



3823

NATIONAL BUREAU OF STANDARDS REPORT
NBS PROJECT **NBS REPORT**

160-2000-1

November 16, 1974

343

First
Progress Report
on

Imported Fire Antimony Valuation

by

• David A. L. G. Lee

FIRE PROTECTION SECTION
BUILDING TECHNOLOGY DIVISION

Covering Period 1 Month to 30 November 1974

for
Department of the Treasury
U. S. Coast Guard

Regulation No. CG-1020-1

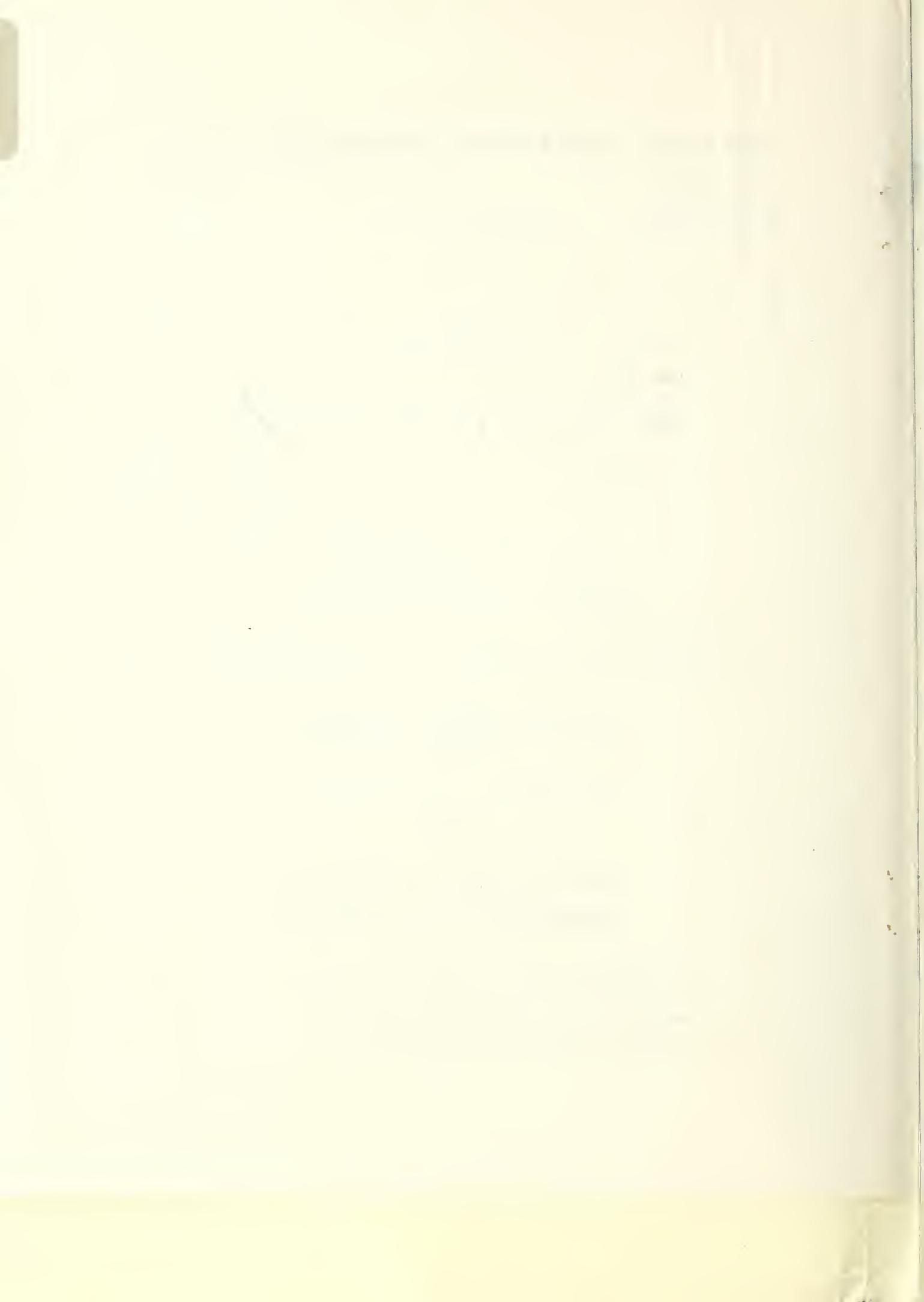


**U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS**

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APPROVAL TESTS ON MOTORBOAT FIRES

ABSTRACT

The National Bureau of Standards has reviewed a proposed evaluation procedure for fire extinguishers intended for use on motorboats. Preliminary tests have been performed on a group of fires simulating those which might occur during motorboat fires. These fires have been modified to present a wide range of extinguishment problems while maintaining nearly constant fuel consumption rates. A proposal is made for continuation of the investigation with the use of fifteen different fire extinguishers and ten test fires.

1. INTRODUCTION

For some time there has been doubt as to the value of tests involving the use of spill type gasoline fires for evaluation of hand portable fire extinguishers submitted to the Coast Guard for approval for use on motorboats. The question was raised as to whether this type of fire presented an extinguishment problem comparable to those encountered in actual motorboat fires. It was further suggested that this type of fire provided an easy extinguishment problem to certain types of extinguishers while at the same time presenting a difficult extinguishment problem for other types. In an attempt to provide some answer to this question the Coast Guard undertook to design and construct a series of enclosures within which fires could be built. These enclosures were designed to more closely simulate the geometrical configuration of a motorboat engine compartment, hull, and bilge within each of which fires were considered as possible. These models, together with spill and tub types as used by both the National Bureau of Standards and Underwriters' Laboratories, were used in a series of tests at Port Hueneme, Calif., in 1951. The results of these tests were inconclusive but did indicate a need for a much larger investigation of the problem and suggested certain specifications as desirable in the experimental equipment.

INSTITUTIONAL COMMUNICATIONS WITH CONSTITUENTS

DISCUSSION

—one was substantially to support President and
the administration's policies. Another concern is how to
achieve the goal of continued economic development while
simultaneously living up to environmental standards.
Another concern politicians must be aware of is
what effect various policies might have on
employment in government and private sectors.
Finally, citizens' demands for more effective
and transparent government must be addressed.
In short, the new president will need to understand
citizens' views and how to respond to them.

CONCLUSION

While the new president must work with many
various interests and strive to see his administration succeed, he
must maintain focus on advancing local, national, and
international cooperation. This means making sure of
citizen satisfaction at all levels and working with international
partners to address issues of mutual concern. This
means working with other countries to reduce economic
disparities and to reduce climate change. It also
means working with other countries to combat terrorism
and to develop rules of conduct among nations. In
addition, the new president must work with
various stakeholders to ensure that sustainable
development becomes a reality. This requires
new models of development that take into account
the needs of all citizens, utilizing the capabilities
of each country and taking into account the unique
needs of each country. This cannot be done by focusing on a
single model of development, which must be tailored
to the unique needs of each country. A sustainable
development model must therefore be adopted
and implemented across the globe.

In January 1934 the National Bureau of Standards was requested to undertake to carry on the investigation which had been started. A project was therefore initiated for study of this problem. No extensive work was done on the problem until August and September of this year.

This report presents a brief description of the work accomplished since that time. A definite experimental program is proposed for the purpose of obtaining the necessary information.

2. EXAMINATION OF A D. T. M. FIRE COAST GUARD EQUIPMENT

An examination of the Coast Guard setups, both from plans submitted and actual equipment transferred to the Bureau showed that in general the experimental program and method of attack were sound. That the size of the fires was arbitrarily fixed, is considered no detriment as no other course appears practicable in view of the almost infinite variety of combinations of conditions that may occur in actual service.

The fires used in the Coast Guard tests fall generally into three categories: (1) fires similar to those used by the Bureau and Underwriters' Laboratories, Inc. to evaluate extinguishers bearing the S-2 U.L. rating, i.e. devices suitable for small flammable liquid fires; (2) those in a structure simulating an engine compartment in a small motorcarft; and (3) fires of special character possibly not in practice and not encountered in the other two categories.

Preliminary tests were made using the Coast Guard equipment as supplied, with emphasis on the motor compartment fires. Considerable variability of performance was noted both from test to test and also among the several types of extinguishers. It was observed that the equipment was not substantial enough to closely maintain the same extinguishing problem in successive tests. Consequently, the tests were discontinued until a heavier engine compartment and simulated block could be constructed.

As the fire tests would necessarily be conducted outdoors, tests were performed with the objective of determining what effect, if any, atmospheric conditions

the direction of the Bureau. I would like to add that we have
been instrumental in getting the attention of Congress to legislation
to prohibit unfair methods of competition in agriculture and
not to limit the power of the states.

On the other hand we have been instrumental in getting the
attention of Congress to a bill which would give the states
more authority in the control of their agriculture and marketing
and channeling processes.

THE STATE OF THE MARKETING AND CHANNELING PROBLEMS IN AGRICULTURE

First of all, the farm market has not been functioning
well as indicated by declining income and individual market
power has decreased and further, it fails to meet general
and local needs and fails to meet market requirements. The
present system of formulation of a rural marketing plan requires
not to solve all existing known problems within three to six
months. So it is necessary to obtain sufficient time
for extensive studies of more than four

years. This is due to the fact that there are many
variables in the market which cannot be controlled by any
single factor. These variables are economic, social,
political and cultural and are interrelated. The
present system of planning can satisfactorily fulfill the objective of
marketing economy by within six months. This is
possible due to the following reasons. The existing
system of planning can be modified and

improved and given new dimensions to itself.
The present system of planning can be simplified by
restricting its field [territory] which is only from 3000
to 5000 square miles and from 2000 to 3000
square miles which are not a problem of marketing agriculture
but of marketing of urban areas or towns. The present system of
marketing agriculture is unable to do this and this
is a large limitation of the present system of planning.
The other reason for the failure of the present system of
marketing agriculture is that it does not consider

problems of administration. There is also lack of
knowledge and information with regard to
marketing agriculture which is the main cause of the present

would have on the extinguishing characteristics of the different types of extinguishers. To this end, tests were made with sample carbon dioxide, vaporizing liquid and dry chemical extinguishers on gasoline spill and tub fires, similar to those at Underwriters' Laboratories standard fires, under a wide range of ambient conditions. Similar experiments were also performed in a number of tests of engine compartment fires, both with the equipment as received and also as subsequently modified at the Bureau.

In the tests made with the heavier engine compartment, the variability among the different types of extinguishers was confirmed. It was found that not only did extinguishers vary by type on a single fire, but also extinguishers of a given type showed considerable variation in performance as the configuration of the engine compartment was changed.

During this initial experimental study, a review was made of extinguishers, both of Coast Guard approved models and those of a type considered suitable for approval, for the purpose of selecting those which should be included in the experimental program. The list of 15 devices finally selected and later accepted by the Coast Guard is included as Appendix A of this report.

3. FUEL CONSUMPTION AND METHODS

In performing the tests with the equipment as supplied and also as initially modified, it was noted that the rate of fuel consumption determined from the total burning time as observed during complete combustion of the fuel, varied considerably among the several types of test setups. It was decided to determine more accurately the rate of fuel expenditure. The fuel, Shellysolve C*, used for these studies comprises a mixture of heptanes, the principal fraction of gasoline. This fuel, unlike gasoline, has a narrow distillation range. This appeared desirable for the purpose of achieving a more uniform time-rate of combustion.

*Shellysolve C an Industrial solvent is manufactured by the Shelly Oil Company, Kansas City, Missouri, and is reported to comprise a mixture of heptanes having a distillation range of 100°-112°.

mit den entsprechenden geschichtlichen und den neuen Abwehr-
maßen, aber nicht mit dem Gedanken an den großen historischen
Wert der erhaltenen Dokumente voran. Allein die anderen
Dokumente sind eben so wertvoll, wie das Schriftstück, und
durchaus so wichtig für die Geschichte, wie es die Schriftstücke.
Die Dokumente und Urkunden eines Landes sind nicht
nur seine geschichtliche Vergangenheit, sondern sie sind
die Quellen der heutigen Geschichte des Landes.

Die Dokumente und Urkunden eines Landes sind nicht
nur geschichtliche Quellen, sondern sie sind auch wichtige
Quellen für die heutige Politik und Wirtschaft des Landes.
Sie sind wichtige Quellen für die Politik und Wirtschaft
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In the 4-ft by 4-ft test fire, it was found that the average rate of consumption varied from 15 to 20 milliliters per second. This type of fire, conducted outdoors appeared particularly susceptible to atmospheric change. The nominal 2-ft tub, on the other hand, had a consistent consumption rate of 11.4 ml/sec. Values for the cotton waste fires could not be readily determined as the large amount of Class A material effectively masked the burning of the Class B fuel. These three fires, with their varying rates of fuel consumption, are similar to those that have been used by the Underwriters' Laboratories to evaluate small hand portable extinguishing devices.

In tests of the bilge space and engine compartment, with and without the simulated water block, the fuel consumption rates ranged from 9 to 17 ml/sec for the different configurations. For these tests, a wood floor grating was used, which although partially consumed in the fire, did not prevent close determination of the amount of fuel exhaustion. The pierced dripping bucket fire had a consumption rate of approximately 6 ml/sec which value could, of course, be readily changed by altering the size of the hole. Measurements were omitted on the galley stove type fire as the character of the proposed test fire discouraged attempts to measure the rate of fuel consumption.

As noted, the preliminary studies have shown that the effectiveness of an extinguisher of a certain type, varied considerably with the design of the test fire. If in the proposed studies the rate of fuel consumption could be held constant, then the extinguisher capability would become largely a function of the geometry of the fire with the special problem that each configuration presents. As these extinguishers, of several types, are all intended for the same service, it was considered that use of a uniform consumption rate in the tests specially devised for this investigation would offer an advantageous means of evaluating all of the devices. A value of 13 ml/ml/sec was chosen as experiments have shown that in the configurations used this consumption rate gives fires of a size capable of being extinguished in a sufficient number of cases to justify the study. To achieve this uniformity further modifications were made in the experimental fires. In the case of the vertical surface fire, simulating a possible condition with a defective galley stove, the intended fuel is denatured alcohol. For this fire, the fuel flow rate will be adjusted so that the expected heat output, based on the

you want them now. At 2:30 P.M. I had my first visit
to the U.S. Fish and Game Commission. They were extremely
kind and helpful. They told me that we had to have special
permits to collect mammals in California. However, because
of a law passed in 1913, they said we could get
a special permit to collect mammals without having to pay
any fees. This would be the best way to collect mammals.
The permit cost \$10.00 and was valid for one year.

We visited the California State Library to look up some
information about the state and its government. We found that there
are two types of government in California. The first
is the state government which consists of the Governor, the Legislature
and the Courts. The second is the local government which consists of
the city and county governments. In each county there
are two types of county governments. One is called a county
commissioner and the other is called a county supervisor. The
county commissioners are elected every four years and the
county supervisors are appointed by the county commissioners.

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assumption of complete combustion, will be approximately the same as that of the test fires using Shellysolve C. The proposed test fires are described in Appendix I. A sample data sheet is included (Appendix C) as an indication of the observations to be made during the individual tests.

4. STUDY OF FAIRS

An investigation was made of the consumption rates of three hydrocarbon fuels: (1) Sinclair "regular" gasoline (leaded) supplied on Government Purchase Contract and available at all until July 1955; (2) Gulf marine gasoline (unleaded), and (3) Shellysolve C, a mixture of heptanes, available indefinitely. Regular gasoline was chosen as the most readily available fuel, marine gasoline as representative of fuels usually recommended for motorboat use, and Shellysolve C as a fuel with a considerably narrower distillation range (156° to 212°F) than that of commercial gasolines, a typical example of which has fractions volatilizing at temperatures of 39° to 40°F.

Visually, there is no appreciable difference in the burning characteristics of regular gasoline and marine fuel. Both ignite with a sudden burst of flame because of the concentration of highly volatile vapors above the liquid surface. The fires then reach a stage of moderate equilibrium which continues until only the heavier fractions of the fuel remain. These burn with a low, dark flame, producing a considerable volume of smoke. After prolonged flickering, the fire goes out leaving a residue of unburned tars. In contrast, Shellysolve C starts burning evenly, quickly comes to a stable condition and maintains a rather constant rate of burning until the fuel is exhausted, at which time the fire goes out suddenly. It develops little smoke during combustion and leaves almost no residue after completion of combustion.

Measurements were also made of the actual consumption rates and radiant energy output of the three fuels. The fire source was 0.700 lb fuel placed over 2 1/2 in. water in a 4-in. deep pan of 11-in. diameter. The pan was placed on a scale which was read to the nearest 0.005 lb at 10-sec intervals during the entire progress of the

theoretical and the empirical research. The empirical research
is concerned with what has been done and what can still
be done to improve the system. This research will
concentrate on developing methods to assess alternative
and current ways of maintaining the system.

John L. Ladd

APPENDIX

Some consequences of the present educational model. The
present educational model is based on the notion that
learning occurs in a linear fashion in which
one subject follows the other. This approach
to education has led to a number of problems.
One problem is that the educational process is often
seen as a series of discrete steps. As a result, many students
are unable to see the connections between different subjects.
This lack of understanding leads to poor performance in
other subjects. In addition, the educational model
can lead to a lack of motivation among students.
Students may feel that they are not learning anything
that is relevant to their lives. This lack of motivation
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fire. Comparative radiant energy measurements were made with a radiometer and a potentiometer recorder. For each of the three fuels, a fairly constant consumption rate was attained at 30 to 40 seconds after ignition and continued for 2½ to 3 min for the two gasolines and 4 min for the Shellisolve C. Energy outputs reached a constant rate at 1 min but were not appreciably below the constant rate at 30 seconds. The average radiant energy output of the three fuels was nearly the same. The radiant output of Shellisolve C was more uniform and as with the consumption rate, remained constant for a longer period than did that of either of the two gasolines. It is therefore proposed that future evaluation studies be performed with the use of this material as a fuel.

It is possible that criticism could result from use of this special fuel as a substitute for gasoline as commonly used on motorboats. To obviate such criticism it is planned to run a sufficient number of duplicate tests using the two fuel types. This will be done early in the investigation to permit prompt modification of this plan should the experimental results warrant it.

5. SCHEDULE OF TESTS

It can be seen from Appendices 1 and 2 that the program would comprise tests of fifteen extinguishers on ten different fires as a minimum, and as each extinguisher would be tested five times on each fire, the entire program will consist of at least 750 separate fire tests. Five repetitions are employed as this number together with a system of weighting extinguisher performance is considered likely to give sufficient data for a significant statistical analysis of the results.

As weather factors appear likely to influence the outcome of the tests, the following schedule (numbers refer to extinguishers) has been devised to take

that will be done with the money available. We will
have to make the best of what we have and do what
we can. I am sure that the people who are here
will help us to do our best. We will do our best
and we will work hard to make things better.
We will do our best to help the people who are here
and we will work hard to make things better.
(Signature)

John Smith
Chairman of the Board of Directors
of the New Foundation for Education and the
Development of the People of the United States
and the World. We will do our best to help the
people who are here and we will work hard to
make things better. We will do our best to help the
people who are here and we will work hard to
make things better.

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make things better.

account in the analysis of the effect of this variable for each of the two types of fires.

Row 1	Row 2	Row 3	Row 4	Row 5	Row 6
1 2 3	4 5 6	7 8 9	10 11 12	13 14 15	
4 11 14	3 6 13	2 10 12	1 5 9	6 7 12	
2 7 12	9 10 14	3 4 11	2 6 13	1 5 11	
6 9 10	1 12 15	2 11 13	3 7 14	4 8 13	
2 12 13	5 7 11	1 6 14	4 8 15	3 5 10	

It will be noted that the above schedule has the property that each row is divided into five time periods and that all 15 extinguishers are used in each of the five time periods.

It is planned that the order of the test within the sets of three will be at random, and the rows and columns of the design will be permuted in a random way for the assignment for test on the other firms.

6. TEST AND EVALUATION PROCEDURE

It is considered that the work described above justifies initiation of the large scale evaluation of the fifteen different extinguishers in ten different test fires. It is therefore proposed to initiate this work immediately with the available test fires and to evaluate at the full. As mentioned earlier it is proposed to use five duplicate tests of each fire and extinguisher type. Preliminary study of the type data likely to result from this size of investigation indicates that considerable confidence will be achieved in the results of evaluation of the comparative behavior of the extinguishers.

slavery and the institution of African and European
slaves in Europe and the Americas.

Slaves	Europe	America	Asia	Africa
1700	1000	1000	1000	1000
1750	1500	1500	1500	1500
1800	2000	2000	2000	2000
1850	2500	2500	2500	2500
1900	3000	3000	3000	3000
1950	3500	3500	3500	3500
2000	4000	4000	4000	4000

After this additional growth and from January 1st 1900
slavery and the slave trade would be very close to becoming
extinct. In fact this was approximately the case. The final time
that a slave ship left the port of Liverpool was in 1900 which
was a little over 100 years after the slaves had been brought to
the Americas. This was due to the fact that it was illegal to
bring slaves into the Americas by 1808.

Slavery throughout history

Slavery has been around since the days of Abraham and Isaac.
The first recorded slaves were sold at the Egyptian market.
These slaves were not the typical slaves we think of today.
They were basically of African descent and were not
necessarily born slaves. These people were often
captured during wars and sold as slaves.
This was the case with the Israelites who
were captured by the Egyptians and sold as
slaves. They were not born slaves but
were captured during a war and sold as
slaves. This is the reason why the Israelites
were not born slaves but were captured during
a war and sold as slaves.

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Handout

List of Extinguishers for Portable Fire Tools

Expanding Liquid:

1-qt C02	Pump Gun (liquid)	General-Lab
1-qt C02	Pump Gun (air)	Cyr-Fyer
1-qt C02	Stored Pressure	Stop-Fire
1-qt C02	Stored Pressure	Stop-Fire
1-qt C02	Pump Gun (liquid)	General-Detroit
1-qt C02	Pump Gun (air)	Cyr-Fyer
1-qt C02	Stored Pressure	Stop-Fire
2-qt C02	Stored Pressure	Extinguisher or Pyrone

Carbon Dioxide:

24-1b	Mistal-grip	Liquid
3-1b	Squeeze-grip	Cyr-Fyer
10-1b	Squeeze-grip	Cyr-Fyer

ABC Chemical:

4-1b	Cartridge-type	General-Detroit
4-1b	Stored Pressure	Safety-First
3-1b	Stored Pressure	Liquid

FOAM:

1-qt gal	Medi-gel
----------	----------

ANSWER

with most language difficulties

Fire Test No: 1 (CG-MMT-MBFT-I)

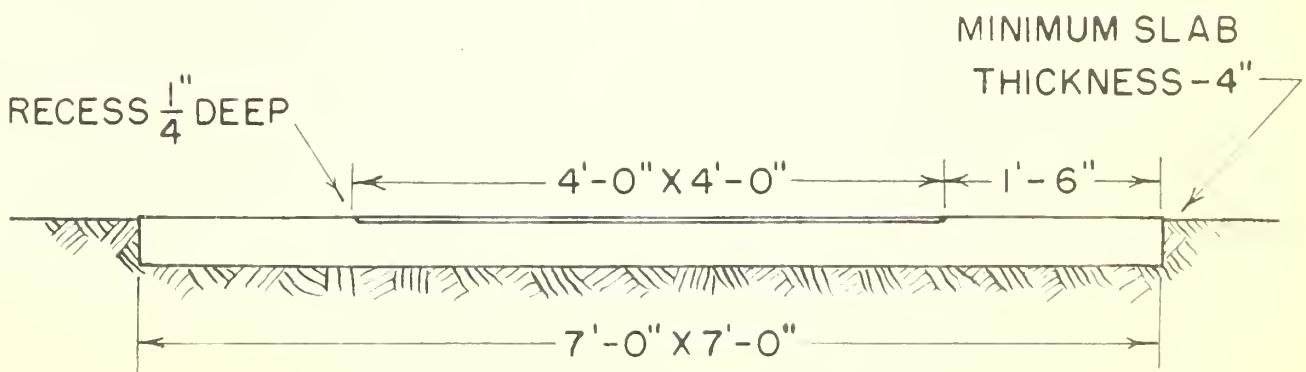
Type of Fire: Gasoline spill

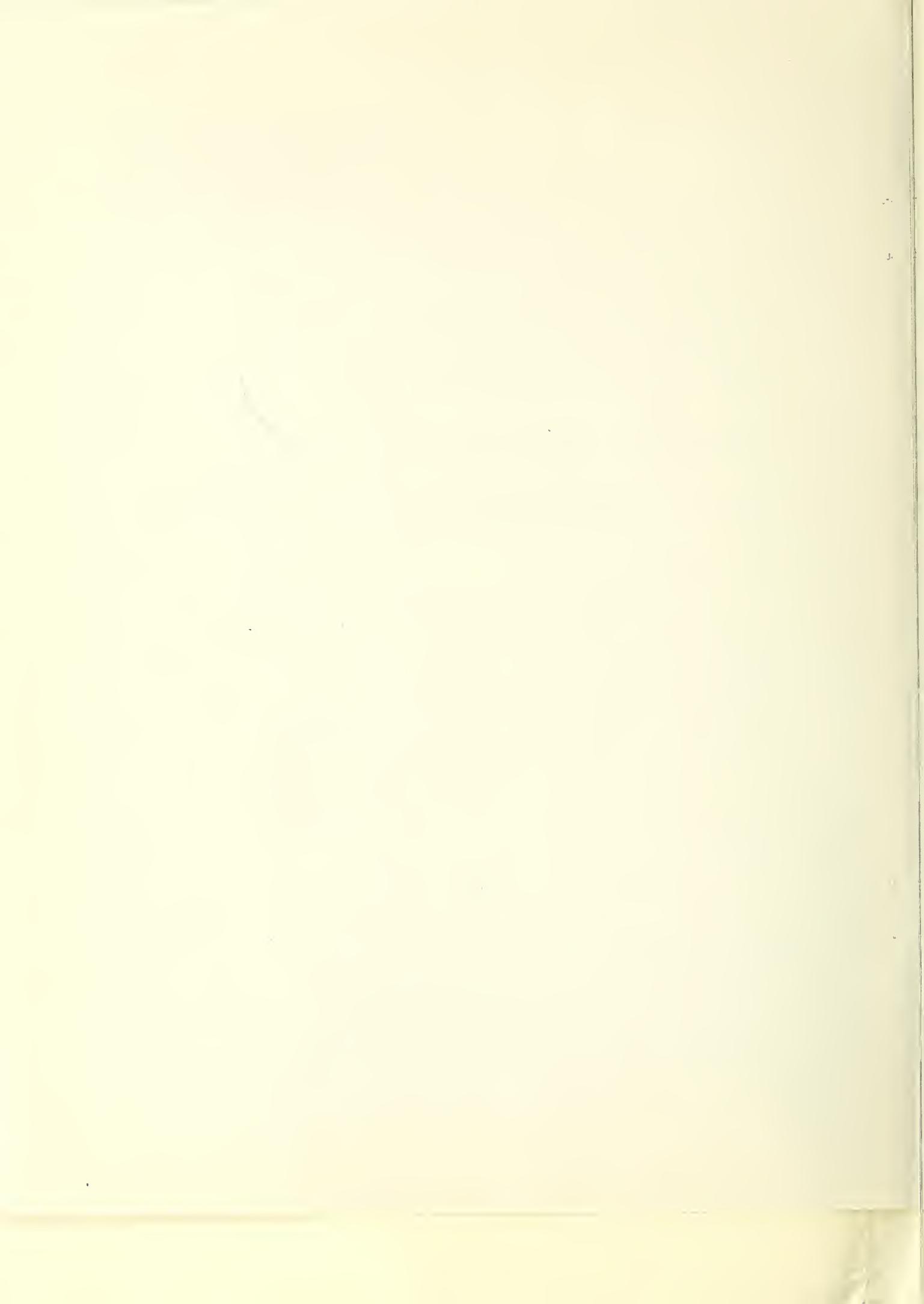
Test Apparatus: Shown in sketch

Fuel: $2\frac{1}{2}$ qt in recessed area

Preburn Time: 5 seconds

Method of Attack: Begin application at windward edge of fire.





Fire Test No: 2 (CG-MMT-MBFT-II)

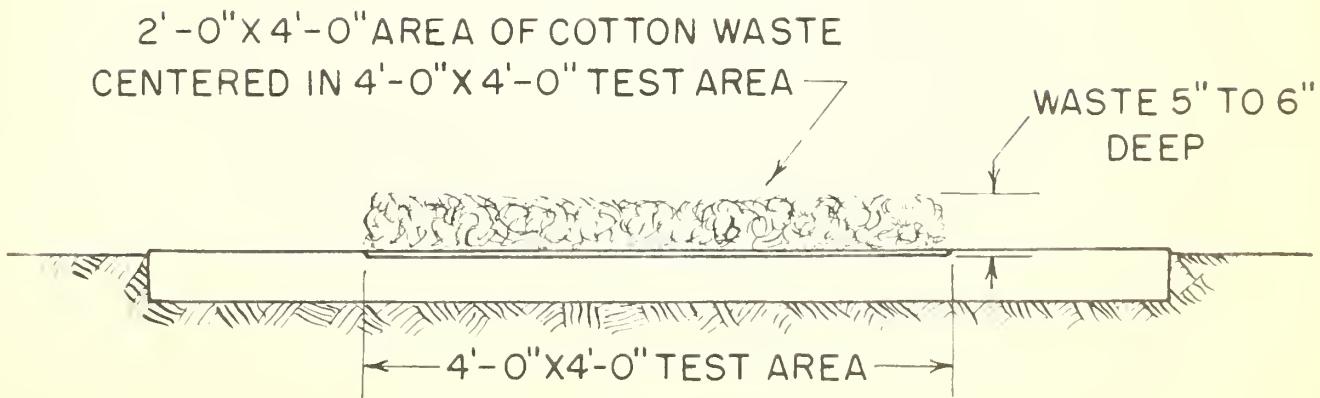
Type of Fire: Fuel saturated cotton waste

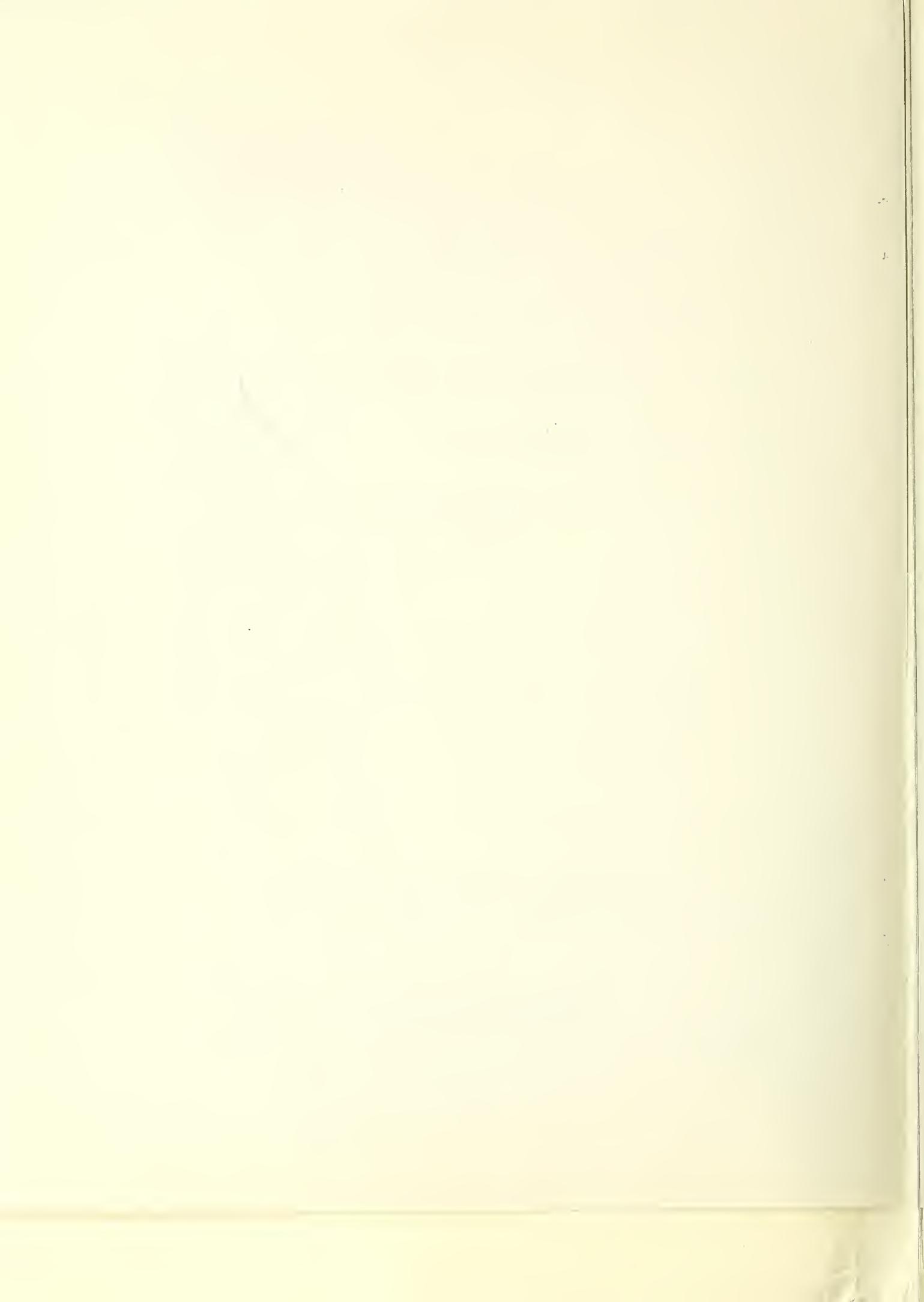
Test Apparatus: 8 lb cotton waste as shown

Fuel: 2 qt sprinkled over cotton waste

Preburn Time: 10 seconds

Method of Attack: Begin application at center of windward long edge





Fire Test No: 3 (CG-MMT-MBFT-III)

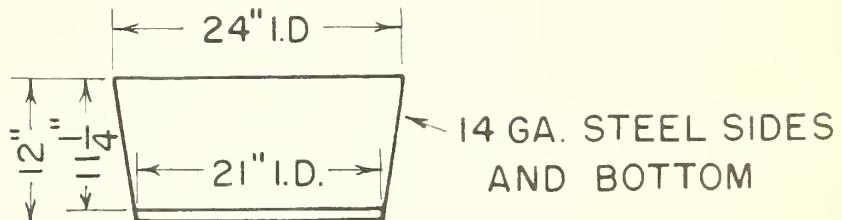
Type of Fire: Two-foot (nominal) tub

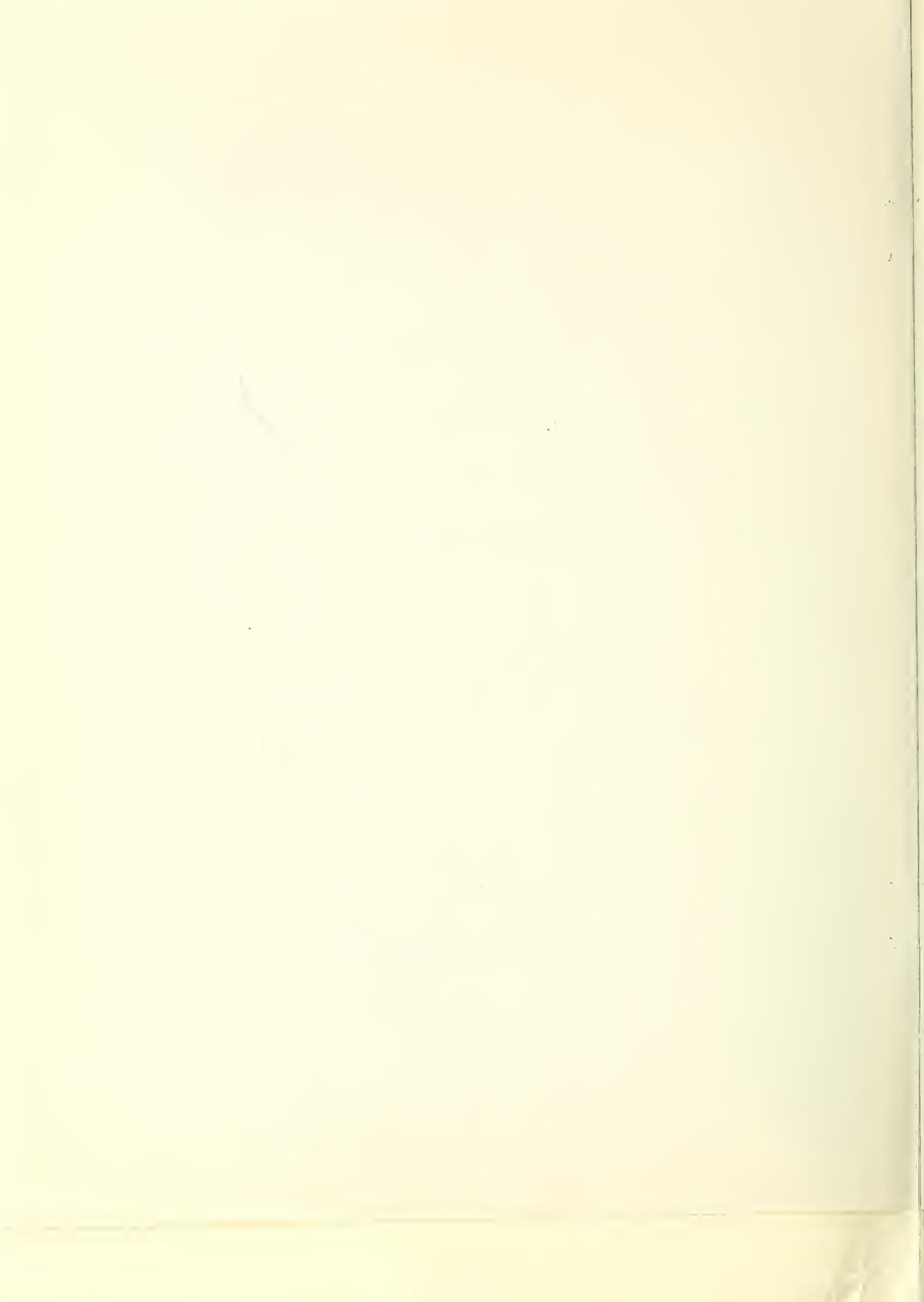
Test Apparatus: Tub as shown. Water to bring level to $10\frac{1}{2}$ in. below top of tub

Fuel: 2 qt poured on water

Preburn Time: 20 seconds

Method of Attack: Begin application to windward of tub, against opposite side wall.





Fire Test No: 4 (CG-MMT-MBFT-IV)

Type of Fire: Running, vertical and horizontal

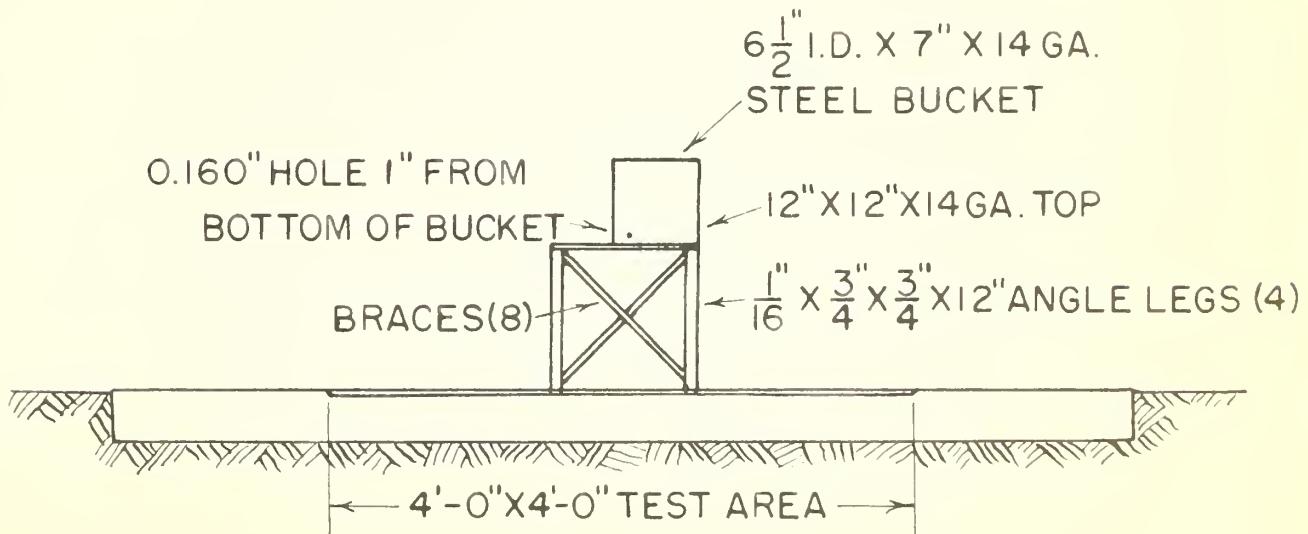
Test Apparatus: 1-gal covered bucket, set on metal stand, bucket flush with sides of stand in downwind corner, hole to direct stream upwind.

Fuel: 3 qt poured in bucket

Flow time: 10 seconds

Preburn time: 20 seconds

Method of Attack: Begin application to windward of spill





Fire Test No: 5 (CG-MMT-MBFT-IX)

Type of Fire: Flowing, vertical surface

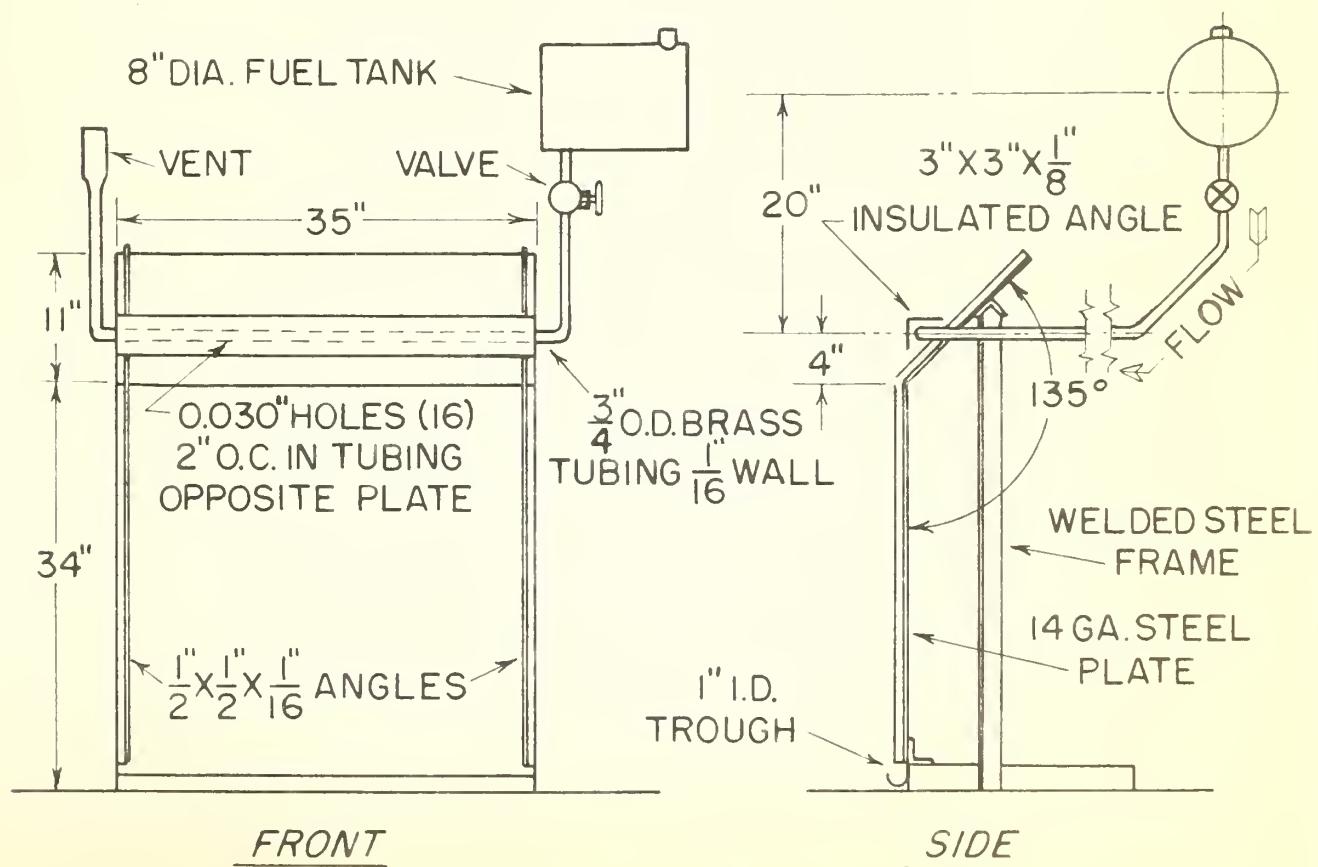
Test Apparatus: Shown in sketch

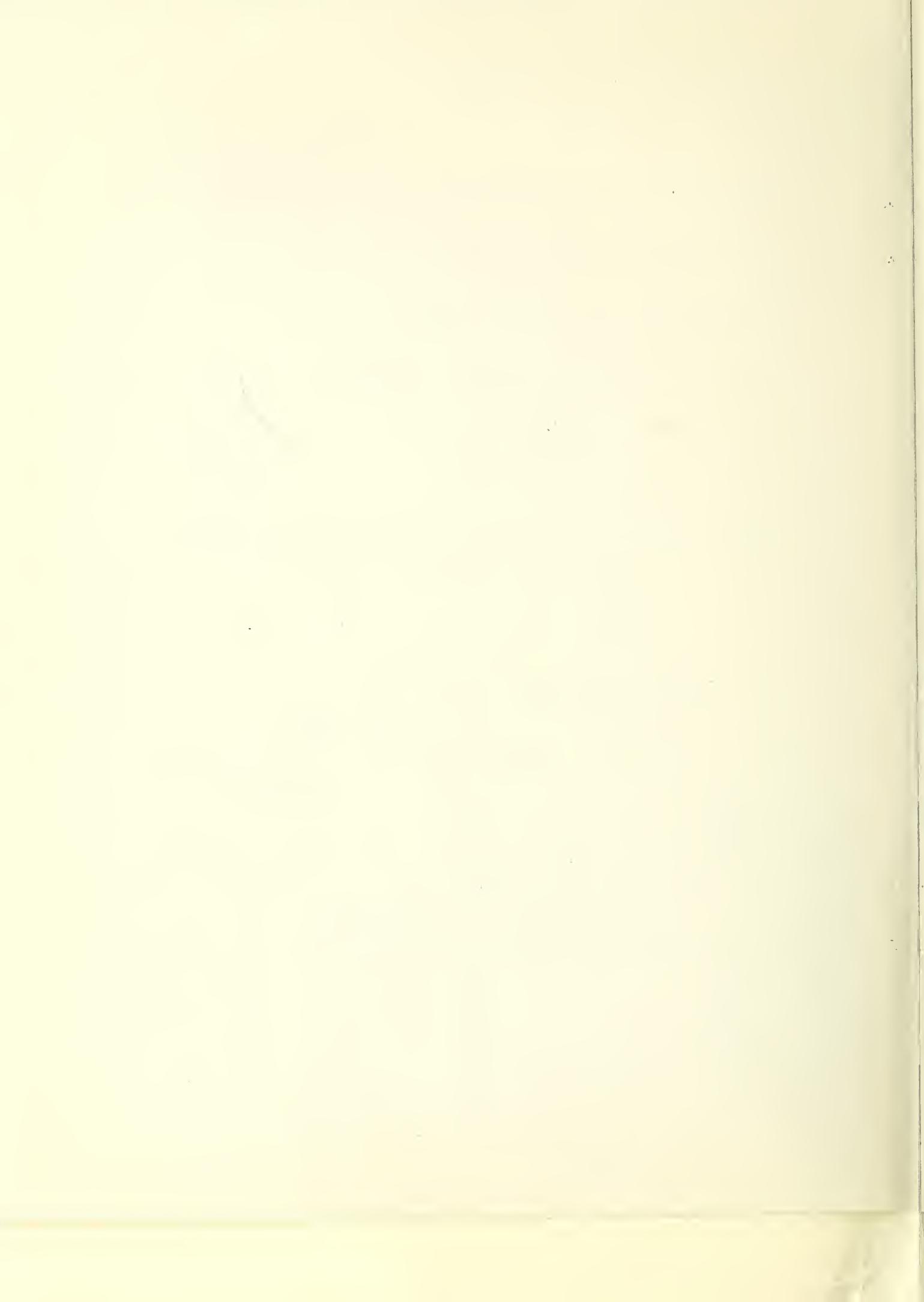
Fuel: 1 gal ethyl alcohol (denatured)

Flow Time: 10 seconds

Preburn Time: 20 seconds

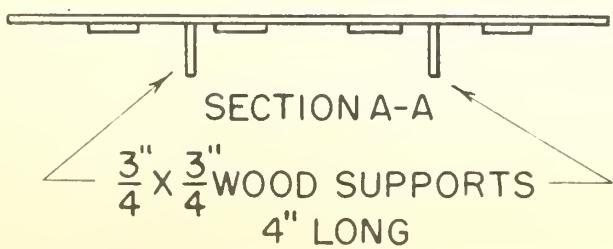
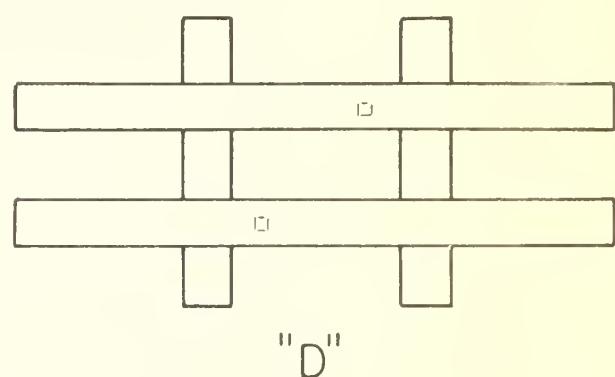
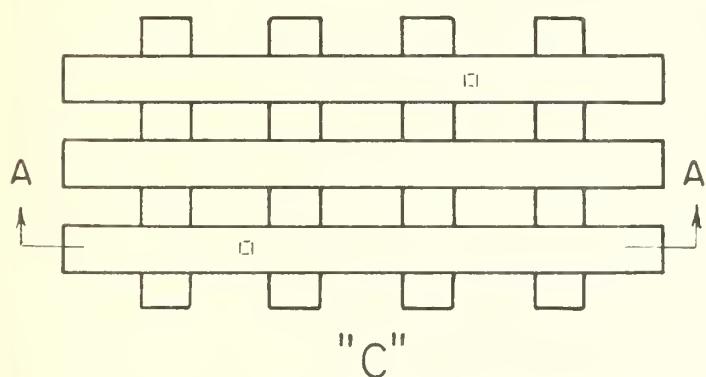
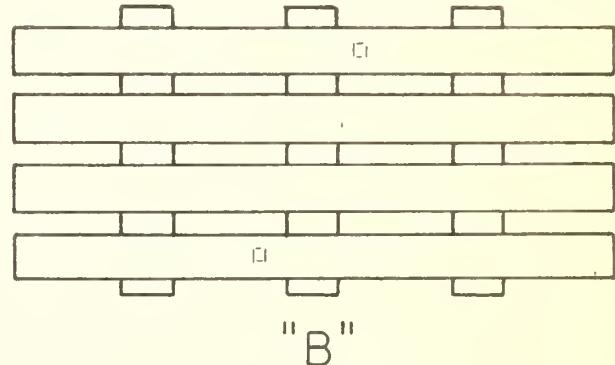
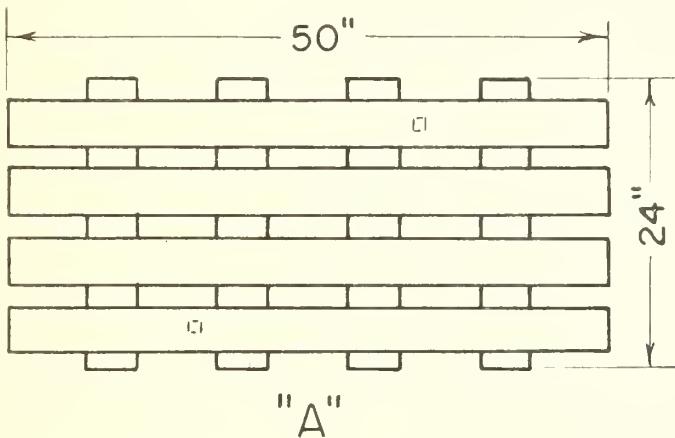
Method of Attack: Apparatus facing upwind, operator to windward

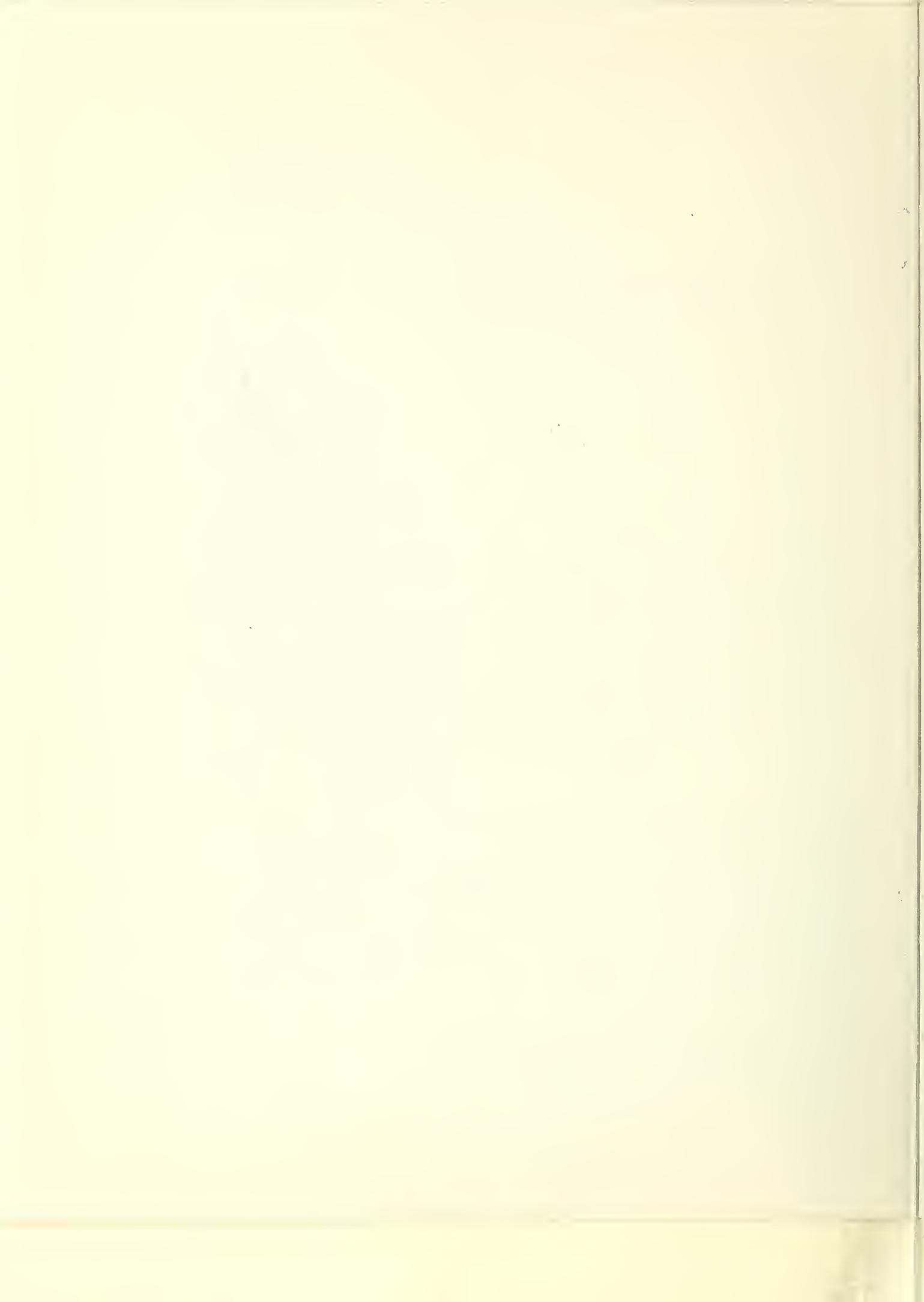




Wood Floor Gratings

Gratings are constructed of Ponderosa Pine, No. 2 common, nominal 1-in. by 4-in. mill lumber (dressed dimensions 25/32 in. by 3 5/8 in.).

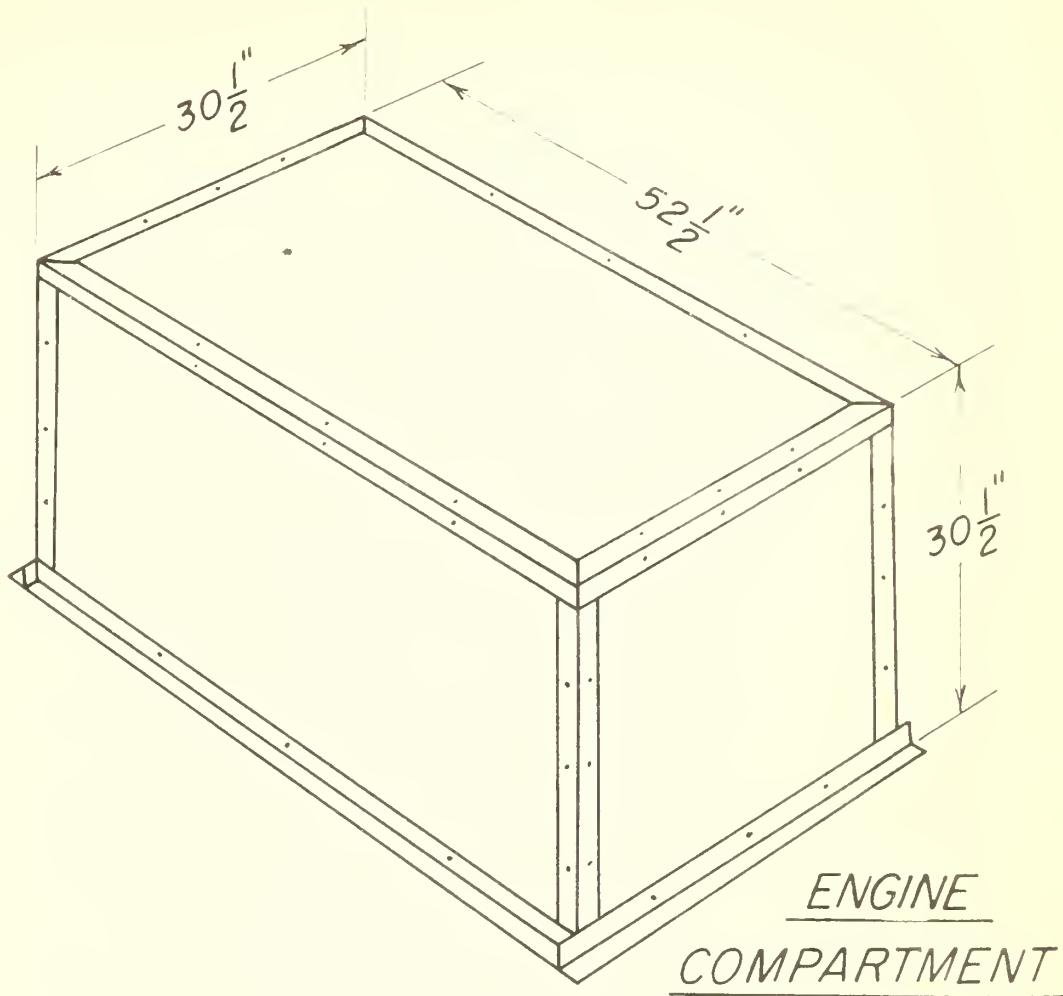




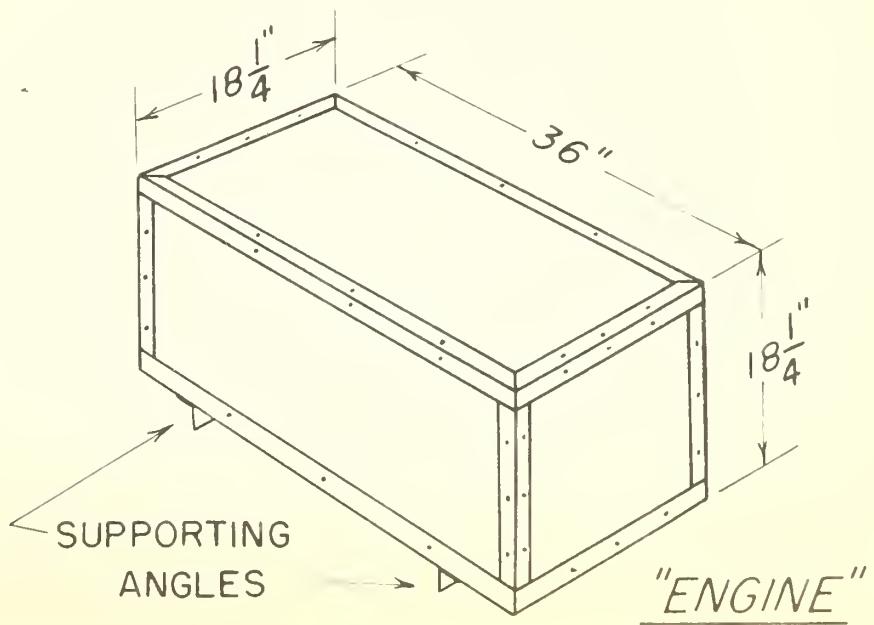
Engine Compartment and "Engine"

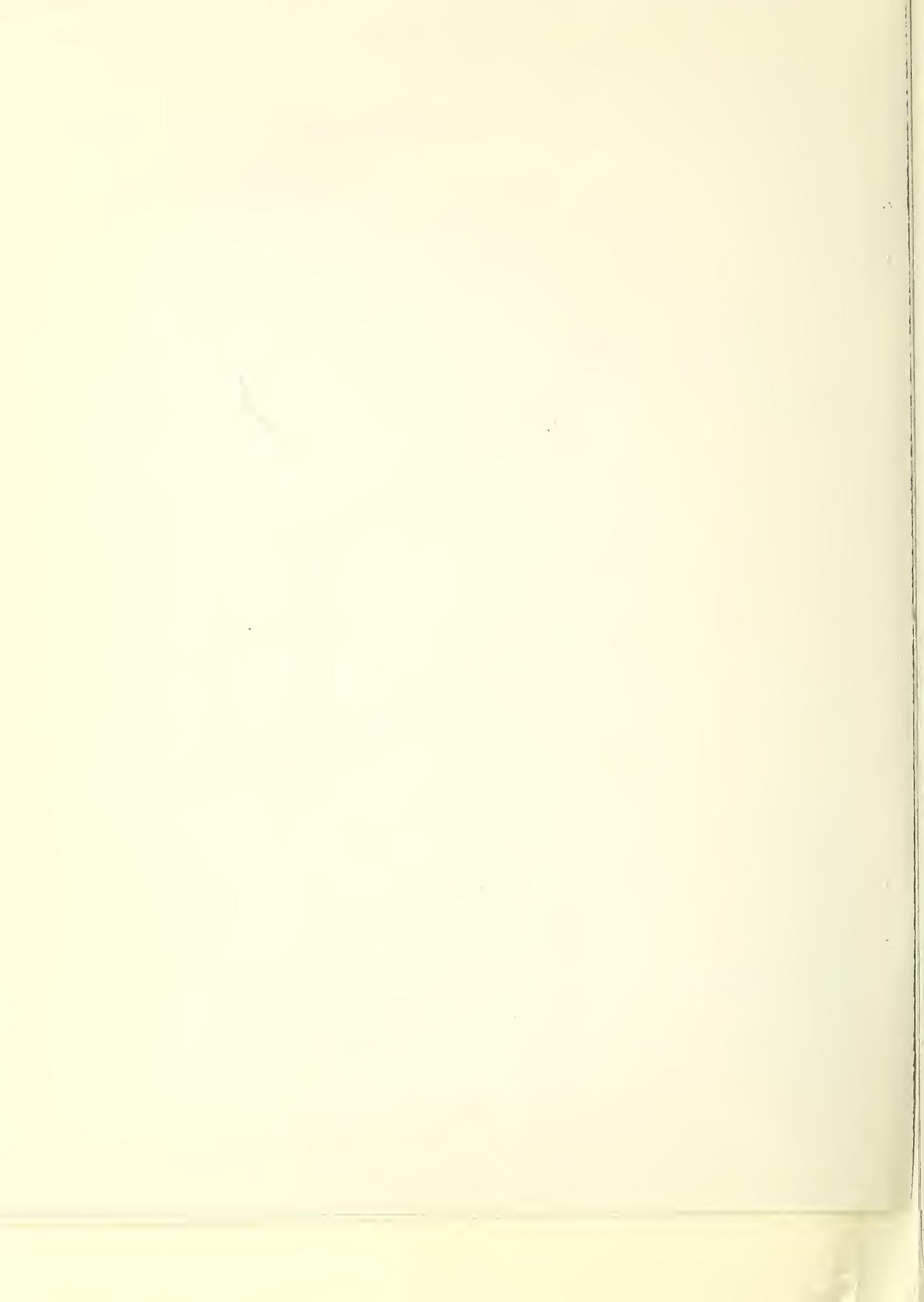
Both units made from 2-in. by 2-in. by 1/8-in. angle
and 1¹/₄ ga steel plate fastened with 1¹/₄-in. bolts

Engine compartment
made with bottom
open, long sides
covered, top and
end plates
removable.



"Engine" covered
on all sides.





Fire Test No: 6 (CG-MME-MBFT-V)

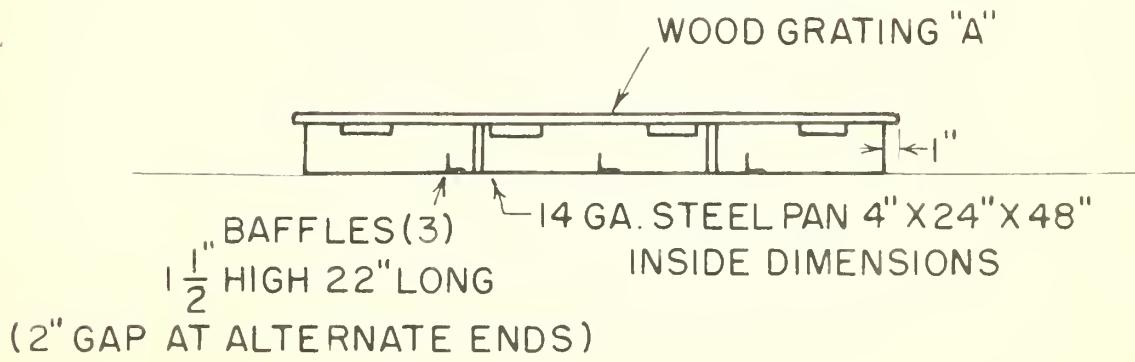
Type of Fire: Bilge

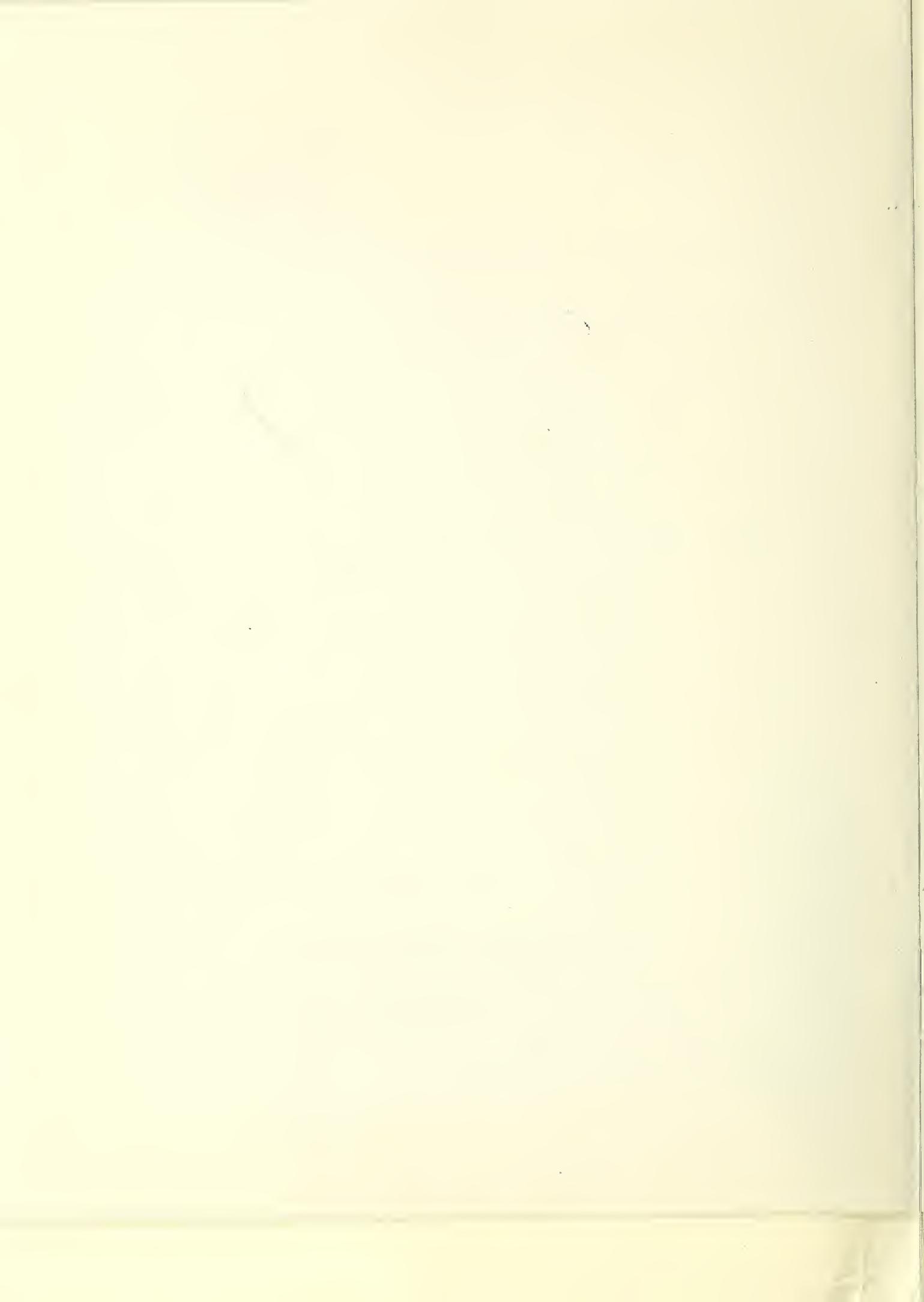
Test Apparatus: Shown in sketch. 1-in. depth water in pan.

Fuel: 1 gal on water in pan

Preburn Time: 60 seconds

Method of Attack: Begin application at center of windward long edge.





Fire Test No: 7

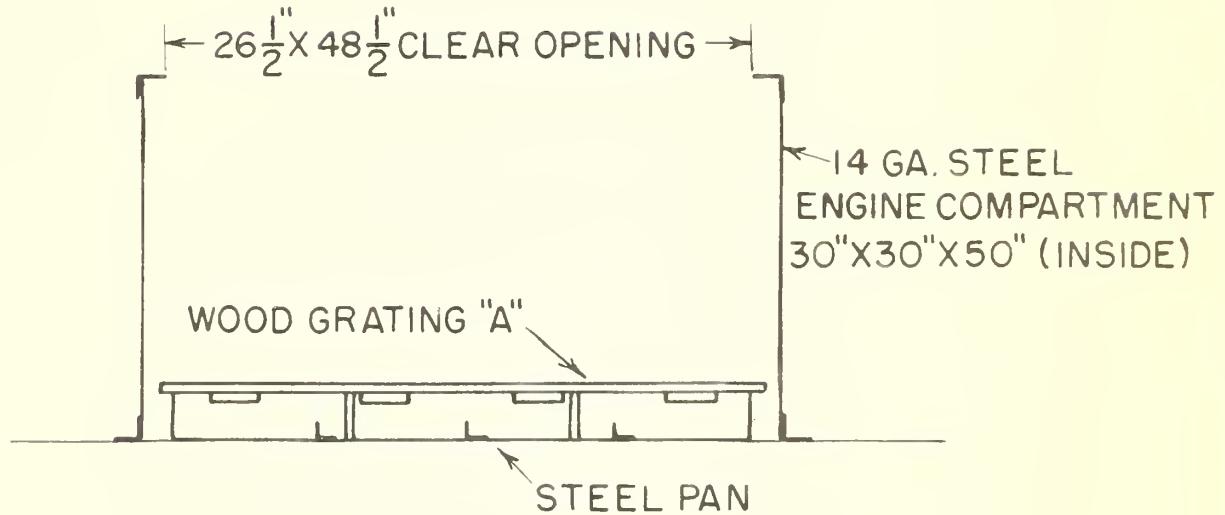
Type of Fire: Compartment (empty)

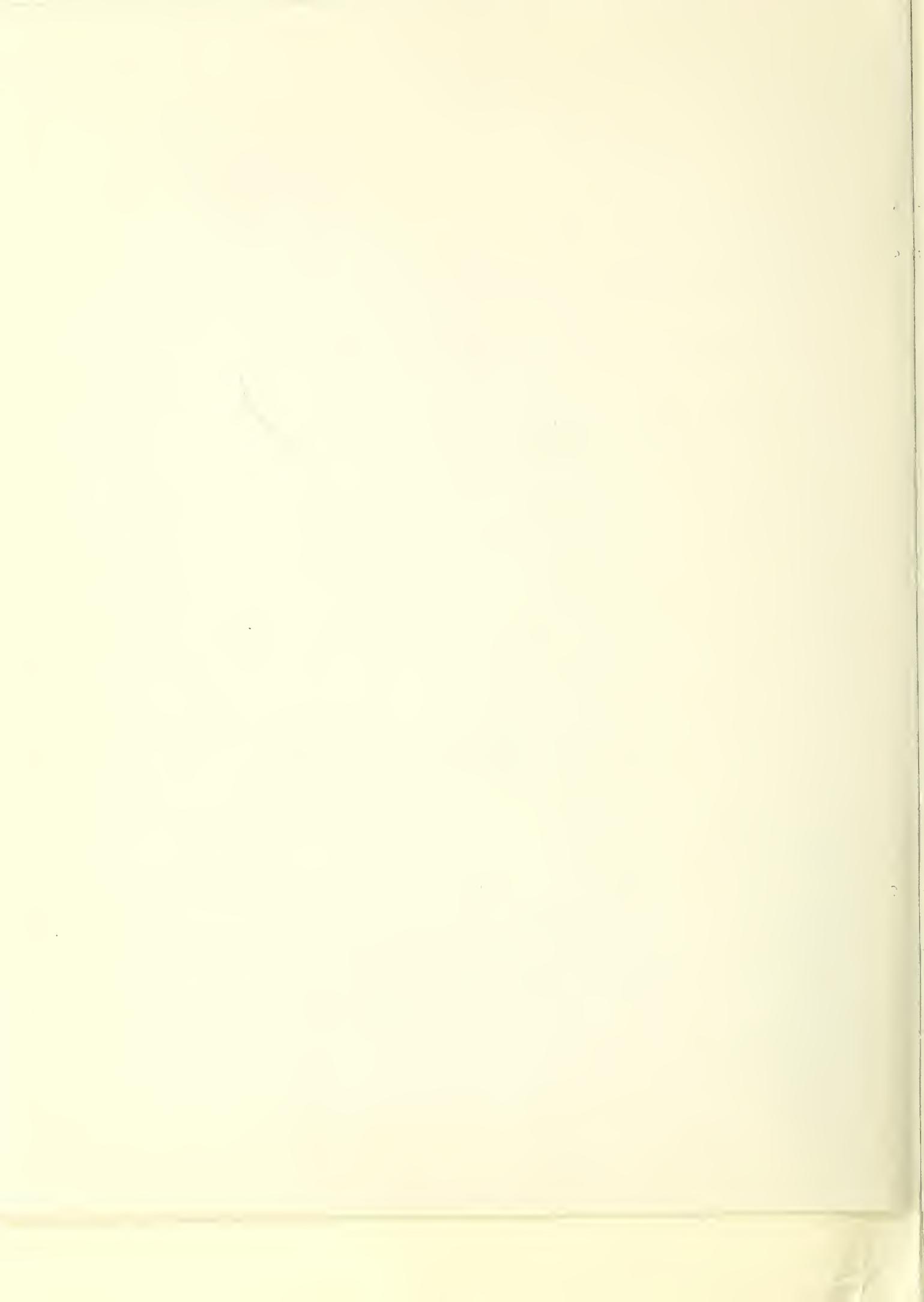
Test Apparatus: As shown; 1-in. water in pan

Fuel: 1 gal on water

Preburn Time: 60 seconds

Method of Attack: Through open top, at operator's discretion





Fire Test No: 8 (CG-MMT-MBFT-VII)

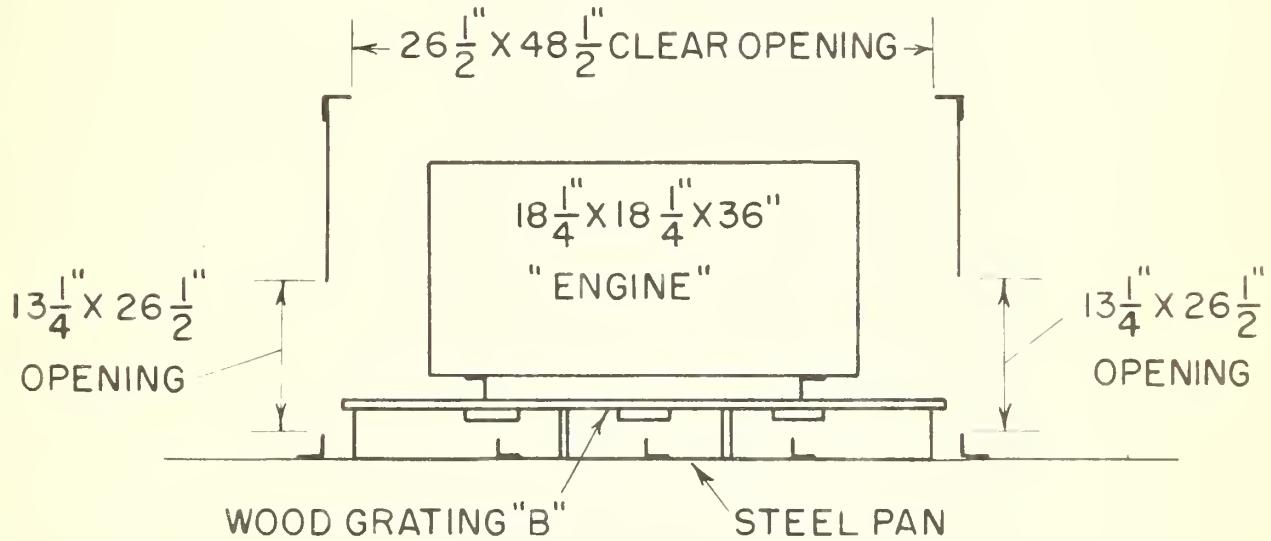
Type of Fire: Engine Compartment

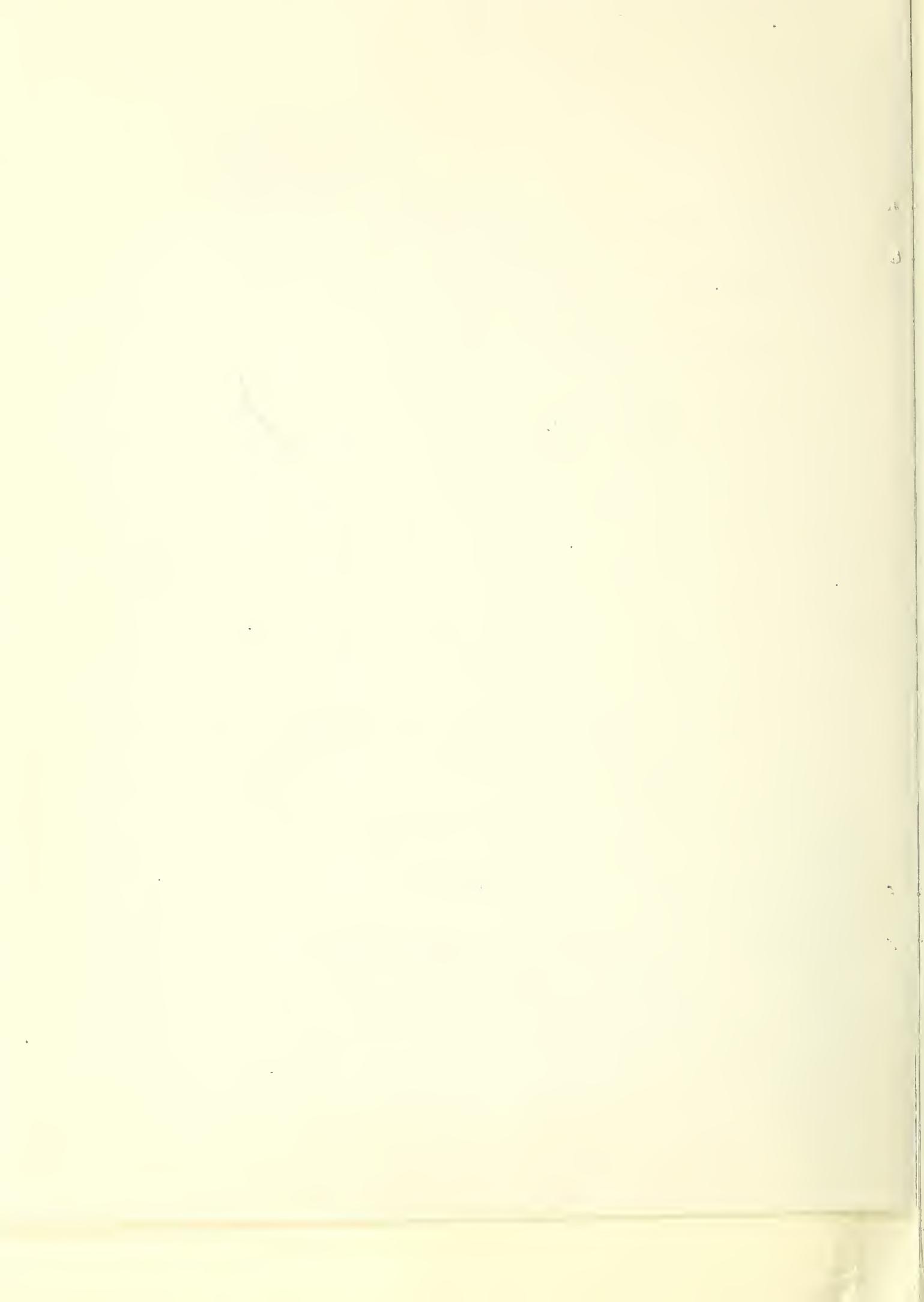
Test Apparatus: Shown in sketch; 1-in. water in pan

Fuel: 1 gal on water

Preburn Time: 60 seconds

Method of Attack: At operator's discretion





Fire Test No: 9

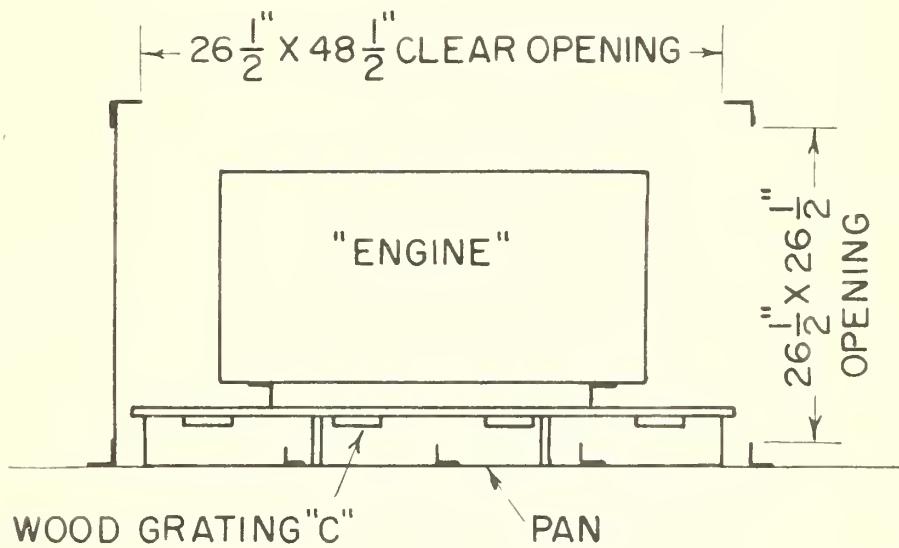
Type of Fire: Engine Compartment

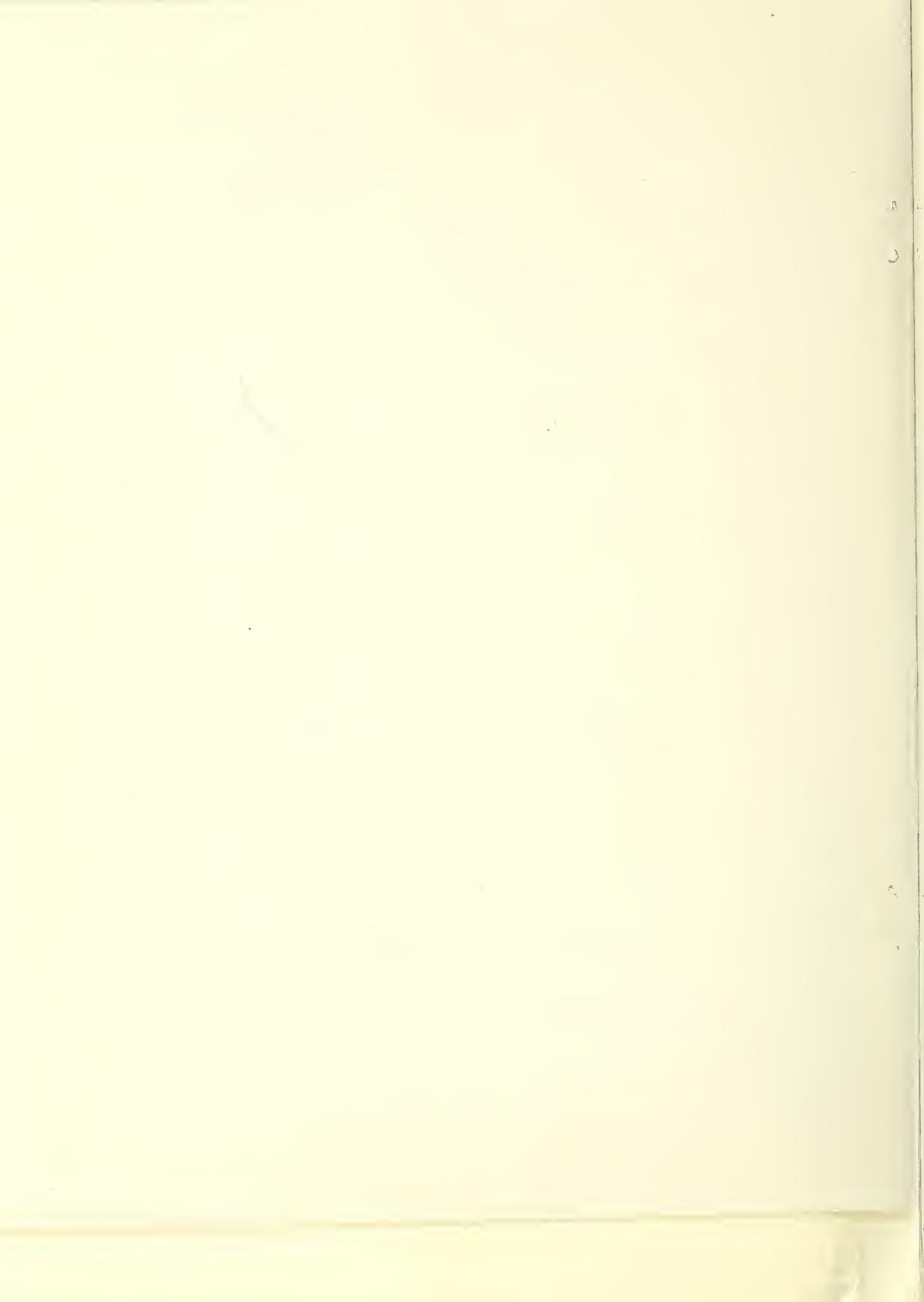
Test Apparatus: Shown in sketch; 1-in. water in pan

Fuel: 1 gal on water

Preburn Time: 60 seconds

Method of Attack: At operator's discretion





Fire Test No: 10 (CG-MMT-MBFT-VI)

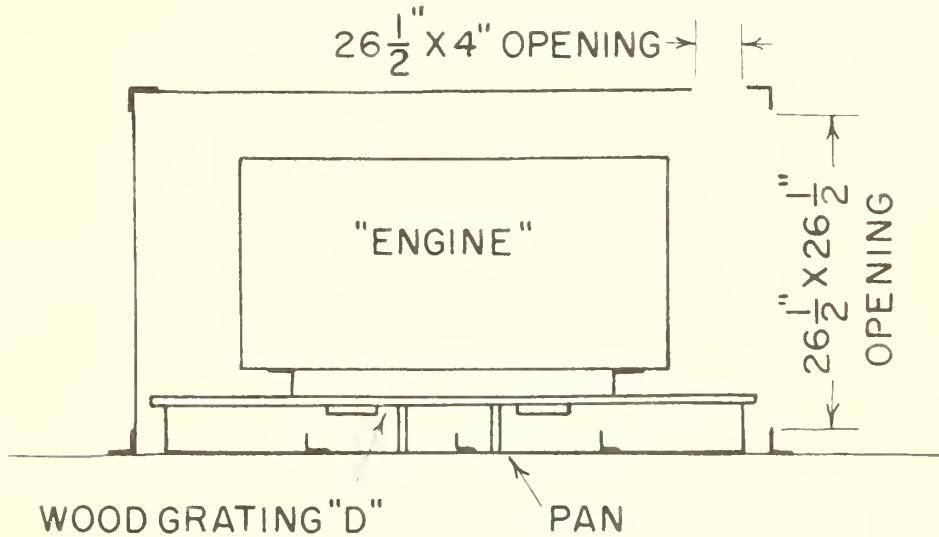
Type of Fire: Engine Compartment

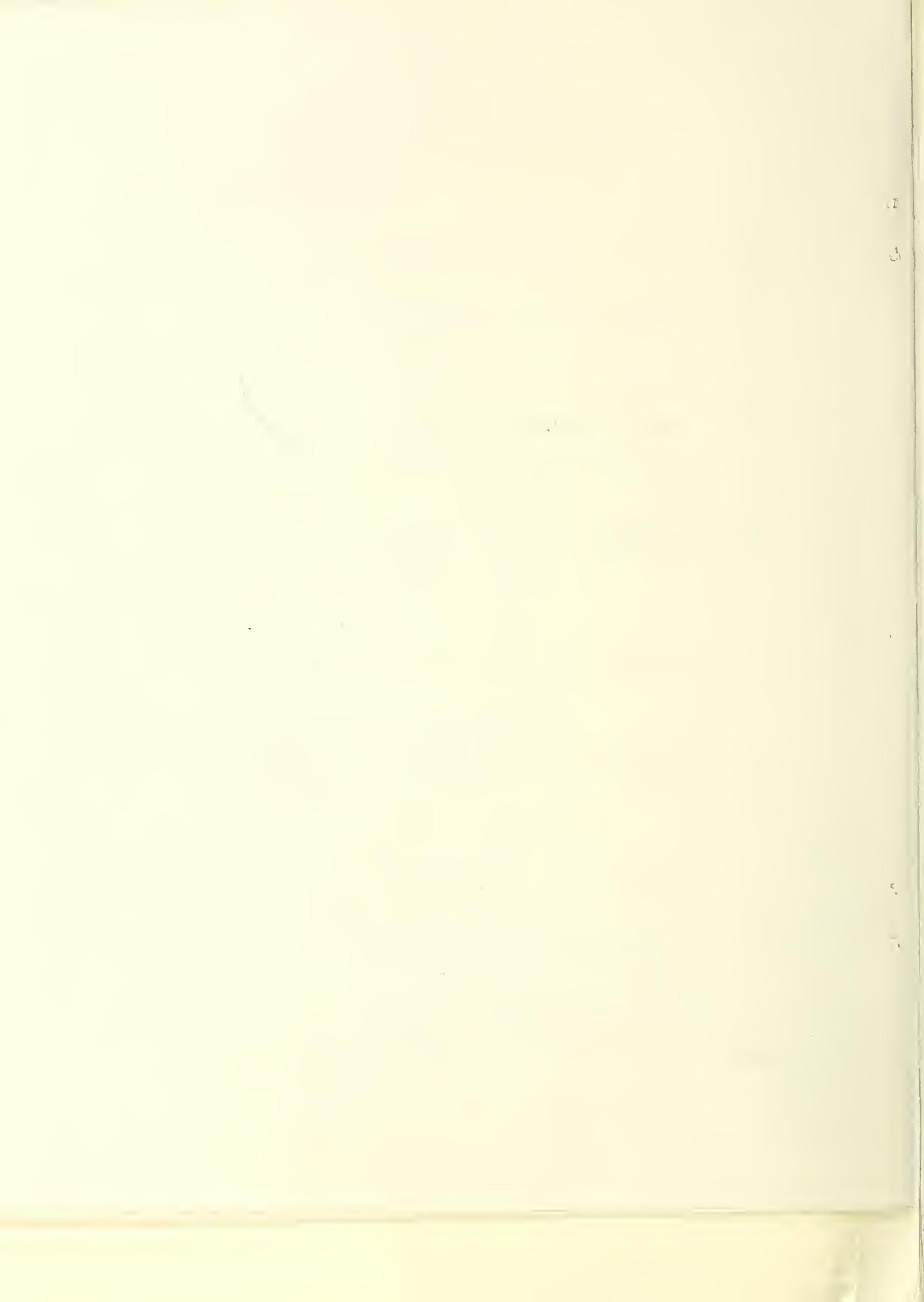
Test Apparatus: Shown in sketch; 1-in. water in pan

Fuel: 1-gal on water

Preburn Time: 60 seconds

Method of Attack: Application through open end; at operator's discretion





TEST CONDITIONS		
ITEM	TEST	TEST
Fire Sz.	Date	Time
Ext. extinguisher	Ext. type & size	
Manufacturer	Type of Charge	Gas
Qty. Total wt	Charge wt	
Exts. Temp	Charge Pressure	
Wind	Test Area Blocked: Yes or partly	
sunny cloudy overcast	Velocity	ft/sec.
rain 1/8"hr		mile/hr
Atm. Temperature	Wet Bulb	
Wind direction (to apparatus)	Leap of Fuel, water	
Humidity	Aflow Time	
Fuel	Area of Fire Spread	
Delay to ignition:		
reburn:		
Time fire out	Method of Attack	
Time fire flow	Initial Position	
Final At	Target	
Final Pressure	Procedure	
Agent Expended	Final Position	
Total Initial wt	Operator	REDFIELD
Total final wt		
Setting: -3,-2,-1; +1,+2,+3	Hits: 10,sec., 17,pm	
Remarks:		

NBS NCP
Jul 26, 2016

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