily, and were supplemented by periodic on-scene aerial transects designed to characterize the overall geometry of the plume.

[6]This was done because particles of this size range are known to cause respiratory and other health effects.

[7]It is important to note that pre-war Kuwait total suspended particulate measurements were among the highest in the world due to contributions from wind-blown sand.

these individuals. This situation did not appear to be life-threatening under the current exposure conditions but, if meteorological conditions were to change (e.g., due to poor air mixing or plume touchdown), there could be adverse health effects.

- The long-term health effects were not readily ascertainable due to insufficient data on the populations exposed, the composition of the smoke plume, the impact of oil pools, and long-term meteorological patterns. Aggravating the problem was the severe damage to the scientific infrastructure of Kuwait that limited in-country analytic capabilities. Both the Kuwaiti and Saudi health communities expressed interest in obtaining training, equipment, and other support from the U.S. medical community.

In addition, the USIAAT worked with the Saudi Arabian MEPA to develop an air monitoring plan for the Gulf region that would provide a comprehensive method for assessing the impact on Saudi Arabia of the oil fires burning in Kuwait. The plan was developed at the request of the Vice-President of MEPA. The Saudis presented the final plan, entitled the Gulf Regional Air Monitoring Program (GRAMP), at the April 1991 WMO meeting in Geneva, Switzerland. This plan was a collaborative U.S. and Saudi effort and mirrors the USIAAT's regional Gulf air monitoring plan released by the EPA in an Interagency Interim Report in May 1991. It also provided the basis for much of the U.S. response. The WMO plan incorporated many international programs into its overall work plan developed in April 1991.

Initially, in the emergency response phase, the USIAAT performed a preliminary assessment of acute health threats. As regional and international plans under WMO and WHO, and the Saudi MEPA's GRAMP were developed, the U.S. moved into the second phase of its response and participated in various portions of the health monitoring and modeling programs.

As the USIAAT continued its activities under the GRAMP and international plans, there was a shift in response efforts, under an international framework, from the emergency phase to the long-term response phase. Broad missions were distributed among federal and non-governmental agencies and organizations within the U.S. with the best resources to complete the tasks. The U.S. undertook the following responsibilities in the region:

- Continued assessing the air quality conditions through air sampling and monitoring in oil fields and other areas;
- Began to determine long-term potential health effects;
- Continued reviewing the relevant health services infrastructure;
- Determined the capability of the region to handle the health threat through air monitoring and appropriate corrective action;
- Continued to provide technical assistance; and
- Considered appropriate follow-up action.

NOAA maintained a continuous meteorological monitoring presence in the Gulf subsequent to the departure of part of the USIAAT. This on-site capability was intended to advise local authorities on meteorological matters related to the plume and its dispersion, support continuing meteorologic scientific missions, and subsequently to set up an early warning system in Kuwait.

Atmospheric models were in place at the end of the war, having been applied to assist in forecasting the drift of the oil slicks in the Gulf. Immediately after the fires were ignited, these models were redirected to address the new problem. In particular, the predictive wind field models developed by NOAA Air Resources Laboratory, which uses wind fields developed by the National Weather Service, were employed to produce predictions of where the plume would go. These predictions were hampered by the lack of local meteorological

data as many meteorological systems in Kuwait were destroyed during the war. Specific NOAA contributions were (a) the provision of a vertical temperature measuring system for Kuwait (through WMO), (b) the setting up of a meteorological system (with the assistance of DOE/Oak Ridge National Laboratory) intended to help drive an early warning system (for providing warnings of perceived or possible high exposure), (c) the development and subsequent refinement of new models for taking local terrain effects into account, (d) the development of a system to archive all relevant meteorological data, and (e) the provision of a specifically detailed subset of meteorological data for addressing questions related to local air quality in Kuwait.

In addition, early observational programs forecasted the transport and dispersion of the plume, especially its rise and radiative consequences. Detailed studies were made, by NOAA scientists on the scene, of the effects of the plume loft on ground level atmospheric conditions.

Existing Monitoring Network Assessment

The USIAAT gathered information on existing air monitoring networks in the region operated by MEPA, Saudi ARAMCO, Kuwait, Bahrain, and the Royal Commission for Jubayl and Yanbu. It then reviewed the spatial distribution of the existing network in the region to identify site locations, air pollutants and meteorological variables monitored at each site, and the overall quality of the existing data. This review determined that the existing network needed to be expanded to include other air pollutants and meteorological variables, and that establishing additional air monitoring stations was necessary to clarify the effects of the oil fires.

The principal pollutants from the burning oil not measured by the Saudi and Kuwaiti networks were PM_{10}, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). PM_{10} are the particles most likely to penetrate deeply into the lungs and cause health problems. Because of the importance of this particular pollutant, and the extensive particulate matter resulting from the oil fires, the USIAAT recommended that special efforts be made to gather PM_{10} data and determine the constituents of PM_{10}, including trace metals and hydrocarbons. The PM_{10} data collection effort was supplemented with collections of PAH samples and air samples for VOC analysis.

The development and deployment of a coordinated and standardized monitoring network accomplished several objectives: it assured data consistency throughout the region; it provided better data to assess the immediate health risks and the potential for long-term health risks; it could be used to initiate, test, and refine forecast models; it can provide information for the development of location and condition-specific alerts, including special advisories for populations at risk under specific meteorological conditions; and it provides a better basis for scientific understanding and knowledge of important regional atmospheric conditions and contributes to the assessment of possible long-term consequences of the fires.

The USIAAT assessed analytical laboratory support for air monitoring by KEPD, MEPA, KFUPM/RI, and Saudi ARAMCO from the beginning of the response. The Kuwaiti laboratory capability to analyze air and particulate matter samples was left largely intact after the war. Quality control, quality assurance samples, and support for the network had to be developed within the available laboratories but also supplemented from external sources.

The level of technical competence within all of the facilities visited by the USIAAT during the period (MEPA, KFUPM/RI, Saudi ARAMCO, and KEPD) indicated that additional equipment, the implementation of standards, and training were needed at all facilities in order to support, in-country, the sampling and analysis required.

International Response and Coordination

Under the umbrella of the United Nations Interagency Plan to assess the environmental effects of the Iraqi invasion, the WMO sponsored a conference on April 27-30, 1991, in Geneva, Switzerland, to assist in the development of a strategy for international efforts in the Gulf and to coordinate international activities related to

atmospheric issues including monitoring, modeling, and weather. Representatives from several U.S. government departments and agencies attended. A coordinated international plan of action was adopted to address atmospheric issues in the Gulf region. The USIAAT continued its assistance within this international framework.

Assessment of Air Quality Impacts

Characterizing the Aerial Plume

The WMO Plan addressed the need for atmospheric studies of several kinds, primarily for the following reasons:

- To develop an Early Warning Health System for the Gulf region to respond to air pollution resulting from the oil fires. The system would provide for health advisories to the affected populations so they would be able to minimize their exposure to high pollution levels.

- To track the air pollution from the Kuwait oil field fires over time to assess potential long-term health, ecological, and climate effects. The proposed air measurement network was coordinated with a parallel health monitoring information system development effort.

- To collect samples of airborne particles to perform toxicity testing and dose response assessments.

- To facilitate evaluations of models used to predict local and regional scale behavior of the emissions from the oil fires. Air quality and meteorological data from the expanded Gulf Regional Air Monitoring Network were important for these evaluations.

Characterization of the aerial plume is being carried out through both ground-based and aircraft-based air monitoring programs.

Ground-Based Sampling

A team from the National Institute of Standards and Technology (NIST) obtained measurements of carbon monoxide, carbon dioxide, methane, hydrogen sulfide, sulfur dioxide, particle size, elemental and organic carbon, metals, polycyclic aromatic hydrocarbons, and acid aerosols close to the fires. These measurements are part of NIST's source term characterization effort detailed later in this report. The overall goal was to determine the amount of smoke and attempt to characterize and categorize emissions from individual well fires. This information will be used together with the energy release rates of a large number of oil well fires to estimate the total production of smoke, other particulate matter, and gases from all of the fires in Kuwait.[8]

Aircraft Air Sampling

Aircraft provide an effective method of measuring plume dispersion, composition, and radiative effects. Largely under NOAA leadership, WMO developed a coordinated plan for aircraft studies as part of its report. A sequence of multi-agency and multi-national aircraft investigations were planned with initial U.S. exploration by a combined University of Washington (UW) and a National Center for Atmospheric Research (NCAR) team, to be followed by a study coupling the facilities of the DOE/Battelle Pacific Northwest Laboratory aircraft with the near-field probing capabilities of the fire-product sampling team from NASA/EPA. The earliest experimental studies were conducted by an English aircraft (C-130, UK Meteorological Office). A German

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[8]Mulholland, G.W., Benner, B.A., Fletcher, R.A., Steel, E., Wise, S.A., May, W.E., Madrzykowski, D., and Evans, D.D., Analysis of Smoke Samples from Oil Well Fires in Kuwait, NIST (U.S.) Report of Test FR 3985; June 1991.

aircraft (Piper, German Environmental Protection Authority) also made measurements during the period that the UW and NCAR aircraft were in the Gulf region.

University of Washington and NCAR Aircraft Mission. The National Science Foundation (NSF) coordinated resources to mount a research aircraft program to obtain data for the assessment of the smoke's environmental and health effects. DOD, DOE, and NOAA provided support for this effort.[9] The National Geographic Society also supported the research aircraft program. The program involved approximately 35 scientists from seven U.S. universities, NCAR, and NOAA.

The scientific goals were:

- To characterize regional emission rates of smoke particles and trace gases;
- To measure the chemical composition of the plume, and determine how the composition changes with time;
- To measure radiative properties of the smoke particles and net radiative effects of the plumes, with attention to how the degree of their radiation affects the altitudes of the plumes and the surface temperature;
- To measure the characteristics of the smoke particles, including determining if the particles are hydrophilic (i.e. having a strong affinity for water), or acquire such a component through chemical transformations, thereby accelerating their removal from the atmosphere by cloud and precipitation processes;
- To search for direct evidence that the smoke particles are removed from clouds and determine the effects of the smoke on the composition and radiative properties of clouds; and
- To study regional weather anomalies associated with these smoke emissions.

The primary tools used were the NSF research aircraft (Lockheed Electra) operated by NCAR and the aircraft (Convair C-131A) operated by UW. The aircraft were in the Gulf region from May 16 through June 12 in the first phase of the program. NOAA's Air Resources Laboratory tailored its modeling facilities to provide plume predictions to guide the aircraft program, together with interpreted satellite data. DOE's Lawrence Livermore National Laboratory also provided its Atmospheric Release Advisory Capability (ARAC) model forecasts of plume transport and dispersion for flight planning and mission support. Such forecasts have also been provided, at WMO request, to several Gulf region environmental and meteorological agencies. This support will continue through fiscal year 1991.

The aircraft gathered the following data in a combined total of 35 flights: measured the sizes and mass distributions as a function of size of the smoke particles; measured trace gases[10]; took multi-wavelength radiation measurements to measure the effects of the smoke (the unique radiative property data collected in these airborne studies will provide inputs to numerical models that can be used to predict the effects of the smoke on health, weather, and climate); took remote sensing LiDAR (Light Detection and Ranging) measurements of the distribution (horizontally and vertically) of the smoke for flux determinations and dynamic observations; measured the characteristics of the smoke particles, including light extinction, scattering, and absorption properties of particles and their activity as cloud condensation nuclei; and measured cloud properties (drop size distributions, liquid water content, cloud interstitial aerosol, and cloud nucleus material).

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[9]This was done through the Federal Coordinating Council for Science and Engineering and Technology/Committee on Earth & Environmental Sciences/Subcommittee on Atmospheric Research.

[10]Trace gases include sodium dioxide, carbon monoxide, carbon dioxide, methane, ozone, hydrogen sulfide, nitrogen oxides, ammonia, nitric acid, non-methane hydrocarbons, and carbonyl sulfide.

DOE/Battelle Pacific Northwest Laboratory, Brookhaven National Laboratory, and Lawrence Livermore National Laboratory Aircraft Mission. DOE's Pacific Northwest Laboratory owns the twin-turboprop Gulfstream (G-1) aircraft that operated in the region as part of the WMO research aircraft plan. DOE financially supported the UW and NCAR aircraft and subsequently made more funds available for the use of the G-1 aircraft. Instruments aboard the G-1 can measure gases such as sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, and carbon dioxide. It can also measure hydrocarbons; the number, size and composition of airborne particles; light absorption and scattering by particles; solar radiation; temperature; and humidity.

Operations started in late July 1991, and the data gathered during these flights is still being analyzed and will complement the data acquired during the NSF organized missions, because they were obtained under different meteorological conditions. The G-1 flights were also coordinated with the NASA/EPA helicopter mission sampling close to the plume sources. ARAC provided specialized forecasts of discrete plume particle age groups in support of the G-1 sampling program.

DOE's scientific approach accomplished three primary program objectives: it measured the pollutant transformation/removal rates in the Kuwait oil fire plume; it characterized the chemical and physical state of the plume over a range of distances from the source; and it applied these measurements for the quantitative evaluation of global atmospheric-chemistry models and associated models of radiant transport through aerosol plumes.

Helicopter Missions

NASA's Langley Research Center and EPA conducted a DOE-funded experiment using helicopter based sampling to characterize emissions from the Kuwait oil fires at their source. These missions, involving NASA, EPA, NOAA, Saudi, and Kuwait research scientists, focused on determining concentrations of both gaseous and aerosol (particle and liquid phases) emissions to be used as source terms for combustion and dispersion models. A Royal Saudi Air Force helicopter was used to collect smoke samples during seven independent missions spanning the period of July 31 to August 7, 1991.[11] Trace gases such as carbon monoxide, methane, nitrous oxide, and non-methane hydrocarbons were found at lower than anticipated concentrations relative to combustion produced carbon dioxide except over the large pool oil fires. Very high concentrations of particles, relative to carbon dioxide, were observed in all "black smoke fires." Surprisingly elevated levels of sodium chloride were measured in the "white smoke plumes." Sulfur dioxide concentrations of several hundred micrograms per cubic meter of sample were determined in most smoke plumes. These concentrations are not at levels that could pose chronic health effects, except for those persons with pre-existing chronic conditions. Analyses to determine heavy metal, PAH, and other specific chemical compound concentrations and interpretations of the significance of these results, will be forthcoming.

Modeling

In addition to ground-based and aircraft missions, the WMO plan also addressed the need for modeling to predict environmental and health effects. Unfortunately, to date, no models have been tested against data obtained in a disaster of this magnitude. Therefore, all experimental model programs attempt to refine scientists' understanding of factors critical to improving the predictions of: (a) the effects on human health; (b) the consequences to local and regional ecosystems; and (c) the effects on the atmosphere on all scales, from local to global. To date, most of the experimental effort has been by U.S. teams working with Saudi Arabian and Kuwaiti scientists, but considerable involvement from other countries has begun as well.

Near field, local scale, regional large scale, and global models all may be used to study the fires' influences. It is expected, however, that the model components now available will need to be refined on the basis of newly obtained data and data now being sought. Further, early sampling results indicated that site-

[11]This mission is included in this report because it began in July even though it was completed after the July 31, 1991 cutoff date for the report.

specific models are needed to forecast where the plume(s) will be most intrusive, warn of periods of likely high exposure, and guide measurement programs. A number of models of different complexities were developed, refined, and applied by NOAA. Some of these models continue to be used to predict plume dispersion and form the basis for the early warning system now being completed.

Numerical models will provide the best assessments of the fires' consequences. As there are many potentially applicable models, a wide range of numerical outputs should be expected. Both predictions of grave environmental consequences and of little damage have been made. For example, some predicted that the levels of hydrogen sulfide and sulfur dioxide would lead to acute health impacts. Thus far this has not been the case. In order to extract the most useful predictions, a program of field measurement has been generated using different model spatial scales.

Near Field Models (1 - 10 km) - the Source Term. All models require accurate source term ("near the source") data. Determining the heat release rate of the fires is critical to determining the rate of input of chemicals into the atmosphere. A fire acts as a pump; air is pulled into the fire, and some portion is used for combustion. The rest is heated, expanded, and injected into the atmosphere and carries away the combustion products.

NIST performed ground-based source term characterization measurements in cooperation with the U.S. Army Corps of Engineers. By making measurements of the fire, thermal radiation emitted, and/or flame height, the heat release rate can be determined. From the heat release rate, emission and near field smoke plume flow can be computed. Coupling the smoke production rate with quantified smoke samples can provide the needed chemical input rate for the atmospheric and health effects models. This data is needed for analysis of near and far field smoke samples.[12]

Local Scale Models (10 - 100 km) - the Merging Plumes. Individual plumes from the separate well fires merge as they rise through the atmosphere. The "merging plume" region is one in which the plumes from the wells lose their individual identity and their heat and reach a height that may be considered as the "effective height of input" for regional large scale numerical models. Studies are needed in this region to ensure that correct effective source terms are driving global models and to test for the effects of the plume on the transmission of sunlight through the atmosphere. Aircraft studies of the merging plumes are integrated into WMO's overall aircraft program, and data for these models are being obtained from the previously described aircraft air sampling missions.

Regional Large Scale Models (100 - 400 km) - The Super Plume. The WMO plan also proposes measurements of the large-scale plume affecting areas of Saudi Arabia, Iran, and other countries in the region. The recommendations call for a strategy of extended investigations of the plume and its composition throughout the period when the fires are being extinguished. Acquisition of these data is the primary goal of the various fixed-wing aircraft missions. ARAC and NOAA have been providing plume assessments on this scale continuously since April. These forecasts allow aircraft flight planners to optimize air time in and near the plume. NCAR, NSF, and several U.S. universities will be doing modeling with the data that have been collected.

Global Models. Global models can be used to look at the large scale dispersion of pollutants from the fires and their possible climate impact. Initial analyses of measurements indicated that smoke from the Kuwait fires may have increased the normal background concentrations of black carbon or soot (very slightly) as far away as Mauna Loa, Hawaii. It was also tentatively identified in air over Wyoming. Initial global model calculations from Lawrence Livermore National Laboratory were consistent with the increased concentrations of soot at Mauna Loa for typical springtime meteorology, but indicated that the concentration levels should

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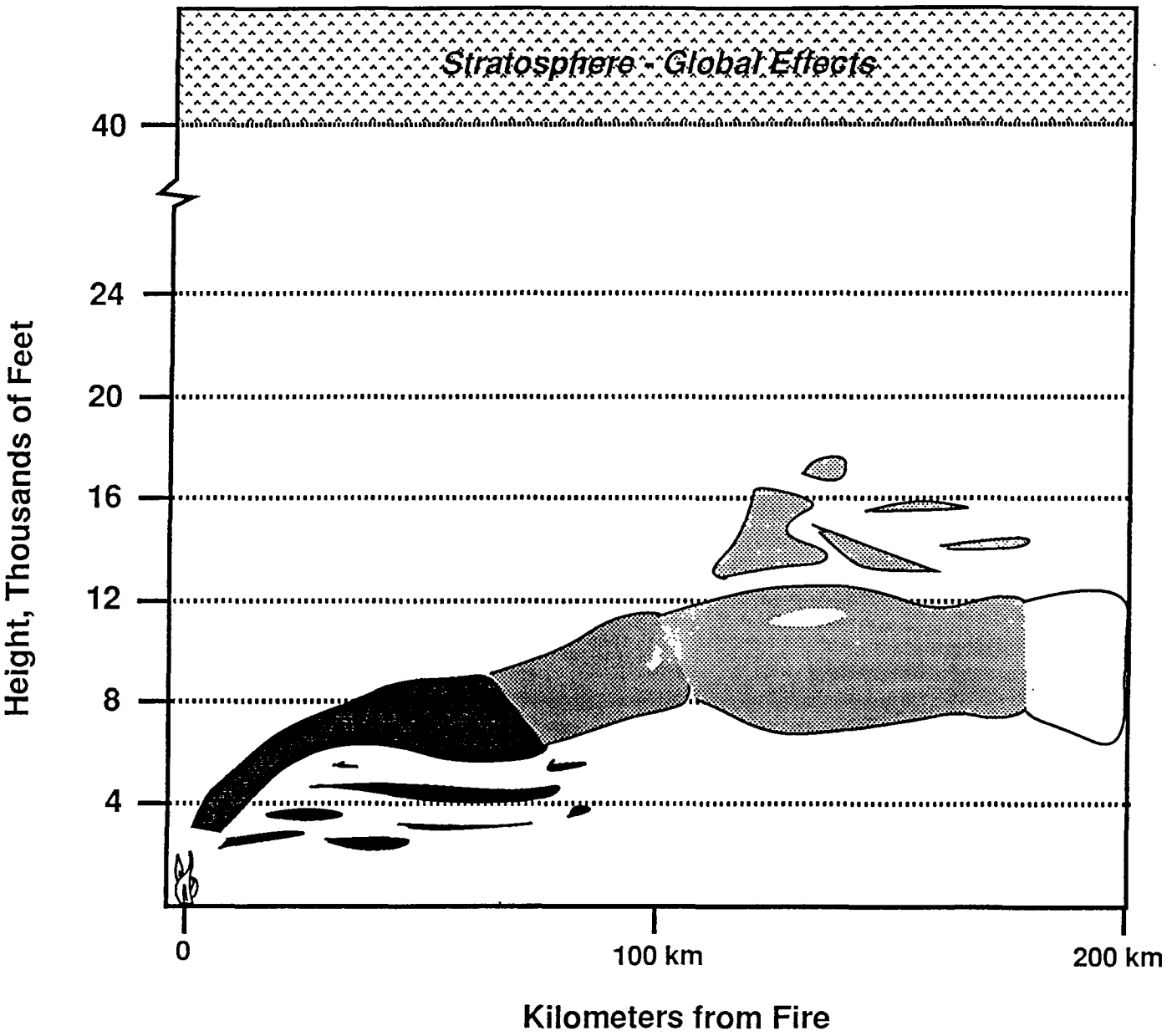
[12]Madrzykowski, D., Evans, D.D., Mulholland, G.W., Bryner, N.P. Baum, H.R., Benner, B.A., Fletcher, R.A., Steel, E., Wise, S.A., May, W.E., and Haynes, G.A., Preliminary Study of the Kuwait Oil Well Fires, NIST (U.S.) (To be published).

decrease throughout the rest of the year.[13] This model also showed that concentrations of soot and sulfates from the fires were elevated over background levels throughout a large area surrounding the Gulf region. These initial simulations did not predict large changes in climate, but also did not account for the correct emissions or emission altitude. Re-analysis using more recent data is desirable.

The diagram on the following page has been developed to illustrate the dissipation of the smoke plume as it travels away from the fire source. The plume has been measured at heights between 1,500 feet to 19,000 feet, but is generally at heights of 1,500 feet to 13,000 feet. As indicated, the plume does not rise into the stratosphere (even over great distances) and therefore, global effects are not likely.

[13]Penner, Joyce. "Global Model Simulations of the Long Range Transport of Soot and Sulfur from the Kuwait Oil Fires," paper prepared for the Expert Meeting on the Atmospheric Part of the Emergency Response to the Kuwait Oilfield Fires, WMO, April 27-30, 1991. (Lawrence Livermore National Laboratory Report UCRL-JC-107737, 1991)

Oil Fire Plumes



Observations:

- **The plume does not rise into the stratosphere and therefore, global effects are not likely.**
- **The smoke plume is generally at heights between 1,500 feet and 13,000 feet.**
- **The smoke plume dissipates as it travels from the source.**

Graphic: U.S. EPA

Data Source: NSF

Data Coordination

King Fahd University of Petroleum and Minerals/Research Institute designed the first system to provide access to data related to the fires. Data transmission capability was established enabling image, graphics, and text exchange among participants in the monitoring, forecast, and health elements of the program. In the short term, a temporary archive was developed to avoid loss of key data sets.

As part of a WMO agreement, NCAR recently began assembling and will maintain a full data archive that will include all available atmospheric data sets. NCAR is also developing a software system to extract and display the data. Regional archive centers will be established through WMO auspices in various Gulf nations. Full access to these data will be available to scientists worldwide. These data will be used for health assessments, weather and climate impact studies, and air quality and atmospheric chemistry studies.

Meteorological data for the Gulf region are being archived by the NOAA Air Resources Laboratory. A specially detailed data set has been produced which covers several months to provide a more firm foundation for testing model predictions against the findings of aircraft sampling programs.

Health Assessment

The Office of International Health, Public Health Service, HHS, at the suggestion of DOS, requested the preparation of a health advisory to be transmitted to the U.S. Embassies in Kuwait and Saudi Arabia and the Department of Defense Central Command in Saudi Arabia. HHS issued the "Preliminary Health Advisory Related to Burning Oil Wells in Kuwait, March 21, 1991." It addressed the potential health threats posed by soot and toxic products form burning and damaged oil wells, the signs and symptoms of exposures to selected hazards, and the public health measures that might be recommended, including advice that the governments of the respective countries could give to health workers and to their people.[14]

The Preliminary Health Advisory stated that, "persons residing in areas thought most likely to be affected by the traveling plume and changing meteorological conditions should be advised on measures they could take to reduce their exposures. These included limiting outdoor activities, keeping windows shut, and monitoring changes in their own health status." The Advisory recommended that, "assessment be made of resources and facilities to provide health alerts and information to local residents as the need arises."

Initial Health Advisory

At the request of the EPA and the Department of Health and Human Services (HHS) Committee to Coordinate Environmental Health and Related Programs, the Kuwait Working Party (KWP) -- a group composed of members of various HHS agencies and other governmental agencies met, beginning in April, to identify public health issues, strategies, and approaches related to the oil pools and oil well fires burning in Kuwait.

Initially, persons with asthma or pre-existing pulmonary disease (chronic bronchitis, chronic obstructive pulmonary disease), and possibly infants, children, and elderly adults were at risk of exacerbation of their conditions due to acute exposure to the oil well fires. This situation will continue until most of the fires are controlled. It is not now known if chronic exposure to oil well fires will be associated with an increased incidence of pulmonary disease.

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[14]The "Preliminary Health Advisory Related to Burning Oil Wells in Kuwait, March 21, 1991" is located in Appendix H.

Initial Health Sampling, Planning, and Monitoring[15]

An initial assessment of the health situation in Kuwait was documented by an epidemiologist with the Agency for Toxic Substances and Disease Registry, Public Health Service, HHS, who was attached to the U.S. Army's 352nd Civil Affairs Command and who entered Saudi Arabia on February 15 and Kuwait City on March 1.

Emissions from oil fires have the potential of causing health effects of both an acute and chronic nature although there is considerable uncertainty as to the extent of the threat. Chemicals such as sulfur dioxide and hydrogen sulfide, as well as carbon monoxide and polycyclic aromatic hydrocarbons are often found along with particulate matter in oil fires. While only limited assessments were performed by the USIAAT, they did not detect these chemicals in any significant quantity in populated areas (based on EPA's National Ambient Air Quality Standards for such chemicals); further, preliminary analysis of particulate matter did not reveal any chemicals at levels of concern. Additional testing continues to discover whether or not other toxic materials are associated with the high levels of particulate matter. Preliminary surveys of the local hospitals by a Centers for Disease Control (CDC) epidemiologist on the initial USIAAT did not show increased admission rates for respiratory complaints, and more detailed analyses are underway to understand more fully the potential health threats. Most of the experience in the U.S. with chronic exposure models assumes exposure throughout a 70 year life span. Therefore, there are inherent limits in applying these models and standards to short-term intermittent exposures such as those that have occurred in Kuwait and Saudi Arabia. Although the fires are burning nonstop, exposure changes frequently due to changing wind patterns. The U.S. Public Health Service Scope of Action Document was developed and released on May 31, 1991.

A CDC epidemiologist participated in the Geneva WMO meeting, and then proceeded to Kuwait to join the USIAAT. While in the Gulf region, the CDC epidemiologist collaborated with the Kuwait Ministry of Public Health Environmental Protection Department (KEPD) to develop a health plan for protecting individuals from the hazards associated with exposure to the burning oil wells in Kuwait. Key elements of the plan are:

- Initiating a health alert system to warn the population when potentially dangerous concentrations of air pollutants are reached;
- Providing medical information and advice to physicians regarding environmental health concerns;
- Providing general information and advice to the public regarding environmental health concerns;
- Collecting and comparing recent mortality data with the same months in 1990;
- Initiating an emergency room surveillance system to monitor respiratory diseases;
- Initiating a longitudinal study of asthmatic patients;
- Designing and implementing a cohort study of presumably highly exposed populations; and
- Implementing the WHO/EPA Human Exposure Assessment Locations (HEAL) Program.

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[15]DOE's Sandia National Laboratories prepared two reports after the war, building on their January 9, 1991 study entitled, "Potential Impacts of Iraqi Use of Oil as a Defensive Weapon." The post-war reports were "Assessment of Effects on Human Health from Kuwaiti Oil Field Fires" (March 29, 1991) and "Kuwaiti Oil Field Sampling Overview" (May 23, 1991). The first report on human health effects provided estimates of the potential health impacts due to the number of fires burning and the meteorological conditions experienced in the region. The overview gave measurement and sampling design needs for a through scientific monitoring of air pollution in Kuwait and the Gulf region.

The Kuwait Ministry of Public Health is developing an implementation plan for the health alert system. Meteorological and air quality data have been combined to predict days of potential alerts. Kuwaiti and Saudi physicians were provided with a five-page document describing the known health effects, the presenting symptoms, complications, and the management of diseases associated with each of the major air pollutants.

Information was collected by the CDC USIAAT member about age, gender, and diagnoses of persons seeking emergency room care at two local hospitals in Kuwait (Mubarek and Sabeh) during the period from January through April 1991. The data suggest that there was no documented increase in the proportion of visits to these hospital emergency rooms for acute upper and lower respiratory infections or asthma during the period after the oil well fires were ignited. A new surveillance form was also developed to be used at five health clinics for a 3-month period. Emergency room visits for gastrointestinal illnesses, heart disease, psychiatric illnesses, chronic bronchitis, emphysema, and bronchiectasis increased during the period after the oil wells were ignited.

The CDC epidemiologist collected blood samples from 14 volunteers on June 1, 1991 in Kuwait City. The samples were tested at the CDC for various volatile organic compounds. Although not all 34 VOCs tested were expected to be constituents of the plume from the oil fires, they were run as part of an automated battery of tests done on each sample. The volunteers' blood had, on the average, about the same amount of VOCs as that of typical persons in the United States.

WHO/EPA Human Exposure Assessment Locations Study

At the request of Kuwait government officials, WHO proposed a study to determine human exposure to inhalable particles (PM_{10}) created by the oil fires. WHO asked for assistance from EPA in designing the study as part of the Human Exposure Assessment Locations (HEAL) - Global Environmental Monitoring System (GEMS). The goals of this study are to:

- Estimate the frequency distribution of exposures to PM_{10} of residents of Ahmadi and Kuwait City; and

- Determine the impact of the oil fires and the possible protective effect of remaining indoors on personal exposure to PM_{10}.

Two EPA scientists traveled to Kuwait to organize the initial phase of the experiment. In the second phase, a sample of individuals will be selected from each city and the degree of personal exposure to, and ambient indoor and outdoor, PM_{10} concentrations will be measured. Exposures to, and indoor concentrations of, nicotine will also be measured to detect the influence of cigarette smoke on personal exposures. Questionnaires will be administered to determine participant activities during the two consecutive 12-hour monitoring periods.

Department of Defense Efforts

At the request of Department of Defense (Health Affairs), the Army is chairing a Tri-Service medical working group to evaluate the potential health effects of oil smoke on DOD personnel. This group met several times between April and July 1991. DOD (Health Affairs), DOD (Environment), Veterans Administration, and medical personnel from each military service attend the meetings. This group is acting to:

- Evaluate acute, mid-term, and chronic health effects to DOD personnel;

- Recommend policies or special studies to better identify any adverse health effects attributable to chemicals in smoke generated by the Kuwait oil fires; and

- Closely monitor the Department of Army's health risk assessment team sampling, analysis, and medical surveillance of the 11th Armored Cavalry Regiment, and the Department of Navy's study regarding potential health effects on Marines.

As part of this effort, on May 1, 1991, the U.S. Army Environmental Hygiene Agency (USAEHA) sent a team of preventive medicine professionals to collect samples and monitor health effects in South West Asia and subsequently to analyze thousands of air and soil samples at their certified laboratory at Aberdeen Proving Ground, Maryland. The team will conduct sampling in Kuwait until at least early November. As of August 1991, 2,500 samples have been collected from U.S. troops. Initial sampling results do not indicate a significant likelihood of long-term health effects. The working group will recommend establishment of a registry or special notation on medical records if the scientific assessment indicates significant risk of long-term health effects. Returning soldiers did have theater specific medical screening which is a permanent part of their medical records. Elements of the 11th Armored Cavalry Regiment received baseline medical surveillance screening during June 1991 in Fulda, Germany before beginning their Kuwaiti tour. Army Medical Department personnel from USAEHA and Walter Reed Institute of Research administered health status questionnaires, performed pulmonary function tests, and collected blood. The blood analysis and study are being done in cooperation with Johns Hopkins University, the Armed Forces Institute of Pathology, and the CDC. Follow-up medical and continuing environmental exposure surveillance on 11th Armored Cavalry Regiment personnel will be performed in Kuwait in August 1991 and will also be done after they return to Germany.

Air samples were analyzed for PAHs, volatile organics, aliphatic and aromatic hydrocarbons, inorganic acids, metals, and particulate matter levels. Soil was analyzed for metals, PAHs, and semi-volatile organics. Sample results are undergoing quality assurance/quality control verifications before being utilized in the health risk assessment protocols.

Sampling sites have included all the former major fixed troop locations and are currently located at several specially selected sites in Kuwait and Saudi Arabia. In September 1991, USAEHA expects to close all but two sampling stations in Kuwait and one in Saudi Arabia. They plan to maintain the remaining monitoring sites as long as DOD continues to have significant troop deployments in Kuwait. Sampling plans have been coordinated with the Navy and Air Force and include coverage of all major fixed DOD troop locations from the time the oil fires started. The USAEHA continues to work closely with EPA and NOAA to ensure that all data collected are comparable and not part of duplicate efforts.

The Navy conducted an epidemiological study of 2,700 Marines in theater to see if sick call rates correlated to potentially greater exposure. Although self-reported questionnaires indicated slightly increased levels of respiratory symptoms for Marines closer to the fires, it does not appear that sick call rates increased with proximity to the fires. Navy analysis of the data continues and a report is expected by October 1991.

Hazardous and Solid Waste

EPA provided a specialist to survey and assist the Kuwaiti government in assessing the Kuwait waste situation and recommend programs for rehabilitating the waste management system. EPA is preparing a recommended plan of action for UNEP.

The Army Corps conducted an environmental survey of all locations occupied by U.S. forces, based on applicable Host Nation and Third Nation laws, identified any necessary cleanup action, and identified priority areas requiring cleanup. The Corps also provided collection and removal of hazardous waste generated by U.S. forces from various locations in Bahrain, Egypt, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates. This included establishing collection sites, transporting waste to disposal locations, disposal of waste materials and waste containers, and close out of collection sites. The Army Corps also is establishing a hazardous waste collection site in Dhahran. The site will be operational initially for a period of three months with an option to extend the operation for an additional three months.

During the Iraqi invasion, Kuwait's sanitation system was damaged and sewage flowed directly into the Gulf, bypassing all pump stations and treatment plants. As a result, the electrical and mechanical systems in these facilities required major maintenance work. The Army Corps participated in emergency work to clean and flush the network, repair pump stations, procure three combination flusher/cleaner vehicles, Clean pipes, and perform a damage survey to the sanitary system on Falaika Island. Significant Corps accomplishments

include the following: completion of a system review and analysis; completion of 27 damage surveys on 77 facilities; restoration of six major pump stations to operational status.

Water

The fresh water system in Kuwait consists of underground and elevated reservoirs and pump stations. Most of the reservoirs were emptied during the occupation, although some have recently built back to about 50 percent capacity. Pipelines between pump stations and reservoirs sustained various amounts of damage. Ongoing work by the USACE has focused on repairing the pressurized network. The USACE has assisted in: repairing breaks within the Kuwait water line, cleaning up and weather proofing of the Al Zour pump station; repairing the water line at the Kuwait naval base; restoring water to all sectors of Kuwait; and making temporary repairs to the Mina Abdullah pump station.

Environmental Remediation

DOE Deputy Assistant Secretary for Export Assistance worked closely with the American companies Kuwait hired to control the damaged wells and extinguish the fires. He served as their primary interface with DOE and other federal agencies. His activities included providing assistance in obtaining logistical support for the rapid and sustained deployment of well control and fire-fighting equipment to Kuwait. Additionally, he served as the primary U.S. government point of contact for inquiries and information on the well fires in Kuwait and oil control technology.

In April 1991, DOE hosted a seminar for representatives of DOE, DOD, and NASA research laboratories to review well control technology and procedures. The participants sought to identify technologies or equipment developed through federal research efforts that could be applied to solving some portion of Kuwait's oil well control and fire problems. Similarly, as DOE's technical liaison to the Kuwait Petroleum Company (KPC), he and his staff agreed to assist with the review and provide technical comments on proposals for new and innovative methods for responding to the oil well fires. The KPC agreed to review expeditiously any proposal forwarded through this channel. To date, over 250 proposals have been reviewed; none have met KPC's operating criteria.

Environmental Restoration

The meteorological network in Kuwait City, which was severely damaged, has been restored by NOAA.

The U.S. government, as of July 31, 1991, was not directly involved in environmental restoration efforts. The primary focus of the international environmental response was in the assessment and remediation phase at the time of this report's printing.

3. U.S. EXPENDITURES

EXPENDITURES BY U.S. GOVERNMENT AGENCIES

Expenditure data has been submitted to EPA by each individual U.S Agency that has been involved in environmental technical assistance efforts in the Gulf. Some agencies were able to submit a breakdown of expenditures which included salaries and benefits, while other agencies were not able to provide this information until after the end of fiscal 1991.

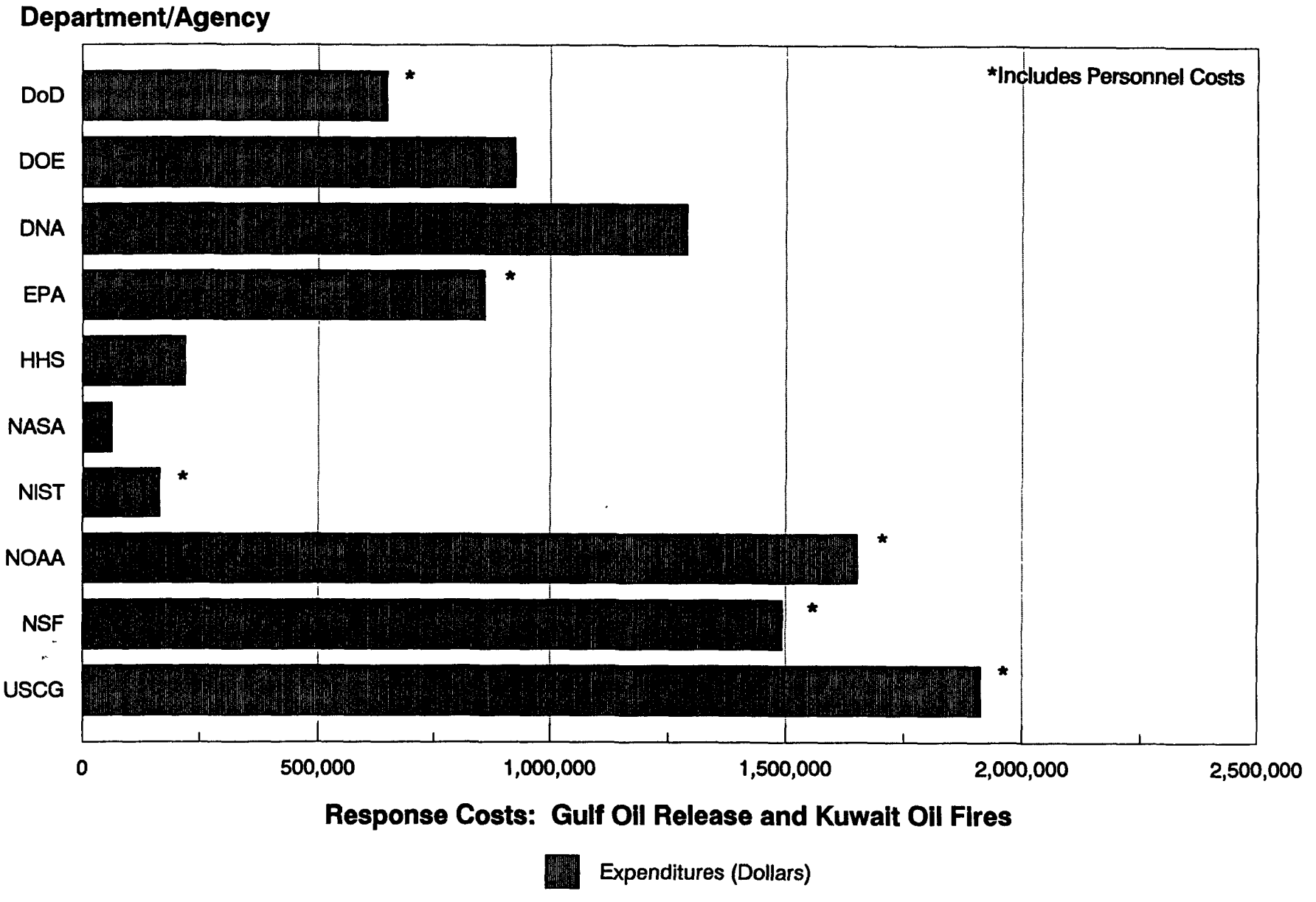
This chapter includes a graph representing the overall expenditures by the U.S. government on technical assistance to the Gulf region between January 27, 1991 and July 31, 1991. The second portion of this chapter contains a table which illustrates: 1) a categoric breakdown of Agency expenditures, 2) funds designated from one Agency to another for technical assistance activities, and 3) funds which are allocated in Agency budgets for reimbursement of technical assistance activities conducted by another Agency.

Each Department and Agency has made these emergency assistance and response funds available within its own FY 1991 budget and without supplemental appropriations.

Saudi ARAMCO agreed to support the funding of the clean-up effort and seek reimbursement from the Saudi Arabia Ministry of Finance after the fact.

While host nations have supported U.S. government personnel with logistical assistance with passports, office space, communications, and some transportation, there have been no substantial payments made to reimburse the U.S. government for health and environmental assistance.

U.S. Government Expenditures as of July 31, 1991



UNITED STATES GOVERNMENT DEPARTMENTS AND AGENCIES EXPENDITURES IN RESPONSE TO THE GULF OIL DISCHARGES AND KUWAIT OIL FIRES

EXPENDITURES	DoD	DOE	DNA	EPA	HHS	NASA	NIST	NOAA	NSF	USCG	TOTAL
Personnel Costs	56,927			151,944[1]			137,000	536,000	333,031	326,475	971,217
Travel	229,605			156,625		35,000	16,000	338,960	313,262	689,000	1,778,452
Transportation	18,192					34,000		35,960	618,632		706,784
Equipment	41,724			104,726			12,000	276,240	197,608	356,000	976,298
Supplies				1,495		16,000		41,000	136,935	79,000	284,430
Contracts	137,019	750,000	266,000	341,641		5,000		517,090	547,780		2,364,530
Other	165,572[2]			7,100[3]		32,000[4]		21,000	692,968	462,000[5]	1,380,640
FUNDS DESIGNATED FROM ONE AGENCY TO ANOTHER:											
DoD											
DOE											
DNA											
EPA											
HHS											
NASA		25,000	24,000					10,000			59,000
NIST											
NOAA			100,000	60,000							160,000
NSF		150,000	900,000	36,100				36,100			1,122,200
USCG											
TOTAL	649,039	925,000	1,290,000	859,631	219,114	122,000	165,000	1,812,350	2,840,216	1,912,475	
FUNDS ALLOCATED FOR REIMBURSEMENT:											
DoD											
DOE						-25,000			-150,000		-175,000
DNA						-24,000		-100,000	-900,000		-1,024,000
EPA								-60,000	-36,100		-96,100
HHS											
NASA											
NIST											
NOAA						-10,000			-36,100		-46,100
NSF											
USCG											
NGO									-225,000[6]		-225,000
TOTAL AFTER REIMBURSEMENT	649,039	925,000	1,290,000	859,631	219,114	63,000	165,000	1,652,350	1,493,016	1,912,475	9,228,625

1.Does not include Office of Solid Waste & Emergency Response, Office of Emergency Remediation & Response, or Gulf Task Force personnel costs.

2.Consumables

3.Registration fees, secretarial services and training

4.Satellite data tapes and lodging for pilots

5.Used to pay for NOAA oil release response work costs

6.From National Geographic and Chevron

APPENDICES

APPENDIX A: PRELIMINARY FINDINGS

APPENDIX B: AGENCY ROLES AND RESPONSIBILITIES

APPENDIX C: TABLE OF AGENCY ACTIVITIES IN THE GULF REGION

APPENDIX D: OIL DISCHARGE AND FIRES RESPONSE PERSONNEL FROM THE UNITED STATES

APPENDIX E: PUBLIC LAW 102-27, SECTION 309

THE FOLLOWING APPENDICES (F, G, H, AND I) ARE PUBLIC DOCUMENTS AND AVAILABLE UPON REQUEST. THEY ARE NOT INCLUDED IN THIS VERSION OF THE DOCUMENT DUE TO THEIR LENGTH. PLEASE WRITE TO THE FOLLOWING ADDRESS IF YOU WOULD LIKE COPIES OF THESE DOCUMENTS.

THE GULF TASK FORCE
C/O THE ENVIRONMENTAL PROTECTION AGENCY
MAIL STOP A-150/ROOM NEMLC 013
401 M STREET, S.W.
WASHINGTON, D.C. 20460

APPENDIX F: UN INTERAGENCY ACTION PLAN ON THE KUWAIT OIL FIRES

EMERGENCY HEALTH PLAN OF ACTION APRIL-JUNE 1991

REPORT OF THE WMO MEETING OF EXPERTS ON THE ATMOSPHERIC PART OF THE JOINT UN RESPONSE TO THE KUWAIT OILFIELD FIRES

APPENDIX G: KUWAIT OIL FIRES: INTERAGENCY INTERIM REPORT

APPENDIX H: U.S. PRELIMINARY HEALTH ADVISORY RELATED TO BURNING OIL WELLS IN KUWAIT

STATUS REPORT OF THE PUBLIC HEALTH IN KUWAIT AS OF MARCH 21, 1991

KUWAITI MINISTRY OF PUBLIC HEALTH PLAN FOR PROTECTION FROM THE HAZARDS ASSOCIATED WITH THE EXPOSURE TO THE BURNING OIL WELLS

APPENDIX I: UNITED STATES AIR STANDARDS AND ALERT SYSTEM
U.S. EPA NATIONAL AMBIENT AIR QUALITY STANDARDS

PRELIMINARY FINDINGS AND THEIR IMPORTANCE

FINDINGS	IMPORTANCE
Oil Discharge	
In January, 1991, 6 to 8 million barrels of oil were discharged into the Gulf. The main oil slick was probably between 0.5 to 3 million barrels.	This discharge is one of the largest in history (up to 30 times larger than the 1989 *Exxon Valdez* spill in Alaska).
The amounts of oil that deposited on beaches, settled to the Gulf's bottom, and evaporated are unknown. The Saudi Arabian coast from Khafji to Abu Ali Island was coated with oil.	The degree of remediation necessary to restore ecological functions is not known.
1.4 million barrels of oil were recovered from the water and placed in pits.	The pits are awaiting remediation.
By the end of April 1991, no more substantial amounts of oil were discharged. Oil skimming was not required by the end of July.	The USCG completed its work in the Gulf and departed the area at the end of July 1991.
Burning Oil Fields	
The retreating Iraqi army damaged over 749 oil wells (of which 610 were ignited), storage tanks, refineries, and facilities. The initial oil well burning rate was about 4 ± 2 million barrels per day. As of September 22, 1991, 441 burning wells had been controlled.	These oil well fires constitute 50% of the total number in the history of the world's petroleum industry.
Global Climate Effects	
The smoke plume is generally at heights between 1500 and 13,000 feet and was never detected above 19,000 feet. The smoke particles are easily attached to water (hydrophilic).	The smoke should have no measurable effect on weather or climate outside of the Gulf region because of its relatively low altitude and short residence time due to capture by water vapor.
In June 1991, these fires emitted about 2 million metric tons of carbon dioxide per day (roughly 3% of worldwide emissions from fossil fuel burning).	The carbon dioxide emissions are diminishing steadily as the burning wells are brought under control. Thus, they are not likely to have a detectable impact on global warming.

Regional Weather Effects

The smoke plume widths range from 10 to 100 miles for distances of 0 to 600 miles from the fires. The smoke plume may strongly reduce the sunlight amount, visibility, and temperatures at ground level. For example, Bahrain had the coolest May in 35 years.

The smoke plume may be the cause of changes in the regional weather.

Meteorology

The spring and summer regional high winds ("shamal") have been strong and mainly from the north/northwest.

The high winds have been effective in dispersing pollutants, causing the concentrations of pollutants to be much less than they would have been if winds had been calm.

Analysis of the Kuwait City Airport meteorological records for 1986-90 shows that the frequency of occurrence for daytime inversions increases from late September to December. Also, the frequency of occurrence of fresh breezes from the Gulf will decrease during this period.

The meteorological potential for acute health impacts may increase during this period, acting in opposition to the progress in controlling the fires. The specific occurrence or probability of occurrence of an air pollution episode cannot be predicted.

Plume Concentrations and Chemistry

During shamal conditions: within the airborne plumes, peak concentrations of particulate mass generally exceeded the U.S. OSHA standards for maximum allowable 8-hour exposure.

During shamal conditions: mixing downward of plume to ground level may cause concentrations of particulate matter to exceed OSHA workplace standards.

During shamal conditions: within the airborne plumes, peak concentrations of ozone, nitrogen oxides, and carbon monoxide were below the U.S. OSHA standards for maximum allowable 8-hour exposure. However, sulfur dioxide occasionally exceeded the standards.

During shamal conditions: mixing downward of plume to ground level is not likely to cause concentrations of criteria gases to exceed workplace standards, except for sulfur dioxide occasionally.

The plume is not photochemically active.

Regional ozone episodes should not occur.

Ground-level concentrations

From May through July 1991, the concentrations of total particulate mass in Kuwait City, which did not exceed historical levels, did exceed U.S. ambient air quality 24-hour standard. The fraction of particulate mass due to the fires is not yet known.

For this period, there is the concern that total particulate mass concentrations may impact health. However, there is no evidence, to date, that it is. (See "Health Impacts" discussion below.) Total particulate mass from the fires may lead to acute health effects during calm periods, especially from September through December 1991.

From May through July 1991, the ground-level concentrations in Kuwait City of sulfur dioxide, nitrogen oxides, carbon monoxide, and ozone did not exceed U.S. ambient air quality standards.

For this period, there is no concern that pollutant gases due to the fires may impact health. Sulfur dioxide may lead to acute health impacts during calm periods, especially from September through December 1991.

The atmospheric particles have concentrations of polycyclic aromatic hydrocarbons (PAHs) and metals such as nickel, chromium, and vanadium, that compare to urban-industrial areas in the U.S., Europe, and Japan. The samples are not very mutagenic.

PAHs and trace metals do not appear to be a concern for chronic health impacts.

Both aircraft and ground sampling data indicate that hydrogen sulfide is present in low concentrations.

Hydrogen sulfide is present in amounts below health threat levels. However it will remain a concern until all known sources are confirmed to be either capped or burning.

Acute Health Impacts

In Kuwait City levels for sulfur dioxide, nitrogen oxides, carbon monoxide, and ozone have not exceeded U.S. alert levels; however, particulate levels have.

For similar conditions in the U.S., for which particulate mass exceeds "warning level," we would expect general health effects to be limited to significant aggravation of symptoms in persons with chronic obstructive pulmonary disease or asthma.

Through July 1991, there was no documented increase in the proportion of visits to hospital emergency rooms for acute upper and lower respiratory infections or asthma compared to the period before the fires were ignited.

Short-term exposure to oil fire smoke at current concentrations does not appear to cause acute health impacts in healthy adults. However, it could exacerbate symptoms of persons with pre-existing lung disease.

Chronic Health Impacts

Serum taken from U.S. troops, six weeks after locating in Doha, Kuwait, show no increased volatile organic compounds (VOCs) compared to troop serum levels taken in Germany prior to coming to Kuwait.

At this time VOCs do not appear to be a concern for chronic health impacts.

Environmental Activities in the Gulf Region

Agency Roles and Responsibilities

Assistance to the Gulf States in dealing with the environmental consequences of Iraqi hostilities is being provided by an international effort in which the United States is participating. The United States has been working with the international community and with the governments of the region to channel its technical assistance through the World Meteorological Organization (WMO), the World Health Organization (WHO), and other United Nations organizations working in the Gulf.

The Environmental Protection Agency is the designated coordinator and spokesperson for the overall U.S. program supporting the environmental crisis in the Gulf region, in consultation with the Secretary of State to assure consistency with U.S. foreign policy objectives.

DNA

Coordinate the DOD Logistics Support to the interagency atmospheric effects research program.

Collaborate with NSF, NOAA, NIST, DOE, and NASA in the atmospheric effects research program.

Provide technical support, as required, to the interagency working groups.

DOE

In collaboration with NOAA, NIST, and NASA conduct planned atmospheric sampling missions to the area.

Conduct analyses/assessments of impacts of air pollution on human health.

Capability to update and modify dispersion model using data collected by NOAA, NIST, and EPA in order to accurately predict exposures.

Provide point of coordination regarding oil well control technologies and inquiries.

Ongoing development and adaptation of technologies for explosive ordnance disposal and extinguishing and capping wells.

DOS

Provide overall guidance to other agencies on all foreign policy-related aspects of U.S. environmental activities in the Gulf region, including relations with international organizations.

Serve as conduit for policy and other official communications with U.S. foreign service posts in the Gulf region as well as with area governments.

EPA

Established and Chairs a high-level coordinating council addressing the environmental problems in the Persian Gulf.

Council is composed of DNA, DOE, DOS, EPA, HHS, NASA, NOAA, NSF, OSHA, and USCG.

Council will provide guidance to all efforts in the area and review overall progress.

Consult with the Department of State to assure overall program is consistent with U.S. policies in the Middle East.

Provide liaison to DOD regarding logistics and military activities.

Convened an interagency working group to consolidate and maintain a current operational plan for all activities. The atmospheric components of the plan have been compiled by NOAA and the health components by HHS and EPA. This framework will be used to include other components of the work.

With the active participation of other agencies, coordinate a communications plan which shall, among other things, describe activities, timing of press announcements, notification of pertinent agencies of press-related activities, and provide periodic updates. Provide central coordination for Congressional, press and citizen inquiries. EPA will refer specific questions to key individuals designated by the agencies for preparation of response, as appropriate. Coordinate and work with other agencies to publish press releases detailing status of activities.

In collaboration with other agencies, prepare special reports mandated by Congress.

In collaboration with NOAA, coordinate with DOS the agencies' missions to the region, their purpose, individuals travel, and requests for country clearance. Assist DOS in briefing host governments and embassies concerning these missions and plans.

Coordinate with non-governmental organizations interested in the regional environment.

In collaboration with the other agencies, coordinate the preparation of an integrated research program plan.

Develop budget plan for EPA and coordinate development of an interagency budget plan to assess overall U.S. level of effort, and actively pursue funding options, including international assistance and work under the Kuwaiti-Army Corps reimbursable agreement.

Provide technical support and training, as required, in ground and aerial monitoring and other in environmental areas such as solid and hazardous wastes, drinking water, ground water, and information management.

FWS

Coordinate all wildlife efforts in an effective manner through development of a Wildlife Response Plan.

Conduct assessments of contaminated or potentially contaminated habitats, providing remedial techniques, as well as protective measures and prioritization of implementation.

Participate as a member of Planning Committee of the Oil Spill Response Group.

Provide technical expertise for the development of natural resource damage assessments.

HHS

Coordinate U.S. activities related to WHO work in the Gulf. Serve as liaison to WHO. This includes compiling and maintaining current a list and descriptions of active and proposed projects covered under the WHO plan.

Oversee and coordinate with work of EPA, NOAA, and other agencies in public health epidemiology and health research including food safety.

Provide technical support and training, as required, to host governments regarding toxicology, food safety, epidemiology, exposure and disease surveillance, computing health data, and public health infrastructure.

In collaboration with NOAA and EPA, initiate the development of a public health and public health-related environmental data management system.

Evaluate and develop, as appropriate, quality assurance protocols for data collection, data management, and evaluation for heath related studies.

Act as liaison to DOD regarding health studies.

Develop, as appropriate, studies on U.S. citizens exposed to smoke who have returned from the Gulf region.

Develop, as appropriate, a library of documents of public health and public health-related environmental data applicable to the Gulf region.

NASA

In collaboration with NOAA, conduct planned atmospheric sampling missions to the area.

NIST

In collaboration with NOAA, conduct planned near-field fire source characterization and plume sampling missions to the area.

Work with NOAA on "merged plume" trajectory modeling techniques.

Evaluate protocols for QA/QC of sample analysis in coordination with EPA, NOAA, and HHS.

NOAA

Provide interagency coordination for U.S. activities relating to the WMO Plan of Action for the Kuwait Oil Fires and the IOC Plan of Action for the Gulf Oil Spills.

In collaboration with EPA, coordinate with the Department of State and appropriate agencies missions to the region, their purpose, individuals travelling and requests for country clearance. Assist DOS in briefing host governments and embassies concerning these missions and plans.

Coordinate U.S. activities related to WMO work in the Gulf. Serve as liaison to WMO. This includes compiling and maintaining current a list and descriptions of active and proposed projects covered under the WMO plan.

Coordinate work of EPA, NASA, NIST, NSF, and other agencies on air quality monitoring and modeling and the preparation of an evaluated interagency research program. Provide scientific oversight of aerial sampling program, and provide scientific and technical program integration, including convening scientific meetings to discuss atmospheric and marine findings.

Provide continuing plume trajectory modeling and assist Kuwait and Saudi Arabia in establishing and operating an early warning system. Assist Kuwait in restoring meteorological capabilities.

Coordinate with EPA and HHS to assure air quality work and health effects work are integrated in U.S. activities and in the WMO plan

Provide technical support and training, as required, to host governments regarding modeling and atmospheric issues.

Provide technical support and training, as required, to host governments regarding the effects of the oil spill in the marine environment.

In collaboration with NSF and HHS, initiate the development of a data management system for all atmospheric and health information.

NSF

Coordinate university and National Center for Atmospheric Research (NCAR) participation in the aerial sampling and modeling programs.

Work with NOAA, NASA, NIST, DOE, DNA, HHS, and EPA to develop an interagency atmospheric effects research program.

Coordinate agency support, as appropriate, of university and NCAR participation in the atmospheric effects research program.

Collaborate with NOAA in the development of a data management system for the aerial monitoring program.

OSHA

Provide technical support and training, as required, to host governments regarding worker protection and safety.

Provide technical assistance and information on occupational health hazards to federal agencies planning

missions in the Gulf region.

USCG

Coordinate U.S. activities related to IMO work in the Gulf.

Through the end of July, continue OSC presence in-country. After that, technical support and training, as required, will be provided by IMO to host governments regarding contaminated and mitigation of oil spills.

Encourage and work with ROPME and GCC to achieve a better preparedness for oil spills in the Gulf.

Based on the experience gained in the response to the oil spills, oversee and define specific research needs for containment and cleanup activities, and assure that experience and findings are available to relevant U.S. agencies.

U.S. Government's Functions and Current Activities in the Gulf

Agency	Health Data Collection/Analysis	Environmental Data Collection/Analysis	Management and Operations
EPA	Interagency Agreement with NOAA to provide real-time sulfur dioxide and particulate monitors for the early warning systems in Kuwait City In conjunction with WHO, establish protocols, surveys, and training for Kuwaiti scientists to measure 24-hour personal exposures to indoor and outdoor concentrations of PM_{10} to determine the potential human impact from exposures Sample and data analysis of joint NASA and EPA helicopter experiments to characterize oil fire emissions near the source	Provide technical support and training, as required, in other areas such as solid and hazardous wastes, drinking water, and information management Provide technical support and training, as required, in ground and aerial air quality monitoring Analyses of air quality samples from Kuwait and Saudi Arabia at EPA research laboratories Continue to provide technical support and training, as required, in areas such as solid and hazardous waste management, drinking water, bioremediation, and Geographic Information Systems Supply assistance, as required, to international environmental damage assessment efforts Interagency Agreement with NSF to analyze aircraft data obtained by University of Washington and the National Center for Atmospheric Research	Coordinate interagency communications plan Collaborate with other agencies to prepare reports for Congress (60-Day Report, March 92 Report) Coordinate integrated research program plan Coordinate development of interagency budget plan Coordinate with DOS agencies' missions to Gulf region Chair high-level coordinating council Coordinate overall U.S. Government technical assistance to Gulf nations through the EPA Gulf Task Force.

Agency	Health Data Collection/Analysis	Environmental Data Collection/Analysis	Management and Operations
NOAA	Provide continuing plume trajectory modeling and assist Kuwait and Saudi Arabia in establishing an early warning system In collaboration with NSF and HHS, develop a data management system for all atmospheric and health information	Provide technical support and training, as required, to host governments regarding modeling and atmospheric issues, and the effects of the oil spill in the marine environment Coordinate air quality and meteorological monitoring and assessment program under the international UN World Meteorological Organization (WMO) plan Erected a network of 16 meteorological towers provided by DOE/Oak Ridge National Laboratory to measure atmospheric conditions surrounding Kuwait City, to model the lofting and dispersion of the smoke, and to transfer data to an analysis center in Kuwait City for the Early Warning System Continue to coordinate the WMO air monitoring and assessment plan Continue to assist the Saudi and Kuwaiti governments with meteorological technical assistance Outputs from the 16 meteorological centers are used to guide the interpretations of forecasts generated by NOAA in the United States	Coordinate interagency activities relating to WMO plan for Kuwaiti oil fires and IOC Plan of Action for the Gulf oil spills Coordinate EPA, NSF, NIST, NASA, and other agencies' work on air monitoring and modeling Provide scientific oversight of aerial sampling program

Agency	Health Data Collection/Analysis	Environmental Data Collection/Analysis	Management and Operations
HHS	Provide technical support and training, as required and funds permit, to host governments regarding toxicology, food safety, epidemiology, exposure and disease surveillance, computing health data, and public health infrastructure Develop, as appropriate and funds permit, studies on U.S. citizens exposed to smoke who have returned from the Gulf region Collaborate with NOAA and EPA to develop a public health and public health-related environmental data management system as funds permit Evaluate and develop, as appropriate and as funds permit, quality assurance protocols for data collection, data management and evaluation for health related studies Develop, as appropriate and as funds permit, a library of documents of public heal' ı and public health-related environmental data applicable to the Gulf region Prepare and revise public health advisories related to burning oil wells in Kuwait Work with the Kuwait Ministry of Public Health to determine the health risks from exposure to the air pollution produced by the oil well fires		Oversee and coordinate EPA, NOAA, and other agencies' work in public health epidemiology and health research, including food safety Act as liaison to DOD regarding health studies
DOE	Prepared a report, entitled, "Assessment of Effects on Human Health from Kuwaiti Oil Field Fires" (March 29, 1991), which estimated the human health effects caused by the oil well fires using the meteorological conditions experienced in the region Conduct analyses and assessments of impacts of air pollution on human health Funded NASA/EPA helicopter monitoring of emissions	Collaborate with NOAA, NIST, and NASA to conduct planned atmospheric sampling missions to the Gulf region Financially supported the NSF atmospheric research effort aboard the University of Washington's aircraft and the NSF's Lockheed Electra	Capability to update and modify dispersion model using data collected by NOAA, NIST, and EPA to accurately predict exposures Coordinate oil well control technologies and inquires Ongoing development and adaptation of technologies for explosive ordnance disposal and extinguishing and capping oil wells

Agency	Health Data Collection/Analysis	Environmental Data Collection/Analysis	Management and Operations
		For one month, starting July 22, DOE will fly a series of missions to measure plume transformation/removal rates and to characterize the chemical and physical state of the plume over a range of distances. This research will complement the NSF mission by studying a different weather regime and the longer distances from the source Three DOE laboratories are involved in the one month DOE aircraft mission. Lawrence Livermore National Laboratory provides real time forecasts of plume behavior for the NSF-led mission, the DOE effort, and will continue to provide these forecasts to Gulf nations as required.	Providing assistance in obtaining logistical support for the rapid and sustained deployment of well control/fire-fighting equipment Reviewing and providing technical comments on proposals for new and innovative methods for responding to the oil well fires.
OSHA	Assessment of potential worker safety needs for U.S. government personnel and civilians working in the Gulf region		Provide technical support and training, as required, to host governments regarding worker protection and safety Provide technical assistance and information on occupational health hazards to federal agencies planning missions in the Gulf region
NSF		Coordinate university and National Center for Atmospheric Research (NCAR) participation in the aerial sampling and modeling Collaborate with NOAA in the development of a data management system for the aerial monitoring program Collaborate with NOAA in the development of a data management system for the aerial monitoring program	Collaborate with NOAA, NIST, NASA, DOE, DNA, HHS, and EPA to develop an interagency atmospheric effects research program
NASA		Collaborate with NOAA to conduct planned atmospheric sampling missions to the area Participated in U.S. airborne observations aboard University of Washington's C-131A aircraft, using multi-wavelength scanning radiometers to measure the upwelling and downwelling of solar radiative fluxes, visual depths, and scattering properties of aerosols	

Agency	Health Data Collection/Analysis	Environmental Data Collection/Analysis	Management and Operations
		Performed near-field source sampling using helicopter sampling equipment with EPA funded by DOE	
NIST		Collaborate with NOAA to conduct planned near-field fire source characterization and plume sampling missions to the area Evaluate protocols for QA/QC of sample analysis in coordination with EPA, NOAA, and HHS	Collaborate with NOAA to develop "merged plume" trajectory modeling techniques
DOS			Provide guidance on all foreign policy-related aspects Serve as conduit for policy and other official communications to Embassies and international organizations Facilitate U.S. country clearances and general coordination activities
DNA			Coordinate the DOD logistics support to interagency atmospheric effects research program Collaborate with NSF, NOAA, NIST, DOE, and NASA in the atmospheric effects research program Provide technical support, as required, to the interagency working groups
USCG		Lead agency for USIAT oil discharge emergency response efforts. Lead international team for IIAT discharge response efforts. Technical support and training with IMO to host governments regarding mitigation of oil spills	Coordinate IMO work in the Gulf Work with ROPME and GCC to achieve a better preparedness for oil spills in the Gulf

OIL DISCHARGE AND FIRES RESPONSE PERSONNEL FROM THE UNITED STATES

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
EPA				
William Reilly	Administrator	5/31 - 6/5	Official Visit	Senate Testimony 6/11
Gordon Binder	Chief of Staff	5/31 - 6/5	Official Visit	N/A
Dave Cohen	Special Assistant	5/31 - 6/5	Official Visit	N/A
Dale Jerome	Special Assistant	5/31 - 6/5	Official Visit	N/A
Jim Makris	Director, Chemical Emergency Preparedness and Prevention Office	3/10 - 3/22 5/31 - 6/5	EPA Team Leader Official Visit	Interagency Interim Report Senate Testimony
Ken Stroech	Chief, General Preparedness Programs	4/15 - 5/6 (Saudi Arabia)	EPA Team Leader	Interagency Interim Report
Bill Hunt	Chief, Monitoring and Reports Branch	3/12 - 4/11 5/31 - 6/5	Provide technical assistance and guidance to Gulf nations in response to fires Official Visit	Interagency Interim Report
Willie McLeod	Chemist, Environmental Monitoring Lab	4/15 - 5/5	Air monitoring	Interagency Interim Report
Phil Campagna	Chemist, Safety and Air Surveillance Section	3/10 - 3/26	Provide technical assistance and guidance to Gulf nations in response to fires	Interagency Interim Report
Alan Humphrey	ERT Environmental Scientist, Site Investigation Section	3/10 - 3/26	Provide technical assistance and guidance to Gulf nations in response to fires	Interagency Interim Report
Dr. Tim Gerrity	Chief, Human Dosimetry Section of the Clinical Research Branch, Human Studies Div. (ORD/OHR/HERL)	3/10 - 3/26 5/31 - 6/5	Provide technical assistance and guidance to Gulf nations in response to fires	Interagency Interim Report
Andy Bond	Chemist, Environmental Monitoring Lab	3/10 - 4/13	Provide technical assistance and guidance to Gulf nations in response to fires	Interagency Interim Report
Fred Stroud	Senior On-Scene Coordinator, Reg. 4	5/1 - 6/5	EPA Team Leader	
Bob Caron	On-Scene Coordinator, Region 3 (Philadelphia)	1/27 - 2/28	Assist USIAT in spill assessment	
Hal Kibby		3/18 - 4/26	Advisor to KFUPM Science Committee; provided tech. advice to MEPA; took place of FWS rep. after he departed	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Matthew Naud (contract support)	EPA Emergency Operations Center contract support, ICF Inc.	4/25 - 6/6	Technical and administrative support	
Jon Schweiss		4/1 - 4/21	Install portable PM_{10} monitor system	
Joe Pinto	Research Scientist	7/22 - 8/12	Perform near-field helicopter plume measurements	Not yet written
Bob Stevens	Research Scientist	7/22 - 8/12	Perform near-field helicopter plume measurements	Not yet written
Steve Levy	Special Assistant, Municipal and Industrial Solid Waste Div., OSW	7/9 - 7/24	Assess solid and hazardous waste management practices in Kuwait	On file
Dewayne Knott	Biologist	5/1 - 5/22		
NOAA				
Dr. Sylvia Earle	Chief Scientist	3/13 - 3/17 5/31 - 6/5 8/19 - 8/29	Meet with officials and discuss oil spill and fires Field visits	
John Robinson	Director, NOAA Gulf Program Office	5/6 - 5/13 6/3 - 6/9 8/19 - 9/3		
Cmdr. Francesca Cava	Special Assistant to the Under Secretary for Oceans and Atmosphere, DOC	5/7 - 5/13 8/19 - 8/29 9/23 - 9/27	Meet with officials and discuss oil spill and fires	
Dr. J.R. Spradley	Counselor to the Under Secretary for Oceans and Atmosphere, DOC	5/7 - 5/16		
Peter Hill	Gulf Program Office	8/18 - 9/2	Meet with officials and discuss oil spill and fires	
Dr. Barbara Bailey	Scientific Coordinator	8/18 - 8/31	Meet with officials and discuss oil spill and fires	
George E. Start	NOAA/ARL/FRD Meteorologist	3/11 - 4/8	NOAA Team Leader	
Will Pendergrass	Director, NOAA Field Office - Scientist, Oak Ridge National Labs, Regional Coordinator, NOAA Field Office, Kuwait City	4/3 - 5/22 6/4 - 8/29 9/11 - 10/2	NOAA Team Leader	
Jeff McQueen	NOAA/ARL Meteorologist	5/15 - 6/4	NOAA Team Leader	
Jerrold F. Sagendorf	Director, NOAA Field Office	8/23 - 9/30	NOAA Team Leader	
Lisa Symons	Gulf Program Office	8/10 - 9/30	Assistant to NOAA Team Leader	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Pam Bondeson (contractor)	Contractor-NOAA	7/7 - 8/13	Assistant to NOAA Team Leader	
Dr. Robert C. Clark	Research Oceanographer, NOAA National Marine Fisheries Service	5/9 - 5/20		
Steve Leamann	NOAA HAZMAT Scientific Support Coordinator	5/11 - 6/15	USIAT primary advisor to Environmental Assessment subgroup of the Scientific Group	
Dr. Gordon Thayer	Acting Director, NOAA National Marine Fisheries Service Restoration Center	5/9 - 5/16		
David Auble	NOAA/ARL/ATDD Engineer	5/11 - 5/21	Met tower planning	
Frederick Weldon	National Weather Service	5/29 - 7/15	Met tower installation	
Kenneth N. Clark	National Weather Service	5/29 - 8/14	Met tower installation	
J. Randall White	NOAA/ARL/ATDD Computer Scientist	5/28 - 6/26 8/10 - 8/28 8/8 - 8/18	Met tower installation	
Dr. Richard M. Eckman	NOAA/ARL/ATDD Meteorologist	5/12 - 5/30	Met tower installation	
Dr. Charles Henry	Professor, Louisiana State University	July/August	NASA/EPA chemical composition of plume	
LCDR. David Kruth	Logistics Officer, NOAA Corps	6/1 - 8/8 (Kuwait) 9/14 - 9/30	Point of contact for coordination purposes	
LCDR. Michael Henderson	NOAA Corps	5/25 - 7/2 (Bahrain)	Point of contact for coordination purposes	
LT Robert S. Pape	NOAA Corps	7/18 - 9/6 (Bahrain)	Point of contact for coordination purposes	
CMDR. Todd Baxter	NOAA HAZMAT Scientific Support Coordinator	6/11 - 7/29 (SA)	Scientific advisor on shoreline cleanup	
LT John Miller	NOAA HAZMAT Scientific Support Coordinator	7/28 - 9/1 (Kuwait)	Scientific advisor on shoreline cleanup	
Joseph Talbott		7/27 - 8/29 (SA)	Point of contact for coordination purposes	
George Frank	NOAA computer programmer	8/5 - 9/4	Setting up part of the hazardous warning system	
Jacqueline Michel (contractor)	NOAA Hazmat/Research Planning Inc.	5/9 - 6/4	Address oil spill related environmental issues - salt marshes, mangroves	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Dr. William J. Lehr	Oceanographer, NOAA Hazmat	2/2 - 3/5 5/9 - 5/21 (SA)	USIAT - Primary advisor to Spill Modeling and Forcasting Subgroup of the Scientific Group	
Dr. Jerry A. Galt	NOAA HAZMAT	1/27 - 2/3 9/24 - 9/24 9/22 - 9/26	USIAT - Primary advisor to Spill Modeling and Forcasting Subgroup of the Scientific Group	
LCDR Gary Petrae	NOAA Scientific Support Coordinator	1/27 - 2/28	USIAT - Primary advisor to Environmental Assessment Subgroup of the Scientific Group	
Gary Ott	NOAA Scientific Support Coordinator	3/18 - 4/24	USIAT - represented NOAA, interpreted SLAR data, provided NOAA with input for maps, advisor to KFUPM Science Committee	
Anthony Geidt	NOAA Attorney	5/9 - 5/16		
Jay Rodstein	NOAA Scientific Support Coordinator	2/21 - 3/25 (SA)	USIAT primary advisor to Environmental Assessment subgroup of the Scientific Group	
CDR Van Den Berg	NOAA Scientific Support Coordinator	4/15 - 5/20 (SA)	USIAT primary advisor to Environmental Assessment subgroup of the Scientific Group	
ACE				
Jerry Greener	USIAT, Primary advisor to Offshore Skimming Group	1/27 - 2/3		
Bob Hopman	USIAT, Primary advisor to Offshore Skimming Group	2/3 - 2/28		
Capt. Carey Hill		3/18 - 4/26	USIAT - Provided liaison with CENTCOM and Army activities	
FWS				
Don Kane	Fish and Wildlife Biologist	1/30 - 3/31 5/9 - 5/17	Develop wildlife response plan and conduct natural resource damage assessment	
NASA				
Joel Levine				
Francisco Valero	Chief, Atmospheric Physics Research Branch	5/7 - 6/10 (Bahrain)	Study effects of oil fires on atmosphere	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Peter Pilewskie	Research Scientist, Atmospheric Physics Research Branch	5/7 - 6/10 (Bahrain)	Study effects of oil fires on atmosphere	
Warren J.Y. Gore	Electronic Engineer, Atmospheric Physics Research Branch	5/7 - 6/10 (Bahrain)	Study effects of oil fires on atmosphere	
Dr. Michael D. King	Physical Scientist, Climate and Radiation Branch, NASA Goddard Space Flight Center	5/7 - 6/10 (Bahrain)	Study effects of oil fires on atmosphere	
Wesley (Randy) Cofer III	Senior Research Scientist	7/18 - 8/12	Perform near-field helicopter plume measurements	Not yet written
Ed Winstead (contractor)	Research Scientist	7/18 - 8/12	Perform near-field helicopter plume measurements	Not yet written
Dan Sebacher (contractor)	Research Scientist	7/18 - 8/12	Perform near-field helicopter plume measurements	Not yet written
DOE				
Jake Hales	Department Manager/Atmospheric Chemistry	7/24 - 8/3	Perform aircraft plume measurements	
Peter Daum	Research Scientist/Atmospheric Chemistry	7/24 - 8/28	Perform aircraft plume measurements	
Ken Busness	Development Engineer/Aircraft Instrumentation	7/24 - 8/28	Perform aircraft plume measurements	
Robert Hannigan	Chief Pilot	7/21 - 8/30	Operate G-1 aircraft	
Carl Berstrom	Aircraft Mechanic	7/21 - 8/30	Maintain G-1 aircraft	
Mike Warren	Co-pilot	7/21 - 8/30	Operate G-1 aircraft	
Stan Tomich	Development Engineer/Aircraft Computer Systems	7/24 - 8/28	Perform aircraft plume measurements	
HHS				
Dr. Ruth Etzel	Medical Epidemiologist	5/1 - 6/2 (Kuwait City)	Assess air pollution health effects	Report on file
Dr. John Andrews	Medical Epidemiologist	2/15 - 3/21	Assess health hazards	Report on file
Dr. Paul Seligman	Medical Epidemiologist	3/10 - 4/1	Assess air pollution health effects	Interim Report
Lloyd Johnson	Supervisory Chemist, FDA	5/10 - 5/15		
USCG				
Capt. Donald Jensen	USCG Research and Development Center	1/27 - 2/28	Chief - USIAT; Primary advisory to Dr. Tawfiq; spokesperson for USIAT	after action report

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Capt. Luchun	Chief, Second Contingent USIAT	2/22 - 4/9	Chief - USIAT; Primary advisory to Dr. Tawfiq; spokesperson for USIAT	
LCDR Keane	Executive Officer, Pacific Strike Team	2/22 - 3/9	Operations Officer, second USIAT contingent	
CDR Donohoe	Commanding Officer, CG Marine Safety Office (Memphis)	2/3 - 2/28	USIAT liaison to Bahrain, Qatar, and UAE	
CDR Schriner	IMO Liaison Officer, Caribbean section		Executive Officer, USIAT	
LCDR Glenn Wiltshire	USCG Commanding Officer Atlantic Area Strike Team	1/27 - 2/28	USIAT NSF representative and primary advisor to Chief, Response Operations Department	
CWO Rick Meidt	USCG Public Information Assist Team	1/27 - 2/3	USIAT Public Affairs Specialist and primary advisor to Public Information Staff Officer	
PA1 Kalnbach	USIAT Public Affairs Specialist and primary advisor to Public Information Staff Officer	2/4 - 2/28		
LCDR Jack Kemerer	Executive Officer, Pacific Strike Team	5/23 - 7/31	Executive Officer, USIAT	
LCDR Henderson	Chief, USIAT	3/18 - 4/26	Directed US activities; conducted liaison w/gov't. agencies; advised Tawfiq, spokesperson for USIAT	
DC1 Schultz	USIAT	3/18 - 4/26	NSF rep. and advisor to MEPA op. officer; logistics, daily reports, documentation, oil spill response training	
LT Howard White	USIAT Air Liaison Officer	3/18 - 4/26	Planned and coordinated all air operations	
LTJG Michael A. Megan	USIAT Air Liaison Officer	3/18 - 4/26	Planned and coordinated all air operations	
CDR Whipple	Commanding Officer, Atlantic Strike Team	4/19 - 5/23	Executive Officer, USIAT	
MK1 Wyatt	Member, Atlantic Strike Team	5/18 - 7/1	NSF representative to MEPA operations officer	
LCDR Jerry Kirchner	Commanding Officer, Gulf Strike Team	5/18 - 7/1	Chief, USIAT	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
LT Christopher J. Stickney		2/16 - 4/11		
CWO3 Stephen Kibner		2/16 - 4/3		
AMC Frank E. Rankin		2/16 - 4/3		
AT2 Frederick S. Baker		2/16 - 4/3		
CDR Thomas Sechler	Flight Crew	2/16 - 4/9		
LCDR Gary T. Blore	Flight Crew	2/16 - 4/16		
LT Robert J. Paulison	Flight Crew	2/16 - 4/3		
LT David M. Singer	Flight Crew	2/16 - 4/3		
LTJG Edward M. Hayes	Flight Crew	2/16 - 4/9		
LTJG John E. Ludlum	Flight Crew	2/16 - 4/3		
CWO2 John K. McGuire	Flight Crew	2/16 - 4/9		
ADC Ronald L. Kenipes	Flight Crew	2/16 - 4/9		
ATC Brad T. Smith	Flight Crew	2/16 - 4/3		
AD1 Randall Coyne	Flight Crew	2/16 - 4/3		
AT1 John Semersheim	Flight Crew	2/16 - 4/11		
AM2 Paul A. Pitcher	Flight Crew	2/16 - 4/11		
AE2 William N. Clinton	Flight Crew	2/16 - 4/9		
AT2 Vincent C. Seidl	Flight Crew	2/16 - 4/3		
AE2 Stuart W. Stryker	Flight Crew	2/16 - 4/9		
AT2 Bruce D. Verfaillie	Flight Crew	2/16 - 4/11		
AM3 George V. Beckham	Flight Crew	2/16 - 4/9		
AD3 Stephen A. Casale	Flight Crew	2/16 - 4/11		
YN3 James A. Clancy	Yeoman	2/16 - 4/3	Clerical Support	
AT3 Kenneth D. McAuley	Flight Crew	2/16 - 4/9		
AD3 Christopher J. Wendt	Flight Crew	2/16 - 4/9		
LT Howard E. White	Flight Officer	2/21 - 4/16	Flight Officer assigned to coordinate air operations w/USIAT and IIAT	
AE2 William K. Reid, Jr.	Flight Crew	2/16 - 4/11		
LCDR Joseph M. Touzin	Flight Crew	4/3 - 5/5		

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
LCDR James A. Peoples	Flight Crew	4/3 - 5/5		
LTJG Michael A. Megan	Flight Officer	4/3 - 5/5	Assigned to coordinate air operations w/USIAT and IIAT.	
LT Timothy J. Cunningham	Flight Crew	4/3 - 5/5		
LCDR Robert C. Boetig	Flight Crew	4/3 - 5/5		
AE3 Joel R. Allen	Flight Crew	4/3 - 5/5		
AM3 Roger D. Boone	Flight Crew	4/3 - 5/5		
AM1 Edward D. Burns	Flight Crew	4/3 - 5/5		
YN3 Donald R. Chenevert	Yeoman	4/3 - 5/5	Clerical Support	
AD1 Gary Connolly	Flight Crew	4/3 - 5/5		
AE2 Richard A. Couture	Flight Crew	4/3 - 5/5		
AT3 Sam J. Dube	Flight Crew	4/3 - 5/5		
AMC Joseph E. Ferguson	Flight Crew	4/3 - 5/5		
AT3 Robert T. Hodges	Flight Crew	4/3 - 5/5		
AD3 Bion J. Holbrook	Flight Crew	4/3 - 5/5		
AT2 Robert L. Johnson	Flight Crew	4/3 - 5/5		
AD3 James C. Mosiman	Flight Crew	4/3 - 5/5		
AD1 Donald R. Peterson	Flight Crew	4/3 - 5/5		
ATCS Barry P. Philippy	Flight Crew	4/3 - 5/5		
AM3 Charles E. Sexton	Flight Crew	4/3 - 5/5		
AE1 Donald H. Taylor	Flight Crew	4/3 - 5/5		
DOD (USAEHA)				
Lawrence D. Clark	Analytical Chemistry	5/23 - 7/31	Quality assurance and supervision for sample accession	N/A
John Cockayne	Atmospheric Scientist	5/10 - 6/10	Planned and coordinated air operation	
2LT Emil J. Dzuray	Sanitary Engineer	5/8 - 7/19	Operated ambient air monitoring station	N/A
Robert Flory	Program Coordinator and Facilitator	5/10 - 6/2	Planned and coordinated air operations	

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Myrnuth B. Fortune	Industrial Hygiene	5/8 - 6/22	Quality assurance and technical support for sampling	N/A
Charles Gallaway	Program Manager - weapons effect	5/10 - 6/2	Planned and coordinated air operations	
John Guest	Scientist - Radiation effect	5/16 - 6/10	Radiation measurements	
Jack M. Heller	Team Chief - Health Risk Assessment	5/2 - 5/25	Design and direct health risk assessment monitoring	Data analysis in preparation
1LT Brian W. Higgins	Sanitary Engineer	5/2 - 7/10	Operated ambient air monitoring station	N/A
1LT John A. James	Sanitary Engineer	7/23 - present	Operated ambient air monitoring station	N/A
SGT William B. Jones	Medical Lab Specialist	7/2 - present	Operated ambient air monitoring station	N/A
CPT Elmer S. Kaiser	Environmental Science	7/23 - present	Operated ambient air monitoring station	N/A
LTC Wendell C. King	Air Pollution Engineering	7/23 - present	Theater Team Chief/direct and control operations	N/A
1LT David B. Martin	Sanitary Engineer	5/8 - 7/10	Operated ambient air monitoring station	N/A
1LT Kenneth R. Mead	Sanitary Engineer - Industrial Hygiene	5/8 - 6/19	Quality assurance and technical support for sampling	N/A
LTC George R. Murnyak	Environmental Science - Industrial Hygiene	5/2 - 6/17	Quality assurance and technical support for sampling (supervisory)	N/A
Daniel G. Noble	Chemistry	5/9 - 7/10	Quality assurance and supervision for sample accession	N/A
Lieutenant Colonel Vayl Oxford	Military Assistant to Deputy Director	5/10 - 6/2	Coordination of air operations	
MAJ Lester Y. Pilcher	Sanitary Engineer	5/2 - 7/10	Theater Team Chief/direct and control operations	N/A
SPC Shawn L. Pinsonneault	Medical Laboratory Specialist	7/23 - present	Operated ambient air monitoring station	N/A
CPT Roger J. Rudolph	Environmental Science	5/2 - 6/27	Operated ambient air monitoring station	N/A
PFC Brian Rudyk	Preventive Medicine Specialist	7/23 - present	Operated ambient air monitoring station	N/A
CPT Brian G. Scott	Physician - Occupational and Environmental Medicine	5/2 - 5/25	Medical advisor to Health Risk Assessment Team Chief	N/A
Nathan A. Shero	Lab Technician	5/16 - 7/10	Operated ambient air monitoring station	N/A

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Michael Snapp	Meteorologist	5/10 - 6/7	Forecasting	
Anthony D. Wagner	Chemistry	6/10 - 7/26	Operated ambient air monitoring station	N/A
CPT Clark H. Weaver	Environmental Science - Industrial Hygiene	5/16 - 7/30	Operated ambient air monitoring station	N/A
Keith J. Williams	Environmental Science	7/2 - 8/30	Operated ambient air monitoring station	N/A
Kenneth E. Williams	Chemistry	5/2 - 6/17	Quality assurance and supervision for sample accession	N/A
2LT Delton Willis	Environmental Science	5/16 - 7/30	Operated ambient air monitoring station	N/A
1LT Robert C. Craft	Environmental Science	9/6 - undetermined	Operated ambient air monitoring station	N/A
MAJ Charles E. Goodman	Environmental Science	9/6 - undetermined	Theater Team Chief/direct and control operations	N/A
Richard S. Price	Medical Item Disposal Instruction System	9/6 - undetermined	Operated ambient air monitoring station	N/A
CPT D. Gustavison	Physician (Resident), Occupational Medicine	8/6 - 8/17 (Kuwait)	Associate Investigator	June 1992
SSG D. Harris	Toxicology Technician	8/6 - 8/17 (Kuwait)	Non-Commissioned Officer incharge of quality assurance	June 1992
CPT B. Scott	Physician, Occupational Medicine	8/6 - 8/17 (Kuwait)	Associate Investigator/Project Officer	June 1992
MAJ R. Broadhurst	Physician (Resident), Occupational Medicine	8/6 - 8/17 (Kuwait)	Medical Testing	June 1992
Dr. V. Kalasinsky	Environmental Toxicologist	8/6 - 8/17 (Kuwait)	Associate Investigator/Medical Testing	June 1992
SGT R. Conway	Practical Nurse	8/6 - 8/17 (Kuwait)	Medical Testing/Courier	June 1992
PFC B. Larman	Medical Lab Specialist	8/6 - 8/17 (Kuwait)	Medical Testing/Sample Preparation	June 1992
NIST				
Dr. D.D. Evans	Head, Fire Suppression Research, Building & Fire Research (BFRL)	5/11 - 5/17	Perform ground-based near field flame measurements	November 1991
Daniel Madrzykowski	Mechanical Engineer, BFRL	5/11 - 5/17	Perform ground-based near field flame measurements	November 1991
Dr. G.W. Mulholland	Research Chemist, BFRL	5/11 - 5/17	Perform ground-based near field flame measurements	Report of Test FR 3985 June 1991
OSHA/DOL				

NAME	TITLE/EXPERTISE	DURATION OF TRIP	PURPOSE	TRIP REPORT/FINDINGS
Earl Cook	Industrial Hygienist on Health Response Team	5/8 - 5/23	Evaluate safety and health aspects of conditions related to Desert Storm and oil fires	yes
Thomas Marple	OSHA Manager	5/8 - 5/23	Evaluate safety and health aspects of conditions related to Desert Storm and oil fires	yes

DIRE EMERGENCY SUPPLEMENTAL
'PROPRIATIONS FOR CONSEQUENCES
OPERATION DESERT SHIELD/DESERT
)RM, FOOD STAMPS, UNEMPLOYMENT
:OMPENSATION ADMINISTRATION,
VETERANS COMPENSATION AND
PENSIONS, AND OTHER URGENT
NEEDS ACT OF 1991

(2) inserting "unless an environmental assessment:

"(i) identifies potential impacts on biological diversity;

"(ii) demonstrates that all timber extraction will be conducted according to an environmentally sound management system which maintains the ecological functions of the natural forest and minimizes impacts on biological diversity; and

"(iii) demonstrates that the activity will contribute to reducing deforestation"

before the period at the end thereof.

SEC. 309. PERSIAN GULF ENVIRONMENTAL TECHNICAL ASSISTANCE.

(a) INTERNATIONAL FRAMEWORK.—Congress strongly encourages the President to seek the establishment of an international framework agreement to—

(1) provide for environmental monitoring, assessment, remediation and restoration in the Persian Gulf region of effects of the recent war; and

(2) provide for the payment, by the host country, of appropriate Federal agencies utilized to establish or implement this agreement.

(b) REPORTS.—

(1) Within 60 days of enactment of this Act, the President shall submit to the Committees on Appropriations of the Senate and House of Representatives an unclassified report identifying the actions taken to implement these provisions and any costs and payments, and President

(2) by March 1, 1992, and subject to the receipt of payment by the Environmental Protection Agency under subsection (a)(2), the Administrator of the Environmental Protection Agency, in consultation with appropriate agencies, shall submit to Congress an unclassified report providing a comprehensive evaluation of environmental effects of the Persian Gulf conflict identified pursuant to this provision.

SEC. 310. CHILD CARE BLOCK GRANT TECHNICAL AMENDMENT.

Section 658J of the Child Care and Development Block Grant Act of 1990 is amended by striking out "expended" and inserting in lieu thereof "obligated". 42 USC 9858h

SEC. 311. SYRIA.

(a) It is the sense of the Congress that—

(1) The successful conclusion of the war in the Persian Gulf provides an opportunity to begin building a lasting peace in the Middle East;

(2) A crucial element of peace in this unstable region is the willingness of Arab states to negotiate with Israel, recognizing her right to live in peace;

(3) The United States should continue to urge Arab states to negotiate peace with the State of Israel;

(4) One of those Arab states, Syria, continues to undermine goodwill and peace in the region by depriving the 4,000 Jews living in Syria of the right to emigrate;

(5) Syrian Jews continue to live in a climate of fear and