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PEACTM Value-Added Project

**Final Report
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EXECUTIVE SUMMARY

Chemical spill emergencies are exacerbated by a lack of information at the scene with which to quickly assess the situation and determine the appropriate protective action. WRI has concluded that the most successful emergency tools (models) for predicting toxic cloud behavior are those that use field test data as part of their development. After analyzing more than 100 real-world chemical spill accidents and field test releases, WRI has also concluded that information from dense gas/toxic models must be communicated in a fast, simple way to emergency responders or it will not be used.

In an effort to address this technology gap, WRI has developed PEAC™ (Palmtop Emergency Action for Chemicals). PEAC is an innovative tool that combines hardware, software, data bases developed by WRI and other organizations, and a unique approach to modeling protective action distances tested with actual field data. PEAC brings modeling data and other reference sources together in a single piece of portable equipment to help emergency responders evaluate a chemical spill incident and quickly determine protective action distances.

PEAC handles chemical release situations that vary in meteorology, terrain, chemical, and source, and calculates protective action distances for a given concentration, as well as provides information on physical properties and mitigation. Even an emergency responder who is untrained in toxic gas dispersion modeling can enter the required information and display the PEAC calculations and chemical hazard and response information in about two minutes.

The following work was accomplished under Subtask 3.8:

- Data from the STF data base was used to compare how well PEAC's modeling system performs against "accepted model techniques on the EPA network." The STF data base was used to test ALOHA, HEGADAS, SLAB, and PEAC.
- Maintained the STF data base.
- Compared PEAC with the Computer Aided Management of Emergency Operations system (CAMEO) system developed by the National Oceanic and Atmospheric Administration (NOAA).
- Explored ways to increase "semi-official" exposure for PEAC through the EPA. WRI explored the procedures for updating Air Quality Modeling Techniques for Regulatory Programs with Jawad S. Touma, a NOAA employee on assignment with the Environmental

Protection Agency (EPA) Office of Air Quality Pollution Standards (OAQPS) to get WRI's PEAC system listed with other models (none of which are as easy to operate as PEAC). WRI submitted the PEAC system to the EPA Chemical Emergency Preparedness and Prevention Office (CEPPO), and we are pursuing setting up a link from their Internet web page to the WRI web page. Such a link represents a kind of tacit approval and will increase exposure for the PEAC system, drawing attention to its ease of use.

- Began the process of converting from an Apple Newton software platform to a Windows platform.
- Examined hardware to explore future emergency response platforms.
- Tested applications for upgrading PEAC data storage and printing.

Activities scheduled over the next 12 months to promote PEAC include advertising, developing contacts and providing demonstrations, and increasing visibility and credibility through journal publication and participation in trade shows.

INTRODUCTION

PEAC™ (Palmtop Emergency Action for Chemicals) is a hand-held computer that contains information for managing emergency response to chemical spills. PEAC was designed to improve the reaction time of the responder. After investigating 123 chemical spills (Nordin and Sheesley, 1989), the hazardous chemicals research team at Western Research Institute (WRI) learned that once a chemical was released and dispersion had begun, the time required to assemble chemical-specific information was dangerously unacceptable. PEAC is designed so that an emergency responder can access information and procedures about a released chemical in about two minutes.

Figure 1.
Palmtop Emergency Action
for Chemicals (PEAC™)

The PEAC system performs two basic functions: information retrieval and evacuation distance prediction. It has a data base of over 3,700 chemicals, including information on toxicity, NFPA hazard rating, and chemical and physical properties. Respirator and chemical protective clothing information is provided, as well as a fire foam program. The PEAC system also includes some of the chemical precursors for explosives and chemical warfare agents. PEAC is offered on a handheld Apple Newton MessagePad 2000, which features solid-state electronics, backlighting, and instant-on readiness.

The PEAC system calculates safety zones/evacuation distances for toxic chemicals based on actual site weather, chemical source strength, and toxic concentration of concern. The evacuation distance for a gaseous release of domestic toxic chemical from a typical storage or transportation container is computed based on source strength and a selected source type.

Source types are: (1) major failure of a container, (2) boiling liquid expanding vapor explosion (BLEVE), or (3) a hole or sheared valve release such that the size of the chemical release opening can be specified. Evaporation rates are computed when the input incident conditions predict the formation of a liquid pool. Even an emergency responder who is untrained in toxic gas dispersion modeling can enter the required information and display the PEAC calculations and chemical hazard and response information in less than a minute.

Development of the PEAC public safety technology is a direct result of WRI's activities to archive spill test facility results from the U.S. Department of Energy (DOE) liquefied gaseous fuels spill

test facility (STF) at the Nevada Test Site, to update the data base on spill control technology documents and data, and to transfer this information to the public.

As mandated in the 1986 Superfund Amendments and Reauthorization Act (SARA) PL 99-499 118 (n) and the 1990 Clean Air Act Amendments (CAAA) PL 101-549 103(f) and 901(h), the Secretary of Energy is to make available the use of the Liquefied Gaseous Fuels Spill Test Facility, near Mercury, Nevada, for use by industry, federal agencies, and others, to deliberately spill chemicals in order to validate and improve model technology and evaluate the effectiveness of hazardous mitigation and emergency response technology. An essential part of the legislation also directed DOE to develop effective technology transfer of the national data base.

WRI has used the SARA guidance to:

- Promote the development of an experimentally verified technical data base by users of fuels and chemicals to aid in the prevention, mitigation, cleanup, and prediction of environmental effects of accidental release of these chemicals
- Make the STF data accessible to industry and the public with documentation and archival of spill control technology data bases
- Design, construct, and make PEAC technology available for responding to spills of liquefied gaseous fuels and other toxic gases and liquids.

BACKGROUND

The intent of the SARA and CAAA included providing public safety emergency response technology development for evacuation or protective action distances for accidental chemical spills. WRI, Desert Research Institute (DRI) of Nevada, the EPA and DOE NN-60 in a former collaboration called the Chemical Hazards from Atmospheric Releases Research program (CHARR) instituted a plan begun in 1991, as required by Title IX of the 1990 CAAA, PL 101-549 and first demonstrated by DRI/WRI in July 1993, for real chemical releases in the field at the Nevada Test Site.

These uses of public funds are based on improving the understanding of roughness effects on toxic gas dispersion in the event of accidents in which fuels and other chemical are spilled. This research and development effort is providing an improved understanding of model validation in

terms of the measured effects of atmospheric turbulence on gas dispersion caused by obstacles near the ground in combination with stable atmospheric conditions.

There is general consensus that the mathematical models used to predict evacuation areas for public safety based on toxic vapor concentration levels of concern (LOC) are only accurate by approximately a factor of two when verified with data from field experiments based on limited meteorological and surface roughness conditions. The data from field studies conducted by Western Research Institute at the national Spill Test Facility in Nevada, which simulated real-world scenarios, may show where these models can be improved.

WRI and DRI conducted tests to improved understanding of the influence of (1) turbulence from surface roughness and obstacles, (2) short, finite duration releases, and (3) dispersion under nighttime (stable, low-wind speed) conditions to provide a technical basis for compliance with CAAA section 112(r), or Risk Management Planning. The design of the experimental testing at the STF was decided between WRI and the EPA contracting officer's technical representative (COTR) Chief of the Applied Modeling Research Branch, National Exposure Research Laboratory in the EPA, Research Triangle Park, North Carolina.

WRI is contractually obligated to give prior notification to the DOE, which provides the jointly sponsored research funds, before releasing the results of the gas dispersion work for publication. The statement of work requires no use or disclosure of these data from the STF tests may be made public for one year. When these data are made public, they will contribute substantially to the understanding of public safety related to toxic gas dispersion from fuels and other chemicals.

ACCOMPLISHMENTS

The overall objective of the WRI public safety subtask is to develop data bases related to releases of fuels and toxic chemicals and provide these data bases for use by industry and the public. The testing and evaluation of technologies and a system to transfer these technologies to chemical spill emergency responders is an essential part of Congressional direction and the DOE mission for emergency response technology development at the DOE STF in Nevada.

By developing PEAC, WRI has provided a tool for the protection of worker and public safety and the environment and has honored its commitment to this national STF program for health and safety engineering research in the interest of the nation's public, as established by

Congress. The STF data base and bibliography were both utilized in the development of PEAC. New references and recent literature cited in the bibliography were used to critically examine the improvements in emergency response technology included in the PEAC system, and the STF spill control technology databases were used in the development of PEAC such that their value is now available to industry and the public.

The STF data base was used to test ALOHA, HEGADAS, SLAB, and PEAC. Numerous computer runs using the STF test data from 1990 to present were conducted to compare how well the PEAC model system performs with "accepted model techniques on the EPA network." Data from at least eight experiments (Ansul 1990, Silicone Health Council 1990, Dow Chemical 1990, Center for Chemical Process Safety 1990, Lawrence Livermore National Laboratory 1991 and 1992, DuPont 1992, and Western Research Institute/Desert Research Institute 1993) were reviewed and compared to PEAC. Field data needed to improve models to make them more realistically predict downwind chemical hazard zones will be released in about six months. These data, which are already being incorporated into PEAC, address these key technical issues:

- Turbulence from surface roughness and obstacles,
- Short, finite-duration chemical releases, and
- Dispersion under nighttime (stable, low wind speed) conditions.

In further analysis of the differences between PEAC and similar systems, WRI has compared the National Oceanic and Atmospheric Administration's Computer Aided Management of Emergency Operations system (CAMEO) with PEAC. In fact, WRI has been monitoring CAMEO since December 1988 when Jim Makris, director of the federal SARA title III program, first endorsed the tool publicly. WRI believes the NOAA CAMEO system is a good tool when used correctly and that the WRI PEAC system complements the CAMEO system by improving emergency response time.

From our investigation of over 100 chemical accidents, we concluded that the first responder on the scene needed the information contained in CAMEO without having to deal with the complex CAMEO input requirements. An advantage of PEAC is that it provides vital information at the incident site before an Emergency Operations Center (EOC)/Incident Command is fully operational. The PEAC system is easy enough to use that within minutes even responders with no modeling experience and minimal computer skills can access critical emergency information. Unlike CAMEO, PEAC is well-suited to emergency situations, featuring portability and durability in the field.

WRI explored the procedures for updating Air Quality Modeling Techniques for Regulatory Programs in an effort to get PEAC listed with other models on the Internet. Working with Jawad S. Touma, a NOAA employee on assignment with the EPA Office of Air Quality Pollution Standards, WRI submitted the PEAC system to the Chemical Emergency Preparedness and Prevention Office of the EPA, which will install a link from their Internet web page to the WRI web page. This will increase the exposure of the PEAC system. Activities were also initiated to link to the DOE web site.

Other work to add value to the PEAC system has included:

- Converting software from an Apple Newton to a Windows platform
- Examining hardware to explore future emergency response platforms
- Testing upgrade systems for applications for data storage and printing.

In 1992, the chemical processing industry produced and managed 12 billion pounds of chemicals and chemical byproducts, and in the same year, according to a Chemical Manufacturing Association study, 826 million pounds of chemicals were accidentally released. This month, a record \$3.4 billion judgment in punitive and compensatory damages was handed down as a result of a railcar incident in which the chemical butadiene leaked and caught fire in a New Orleans rail yard in September 1987. The money, which will be shared by 8,000 plaintiffs and their lawyers, will be paid by five organizations involved in transporting the hazardous cargo: CSX Transportation Corp, Illinois Central and Norfolk Southern Railroads, Missui & Co., and GATX Corp. A 1988 National Transportation Safety Board report on the incident noted that the emergency was exacerbated by a lack of information at the scene. There is great motivation to use emergency response technology!! The stakes are HIGH!!

Activities scheduled over the next 12 months to promote PEAC include advertising, developing contacts and providing demonstrations, and increasing visibility and credibility through journal publication and participation in trade shows.

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APPENDIX A

Potential for Accidental Releases

POTENTIAL FOR ACCIDENTAL RELEASES

The chemical processing industry produced and managed 12 billion pounds of chemicals and chemical byproducts in 1992. According to a Chemical Manufacturing Association study, 826 million pounds of chemicals were accidentally released in 1992. The study also reported that in 1992 emissions/releases of 17 chemicals have been reduced under the Environmental Protection Agency's voluntary 33/50 program. Implementation schedules and proposed rule making will require risk management planning for each category of chemicals to schedule maximum achievable control technology.

In an unpublished report (Nordin 1989) to the Department of Energy, Western Research Institute (WRI) investigated 123 accidental releases during 1987-1988 in the U.S. that resulted in public evacuations (excluding natural gas leaks or explosions). Fire was involved in 58% of the toxic gas releases. Explosions occurred in 36% of the releases. Train derailments accounted for 24% of the evacuations and highway accidents accounted for 9%.

A potentially catastrophic hydrogen fluoride (HF) release occurred on October 30, 1987, at the Marathon Corporation refinery at Texas City, Texas. Equipment dropped from a crane sheared two pipes on top of a 12-ft diameter, 20-ft high pressurized tank containing an estimated 40,000 lb of liquid hydrogen fluoride capped with isobutane. The contents escaped over a period of two hours, resulting in a hydrogen fluoride plume 2 to 3 miles long and 0.5 to 1.0 miles wide, which led to the evacuation of 3,000 people. The evacuation was criticized by Dr. Fred Miller of the Environmental Policy Institute, who issued a public statement that based on hydrogen fluoride spill tests conducted at the Nevada Spill Test Facility, the evacuation distance downwind should have included a semicircle of 7 miles or 70,000 people.

In August 1986, Amoco had conducted two spill tests of 1,000 gallons of liquid hydrogen fluoride and found that the HF liquid was carried away quickly with the wind as a ground-hugging fine aerosol, a behavior much different than that predicted by plume models. Amoco had shared the spill test results with the petroleum industry. Dr. Miller said that the results, however, were not adequately communicated to local emergency response officials. If a pipe on the side or near the bottom of the tank had been sheared, the entire tank contents would have escaped at once, and a disaster comparable to the December 1984 methyl isocyanate spill in Bhopal, India, which killed 2,000 people, would have resulted. WRI, in reviewing the Amoco spill test, noted that the HF release system had a nozzle configuration which would lead to aerosol formation.

Models were available for calculating the evaporation rate from a spilled pool. When spill tests were done at the Nevada Spill Test Facility in 1986, however, no liquid pool formed. Instead, the hydrogen fluoride dispersed 20% as a gas and 80% as a ground-hugging aerosol carried with the wind. The hydrogen fluoride gas also reacted or solubilized readily with moisture in the air, forming a mist. The Amoco tests are summarized in the *Oil and Gas Journal*, 68(42), Oct. 17, 1988, pages 58-62.

According to a report by the National Environmental Law Center and summarized in *USA Today* (August 19, 1994), chlorine, ammonia, sulfuric acid, and hydrochloric acid were the chemicals most involved in cases of immediate injury, evacuation, or death. About 75.3% of the toxic chemical releases occurred at plant sites or buildings, 3.1% associated with pipelines, and most of the rest occurred as the result of transportation accidents. This report was compiled from Environmental Protection Agency statistics from 34,500 accidents involving toxic chemical releases between 1988 and 1992. Operator error or equipment failure was the cause of most accidents. During the American Institute of Chemical Engineers 1994 summer national meeting on August 15 in Denver, Colorado, authors presenting papers relating to risk assessment singled out equipment failure rather than operator failure as the cause of most accidents releasing toxic chemicals.

A Chemical Safety and Hazard Investigation Board has been established (sect. 112 (r)(6)), which investigates and reports to the public the circumstances and causes of any accidental release resulting in a fatality, serious injury, or substantial property damage. This board is also required to make a report to EPA and OSHA recommending regulations for preparation of risk management plans to prevent accidental releases into the air, including mitigation of releases or spills. The EPA (sect. 112 (r)(7)) is to issue regulations requiring an owner or operator of sources where a regulated substance is present to prepare a risk management plan to detect and prevent or minimize accidental releases and to have in place an emergency response plan to mitigate such a release. Chemical accidents resulting in public evacuation show the need of having a risk management program and communication to state and local agencies and the shortcomings in the use of air dispersion models in predicting evacuation zones. For industry to remain competitive, models for risk assessment providing more accurate source term definition and accounting for variable terrain and obstacles must be developed.

The major provisions of Title III of the CAAA incorporate laws begun under emergency planning and the Community Right-to-Know Act of 1986, also known as Title III of the Superfund Amendments and Reauthorization Act (SARA). The risk management plan and emergency response plan required by the Clean Air Act are in addition to reporting requirements under the Emergency Planning and Community Right-To-Know Act of 1986, also known as Title

III of the Superfund Amendments and Reauthorization Act. The latter legislation requires owners and operators of facilities where hazardous chemicals are manufactured or used to prepare material safety data sheets, inventories, and locations. This information is to be submitted to appropriate local emergency planning committees, the local fire department, and state emergency response commission. There are also reporting requirements in case of a spill or accidental release.

Requirements are spelled out for the reporting of chemical inventory and accidental spills or releases. SARA-established reporting requirements for industry and the DOT, DOE, EPA, DOD, and the process for reporting the chemicals in the EPA list, and their thresholds, are in 59 Fed. Reg., Jan. 31, 1994, p. 4477. EPA has estimated that 118,000 facilities will be affected. The list includes 77 toxic substances, 63 flammable substances, and explosives (listed by DOT in Division 1.1 of 49 CFR 172.101).

A major conclusion learned as the result of the 123 accident investigations was that the accidents and resulting toxic emissions were very diverse and were rarely describable by available plume dispersion models. Weak points were source term definition and inadequate or unknown meteorology at the time of the release. Also poorly understood was the effect of real-world surface roughness (buildings or structures and surface topography) on plume dispersion. The models also did not account for the effects of sprays, foams, or liquid caps placed on a second liquid to minimize evaporation, or other mitigation methodology to minimize emissions.

There is a real need to do spill test work to define these unknowns in order to develop risk management and emergency response plans. There is also a real need to communicate spill test results to industry and local agencies responsible for emergency planning and response.

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APPENDIX B

PEAC Value-Added Market Project

PEAC VALUE-ADDED MARKET PROJECT

Base Task Objective

Expand the potential markets for the WRI Palmtop Emergency Action for Chemicals (PEAC) product by increasing its capabilities.

Description of Project

The WRI Chemical Emergency Response Technology team has set a goal of technology transfer by developing a marketable product that will be available to the public. The product is designed to assist the first responder to a hazardous material spill incident in making decisions related to response personnel and public safety by providing information and calculations specific to the described incident.

The described project for base funding is to allow increased development and implementation of additional features and capabilities into the PEAC product, which will expand the target market and marketability of the product.

Description of Product

A prototype version of PEAC has been developed and submitted to a number of outside experts at various locations across the nation. Their appraisal of the unit in the form of suggestions, recommendations, and comments has been utilized to modify PEAC to its current platform and application capabilities. The primary PEAC feature is the calculation of a Protective Action Zone for a toxic chemical spill specific to actual conditions for the location of the incident. PEAC also provides generic guide information related to fire or explosion, health, protective clothing, evacuation, fire, spill, or leak, and first aid.

The WRI product allows on-the-scene input of:

- chemical or UN number
- meteorology
- terrain type
- container type
- type of release and additional specific parameters, e.g., hole size and liquid pool parameters

The information and calculations provided to the user are from the input information and the data bases stored on PEAC. Current types of information provided to the user:

- prediction of the protective action distances to protect emergency response personnel and the public
- reference to NFPA hazard codes
- chemical and physical properties of specific chemicals

- recommended respirator information
- personal protective equipment information for a large number of chemicals

Potential New Features for the PEAC Product

The capabilities that are to be included in the PEAC application are summarized below with discussion. The initial phase of this project will be to develop the information allowing assignment of a priority, estimated schedule, and resources required to implement the following capabilities. It should be understood that not all of these capabilities are expected to be accomplished during the next twelve months, but it is anticipated that at least 4 to 6 can be completed and incorporated into PEAC.

A focus of future upgrades should be on broadening the PEAC application to address the new EPA rule for risk management planning (RMP) PL 101-549, section 112 (r). Congress has given direction to different agencies in the matter of the safe handling of fuels and other chemicals (commonly called hazardous materials or hazmat). The EPA rule, June 20, 1996, requires any facility with a threshold quantity of specified materials to conduct a hazard assessment. The hazard assessment must take into account the area surrounding the facility and the population that would be affected by "worst-case" and "most-likely" fuel and other chemical releases. Addressing this rule in WRI's PEAC with some of the capabilities described below will increase sales.

- Save chemical spill incidents information for download to PC. One concern that prototype testers have expressed is that PEAC is a very useful tool for the first responder but after the incident has come under initial control, command is typically passed to another individual that has appropriate resources and training. The ability to transmit, PEAC information via serial connection, IR interface, etc., to the modeling software being used by the Incident Commander would be useful, save time, and reduce chances for errors.
- Develop a PC version of PEAC application. The current version of PEAC is programmed with a specific application software that runs only on the Apple Newton MessagePad operating system and is not portable to other platforms, i.e., desktop or laptop IBM compatible machines. Feedback from prototype testers has indicated that like many other businesses or government agencies, budgets are tight and funds may be available for procuring additional software applications but not to purchase additional hardware platforms (PEAC might fall into this category). Making a Windows version of the PEAC application that would run on desktop or laptop PCs could potentially open up an entirely separate market.
- Expand the Chemical Synonyms List. The current version of the PEAC application has a substantial number of synonyms for specific chemicals. As WRI's Chemical Emergency Response Technology team has accessed additional data bases to incorporate the respirator and personal protective equipment information into the current PEAC application, it has become obvious that the PEAC synonyms list would be more useful when dealing with future data bases if it was expanded. This would not only benefit working with and incorporating additional information and/or capabilities into PEAC but it would also benefit the users of

PEAC since the current organization of PEAC and its synonym list allows easy reference into the other information regarding a specific chemical by selecting a chemical by name.

- Improved spill duration for dense gas dispersion model predictions. Current modeling capability in the PEAC application uses a simplified analysis when a puncture hole or sheared-off pipe on the container is the specified release type. The flow from the orifice can be more accurately predicted if additional information is requested and a more sophisticated model of flow through an orifice is used.
- Add CAMEO/SARA fixed facility data and situation plans. One of the most prevalent software applications used in the emergency planning segment of the market, and to some extent also used in the emergency response segment, is CAMEO. This product, which is distributed by the National Safety Council, provides the user with the ability to enter the in-house inventory of hazardous materials into data base files and generate reports for compliance with SARA Right-to-Know regulations. Access to this inventory data is very useful when a hazardous material has been released at a fixed facility. Developing the software so that the CAMEO data could be transferred to PEAC and therefore be available when an incident at a fixed facility occurs would be very useful to many users of the CAMEO application.
- Include model predictions of fire and explosion protective action distances. The current PEAC application deals only with predicting toxic vapor protective action zones. An additional concern for first responders is dealing with hazardous materials that may be explosive or highly flammable. There is at least one widely used model in the public domain that deals with predicting proper protective action zones for fires and explosions. Incorporating this model or an appropriate substitute into PEAC would address two more potential areas of concern for the first responder.
- Search by Chemical Abstract Service (CAS) number. The current PEAC application provides the user with the ability to search for a material by chemical name, United Nations number, or by DOT Guide number. A large number of the materials included in PEAC have an associated CAS number. This feature would provide the ability of the PEAC application to search the chemical names by using the CAS number as an input.
- Printer for hardcopy distribution. Prototype testers have requested the ability to generate a hard copy of the predictions and other information provided by PEAC. The Apple Newton MessagePad has a printer port, and compatible printers are widely available. Providing an option to output a screens or text to a printer would be a fairly straightforward and very useful.
- Include population density and mapping features. The CAMEO software application features the ability to display local street maps showing specific locations of schools, hospitals, etc. that might be downwind of an incident. Along with this is the ability to plot the footprint (predicted protective action zone) on the map for the user. WRI's Chemical Emergency

Response Technology team would have to investigate the complexity and storage requirements, but developing a similar capability for PEAC on the Apple Newton MessagePad platform may be possible.

- Applications for worst- and best-case distances (variable). One of the major concerns when predicting protective action distances is the accuracy of the information provided by the. In some cases, depending on specific circumstances, even slight changes in a parameter's value can make a substantial difference in the calculated protective action distance. It may be extremely useful to the user to have PEAC automatically make multiple protective action distance calculations by assuming some variation (perhaps user specified) in the user-provided inputs. The user could then be provided with a range from best to worst case predicted protective action distances generated from the given values.

A second and separate area of enhancement to PEAC is the modification of the current dispersion model algorithms when the WRI-PERF 93-16 project results are made public in hopefully about 12 months. The 1995 Kit Fox field experiments measured airborne dispersions under neutral and stable meteorological conditions and three different surface roughness domains. Unfortunately, entities within the federal government and industry beyond the control of WRI have caused the reduction, validation, and analysis of this data to be delayed. If proposed funding becomes available to allow completion of these remaining tasks for the Kit Fox data, a new and currently unavailable model for predicting the dispersion of heavier-than-air chemicals under worst-case conditions could be developed and made public through the PEAC product. The WRI Chemical Emergency Response Technology team has already demonstrated its ability to develop and implement technology transfer faster than any other government or industrial concern to date.

Schedule

Task	Calendar Year 1997			
	Qtr 1	Qtr 2	Qtr 3	Qtr 4
Phase 1 Evaluate potential capabilities and select targeted development	--◆			
Phase 2 Develop data/algorithms Implement software applications	-----	-----◆ ---	-----◆	
Phase 3 Incorporate new capabilities into PEAC In-house testing and verification				----◆ ----◆

Personnel Involved

Resource	Rate*	Hours	Cost
D. Sheesley	48.60	1,200	58,320
V. Smith	49.46	500	24,730
J. Nordin	50.81	1,500	76,215
T. Routh	32.01	500	16,005
B. King	32.01	1,200	38,412
B. Cochran	19.42	500	9,710
T. Anderson	14.80	1,000	14,800
	Total	6,400	238,192

*Labor costs are not burdened with GOH.

PEAC development and management is in the commercial division of WRI under the direction of Dr. L. Brecher. D. Sheesley is the program manager for this area and has had the experience of developing new products, and start-up sales in former business arrangements. Other key professionals who have had experience in business start up and development of these products are S. B. King, T. K, Routh, V. Smith, and J. Nordin.