Proposed Biomedical Field Test

Report of Thermal Biology Task Unit

On 9-10 October 1957 an interagency conference on the biomedical effects of nuclear weapons was held in the Pentagon. At that time our knowledge of thermal burns was discussed. It was pointed out that Operation Greenhouse was utilized to make a major study of the factors influencing thermal lesions from nuclear weapons. The motivation for these studies was two-fold: first to validate the results of laboratory investigation by actual field observations and second to obtain physical measurements of nuclear detonations which could be used to accurately control their simulation in the laboratory. After Greenhouse several areas of uncertainty were clarified at operations Tumbler-Snapper, Upshot-Knothole and Plumbbob. Even so there are gaps in our knowledge which are largely due to: (1) a discrepancy between the capability of the weapons tested and the thermal effects desired. Except for Operation Greenhouse they were experimental devices which often did not yield the anticipated thermal flux. (2) The limitations imposed by experimentation at the Nevada Proving Site where only small yield weapons are used. For example the thermal burns from megaton devices have never been studied. (3) The limitation of laboratory sources to adequately simulate nuclear weapons. This is most important in studies on the protective effects of fabrics where the edge effects and damage from flaming are much more pronounced in field than in laboratory experiments. (4) Our inability to make use of the clinical material on thermal burn casualties in Japan because of the lack of cross over between the factors existing in the weapons detonated there and those used in field experiments.

Subsequent to the interagency meeting to consider the needs of a biomedical field test a Task Group on Thermal Biology was created. This group met

on 12 September 1958. The agenda was as follows:

Meeting - Task Group on Thermal Biology

1717 H Street, Washington, D.C. - 9:30 A.M., 12 Sept., 1958

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| 9:30 A.M. | Introduction - H. E. Pearse, Univ. of Rochester |
| 9:45 A.M. | AFSWP Interest in Thermal Biology<br>Sven A. Bach, Lt. Col. (M.C.) |
| 10:00 A.M. | Atmospheric Transmission of Thermal Energy<br>Harold Stewart, N.R.L., Washington |
| 10:20 A.M. | Cutaneous Heat Flow<br>Thomas P. Davis, Univ. of Rochester |
| 10:40 A.M. | Influence of Cooling on Experimental Burns<br>James D. Hardy, Univ. of Pennsylvania |
| 11:15 A.M. | Retinal Burns and Flash Blindness<br>Robert R. Newell, N.R.D.L., San Francisco |
| 11:35 A.M. | Protection from Fabrics<br>J. Fred Oesterling, Q.M.C., R & D, Natick |
| 11:55 A.M. | Fabric Studies at N.M.L.<br>Thomas I. Monahan, N.M.L., Brooklyn |
| 12:10 P.M. | Clinical Management of Burns<br>Curtis Artz, Univ. of Mississippi |
| 12:30 P.M. | Burns within Shelters<br>H. E. Pearse, Univ. of Rochester |
| 2:00 P.M. | Summary and Recommendations |
| 4:00 P.M. | Adjourn |

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The speakers at this conference discussed the present state of our knowledge and the need for further field studies. There was fairly general agreement that in most areas sufficient empirical observations had been made in the past but that there was a need for more basic data which would permit mathematical generalizations. This requires more accurate measurements of the

thermal pulse in order to analyze its effect on the biological material. It was suggested by Stewart that one should: a) Measure the total incident thermal energy; b) Determine the power as a function of time; c) Measure the spectral power. He said one could not assign numbers to a stockpiled weapon but must take measurements. Present techniques permit recording with a time constant of 0.001 sec. and a wave length of $\pm$ 50 A° with an accuracy of $\pm$ 10%. Such measurements would allow an analysis of the biological effects in terms of physical causation. This would permit better validation of basic laboratory studies and improved prediction of bomb effects.

At the end of the conference on Thermal Biology it was agreed that each laboratory would make recommendations for field projects and that a subsequent meeting would be held if necessary to discuss these. However very few concrete proposals were made. The chairman conducted correspondence with all the members and visited several laboratories without immediate results. There was general lethargy because of the international agreement to ban nuclear tests. The attitude was taken that if there was to be no field testing there was little point in planning a program. This plus the lack of any really pressing need for more field data in order to conduct laboratory research has delayed this report.

The following are suggestions for field studies in the area of thermal biology:

I. <u>The University of Rochester A.E.P.</u>

a) If a Nagasaki-Hiroshima type weapon is fired then animals (pigs) should be exposed at a range of from 3 cal/cm$^2$ to 20 cal/cm$^2$ (3, 5, 10, 15, 20 cal/cm$^2$) in order to correlate the lesions in animals with those in the Japanese.

Accurate measurements of thermal flux and atmospheric transmission should be made in order to evaluate the energy level causing

any specific burn severity. This would require that the shot be fired in daylight, on a hot day, so that the influence of skin temperature would be known.

b) There is inadequate information on bare skin burns from nuclear weapons where good thermal measurements have been made and biopsies of the lesions, for depth of injury, have been obtained. Techniques have improved since Greenhouse. There is a current need for more accurate prediction in military and civil field manuals. The numbers now available are often from only one weapon yield. Thus if a series of detonations of different yields are considered then animals should be exposed for bare skin burns and measurements made at each shot over a range of 5, 10, 15, and 20 $cal/cm^2$.

c) The cause of burns in open door shelters should be studied. Containers having an exposure port which permits a separation of the thermal pulse from the blast wave should be used. Thus animals could be exposed within the shelter to only the period of the thermal pulse, to only the blast wave, and to both.

Physical measurements of air temperature and air velocity should be made in conjunction with the exposure of the animals. It would also be desirable to take samples of the composition of the air (dust, etc.) during the various phases of the detonation.

d) There are questions about the thermal burns from megaton weapons such as the time the burn is sustained, the possibility of evasive action, the effectiveness of the tail of the pulse, etc., but these cannot be studied at the Nevada Test site.

II. Quartermaster Research and Engineering Command

a) The greatest advance in the laboratory study of thermal burns has been the installation of a solar furnace at the Q. R. & E. laboratory at Natick, Mass. This thermal source is vastly superior to any other laboratory tool yet devised not only in the high level of radiant flux obtained but also in the increased area of exposure. At present experiments with this source are being actively pursued at Natick. It is desirable to validate the results of these by observations in the field with nuclear detonations. This would "check out" the solar furnace against atomic bombs.

b) One of the simplest and most effective means of increasing the protective effect of fabrics is to provide an air space between the layers of cloth. In the past there has been a discrepancy between the laboratory and field observations due largely to the amount of flaming that occurred. It would be desirable to test in the field the effect of a controlled increase in the space between a two layer fabric ensemble. This would not only be of practical value in the design of uniforms but also would point to the cause of differences found with laboratory sources.

c) The QMC is required to furnish protective clothing to meet the needs of changing conditions. They wish the privilege of evaluating, in the field, the effectiveness of laboratory tested new designs and new methods incorporated into protective clothing.

III. Naval Material Laboratory

NML believes that the following program should be implemented, but not necessarily by NML, in order to corroborate laboratory findings or

to remove inconsistencies from earlier field tests made with less precision than is now possible.

a) Thermal Effects on Skin

The critical radiant exposures for threshold bare skin burns of various severities should be documented in the field using at least two species. The temperature history of a skin simulant should be measured during the irradiation period.

b) Sub-Fabric Burns

There is little systematic information available using nuclear weapon pulses. The experiment proposed is a study of various fabric fibers, geometries and treatments under controlled conditions using one animal species. The temperature history of a skin simulant would be determined as a corollary of these experiments.

c) Skin Simulant

In the laboratory study of burns beneath fabrics generalization is often difficult because of the complexity of the factors involved. This may require many experiments on each fabric which is expensive and time consuming if animals are used. Yet to date, the animal skin has been the most accurate receiver. It is desirable to test inanimate receivers developed in several laboratories using a bomb pulse and checking the findings against actual animal burns.

IV. Institute of Optics - University of Rochester

Measurements of the thermal flux must be made accurately in order to evaluate biological results. These must be made at each station and in greatest detail at the first and last station. The mass-yield ratio and

the altitude are important for the first maximum. Present techniques allow the measurement of total incident thermal energy to an accuracy of ± 10%, a time resolution of 0.001 sec. and a wave length to ± 50 A°. These are better than required for biological work so it is assumed that it will be feasible to measure satisfactorily:

1) Total incident thermal energy

2) Power as a function of time

3) Spectral power

It is suggested that the field measurements be made by a contractor under the supervision of Dr. Harold Stewart, Institute of Optics, University of Rochester, who is expert in this area.

V. School of Aviation Medicine

Field studies on flash blindness and retinal burns have been conducted in the past by the Air Force. The Naval Radiological Defense Laboratory, Medical College of Virginia, and A.E.P., University of Rochester, have also been interested in these lesions.

S.A.M. has submitted a proposal for a continuing study of retinal burns to the D.O.D. via DASA (AFSWP). Such studies are better done on high yield weapons in the Pacific but might be modified to be performed in Nevada for there have been retinal burns sustained from detonations at the N.T.S.

It is felt that these studies should be actively pursued. The threshold of thermal energy which causes a retinal burn in several species of animals has been determined at the U. of R. using a laboratory source. This must be validated with field sources in order to make accurate predictions.

## Summary

This report gives the proposals suggested to date for field studies in Thermal Biology if a Biomedical field test is implemented. They must be considered tentative until the present moratorium on nuclear detonations is clarified. If there is international agreement on atomic bomb testing then the suggestions made here should be reviewed in the light of that agreement.

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