FORMAL DISCUSSION SESSION SUMMARIES

The discussion topics were chosen by FEMA Headquarters personnel. The four topics were:

Group 1: Shelter environment in attacked areas, including dust, blast, heat, and debris.

Group 2: Uses and limitations of shock tubes.

Group 3: Utility of computer models for civil defense planning and research.

Group 4: Fire fighting under adverse circumstances.

The thrust for each group was to identify problem areas that had not been addressed adequately in the past. Identification and discussion of these problem areas could result in innovative ideas for research and the application of research methods to solve the problems posed.

SUMMARY

SHELTER ENVIRONMENT IN ATTACKED AREAS, INCLUDING DUST, BLAST, HEAT, AND DEBRIS

Discussion Leader: Chuck Wilton, SSI
Report by: Jim Zaccor, SSI

Our nine-member group addressed these basic questions: What are the problems? What do we need to know? What should we do at MINOR SCALE, that is, the 1985 7-kt blast simulation?

In our deliberations we considered two shelter conditions: 1) upgraded structures, and 2) designed shelters. By upgraded structures we mean those structures which were upgraded to sustain a blast peak pressure of 40 psi. Though we could build structures of 100-psi rating, the consensus was that the cost would be prohibitively uneconomical. We also discussed shelters of lower rating but concluded that 50-psi shelters are adequate and more practical. With the 50-psi shelters, the probability of survival is supposed to be more than 98%, assuming randomly located industry and shelters. In the US, there are few 50-psi shelters; therefore, it is desirable that these shelters be built in all the risk areas. It was also concluded that all future upgrading of the existing structures be targeted for 50-psi overpressure. It is desirable that probability analyses of survival for structures of different ratings also be made available.

Next, we concentrated on the designed shelters. We recognized that until new shelters are designed and built for 50-psi blast loads, upgraded ones might be needed. We also felt that the problems associated with the designed shelters would not be much different from those of the upgraded structures. However, perhaps it is not easy to identify and upgrade the existing structures for shelters. If not upgraded properly it could lead to an uncertain shelter environment at the time of nuclear attack. Once designed shelters exist, we could use the upgraded shelters for the protection of industrial equipment.

We then considered the problem of shelter closure and discussed the tradeoffs associated with a horizontal door that only has to take 50 psi versus a vertical blast door that has to take 190 psi. The differences in weight and cost between horizontal and vertical doors are not significant enough to make horizontal closures worthwhile. Moreover, there is a potential safety problem associated with the fact that people can more easily close vertical doors, while there might be some difficulty in actually getting a 3/4-ton horizontal door to shut properly. Another concern we discussed was the debris that might pile up in stairwells required for vertical closures. Because we realized that this debris problem would make egress more difficult, we concluded that no shelter should be without a second entryway for access and egress.

From this point, we resorted to a generalized casualty function chart (attached) made up by one of the FEMA contractors for another purpose. We concluded that: 1) neither ground shock nor initial radiation would be a problem in our engineered shelters; and that 2) fallout was not a problem either with properly designed shelters. We felt that a decision process as to when to exit needs to be established so that the occupants are not exposed to fallout.

Siting will be very important. Shelters must be located away from hazardous materials, tank farms, high-rise structures that are debris sources, and high fuel loading areas, which are debris and fire sources. Another consideration is the location of the water tables. For example, in the San Francisco Bay Area there would be few below-grade key-worker shelters that wouldn't have some problem with the high water table which is down about 2 ft all along the Peninsula.

A way to assess the radiation field, particularly if debris piles up on the structure, is necessary because a probe extending just outside the initial structure could wind up under a large debris pile and therefore give a false reading. In addition, one needs to consider how the shelterees will get out if they are under debris, and what kind of communications systems they might be supplied with in order to contact other shelterees or someone in their host area who could rescue them.

The question of design options for dual use was considered, which the industry will probably require if these structures take up space on their property. While we felt that rigid concrete structures would be preferred by the industry, we also recognized that for last-minute quick installations, the corrugated arch would probably be more desirable. In view of this, we decided that it would be well to pursue both types of shelters. Quality of construction would be a concern that would have to be examined because of the probable use of unskilled labor in implementing the shelter program.

Next we looked at the question of life support systems. Heat conduction would not really be a problem, because most fires would be out before heat penetrated through the fallout protection into the shelter. However, where fires occur, there are problems (even in the early stages) resulting from entrainment in the ventilation systems of toxic smokes, gasses, etc. The question of bringing heated air into the shelter where large areas burn and where, perhaps, insufficiency of oxygen might result must be examined as well. The problem of toxic substances entering the ventilation system might be solved via the use of various filters, but the question of the heated air and the insufficient oxygen supply would require considerably more extensive facilities in the shelter. These questions need to be addressed.

Another important area that we considered was the optimum use of soil properties. How do we make use of arching and soil structure interaction (coefficient of earth pressure)? Can the native soil be used as backfill? How different are native soils in different regions? How long does it take the native soil to compact if you build shelters well in advance, before it becomes comparable to the initial material excavated? Soil arching requires a differential compressibility to work. There is the additional question of soil saturation that could make the coefficient of earth pressure equal to one thus losing the benefit of this soil property.

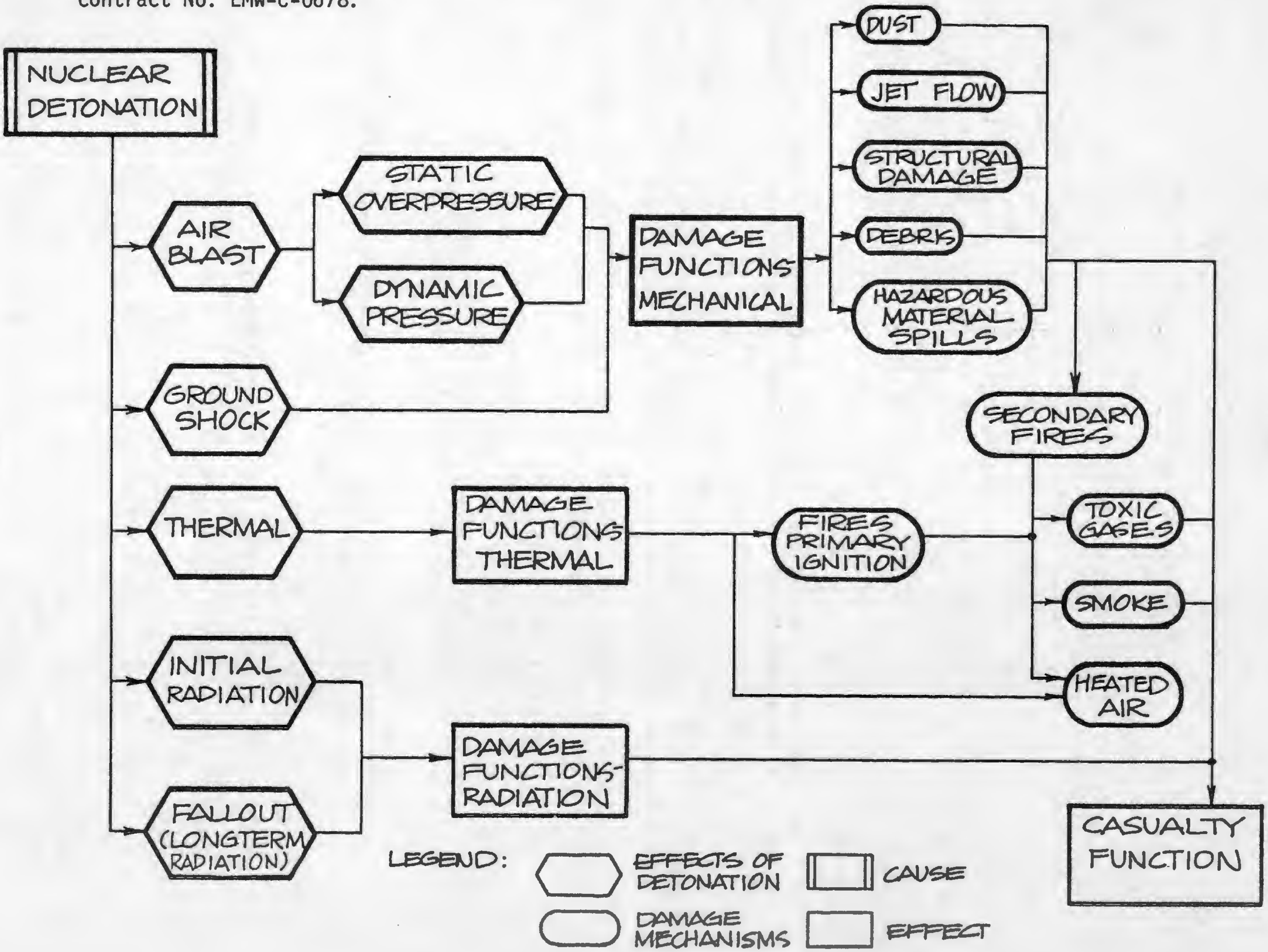
We then addressed the question of what we need to do and what we should do in 1985 with the larger weapon simulation. We agreed that planning, to be completed in 1984, for the 1985 simulation was the most important element.

This effort would require a budget with funds not only to accomplish the planning, but also to do exploratory and parametric tests. MINOR SCALE should be a proof test and not an opportunity for an exploratory program which we felt should be done beforehand. So, before 1985 we need to look at weapon size scaling studies to evaluate scaling effects. We need to know how designed shelters would be expected to perform under a 1-Mt weapon loading. This will mean that we won't be testing at 50 psi in the field at MINOR SCALE, but at a higher overpressure. In addition, it was suggested that 1) we look at a model city at MINOR SCALE, one that extends a few city blocks in both directions, and that 2) two overpressures be used with a fifth or a fourth scale. We should also test expedient shelters at MINOR SCALE. This would include, for example, utility vaults found at intersections in most major cities (and on hand in yards that manufacture and sell those vaults) to identify the failure overpressures for 1-Mt weapons. We also need to test mounded shelters in recognition of the fact that there will be quite a few regions where the high water table will preclude below-grade shelters. And we should design and test key Life-Support systems at MINOR SCALE to see that, in fact, they are adequate.

Connections of structural members are another problem. Many buildings have poor connections, and this needs to be studied again for the upgraded structures to see what potential complications might exist in the upgrading process as a result.

Finally, we decided that somewhere in the program consideration had to be given to amenities in shelters, such as light, food supplies, water, toilet facilities, and auxiliary power.

NOTE: This chart is a modified version of an original provided by Chuck Wilton of SSI under contract No. EMW-C-0678.



SUMMARY

USES AND LIMITATIONS OF SHOCK TUBES

Discussion Leader: George A. Coulter, BRL

A very brief summary of shock tube description and operation was given for the newcomers to the group. Note was made of facilities at Ft. Cronkhite, BRL, and SRI. It was noted that the DASACON conical shock tube at Dalgren, VA is not in operation although a proposal has been made to reopen it after replacing the explosive driver with a new gas driver. The explosive driver created a great deal of undesirable soot during the operation. It also had been comparatively expensive to test there. Both were drawbacks to its usefulness. A brief description of the large French blast simulator at Gramat was given. Some of the Army's vehicle/shelter combinations have been successfully tested in that facility. A similar facility for the US is presently being planned jointly by BRL, HDL, and DNA. Large-scale testing by FEMA could be accomplished in such a simulator if built.

The group consensus was that a general application of shock tubes could be made to validate analytical techniques, check design procedures, and test system elements. Small-scale systems or models could equally well be tested to advantage in the shock tube. Fundamental blast/fire or ignition/blast reactions could also be studied in a shock tube equipped for this study. In general, shock tubes can be used to support the expedient shelter program and can also be of help in the design of large-scale or full size field tests.

Specific examples of areas where shock tube testing would be helpful in planning for the 1985 large-scale field test are:

1. Fire/blast interactions--
   a. Investigation of fire phenomena.
   b. Barrier/fire interaction studies.
   c. Burning debris/fire brand blast interactions.
   d. Thermal/blast simulation with real time delay.

2. Blast tests--
   a. 1/5-scale building blast tests to compare with field test data.
   b. Shelter and room fill modeling.
   c. Outside shock tube debris study.
   d. Dusty gas problems.

The usefulness of the shock tube is attributed to its repeatability, ease of operation, multiple shot capability, and relatively inexpensive operation (compared to large-scale field tests).

Its limitations are characteristic of specific shock tubes (for example: size at SRI; lack of a thermal source at BRL; and a lower tank pressure limit of 12 psi at Cronkhite). As was noted above with the DASACON, the explosive driver was a liability. The shock duration may be a limitation depending on specific test needs. The tendency to choke the tube exists if the test specimen becomes significant in cross section compared to the shock tube cross section, also. However, in spite of the limitations, shock tubes can be a most useful research tool.

SUMMARY

THE UTILITY OF COMPUTER MODELS FOR CIVIL DEFENSE PLANNING AND RESEARCH

Discussion Leader: Thomas A. Reitter, LLNL

Discussion began on the conflicting models of firestorms. This problem represents an example of a difficult question: how can a model be verified when its results are not accessible to experiment. We agreed that this makes it important to seek out experiments which can, at least in part, exercise the model. This might involve a series of experiments of increasing scale, although this raises the usual questions of scalability.

The suggestion was made that civil defense should concentrate on specific questions related to its needs and responsibilities, rather than seeking general, all-purpose models. This raises the question of how does one develop confidence in limited models if one does not fully understand the relevant phenomena.

This led to a distinction between two classes of models: research and application. A research model studies the physics and chemistry to gain insight into phenomena. These models are scientific models because they can be used to predict new, previously unobserved phenomena, and they can be proven wrong. Application models, on the other hand, should provide a specific answer (number) and a measure of its reliability (variance). Application models meet neither of the requirements of a scientific model, but they can be used to answer operational questions within their limited, verified ranges of validity.

An example of a research model that has become an application model is the Forest Service's fire behavior model. This is now in routine field use in the Forest Service on programmable hand calculators. It is estimated to have required 60 man-years over 12 years at Missoula to develop this from a research model to an application model.

It is generally accepted that civil defense policy should indicate the specific questions to be addressed by both types of models. The British and Swedish civil defense programs, for example, appear to pose very specific questions with the goal of devising actions to minimize loss of life and resources.

A list of policy-based questions by FEMA would provide roles for both types of models.

The group also briefly considered the status of models for some of the high priority research areas identified at last year's conference. The major goal for civil defense was felt to be the characterization of the post-attack environment, especially with respect to gases and dust, inside and near shelters, and throughout the affected areas. To achieve this goal would require progress on more limited questions: ignition criteria for "real" materials (NBS has made recent progress on this for very different materials); debris formation and distribution (little verification, lack of parameter sensitivity studies, no "characterization" debris piles for various types of buildings subjected to various types of loads); fire spread across debris fields (rate of spread across a given debris field appears possible, but not the combustion of the thicker fuels behind the front); mass fires (two sets of existence criteria for firestorms are available, but none are available for moving-front conflagrations; no detailed understanding of mass fire behavior); multiple-burst effects (except for blast waves, these have only been treated as independent events, and they are not); and the environment in shelters (some work has been done on effects of burning debris above shelters).

A political question, beyond the scope of this conference, was how Congress and the public might be convinced to act on the basis of the results of models.

SUMMARY

FIRE FIGHTING UNDER ADVERSE CIRCUMSTANCES

Discussion Leader: Robert G. Hickman, LLNL

It seems that little in the way of new technology in this area needs to be developed. With regard to debris removal, most fire departments have some limited capability already. Use of tracked vehicles makes no sense, mostly because they can't move through heavy debris. Smothering a fire with soil will work, but dousing with water is better. Because there is so little need for equipment built that employs dirt-smothering methods during peacetime, few (if any) fire departments would buy it for use in situations where water is unavailable.

Nevertheless, there are some things that could be done that would be beneficial. In the area of long-term passive measures, firebreaks could be built into cities, probably in the form of parkways. Likewise, firebreaks could be built around critical facilities, whether they be EOCs, factories, or something else. In the latter cases they might be wide parking lots. Swimming pools or ponds could be located close to critical facilties to provide an emergency water supply for fire fighting. Self-contained sprinkler systems using blast hardened water tanks could be built into critical facilities. They would be tied into the municipal water system only as needed for filling.

On a shorter term, key workers assigned to a particular critical facility could be trained to fight fire in that facility. Urban fire fighters, who are typically water-rich, could be taught the fire fighting tactics of rural fire fighters who are typically water-poor. Then in an emergency, the urban fire fighters might be able to respond more effectively. Fire chiefs should be given a prioritized list of critical facilities within their jurisdictions so that they could become familiar with the facilities beforehand to maximize their efficiency in fighting a fire. In addition, they can use this information to preplan routes to survey the area for fire, since normal telephone service to report fires is not expected to be available during an emergency.

Finally, it was asked if FEMA shouldn't have one person within its civil defense organization be responsible exclusively for fire hardening and countermeasures at critical facilities.