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Annual Report

August 1970

CIVIL DEFENSE TEST DESIGN AND SUPPORT OF OPERATION FLAMBEAU-TYPE FIRES

Prepared for:

CONTRACT DAHC20-70-C-0219
OCD Work Unit 2561B

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CIVIL DEFENSE TEST DESIGN AND SUPPORT OF OPERATION FLAMBEAU-TYPE FIRES

By: STANLEY B. MARTIN

Prepared for:

DEPARTMENT OF THE ARMY
OFFICE OF THE SECRETARY OF THE ARMY
OFFICE OF CIVIL DEFENSE
WASHINGTON, D.C. 20310

Attention: MR. STEPHEN R. BIRMINGHAM

CONTRACT DAHC20-70-C-0219
OCD Work Unit 2561B

SRI Project PYU-8150

Approved by:

NEVIN K. HIESTER, *Director*
Physical Sciences (Materials)

CHARLES J. COOK, *Executive Director*
Physical Sciences Division

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

SUMMARY

This report describes annual progress in a continuing program to review and appraise potential opportunities for mass-fire tests and other sources of field-test data relevant to the civil defense fire problem and to provide objective and technically sound advice in such matters as required by the Support Systems Division of OCD, Research.

Progress for the year is summarized in the following subject-area categories:

1. Review of reports on Flambeau-type fires
2. Investigation of new sources of data
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4. Participation in the writing of a Handbook on Forest Thermal Effects.

Plans for the coming year are also presented.



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I INTRODUCTION

Data gathered in the past and current Flambeau-type experimental fires are of value in providing a definitive analysis of (1) the temperature history and life hazards of large fires, (2) civil defense experiments that may be useful, and (3) the feasibility of different media for large fire tests. This program has evaluated and utilized these data and will ensure coordination of the efforts of OCD contractors in performing any experiments that OCD may sponsor in experimental research on the dynamics of large fires.

In satisfaction of the contract (No. DAHC20-70-C-0219, Task Order 2561B), progress for the year is summarized herein.

II PROGRESS

Accomplishments under this subtask number may be categorized into the following subject areas:

1. Review of reports on Flambeau-type fires
2. Investigation of new sources of data
3. Conduct of annual OCD Fire Research Contractors Conference
4. Participation in the writing of a Handbook on Forest Thermal Effects (TTCP, Panel N-2, Working Group J)

Progress in each area is summarized below.

1. Review of Reports on Flambeau-Type Fires

The principal activity during the year occurred in Australia and Canada. The following reports have been received and reviewed to date:

- a. "Euroka Mass Fire Test, Langely, Queensland, October 23, 1969," A Preliminary Report by J. A. Keller, The Dikewood Corporation
- b. An Informal resume of the Euroka Fire by A. G. McArthur, Forestry and Timber Bureau, Yarralumla, A.C.T.
- c. Forest Research Laboratory (Alberta) Information Report A-X-24, "The May 1968 Forest Conflagration in Central Alberta," by A. D. Kiil and J. E. Grigel, June 1969
- d. A preprint entitled "Fuel Consumption by a Prescribed Burn in Spruce-Fir Logging Slash," by A. D. Kiil, Forest Research Laboratory, Edmonton, Alberta

Preliminary results from the Euroka Fire are briefly summarized as follows:

1. Wind inflow and burning rate data show that experimental values deviate considerably from values predicted by the Australian model theory.
2. Meteorological conditions of low relative humidity and high ambient wind speed are characteristic of an explosive fire condition.

3. Subrefraction, or a backward tilting of the wave fronts of radio signals transmitted through the high temperature region can adversely affect radio communication.
4. Life hazards due to radiant heat and high air temperatures exceeded thresholds in the central areas of the fire. Personnel housed in a bunker near the center would have survived the heat, but would have been in serious trouble with CO concentrations, even many hours after active burning.
5. The following constants were determined for the Euroka fire:

a. Semiangle of convective column cone	14°
b. Ratio of pinch height to fire radius	0.84
c. Ratio of pinch radius to fire radius	0.38
d. Projected column radius to fire radius	0.18
e. Constant relating inflow to energy release	1.25 m/sec
f. Reynolds number	1.4 x 10 ⁸
g. Logarithmic wind velocity profile	0.2
h. Velocity deviation to average velocity	0.12 before 70.25 during

The severe forest fires that occurred in Alberta in May 1968 had many features in common with the spectacular Sundance Fire in Idaho in 1967. Particularly noteworthy are the rapid "runs" and large and intense firewhirls. During a 10-hr run, one fire spread at a rate averaging 4 mph and released an average of about 11 kilotons of energy every minute. Several areas were seen where thousands of tree stems had been felled by the force of the wind generated by the fire or scattered in a circular pattern up to several hundred feet in diameter. The severity of these fires was found to correlate very well with weather and fuel characteristics as they are applied in fire-danger rating methods.

The Pacific Southwest Forest and Range Experiment Station's Final Report on Project Flambeau arrived too late to be reviewed as part of the current year's work.

2. Investigation of New Sources of Data

Information received regarding Canadian land-clearance burns indicates that relatively little, if any, new information is likely to be offered by experimental efforts on such operations. In most respects, such tests would be quite similar to tests already run in this country

and in Australia (i.e., Flambeau, Tumut, and Euroka). Also, fuel loadings tend to be less than some of those previously tested.

During the past year, Mr. C. P. Butler, the project leader for Work Unit 2561B, participated in the Navy's Carrier Aircraft Support Study (CASS) by assisting the NOL group in residence at SRI with measurements of the characteristics of large pool fires. Fires of this sort appear to have utility in the study of the general nature of large fires burning in the normal atmosphere. It is noteworthy that data on burning rates and flame heights collected during the CASS test series are in excellent agreement with the correlation of Blinov and Khudiakov [Fire Research Abstracts and Reviews 1, 41-44 (1959)] and represent a substantial validation of the capability to extrapolate to larger fires.

The Willows (California) urban-burn program has been discussed with the State of California Department of Education, whose objectives involve educational films and commentaries for use in fire training. Participation by fire research groups has been actively solicited, but adequate levels of fundings are not currently available. The National Science Foundation has expressed an interest within the context of developing a capability to instrument "fires of opportunity." Additional sources of funding are being sought.

Inquiries have been made to several sources in Japan concerning the explosion and fire in Osaka, Japan; however, at this time no conclusive information has been obtained.

3. Conduct of Annual OCD Fire Research Contractors Conference

The 1970 Fire Research Contractors Conference, held at Asilomar, California, in April, was hosted by SRI, and Dr. Nevin K. Hiester served as the program chairman during the conference. This annual conference brings together, in an atmosphere conducive to the informal exchange of ideas and information, not only those investigators who are actively engaged in fire research for OCD, but other experts in the field, as well as representatives of other areas of civil defense research that interact with fire. The central theme at these meetings is the threat of mass fires following nuclear attack. The information needs of those

who are required to evaluate the survival and operational implications of fire are presented to those whose research is directed toward the characterization of fire. Conversely, the status and plans of fire research are presented to those who require the information, to apprise them of the state of the art and to allow critical review of research objectives.

4. Handbook on Forest Thermal Effects

Under the auspices of The Technical Cooperation Program (Panel N-2), Stanley Martin participated in the preparation of a Handbook on Forest Thermal Effects ("Thermaldown")--a document paralleling the previously issued "Blowdown Document." A complete initial draft was written at a workshop held at DAS'AC in Santa Barbara during the week of April 12, 1970, attended by representatives of DASA, OCD, U.S. Forest Service, U.S. Army, and SRI, and directed by Mr. James W. Kerr, Chairman of Working Group J. Final revisions to the draft have since been made, and the document is soon to be published.

III PLANS FOR NEXT YEAR

Any future large-scale experimental fires should take the fullest possible advantage of the experiences gained and the techniques developed during relevant tests to date, whether they have been carried out in this country or abroad. Expenditure of OCD resources in further acquisition of test data on such mass-fire characteristics as burning rates, temperatures, air velocities, and gas concentrations must be tempered by its probable usefulness to OCD as a research input to guidance for future plans and operations. It is the central purpose of Work Unit 2561B to provide objective and technically sound advice in such matters as required by the Support Systems Division of OCD, Research. Selected members of the SRI fire-research staff will be available for consultation as needed and will continue to update their capability to provide such service.

Consulting at the planning level for future large-scale fires will ensure that the character of the simulation, the measurements attempted, and the evaluation of the data acquired will be both state-of-the-art and entirely pertinent to OCD's fire-problem objectives. Data from experimental fires such as Euroka and the CASS series will continue to be evaluated for its utility and pertinence to the OCD program.

Finally, assistance in the coordination of fire research efforts and the effective exchange of information between agencies involved in fire research and fire protection will be supplied through the conduct of, and active participation in, numerous technical meetings, symposia, workshops, and field exercises. As just one specific example, the SRI fire-research staff will again take an active part in arranging for, conducting, and contributing to the annual OCD Contractors Conference in the coming year.

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