APPENDIX

SUBJECT: Method of the Exposure Assessment to the Fumes of Burning Oil Well Fires

1. AUTHORITY.
   a. Public Law 102-190, Section 734, Registry of Members of the Armed Forces Exposed to Fumes of Burning Oil in Connection with Operation Desert Storm.

2. BACKGROUND.
   a. Public Law 102-190 requires the Secretary of Defense to establish and maintain a record relating to members of the Armed Forces who were exposed to the fumes of burning oil wells. Section 734 of this law and Section 704 of PL 102-585, requires a means of calculating exposures to DOD military and civilian personnel deployed for Operation Desert Storm/Shield and who were exposed to air contaminants as a result of oil well fires. This includes the length of time of the exposure, the circumstances of each exposure to the fumes of burning oil, and the locations in the Operation Desert Storm Theater of operations. The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) is assigned this mission of determining the exposure of Persian Gulf veterans to the fumes from burning oil as an adjunct to the troop registry requirement.

   b. The U.S. Armed Services Center for Unit Records Research (USASCURR) was charged with determining the locations of all troop units on a daily basis for the period of time the oil well fires were burning (February through November 1991). The USASCURR Troop Movement Database was constructed by examining all existing Gulf War records, such as troop unit logbooks and situation reports that contained daily troop-unit location data by latitude and longitude. Over 5 million records were examined. The individual personnel in each troop unit were determined from the Defense Manpower Data Center’s (DMDC) Persian Gulf Registry. In addition to containing a list of individuals in each troop unit, this registry contains the dates when an individual entered and left the theater of operation. This data was used to determine the length of time when an individual may have received oil fire smoke exposure.

   c. To determine the oil fire exposure an individual received, the USACHPPM enlisted the aid of the National Oceanic and Atmospheric Administration (NOAA), Air Resources Laboratory (ARL) to assist in the oil fire exposure modeling effort. The USACHPPM used the output from the NOAA HY-SPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectories) model, in conjunction with their AVHRR (Advanced Very High Resolution Radiometer) satellite images, to determine where the oil fire plume impacted troops on a daily basis and at what level. HY-SPLIT was able to predict the concentrations of individual oil fire contaminants at the breathing zone level (2 meters) for 40,000 points (15 kilometer grid spacing) throughout the theater. The USACHPPM Troop Exposure Assessment Model (TEAM) can then calculate an individual troops’ exposure and resultant health risk using model exposure data, standard U.S. Environmental Protection Agency toxicity factors (i.e., reference dose/concentration and cancer slope factor), and risk assessment methods. Figures 1, 2, and 3 show an example for May 20, 1991 of the modeled, satellite, and merged oil fire plumes used to determine daily troop exposure levels. Daily troop unit locations are then plotted on the map (Figure 4) and their relationship to the oil fire plume is determined so exposure levels and risk from the various compounds coming from the oil fire smoke can be determined.
Figure 1. Modeled Plume Boundary for 20 May 1991.
Figure 2. Satellite Plume Boundary for 20 May 1991.
Figure 3. Plume Features for 20 May 1991.
3. EXPOSURE ASSESSMENT.

a. Oil Fire Exposure. The measurement and assessment of oil fire exposure was based on four factors; exposure to suspected carcinogenic compounds and the risk from that exposure (excess cancer risk), exposure to non-carcinogenic compounds and the risk from that exposure, particulate exposure, and the number of days exposed. These exposure levels are then compared to USEPA national standards to determine the extent of risk they pose to the individual.

b. Excess Cancer Risk. Excess cancer risk from a particular environmental exposure such as the oil well fires, is defined as the extra risk of getting cancer from that exposure alone. This risk is in addition to the risk of cancer from other sources. This includes such things as smoking, diet, excess sun, or other environmental exposures. The excess cancer risk caused by exposure to the oil well fires is determined by evaluating the air concentration of the compounds that cause cancer against a USEPA toxicity factor (cancer slope factor). The risk from all the cancer causing compounds in the oil fire smoke, for all the days the person is exposed are added together to determine the total excess cancer risk.
c. Non-Cancer Risk. Exposure to certain compounds causes health effects other than cancer. These compounds, called non-carcinogens, may affect the function of organs and systems in the body. One major difference between exposure to carcinogens and non-carcinogens is that the effects caused by non-carcinogens stop when the exposure stops. To determine the hazard from environmental exposure to non-carcinogenic compounds in oil well fire smoke a method similar to that used for carcinogens is applied. The air concentration of the compound is evaluated by comparing it to a USEPA toxicity value called the reference concentration. The reference concentration is the amount of a chemical that a person can be exposed to in the air for their entire lifetime without a bad health effect. These reference concentrations are set to protect sensitive subpopulations (i.e. the elderly, children in schools, daycare centers, etc.). To determine the impact of many non-carcinogenic chemicals in the air, the value obtained when each non-carcinogen is evaluated are added together to obtain the hazard index for the total exposure. The USEPA limit for exposure to non-carcinogenic compounds is a Hazard Index of 1.

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