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The Army's Risk Assessment of Chemical Munitions Transportation

Statement for the Record
Submitted by
Thomas J. Brew, Associate Director
National Security and International
Affairs Division

To the
Subcommittee on Government Activities and
Transportation
Committee on Government Operations
House of Representatives

Madam Chairwoman and Members of the Subcommittee:

In August 1986, we were asked by the Subcommittee on Investigations of the House Committee on Armed Services to conduct a review of the U. S. Army's chemical munitions disposal program. We testified on the results of our review in March 1987. One of the objectives of our review was to determine whether the documentation supporting the Army's assessment of the risks involved in disposing of or transporting chemical munitions fully addressed all aspects of risk. This statement discusses our findings, which are based on information available as of March 1987. We interviewed Army officials to determine changes which have been made to the program since March but have not validated these changes. Unless otherwise noted, however, our information in this statement is current as of March 1987.

/Public Law 99-145/ directed the Secretary of Defense to carry out the destruction of the U. S. stockpile of lethal chemical agents and munitions by September 30, 1994. The law specifically directed that a plan be developed defining the safest and most effective means of disposing of the stockpile. The Army provided its plan to the Congress in March 1986, describing implementation plans for the following possible alternatives: (1) on-site disposal at each of the eight existing continental U.S. storage locations, (2) transportation to two regional disposal centers, and (3) transportation to a national disposal center in the continental United States.

The National Environmental Policy Act requires an agency to develop an environmental impact statement when making a major program decision. The statement must discuss significant environmental impacts and inform decisionmakers and the public of reasonable alternatives to avoid or minimize adverse environmental impacts. The Army's draft impact statement, issued in July 1986, analyzed the program alternatives, including discussions of the risks of transporting the munitions.

The draft statement describes the overall chemical munitions disposal program, the munitions, the program alternatives, and their associated risks. To determine the risks and potential effects of each alternative for a program of such national scope, the Army created generic or common communities and environmental settings rather than site-specific or route-specific locations. Consulting contractors used these general scenarios to assess the potential impacts of normal disposal operations and of accidental agent releases on humans, the environment, and local economic and social conditions. The assessment of accidental agent releases included worst-case and most-likely accident scenarios resulting from disposal operations and transportation. The Army plans to do additional site-specific studies after deciding on a final disposal option. The Army currently expects to select a final disposal option in February 1988.

In assessing the risk of transporting chemical munitions, the Army relied on various hazard and risk analyses, which had previously been conducted for disposing of one type of munition included in the stockpile--M55 rockets--which contain lethal nerve agents GB or VX. For the draft statement, the Army contracted with the Department of Energy's Oak Ridge National Laboratory (ORNL) to integrate these analyses of accidents and their probabilities along with qualitative estimates of risk for other chemical munitions in the stockpile. To define accident consequences that could occur while transporting the munitions or while disposing of them, an Army contractor for risk analysis provided preliminary estimates of the amounts of agents that could be released. The ORNL analysts used atmospheric modeling techniques to estimate the distances released agents would travel downwind. Finally, ORNL used this information to estimate potential human health and environmental effects.

Using information collected from Army staff, ORNL, several contractors involved with risk studies, other agency experts, public comments, and congressional hearings, we identified areas in the draft statement where (1) the analysis was incomplete, (2) uncertainties affected the impact analysis, and (3) limitations in the supporting data bases and available research restricted determination of program effects.

INCOMPLETE ANALYSIS

We identified four areas of the draft statement where the risk assessment was incomplete. These areas were also identified by the Army, and plans are currently under way to improve the final environmental statement.

First, we found that the hazard and risk analyses only contained accident probabilities for the M55 rockets. The Army did not have similar analyses or probability estimates for other types of stored munitions, such as bulk chemicals and bombs, and relied on a general assessment of risk for these munitions. Subsequent to the draft statement, the Army contracted for a more complete risk analysis for all munitions and for other accident scenarios, such as earthquakes and airplane crashes. For this additional data, the contractor used a fault tree analysis which divides the disposal process into various components to determine which components may fail and cause an accident. The contractor then calculated each accident's probability and the expected amount of agent that would be released.

To determine accident probabilities for the rail transportation risk studies, the contractor for the transportation risk estimates relied on various data bases, including a national laboratory's data base compiled from Federal Railroad Administration incident reports, engineering estimates of additional potential accident

frequencies, and computer models of accident duration. Since the draft environmental statement was prepared, the contractor analyzed hundreds of additional accidents to use in the final impact statement to compare the risks for each program alternative.

The second area we identified as incomplete was the transportation risk assessment. We found that the draft statement primarily addressed the risk of rail transportation and did not address other transportation modes. The rail transportation plans that were analyzed were not fully defined, and as a result, analysts said that some potential accident scenarios for both the regional and national disposal options had not been identified in the draft statement. Therefore, not all of the risk and potential impacts associated with transportation were included in the comparison of disposal alternatives. Subsequent to the issuance of the draft statement, the Army convened a panel of transportation experts which included members from industry and academia to finalize rail, air, and barge transportation concept plans.

One of the transportation panel's main findings was that the packaging for munitions during movement is a crucial component in transportation. The Army had planned to use an existing container which transports radioactive materials, but the panel concluded the Army should specifically design a new container for the munitions. The panel established criteria for such a container, and the Army is now studying design concepts to meet these criteria. According

to Army staff, incorporating a new container in the program plan led to a dramatic change in the transportation accident scenarios and their risk estimates. For example, the new container, yet to be developed, will reduce the occurrence of certain fires and explosions, which, under the previous concept, would have released chemicals into the environment and increased the risks involved in disposal options requiring transportation.

The third area we determined to be incomplete was in planning for emergency response capabilities if an accident occurred during transportation or disposal. Emergency response planning was defined in the statement as a socioeconomic issue, but its impact was not fully assessed. Since issuing its draft plan, the Army has found that there is no central data base of emergency response capabilities by jurisdiction or location. Consequently, the Army asked a contractor to develop an emergency response concept plan for the various program alternatives, and to determine what resources are currently available at each of the eight potential disposal sites. The contractor completed the plan in July 1987. Program office staff recently presented it to the Undersecretary of the Army who has requested additional information before proceeding to the development of site-specific emergency response concept plans.

In exploring the emergency response provisions along the proposed transportation routes, the contractor stated that it was not

practical to develop detailed emergency response plans for all of the communities along the routes because of the broad geographic area covered. As a result, the contractor stated that the emergency response plans for disposal alternatives requiring transportation cannot be as effective, responsive, or complete as the plan for disposing of the munitions at the current storage sites. The contractor concluded that emergency response plans for specific disposal sites would be more effective in preventing the accidental release of agents and in providing protection against public health effects from such releases than plans for the communities along the transportation routes.

The emergency response concept plan also recognized that resources required to provide adequate emergency response capabilities could vary significantly among the disposal program alternatives. The contractor recommended for the disposal options requiring transportation that the Army consider limited mobile emergency response resources, which would be transported with the munitions. The contractor also suggested developing a state or regional emergency response coordination system for the options requiring transportation. The contractor found that at the potential disposal sites, a number of general emergency response program components must be developed or improved quickly. The Army agreed that emergency response could significantly impact local resources and could affect the selection of the disposal alternative.

Finally, the risk assessment did not adequately disclose the fact that available air monitoring technology is limited. For example, the Army's current air monitors are not sensitive enough to detect very low levels of mustard agent present in the air which might still affect human health. The monitoring limitations were recognized by the Army but were not described in the draft environmental statement. After the draft statement was issued, the Army released a monitoring concept study which examined available technology and monitoring requirements for every step of the disposal program--including the transportation of munitions. As of August 1987, a program official said the Army was also exploring methods to reduce the amount of time required for a monitor to detect a released agent and to signal a warning. In addition, the Army has requested that the National Institute for Occupational Safety and Health evaluate and comment on current monitoring technologies.

UNCERTAINTIES LIMIT THE ANALYSIS

The draft environmental impact statement contains analytical uncertainties that affect the accuracy of fatality estimates and the determination of effects on health and the environment. We identified uncertainties and limitations in computer models used to (1) select transportation routes for analysis, (2) estimate how far chemical agents might accidentally travel, and (3) estimate populations at risk for each disposal alternative.

Selecting transportation routes

While the discussion of transportation alternatives in the draft statement primarily included only rail transportation, the Army had considered risks for other modes, including truck transportation. To assess truck transportation risks, ORNL selected an existing data base which contained most of the highways in the United States, and could easily be adapted to their risk analysis of the Army's program alternatives. In selecting truck routes for analysis, ORNL staff gave priority to (1) interstate highways, (2) routes that avoided population centers of 100,000 or more, and (3) routes that did not restrict the transportation of hazardous materials. An ORNL official said that the highway data base took into account most state government road restrictions and as many local government restrictions as could be identified. However, the official was not certain of the data base's completeness because it was designed to assess routes for moving radioactive wastes, and restrictions which apply to other types of hazardous materials might not have been considered.

To select rail routes, an ORNL official explained, the analysts used data originally drawn from a 1970s Federal Railroad Administration data base showing the rail network of the United States. The analysts factored in changes to railroad structures, track mergers, and lines abandoned since the original data base was developed, and continue to update the data base as new changes

occur. The analysts acknowledged, however, that the accuracy of the data base is limited and may not reflect actual routes.

The ORNL analysts combined the rail network with a computer model to select routes, giving preference to higher quality track, while trying to avoid population centers. The panel of transportation experts who were convened to develop the transportation plans recommended that the Army use track quality as the only criterion, but the Army wanted to also retain population as a criterion. According to the analysts, no national data base on track quality exists, and they did not have data on quality factors such as railbed maintenance records. Consequently, they inferred quality by comparing the amount of cargo the track handled, assuming that the most heavily used track would get priority maintenance. After selecting potential routes for the Army program, ORNL selected another firm to contact the railroads and determine actual track quality for these routes. According to the Army, if a disposal alternative requiring rail transportation is chosen, the Army will have to pay for the upgrade of any poor quality track.

Dispersion model for accidental chemical releases

The Army also estimated how far chemical agents would travel downwind from accidents at a disposal site or while being transported and how much of an effect the chemicals would have on public health or the environment. The Army relied on an

atmospheric dispersion model, D2PC, to estimate these distances. The model's results are a major component of the risk assessment.

The model makes the following assumptions, which inevitably limit its accuracy: (1) the wind is equally likely to blow from all directions; (2) a cloud of agent moves in a straight and narrow path over the maximum population at an accident site without meandering or spreading very rapidly; and (3) the terrain is always flat. In describing the model's assumptions and logic, analysts acknowledged that the model's estimates of distances that an agent cloud might travel were only accurate to plus or minus 50 percent. However, despite these inaccuracies, others knowledgeable in the field generally agreed that the D2PC model was the most appropriate dispersion model for the Army program.

Analysts combined the D2PC model's results with the selected routes to estimate the size of the population at risk for each program alternative. Risk to public health is the Army's primary criterion for selecting a program alternative. To estimate this risk, ORNL used census data to develop a population grid of the United States. The analysts then overlaid the D2PC-estimated downwind cloud distances with the population grid at the eight storage sites and along the various transportation routes to count the population at risk. The population at risk estimates, however, did not account for (1) problems with some of the source data (for example, some of the geographic locations of population centers were not accurate),

(2) the limitations of analyzing nighttime rather than daytime populations, and (3) the uncertainty of the dispersion model results, as previously described.

Because analysts used the D2PC model to quantify the population at risk and expected fatalities, we concluded that the shortcomings of this model, as well as those of other models in determining program effects, should be better highlighted in the final environmental impact statement and considered when selecting a program alternative.

DATA LIMITATIONS

Limited available data affected the risk assessment results. Analysts were able to obtain only limited actual and research data to determine lethal and non-lethal long-term effects of human exposure to the agents. Actual human toxicity data was based primarily on information about the exposures of young, healthy, adult males to toxic agents during World War II and may not reflect the effects on other segments of the general population. Researchers also had to infer potential human health effects from data compiled from research on animals. Analysts said that because of limited data, they could not determine various long-term effects, such as cancer or reproductive problems, or quantify non-lethal effects. Analysts also relied on this data to determine the dose necessary to impact human health. Dosage estimates based on

this data were used in the D2PC dispersion model to determine toxicity distances and populations at risk.

In addition to computing public health risks, the Army tried to analyze the tradeoffs of other risks posed by the disposal alternatives. Researchers said that they could describe but not quantify potential environmental effects on animal, plant, and marine life and surface waters. For example, in their attempt to determine impacts on wildlife, analysts extrapolated data from domestic animal exposures. Little data exists to determine how agents affect plant life or how one of the chemicals--mustard agent--travels and decomposes in water.

Another area where researchers said that they could describe but not quantify the effects of the disposal program was the socioeconomic impact on communities. Analysts said that limited research on similar programs, such as programs for nuclear power plants, did not show causal links between programs and changes in communities' economies but did indicate potential effects on their quality of life.

Finally, while the draft environmental statement acknowledged sabotage and terrorism as program risks, Army and ORNL staff stated that no data base exists to calculate legally defensible probabilities of such events either during transportation or during disposal. Thus, the Army's risk assessment does not include the

risk of sabotage and terrorism. The transportation panel, however, in its July 1987 report to the Army, recommended that the Army conduct an assessment of the munitions' vulnerability to terrorist activities during transport.

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The Army has done a great deal of research to determine the safest way to dispose of its chemical munitions, including any necessary transportation. In its comparison in the draft statement of various transportation options with on-site disposal, Army staff and contractors used information of limited applicability because of incomplete data sources or modeling constraints. We have presented in this statement some of these weaknesses. Additional studies and analyses will probably not totally eliminate all of these shortcomings. A hazard and risk analysis will entail some uncertainties regardless of its completeness. The Army needs to explicitly point out data and methodological weaknesses and their impact on the comparison of alternatives in its final environmental impact statement. According to the Army, the final statement, currently planned for January 1988, will correct some of these analytical weaknesses of the draft statement, better highlight the areas in which weaknesses cannot be corrected, and better describe the impacts of any weaknesses on the risk assessment.