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THE OCD RESEARCH PROGRAM

A Review by the
Advisory Committee on Civil Defense
July 1, 1963

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Human Studies Project

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL
2101 CONSTITUTION AVENUE, WASHINGTON 25, D. C.

ADVISORY COMMITTEE ON CIVIL DEFENSE

June 25, 1963

Dr. Frederick Seitz, President
National Academy of Sciences
2101 Constitution Avenue
Washington 25, D. C.

Dear Dr. Seitz:

In response to the request from Mr. Pittman, Assistant Secretary of Defense for Civil Defense, contained in his January 14, 1963 letter to you, the Advisory Committee on Civil Defense has reviewed OCD's research program and herewith reports its views.

The Committee's review did not have the depth and comprehensiveness originally envisioned because it was evident that the summer study would be capable of a much more detailed examination. Furthermore, the preparations for the summer study put demands on Committee members that curtailed the time available for reviewing the research program. Thus the comments and recommendations are on the broader aspects of the program. More detailed comments on those parts of the program that were examined in depth are contained in Appendix A. The Committee did not attempt to reach formal agreement on each of the recommendations in Appendix A, but believes them generally sound. Appendix B presents the Committee's views on program subdivisions.

The Committee believes that the current program represents a notable achievement in seeking answers to important questions, but that it lacks cohesiveness and is inadequately integrated and coordinated into an approach toward the whole civil defense problem. The Committee recommends more effort on making analyses of the threat and its effects. From such evaluations must come the basis for planning all phases of civil defense, including research.

With regard to the concentration of OCD research, it is the judgment of the Committee that civil defense program needs can best be met by establishing a single civil defense facility.

> "The Committee therefore recommends that OCD establish a civil defense research facility within either a new or existing laboratory or research institution. The facility should feel a true responsibility for research on technical and operational problems of civil defense. It should be

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responsive only to the demands of civil defense, and to all aspects thereof. Not only should this facility have a direct line of communications with OCD, but it should come under the operating authority of OCD, eliminating any chain of command coming from the headquarters of the laboratory or research institute concerned. The civil defense facility should be able to subcontract those parts of the civil defense program assigned to it which can be carried out better at other institutions."

For the Committee

Lauriston S Taylor

Lauriston S. Taylor, Chairman
Advisory Committee on Civil Defense

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THE OCD RESEARCH PROGRAM

A Review by the Advisory Committee on Civil Defense

INTRODUCTION

Request

On January 14, 1963, Mr. Pittman, Assistant Secretary of Defense for Civil Defense, wrote to Dr. Seitz, President of the National Academy of Sciences, requesting that the Advisory Committee on Civil Defense review civil defense research programs. Specifically, he asked the Committee to

"(1) Review the current scope and emphasis of the OCD Research program in relation to the known technical requirements of civil defense and with due regard for applicable research programs of the Department of Defense, the Atomic Energy Commission, and other agencies.

(2) Recommend the desirable scope and emphasis for the OCD Research program at the present budget level of approximately $10 million, the level of the proposed FY 1964 budget of $15 million and at any other level of effort consistent with the Committee's views of the requirements of the research task.

(3) Review our plans for greater concentration of research effort in several institutions and consider where possible in its program recommendations, the need to organize research requirements in several complexes to fit such concentration of management."

With regard to research management, he stated that

"It seems clear that it is not practical to expand the OCD Research staff to properly manage the many necessary research projects, nor are we likely to be able to attract personnel as highly qualified as might be expected to be available in many research laboratories. Accordingly, it has been decided to concentrate the management of the bulk of the OCD Research program in not more than three lead laboratories or research institutions. The effective realization of this move will be greatly aided by a thorough and discerning projection of civil defense needs in future years."

Procedures for the Review

The review of the Advisory Committee has been supplemented with reviews by the Subcommittees of the Advisory Committee in their fields of interest, by other Academy groups such as the Fire Research Committee, and by special groups

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established for that purpose. The Advisory Committee has used the work of these various groups as a basis for preparing this report, which will consist of three parts that conform to the three requests contained in Mr. Pittman's letter.

1) A Summary of Committee views on the current OCD research program.
2) Recommendations on the scope, direction and emphasis of future programs.
3) Discussion and recommendations on concentration of research.

The review of the current OCD research program has not been as comprehensive as originally planned. In view of the Academy Summer Study, which will bring together some 60 experts for a sustained, concentrated examination of civil defense problems, the Committee decided to concentrate its efforts primarily on the research management question and on the overall scope and emphasis of OCD research. The Summer study will provide the basis for a more detailed examination.

Appendix A contains comments and recommendations of the Subcommittees, the Special working group, and of individual members. No attempt was made to get formal Committee approval on each recommendation contained. The Committee, however, considers them generally valid and includes them with the caution that the research areas not commented upon in Appendix A were those not examined. Hence they are not necessarily free from gaps and deficiencies.

Appendix B gives the Committee's discussion of the problems of subdividing the OCD program to fit a concentration of research in 2 or more facilities.

CURRENT OCD RESEARCH PROGRAM

The scope and emphasis of the technical work of OCD can be gleaned from numerous publications issued by the OCD. These documents clearly demonstrate the success of the past work. The work carried out to date considers questions of obvious importance. They include the extent of fallout danger, the danger from chemical and biological weapons, shelter design, the need for warning and of systems to provide such warning, shelter habitability, the availability of food, and many others. The studies carried out make it possible to obtain an estimate of the extent that one can alleviate, as far as the civil population is concerned, various effects of a possible attack on the U.S. and how this alleviation depends on the cost and effort that one is willing to devote to civil defense. The present effort, however, is more nearly in the nature of several spearheads toward the goal than a systematic, comprehensive and integrated effort. It shows gaps -- examples of these will appear in Appendix A. Such gaps were unavoidable at the level of knowledge at which past thinking had to start. The past work does not yet contribute a systematic and fully coordinated effort, based on a picture as clear as now possible, to assess all the effects of an attack and to design the best ways to alleviate them. We wish to re-iterate that it was hardly possible to develop such a picture before the outlines of possibilities became available.

More specifically, the Committee believes that too much of the current program appears to be directed toward preparing reports that consist only of the assembly of data, without evaluation. The Committee believes that the program

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should, where possible, seek the solution of problems. In so doing, a multi-discipline team of researchers should be used. In the current program, the Committee found little evidence of a problem approach where engineers, physicists, behavioral scientists, and others work together on a whole problem. Too often it appears that the various technical aspects are attacked by the disciplines working separately, and without making the evaluation and integration of the resulting data a part of the research task.

RECOMMENDATIONS ON FUTURE PROGRAMS

Committee recommendations on the desirable scope and direction of future OCD research programs are based on the examination of the current program and the requirements foreseen for the future. The present section of the report contains the recommendations that, in the opinion of the Committee, are most important and most applicable to civil defense research as a whole. Most of the examples of gaps and deficiencies given in Appendix A include recommendations for corrective action. (Details on the following recommendations are given in Section I, Appendix A.)

Planning Requirements and Effectiveness Studies

The central problem of civil defense is to plan, construct, and hold in a state of operational readiness a working civil defense system. Such a system includes structures, hardware, training, command and control, supplies, etc. There are a myriad of unsolved problems involved in this process including such fundamental ones as: What type of civil defense is needed in face of a not very well-defined threat? What system is likely to give the greatest return in terms of lives and property saved per dollar spent? What factors in addition to shelters are critical?

The Committee believes an essential part of civil defense research is a detailed and, as far as possible, quantitative analysis of the physical threat posed by the direct and indirect effects of the range of probable nuclear attacks which might be launched on the United States now and some years in the future. Such a quantitative analysis must be as precise as possible in defining likely attack conditions. Since there will inevitably be uncertainties attendant on any attempt to define the threat, they must be carefully identified, their magnitude estimated, and their effect evaluated.

The Committee believes that such estimates of the threat must be interpreted into terms of human casualties, and of damage to structures and to the environment, both immediate and long term. Evaluations of different levels of civil defense protection, beginning with the no-preparation situation, against the spectrum of the threat should be the basis for all civil defense planning.

The Committee recommends strong and continuing effort in this area.

Command Structure

Another and related major objective of future research is that of ensuring that all national resources are prepared and organized to minimize the effects

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of attack. It is of paramount importance that a coherent command system, reaching to the neighborhood level, can be created in time of emergency to ensure that law and order and survival procedures are organized and maintained before, during, and after an attack. A basis for providing this capability may exist in the form of civil defense officials, state and local governments, police, and fire departments, the national and state guard, and the army. But this potential structure is not at present organized to provide the coherent command capacity needed. Training and coordination are needed, and an operating doctrine.

The Committee believes that an operating doctrine is the most important immediate requirement for achieving a capability for a coherent, comprehensive, command structure. Such a doctrine must be based on evaluations in the actual attack environment of the vulnerability of personnel, of communications, of material, and of the operating doctrine itself. It must reflect the levels of protection available. The Committee is not satisfied that a satisfactory operating doctrine exists or that the command structure to implement it is adequate or visible. The Committee feels that research programs must be evaluated on how well they meet the technical requirements of an operating doctrine.

It is the Committee's hope that the summer study will provide significant help toward attaining a complete evaluation of the threat and a full description of possible attack environments. These would contribute to meeting the first requirements for developing an operational doctrine and for making estimates of the strengths and weaknesses of each phase of the doctrine.

The Committee is aware that work is going on in the difficult field of post attack management of resources by federal and state agencies, particularly by the OEP. It is concerned however that in this area authority appears to overlap, and conflict will result between federal agencies, between the states, and between federal and state agencies over the management of resources, including manpower. Further, the existence of this authority, such as it is, is not publicly known. It is felt that any meaningful civil defense program must be predicated upon a realistic understanding of post attack operational problems in the resources management area and that an analysis of federal and state relationship be given a high degree of priority.

RESEARCH PROGRAM MANAGEMENT

On November 4, 1961, a letter from Dr. Taylor to Secretary Pittman expressed the Advisory Committee views on OCD's research program management problems and its research staff limitations, as follows:

> "The Committee feels concern over the difficulties that the Office of Civil Defense must face in managing the large number of projects of a very diverse nature contained in the research program. We believe that the task of seeking out new contractors, who will have had little or no experience with civil defense matters, and of monitoring their efforts with sufficient care to prevent serious waste, will require an 'in-house' staff considerably larger than anything you now have.

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The Committee discussed the desirability of reducing this management burden by delegating responsibility by contract with a few large organizations for major parts of the program. We agreed that such a policy, with individual projects carried out on a sub-contract basis, might lead to losing the vital interplay and feedback between research and the civil defense planning done in your office. Therefore we think it should be considered as an interim expedient to be undertaken only with carefully selected contractors. In no case should the contract include doing the fundamental thinking on civil defense."

The Committee recognizes that there is no likelihood that the current OCD research staff will be augmented to a size and level of competency adequate for the management task. It has therefore examined other possible procedures.

The discussion of the problems of subdividing the program are given in Appendix B. (Individual views are also contained in Appendix A, Section VII - XI.)

Guiding Principles

The Committee discussed and agreed on certain basic principles for research management and for carrying out the proposed concentration plan.

Competence. One of the criteria of any laboratory or research institution that is responsible for civil defense research is a proven competency for conducting the types of research for which management responsibility is assigned. The Committee does not believe that subcontracts can be properly monitored, or their results properly evaluated, by personnel who do not themselves know the areas of research involved, and are not themselves engaged in research in them. The Committee recognizes that there is now no single laboratory or institution competent in all areas of civil defense research, and urges that immediate steps be undertaken to fill any gaps in staff competency in the laboratory to be selected.

OCD Control. The Committee's concern over the danger, inherent in the proposed plan, that the delegation of research management responsibility to contractors outside the OCD might lead to a weakening of the essential ties between research and decision-making has already been mentioned. This danger must be recognized and forestalled through careful planning of management procedures and by close communications both formal and personal. To ensure effective OCD control, it is important to maintain as strong a staff as possible in the OCD Research Division. Efforts should continue to be made to increase it in size and improve it in quality.

Lastly, funds for civil defense research should be budgeted for and appropriated to OCD, with OCD retaining control of funds through usual contracting procedures.

Dedication. It is essential that any contracting laboratory or research institute should assign to the civil defense research program or programs a staff and staff facility that devotes all its time and resources to civil defense research.

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Danger of Expedient Solution. A final guiding principle for carrying out the concentration of research is in the form of a caution against allowing considerations of expediency to control the decisions of OCD. It is the Committee's opinion that the best feasible solution should be sought, even though there might be some temporary disadvantages resulting. Specifically, the Committee believes it is preferable to accept temporary delays in the program in order to achieve the best solution attainable under present and foreseeable circumstances. Furthermore, if such a solution cannot be immediately achieved, it should be the ultimate objective toward which any steps taken now should lead.

Optimum Procedure

The Committee agreed that under present and foreseeable conditions a single civil defense research facility would provide the best procedure for managing the OCD research program. This conclusion is based on the Committee's conviction that it is the only procedure whereby a fully integrated research approach to the whole civil defense problem can be achieved. See Appendix B for a more detailed discussion.

Recommendation. The Committee therefore recommends that OCD establish a civil defense research facility within either a new or existing laboratory or research institution. The facility should feel a true responsibility for research on technical and operational problems of civil defense. It should be responsive only to the demands of civil defense, and to all aspects thereof. Not only should this facility have a direct line of communication with the OCD, but it should come directly under the operating authority of OCD, eliminating any established chain of command coming from the headquarters of the laboratory or research institution concerned. The civil defense facility should be able to subcontract those parts of the civil defense research program assigned to it which can be carried out better at other institutions.

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APPENDIX A

Comments and Recommendations on OCD Research

Given below are the comments prepared by the several groups and individuals during the examination of OCD research. The Advisory Committee on Civil Defense presents them as supplements to its report.

I. Statement of Dr. Robert J. Hansen, Dr. Harold A. Knapp and Dr. Lewis V. Spencer. (Excerpt from statement prepared by special working group of the Committee, May 27 & 28, 1963, on Planning Requirements and Effectiveness Studies.)

It is of fundamental importance therefore that

A. Detailed expositions of possible attacks in terms of weights, types, geographic and time distribution of weapons be predicted for the near future, and up to 10 years in the future, using information from all suitable intelligence sources and targeting doctrine.

B. For each of the presupposed attacks predict the following:

1. warning times as a function of geography, and various warning systems,

2. blast pressures, nuclear radiation, thermal radiation, fallout patterns as a function of geography, time of year,

3. interpret these data in terms of physical damage to buildings, utility and communications facilities, transportation routes and facilities, industry, stored goods, water supply and sewage disposal systems, hospitals and relevant medical personnel and supplies, forest and agricultural crop damage,

4. interpret the physical phenomena in terms of casualties and mortalities to people for

   a. the population unsheltered and unwarned
   b. the population unsheltered and warned
   c. the population sheltered to various degrees as provided by civil defense programs of several grades (i.e., fallout shelter only, fallout shelter, blast shelter of various grades and plans).

5. for the various civil defense programs estimate the cost of such program for structures, facilities, personnel costs, etc.

C. The results of these studies should be presented in terms that

1. give the overall picture of the country,

2. give an inventory of people, buildings, facilities, natural resources,

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3. present detailed pictures of what happens to a community that

   a. suffers extensive blast and fire damage
   b. suffers fallout only
   c. suffers some intermediate effects

D. The impact of the weapons effects on people and facilities should be studied to determine what requirements are imposed on the command and control system, what problems are paramount to such a system and what alternative ways are possible to solve such problems.

The results of these studies, which should be of a continuing nature, can serve four extremely important functions.

1. The identification of unknown facts concerning reactions of people, facilities, systems, etc. to weapons and ancilliary effects, thus guiding the research program.

2. The realistic evaluation of command and control problems.

3. Regional and local bases for planning, <u>and most significantly</u>

4. A national basis for planning.

A whole graded system of reports should be written and available which can serve

1. as a guide and training aid to officials and operators at local, and regional levels,

2. as a guide to nationwide planning of civil defense systems,

3. as a guide for the planning of post attack government, industry mobilization, movement of goods from one locality to another, etc.

The salient fact that motivates this program is that few, if any, people involved in the planning and implementation of civil defense programs, particularly at local and regional levels,have any realistic concept of the environment within which they must operate in the attack and post attack periods.

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II. Personal Views of Dr. Harold A. Knapp, Member Advisory Committee on Civil Defense. (Summary of memorandum for Members of Committee, dated 24 May 1963.)

At present, the OCD Research program consists of approximately 200 contracts with a large variety of contractors, monitored by about 30 people with technical background. From the title of the projects, it would appear that every conceivable problem area is covered at least once. Upon close examination, however, it is not evident that those problems which are most important are really covered at all, or, alternately, that there is reasonable assurance that solutions will be forthcoming.

This conclusion was reached by starting with the assumption that the most direct way to evaluate a research program is to determine how well it:

a. Has solved (or is solving) specific, well formulated problems of recognized importance and presented the results in terms which are clear and useful.

b. Finds problems which were not recognized, or formulates problems only poorly defined, and either solves them, or puts them in a form in which they can be solved.

c. Recognizes that if the solutions to some problems are crucial and necessary for a successful program, these problems must receive the highest priority, and otherwise distribute its available effort in such a way that the useful output in terms of volume and importance is in some sense maximized.

In some respects item c -- which involves doing some research on what research to do -- is the most difficult and most important task to be accomplished in a newly developing research program. It is on this point that the present program is unsatisfactory.

The requirement for national planning objectives, and for the studies called for by Dr. Tompkins (see below) are necessary. Perhaps 30% of the OCD's research program should be directed toward clearly stated, detailed, unclassified solutions to those problems. This is not apparent, and there is no indication that there will be clear and useful answers to the following questions:

a. What degree of protection against blast, fire, and fallout can be projected as necessary for survival in various areas of the US under various conditions of attack, now and in the future?

b. How much it would realistically cost in typical communities to achieve various levels of protection against all the effects of nuclear weapons under the various conditions which might be anticipated in the event of war?

c. What degree of blast protection can be achieved for underground shelters of various designs utilizing standard building materials, e.g., cinder block walls?

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The recommendation for augumentation of Project 4100 (see first paragraph of Dr. Tompkins summary) is endorsed. It is a difficult type of research requiring access to sensitive information and close contact between researchers and those responsible for the program.

Also endorsed is the recommendation for a central civil defense research and development laboratory. In addition, a small (5 or 6 scientists) research capability should be established within Mr. Pittman's office to study basic problems of civil defense and to use the results of all civil defense and related research. It should give the Secretary its best scientific advice without being influenced by existing policy of OCD, the Defense Department, or the Administration. This group should do fundamental thinking on civil defense.

(See also Dr. Knapp's Article in the "Bulletin of the Atomic Scientists" April 1963, Vol. XIX, No. 4).

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III. Personal Views of Mr. Luke Vortman, Member Subcommittee on Protective Structures. (Summary of letter to Mr. Park, dated April 1, 1963.)

Listed in order of importance are six major research problems not now receiving sufficient attention from OCD.

1. Casualty Estimates. It is doubtful if OCD computer programs have given satisfactory answers to questions of how to protect people, i.e., what kinds of shelter are best -- because (1) problem simplification to fit the computer may have seriously affected accuracy; (2) the right questions may not have been asked; and (3) imputs may have been inadequate.

Only careful scrutiny of each problem can solve the first doubt.

For the second, ask

What is the vulnerability of:

(a) An unsheltered, unwarned population (as a function of time of day).

(b) An unsheltered, but warned population (as a function of warning time as well as of time of day).

(c) A population with fallout shelters only (as a function of protection factor).

(d) A population with at least fallout protection for all but varying degrees of blast protection for those near target area.

Varying types of enemy attacks would have to be examined to determine the sensitivity of the outcome on various enemy options.

For the third, the imputs require combined consideration by 7 disciplines: Behavioral Scientists, Structural Engineers, Radiation Biologists, Blast Biologists, Thermal Biologists, Weapons Effects Physicists, and Mathematicians (in a subservient role).

Such an inter-disciplinary group can use Hiroshima and Nagasaki data, and recent laboratory findings, to interpret casualties in structures and other environments in a US attack. Application of Japanese data to US environments must be in terms of structural differences, and requires judgments of best minds available, working as a study group.

Until adequate casualty criteria are established, system studies to evaluate relative merits of various approaches to a shelter program may yield misleading results.

2. Vulnerability Definition for Target Areas. The results of an unclassified target analysis are badly needed to aid both individuals, industries and units of government in determining the level of

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protection which is required at a particular location. Considerably more work is required than has been done heretofore on the sensitivity of the protection required at specific points to changes in the attack options available to an enemy. Although intelligence information is necessary to develop the vulnerability information anticipated here, considerable thought should be given to producing results which are in themselves unclassified. One commonly hears statements to the effect that such information should be classified because it provides an enemy with an attack plan against this country. Investigation should be made to show whether, with the various options available to an enemy, the results in terms of target vulnerability definition are appreciably different on an average from a plan he is likely to have arrived at for himself. This can be done by arranging two attacks, one using only unclassified information and the other making use of all available intelligence. If the results in terms of local vulnerability contours are not significantly different, then the need for classification is not established. Also, it may be possible to show that from an unclassified end-result in terms of local vulnerability contours, it is not possible to extrapolate back to a specific attack plan which reveals the intelligence upon which it was based.

3. Optimized, Standardized Shelter Designs. Many shelter designs have been published by OCD for both families and larger groups. Emphasis has been placed on shelters in schools, hospitals, underground garages, etc., which are compatible with the incentive program now envisioned. Designs for private and public shelters and for both family and group shelters are needed. In an attempt to keep costs down, considerable emphasis has been placed on inexpensive and makeshift shelters. While these are necessary, there is also a crying need for a series of standard family and group shelter designs for fallout as well as for overpressure of increasing incremental levels. Complete and optimized in terms of protection and economic construction, these ideal designs would serve as a standard against which to compare the adequacy of the makeshift shelter.

4. Acceptable Nationwide Radiation Burden. To avoid the danger that programs (such as the marking and stocking for fallout shelters of existing structures) may use protection standards based on emergency exposure levels for special cases taken from NCRP Report #29, the NCRP or a similar group should be asked to determine what radiation dose is acceptable as a nationwide standard for newly constructed shelters. This standard should be based on the average radiation burden one would be willing to accept in an ideal program for sheltering the entire population. Planning and design of shelters should recognize exposures anticipated after attack and should

(1) minimize doses received in the shelter from anticipated fallout and prompt radiation, and

(2) minimize doses after an attack by planning duration of stay in shelter that will result in exposure on emerging that is the minimum consistant with post-attack conditions.

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5. Regional or Local Basis for Planning. Only a few subtasks of the research program are devoted to studies concerning evacuation. None fulfills the need for a definition of those areas in the country where evacuation may vie with shelters in providing protection for the population. There are between the Mississippi River and regions inland from our West Coast rather large areas from which populations might be evacuated from the few rather widely dispersed target areas into vicinities whose probable radiation levels are sufficiently low that they would be able to survive without fallout protection. An effort should be made to determine such areas.

6. Biologically Preferable Levels of Overpressure. Information is available on the pathologically determined blast damage to human beings and other biological systems which is valuable for determining physical effects for the estimation of casualties. However, some lower level, probably below a pain threshold, is a more desirable basis for new shelter designs. Where slow-acting blast valves, or makeshift equipment such as sand filters, are anticipated for use in a blast environment, it is desirable to know the effect of the overpressure and the rate of rise of the pressure inside the shelter upon the occupants. It is expecially desirable that the subpain threshold of these parameters be determined so they can be used as design goals.

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IV. Personal Views of Prof. H. C. Hottel, Chairman of Committee on Fire Research. (Extract from letter to Mr. Walmer E. Strope, dated January, 30, 1963.)

The biggest single problem in the national defense area in relation to fire is that of acquiring sufficient understanding of very large fires, including fire storms, to permit visualization and prediction of the effect of such fires on the problems of ventilation of protective structures within the fire area and on the spread of fire at its edges. This enormous question cannot be answered in our opinion, or experiments be effectively planned to yield the answer, until we first have answers to many lesser questions; and a listing of some of those lesser questions in the approximate order in which they might profitably be attacked, should be of help to any group planning an experimental program on large-fire phenomena. The questions that deserve study include these:

1. How do regularly spaced fires interact? What is the effect, on the flow patterns of rising hot gas columns in a gravity field, of the spacing of fires and of individual-fire size? (The unit fires of the complex must be of a minimum size large enough to guarantee turbulent natural convection within the fire plumes.)

2. What is the pattern, in time, of buildup of flows in interacting fires?

3. What is the influence of the fuel bed, - its mean hydraulic radius and that of the internal air, - on the burning rate?

4. What is the influence of randomness of placement of combustion centers on the interaction phenomena referred to in items 1 and 2?

5. To what extent does a large fire interact with atmospheric lapse rate and humidity, i.e., what is the effect of the latter variables on the currents above fires of various sizes, and on the horizontal inflows? (Both lapse rate and humidity are included because the first determined the extent to which a parcel of heated and combustion-moisture laden air continues to maintain a net upward buoyancy force as it rises into air which, if the lapse rate is subadiabatic, will ultimately stop the buoyancy and the second helps determine the extent to which the phenomenon of buoyancy creation by condensation of rising moisture laden air - analogous to rain formation in tropical cyclones - contributes a force to the fire column.)

6. Is the peripheral inflow to such fire systems high enough to explain fire-storm phenomena? How does rotation in the atmosphere, - which is always associated with the existence of a horizontal gradient in wind velocity -, affect the flow pattern around and through a fire on a controlled area? Is rotation an essential ingredient for fire-storm buildup?

7. How do concentrations of CO_2, O_2, CO and smoke vary at ground level under various combinations of meteorological and target conditions mentioned? (There is an expectation here of many answers; certainly no prospect that smoke or CO concentrations found to be representative of

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some conditions of target and weather are necessarily applicable to other conditions.)

These are difficult questions calling for a very extensive and expensive research program. They cannot be attacked all at once with anything like the economy of man hours and material that would attend their consecutive attack, although several could profitably be under attack simultaneously. I cannot see any measure of success to be expected from large-scale (mile square) burns without some considerable headway having first been made on some of the above seven items. Some of them will of course themselves involve fairly large-scale field tests.

As to the extent to which your present program embraces studies of the above type, it is difficult from reading contract proposals and progress reports to determine whether the seven items above are receiving attention. I suspect that if they are, it is presently quite inadequate.

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V. Personal Views of Dr. John W. Raker, Member Advisory Committee on Civil Defense. (Extract from letter to Mr. Park, dated June 5, 1963.)

Important gaps seem to exist in biological and medical areas related to the civil defense research program. These gaps are of several general varieties: (1) In specific information on biomedical effects of radiation as they apply to the problem of handling of the injured. (2) In assessment of the present status of organization and preparedness of the medical facilities of the nation for management of the casualties of nuclear warfare. (3) In exploration of possible plans which could be developed for the integration of operational management of mass casualties.

Among the pieces of specific information needed in order better to understand the biomedical effects of nuclear weapons are data on the results of combinations of injuries. We know something about the separate effects of radiation, thermal damage, and physical injury on the individual. We need to learn more about the effects produced by these injuries when they occur simultaneously.

From available evidence, little effort has been put into the evaluation of the present state of preparedness of the country in the medical field. As has been pointed out before, this needs to be accomplished before reasonable plans can be evolved for the management of casualties.

The evolution of plans for integrated casualty care could be initiated by pilot studies in selected areas which have manifested interest and competence in this field. From these pilot studies and other work, it should be possible to develop operational plans for integration of casualty care for local areas, for larger regions of the country, and eventually for the nation at large. Such operational plans would be based upon the different planning assumptions evolved by the studies previously recommended. Such plans would contemplate the integration of medical handling of mass casualties including the functions of rescue, transportation, triage, distribution of casualties to available facilities, the development of a command and control system for rendering policy decisions governing medical care, and communication between hospitals and the command and control system. The development of such a comprehensive overall plan for local areas seems desirable for the management of naturally occurring disasters and it is absolutely essential for large regions and for the entire country if the civil defense effort is to be effective.

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VI. Personal Views of Dr. L. V. Spencer, Member of Advisory Committee, Chairman, Subcommittee on Radiation Shielding, dated June 10, 1963.

Future research on the nuclear radiation shielding aspects of civil defense must take into account several problems.

First, there does not yet exist an engineering methodology for initial radiations which is comparable to that for fallout radiations. Such a methodology would be needed in any case for its applications to design criteria for shelters incorporating blast protection. Recent publicity about 100 megaton bursts, neutron bombs, and large anti-missile devices suggest that the need for such a methodology is increasing. First steps in this direction are being encouraged by the Radiation Shielding Subcommittee.

Second, the experimental progress on problems relating to the fallout methodology has progressed to the point that a reassessment of many features and types of data is now in order. Such a reassessment has begun, and it should carry through to a complete analysis of all phases of this methodology.

Third, a start has been made towards incorporating shielding research, and the corresponding protection technology, into civil, architectural, and nuclear engineering curricula. But the literature is not adequate, and the whole effort is not really accepted as yet. Constant, rather than sporadic, effort in this direction is important.

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VII. Subcommittee on Protective Structures. (Extract from Minutes of 8th Meeting, Atlanta, Ga., February 27 & 28, 1963.)

With reference to the question of subdividing the program and giving management responsibility to no more than three contractors, the Subcommittee agreed on the following points: 1) the Subcommittee is greatly concerned over the decision to assign management responsibility for large sections of the program to outside agencies and re-endorsed the statement made by the Advisory Committee in November 1961 which was quoted in the letter from Mr. Pittman to Dr. Seitz of January 1963. The Subcommittee considers the proposal only as an expedient to be abandoned as soon as possible. The Subcommittee agreed that the conduct of civil defense research and development can contribute most effectively to the national program only if conducted or closely directed by the Federal Office responsible for civil defense; 2) the Subcommittee agreed that the staff of the institution selected must be competent to do the research themselves even though they may only manage subcontracts; 3) the Subcommittee agreed on the following statement:

> "The civil defense research and development program lies very close to the formation of civil defense policy. Just as the ultimate formulation of military weapon systems is accomplished by Armed Services Staffs, not by contractors, civil defense planning must stem from those offices responsible for the civil defense program. For this reason, the shifting of research management out of the OCD should not include such research areas as are primarily concerned with national policy, government continuity, public safety, war games and formulating basic policy.
>
> A most apparent division of possible contract management responsibility results in three rather distinct disciplinary groups: (1) a physics and engineering section to include both the engineering-construction and phenomenological aspects of the blast, thermal and radiation problems; (2) a bio-science section involving the medical and ecological concerns; (3) a societal section dealing with the urban planning, transportation, communications and socio-economic aspects. Some investigations in the last section, particularly systems analysis efforts, should be retained directly under OCD management.
>
> It is essential that the OCD research director have directly available a highly competent staff to advise in program formulation. Timely and meaningful results from research efforts can not be insured for such a large and complex set of problems without extremely careful and thorough guidance on the translation of objectives into program."

The on-going program was discussed and the Subcommittee agreed that a research program should avoid review or state-of-the-art studies; and data reports that do not contain analyses or evaluations. The Subcommittee also warned of talent limitations that might make expansion of the research base a wasteful step.

VIII. Subcommittee on Radiation Shielding. (Extract from Minutes of 14th Meeting, Washington, D. C., April 11 & 12, 1963.)

The Subcommittee agreed generally that the major needs were for (1) shelter designs, (2) extension and improvement of survey, (3) validation of techniques and procedures for estimating protection factors, and (4) provision of literature, e.g., texts and publications of technical information in both professional and popular periodicals.

The problem of reorganizing the OCD research program to conform with the proposed concentration of management was discussed at length. The Subcommittee did not agree on any scheme for subdividing the program to fit two or three agencies outside the OCD. During the discussion these points, some of them contradictory, were made by individual members: the AEC has successfully conducted research in a manner somewhat similar to that proposed for OCD; under the proposed plan it seems inevitable that work by subcontract would diminish drastically with resulting loss of proven capability; under the proposed plan costs might go up; the proposed plan might result in decreased costs; there are laboratories that could manage all civil defense research except work in the behavioral sciences; a breakdown by disciplines would eliminate essential coordination functions; a discipline breakdown is preferable; a mixed discipline or system breakdown is preferable; retention of the planning function in OCD would be extremely difficult if not impossible under the proposed management scheme.

There was general agreement on the following:

(1) At the same time that such major changes in research administration are considered, a close look at the internal structure of OCD administration appears desirable to eliminate evidences of duplication and obtain the advantages of a better distribution of available manpower, and partial relief of a manpower shortage in research.

(2) Any outside agency or agencies selected for managing OCD research should have a proven capability in the areas of research for which it would be responsible.

(3) Concentrating research management responsibility in one outside agency is much preferable to concentrating it in 2 or 3 agencies. Furthermore it appears preferable to work through major contracts in up to 10 or so outside laboratories, rather than to use 3. This latter method requires a different approach but can also reduce the administive load at OCD.

(4) If a single agency were chosen for concentrating management there are alternative procedures that could be followed: (a) use of a facility for management only, (b) add the function of making theoretical studies as in RAND or Ramo-Wooldridge, or (3) use as a civil defense laboratory with in-house capacity as well as for management and studies. The Subcommittee was divided, however, on which of these alternatives was preferable.

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IX. Special Group on Behavioral Sciences. (Extract from May 15, 1963 memo for members of the Advisory Committee from Mr. Park, Subject: Behavioral Science Aspects of the OCD Research Program.)

The future public acceptance and continuity of an effective civil defense program is critically dependent on developing a close fit between civil defense operations and the on-going, normal needs of society, both national and international. The research program should therefore address itself to the broad question of how civil defense can be built into the normal social structure and thereby contribute to the continuous protection and enhancement of human life.

All civil defense research should be oriented more toward the objective of devising civil defense programs, equipment and techniques that would be useful in peace time. The approach should be a step-by-step rather than a crash program. It should start with existing social structures (e.g., police, schools, churches, armed forces) and build them up to give them civil defense capability. This approach has been and could be further applied to the building of protective structures, by placing further emphasis on dual or multiple use of community buildings (e.g., underground schools) and by continuing attempts to aline civil defense shelter planning with on-going urban and regional planning efforts.

The group agreed on 2 main recommendations with regard to the research program: (1) where possible adopt the problem approach, using multi-discipline teams, in all parts of the program thus ensuring that behavioral science aspects are considered from the beginning of the program, and (2) use a step-by-step rather than a crash approach to civil defense, with the objective of making civil defense become an integral and useful part of everyday life, as well as saving lives in nuclear war. The first step might be to determine the criteria for an acceptable civil defense program.

In considering general questions of research management the group agreed on the following:

No present laboratory or institution is adequate for conducting or directing the behavioral research for civil defense. A delay of 3 or more years is probable before an effective capability could be achieved. This applies both to establishing a new facility or to supplementing an existing one with a behavioral science capability.

In general, non-government, non-civil service facilities are preferable for conducting or managing civil defense research.

A single national civil defense laboratory is a good solution to the management problem. Delays seem no greater with such a solution than with use of three outside agencies.

The group considered that the proposed program subdivisions that have been suggested already could be made to work, provided the behavioral science competence was developed. Those proposals, however, do not seem to encourage the problem approach and the use of inter-disciplinary research teams. There

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seems to be no particular advantage in concentrating research management in 6 - 10 or more agencies instead of three.

The organization recommended by the group would consist of three outside agencies plus the OCD staff. One of the three outside agencies would have a competent staff representing all disciplines, and would take overall research management responsibility. The other two would be divided for program management into bio-medicine and physics/engineering labs.

Thus the OCD staff would be responsible for policy making, major decisions, the relationship with other government departments and for operations research on civil defense (using its own contractor). The inter-discipilinary laboratory would have primary research management responsibility and would apportion work to the two secondary labs or to subcontractors as appropriate. This "master" laboratory would be of the SRI type, although the group did not feel that SRI and similar institutions are presently qualified to serve the full spectrum of functions that would be required by present and future civil defense research needs.

As a final conclusion, the group suggested that the Advisory Committee give further advice at a later date when the candidates for research management are known.

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X. Personal Views of Dr. Paul C. Tompkins, Member Advisory Committee on Civil Defense. (Summary of letter to Mr. Park, dated February 27, 1963.)

The scope and emphasis of the current research program and the proposed changes and trends are reasonably satisfactory. For an increased level of support, priority consideration should be given systems analysis (Project #4100) to get the insights necessary to fit civil defense policy systematically with military, foreign, and strategic policy. With the extensive background in component-type information which is now available, the urgent need is to consolidate, digest, interpret, and make applicable the information which already exists.

With regard to centralization of program management, OCD should encourage other areas to formulate independent programs on weapons effects, biological effects, etc. where OCD is keenly interested in results, but not directly responsible. OCD should not delegate areas of responsibility without funding, nor should it be required to place research contracts with other agencies on the basis of their missions. Instead, research should be contracted for where technical competence exists, either inside or outside the government.

The one logical mission which ORNL could successfully implement does not fit OCD research program structure or management. In civil defense technology, ORNL would be most productive if it used its own funds and program direction and worked directly for the AEC. Its mission should be to develop the application of nuclear technology to relevant phases of OCD programs: primary weapons effects in relation to civil defense operational problems, biological effects information, special instrumentation, cheap reactors as emergency power sources, etc. Close relationship between ORNL and OCD research would be essential. It is doubtful if ORNL could mount a sensible, stable program as a direct OCD contractor. Under the system proposed here, the AEC would have to accept that it is an OCD responsibility and preogative to use the technology developed at ORNL. Success of this scheme would be great if relationships between OCD and ORNL are good. Unless OCD program concept is changed, ORNL should not be one of the OCD program managers.

OCD should start immediately on plans for a central civil defense research and development laboratory, of general size and scope of an AEC national laboratory, and operated by contract, preferably by a major university. This would be the only way to get the required critical mass of scientific ability into the civil defense program. This laboratory should be the center for systems evaluations, including the strategic-type such as are conducted in OCD's Directorate of Plans and Programs.

For more than one contractor, there are serious, and perhaps disastrous, flaws in conceivable combinations of program organization and management. If OCD studies several postures of civil defense, it is dealing with several different systems each with its own modifications in doctrine and technology. This introduces an additional problem, and if systems evaluations are carried out in isolation, the interplay between programs, not only among disciplines, but between immediate and long term projects, and among different postures of civil defense, will be lost.

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Only with a single research center can this sort of problem be avoided. If such an approach is used and the AEC participates, it is expected it would exploit the resources of all, not just one, of its laboratories. Thus the AEC could concentrate on any problems of radiation, nuclear phenomena, nuclear technology, and the central civil defense laboratory on non-nuclear problems.

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XI. Personal Views of Dr. Karl Z. Morgan, Member Advisory Committee on Civil Defense. (Excerpts from letter to Dr. Taylor, dated February 18, 1963.)

The most valuable contributions to civil defense research could be made by the Laboratory (ORNL) in specialized areas such as follows:

1. long-range evaluation of the radiation hazards resulting from a nuclear war;

2. evaluation of dose rates in various shelter and shielding complexes from prompt radiation, making use of weapons test information;

3. relating information in No. 2 above to the biological consequences, making full use of information gained from the Japanese studies;

4. limited evaluations of dose from fallout;

5. decontamination studies;

6. specialized instrument development, keeping practical aspects of the problem in mind; and

7. water decontamination.

I have given some thought to a regrouping of the OCD research programs. Should major parcels of the program be handed out to subcontractors, arrangement D (below), which breaks down the program in terms of conventional problems of scientific disciplines, would be much more convenient if a large segment of the program were turned over to three outside agencies, one of which might be Oak Ridge National Laboratory. With such an arrangement, ORNL could make major contributions to Item D(3) and important contributions to parts of Item D(2).

D. Arrangement of OCD Research Programs

1. Social Problems

Economics, Social Sciences, Psychology, Problems of Religious Nature, Government at all levels, Law and its enforcement, Methods of war prevention, etc.

2. Engineering and Physical Problems

War games	Weapons	Shelters
Patterns of fallout	Kinds	Design
Meteorology	How Used	Testing
CW and BW		Filters
		Upkeep

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Communications Transportation Thermal Damage Blast Damage Radiation Damage [a]	evaluation, methods of prevention and control, relation to shelter location and design, etc.

3. Biological, Medical and Health Physics Problems

Evaluations[a]

Estimates of damage from blast, burns, prompt radiation, fallout (internal and external); effect of concurrent biological insults, etc.

Long-Range Damage[a]

Burned-over areas, dead pine trees, destruction of birds and insects, etc.
Erosion and flood control
Ecological studies relating to future survival and world populations

Medical[c]

Care of people
Abortions
Birth Control

Instrument Development[b]
(for measuring dose of ionizing radiation)

Practical developments

Shielding

prompt[a]
fallout[b]

4. Over-All Evaluations

Best that this be an "inhouse" program of OCD.

[a] Projects that could be conducted at or supervised by ORNL. This includes projects similar to those now underway at ORNL or projects that could be made extensions of present ORNL programs.
[b] Same as (a) above except these programs could be conducted equally well by other organizations.
[c] Projects that might be supported at ORNL but that could be conducted better elsewhere.

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APPENDIX B

Discussion of Possible Program Subdivisions

The current OCD research program has four major administrative subdivisions, 26 projects, 85 tasks, and about 200 subtasks or contracts. The disciplines involved include physics, instrumentation, civil and mechanical engineering, fluid mechanics, chemistry, biochemistry, radiobiology, medicine, nutrition, operations research, sociology, psychology. The four administrative subdivisions used by the OCD research division are made according to a systems breakdown: shelter, shelter support, post-attack recovery, and systems analysis. Some of the 26 projects are inter-disciplinary, others by discipline. The contracts are largely by discipline.

An examination of the capability of the facilities potentially available as major contractors (e.g., ORNL, NRDL, SRI, IDA and IIT) indicates quite clearly that those with a proven capability in the basic civil defense, hard science disciplines (e.g., physics, engineering, radio-biology) are deficient in the behavioral sciences. The only facilities with any capability in that field seem to be SRI and IDA, and they do not have proven capability in all phases of either the behavioral or hard sciences that contribute to civil defense. It therefore seems quite likely that, whichever facility is selected, augmentation of staff would be necessary to achieve a capability for managing all the phases of research needed for civil defense.

Since the request from Mr. Pittman specified consideration and advice on procedures for reorganizing research management to fit into two or three outside agencies, the Committee has proceeded to do so, even though it considers that such a procedure is less desirable than the establishment of a single civil defense laboratory, either new or adapted from an existing laboratory or research institute.

Three Outside Laboratories. If three outside laboratories or research institutions contract for the management of most of civil defense research, a means for dividing the program into four subdivisions is needed, assuming that OCD itself manages one part of the program. The Committee first examined the feasibility of using the breakdown by which the OCD currently manages the research program:

1. Shelter Systems
2. Supporting Systems
3. Post Attack Systems
4. Systems Evaluation

If program four were retained in OCD and the other three contracted out, this system would appear to have a minimum disruptive effect on the management of the program. However, a close look at the makeup of the programs and of the capabilities of the logical candidates for contractors indicates quite clearly that there are serious drawbacks to this approach. The behavioral science areas, for example, are spread across all four of the above subdivisions; physics

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and engineering are carried out in three of them; bio-medical and radio-biological projects are in two of them. This results in many discipline redundancies in the OCD research staff breakdown, and makes such subdivisions incompatible with the competencies of the likely candidates for contractors. The Committee therefore believes that a breakdown more nearly conforming to the disciplines involved is preferable.

Several such breakdowns have been suggested that vary only in minor ways. They all put physics and engineering in one category; biological, medical and health physics problems, and ecology in another; the behavioral sciences, including economics and social problems in a third; and systems analysis and over-all evaluation in the last.

Although the Committee concludes that a subdivision of organization conforming to the major disciplines involved is preferable if three outside major contractors are to be selected, it considers the separation of the behavioral science to be a serious disadvantage since this does not encourage a problem or team approach to civil defense research.

Two Outside Laboratories. Subdividing the OCD research programs to fit a procedure whereby two outside contractors are responsible for the program has much the same disadvantage, since the most logical subdivision, based on the competencies of personnel in available facilities, is one that puts the management of the behavioral sciences under one contractor and of the hard sciences under the other, with OCD conducting or directing the systems analysis work.

This procedure poses another problem: the hard sciences involved in civil defense research include such major disciplines as physics, engineering, biology, radio-biology, and medicine that are reasonably well represented in such major laboratories as ORNL and NRDL. In the civil defense research program, however, there are special types of problems in such areas as fire protection, blast biology, medical care, warning, earth shock, or even shelter design where proven capability is not at present so available in these laboratories and must therefore be acquired.

More than Three Laboratories. Although not requested to do so, the Committee briefly examined the advantages and disadvantages of concentrating OCD research management in more than three outside laboratories, specifically in 6 - 10. This is the procedure followed by DASA.

The advantages include the following: (1) program subdivision can be quite readily accomplished by disciplines that conform to the competence of possible contracting laboratories; (2) there would probably be little disruption of the on-going program, since the changes involved are less drastic; and (3) maintenance of control by OCD would be in relatively little jeopardy -- the responsibility for integrating 6 - 10 research programs would require such close supervision and OCD staff activity that there would be little tendency for control to be lost.

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The disadvantages include: (1) little improvement over the present procedures with regard to a problem approach to research and close integration of research programs, since the individual laboratories would not have large enough parts of the total program; and (2) therefore, less efficient use of the services of highly qualified personnel to be found in outside research laboratories.

Achieving Recommended Procedures

The OCD research staff personnel have mentioned their concern over the delays and interruptions in the current research programs that might take place while a national civil defense facility is being established and staffed. In arriving at its recommendation for a single facility, the Committee has considered this point, and, while not completely convinced that such delay will ensue (since current procedures can stay in force during the transition period), believes that long range national needs would be better served by accepting delays and interruptions, if any, in order to achieve an enduring, satisfactory, research set up.

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