FOREST RESEARCH BRANCH

REPORT ON ATTENDANCE AT THE INTERMOUNTAIN FOREST FIRE RESEARCH COUNCIL MEETING BOISE, IDAHO, MAY 14-15, 1963.

by

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Report on Attendance at the Intermountain Forest Fire Research Council meeting at Boise, Idaho, May 14-15, 1963.

1. <u>Introduction:</u>

This report deals with 1) my attendance at the Intermountain Forest Fire Research Council meeting in Boise, Idaho, and 2) a visit to the Northern Forest Fire Laboratory and the Lubrecht Forest near Missoula, Montana. One whole day was spent at the Lubrecht Forest observing field sites and sampling procedures in slash. A short tour of the Northern Forest Fire Laboratory was conducted by Dr. W.R. Beaufait, who was most accommodating in his hospitality and knowledge. The welcome afforded during the entire trip was most cordial.

2. <u>Intermountain Forest Fire Research Council meeting, Boise, Idaho.</u>

The purpose of the Intermountain Forest Fire Research Council is to provide a meeting ground for all private, state and federal agencies interested in the stimulation, coordination, and understanding of forest fire research and equipment development. Effort is concentrated on three major goals:

1. Analyzing forest fire problems and feeding these problems to research organizations.
2. Keeping informed on research progress and results and stimulating research activities.
3. Developing methods for the application of forest fire research results.

The Council brings together fire protection agencies and fire research organizations in Montana, Idaho, Utah and Wyoming. Other agencies and organizations interested are invited to attend the meetings.

This year's meeting was devoted to the Critical Fire Period, which is characterized either by many days of high fire danger, an overload of fires, or several big fires. It is during such periods that the fire control organization experiences its greatest problems and losses. The specific purpose of this meeting was to review how research and equipment development may help to solve the problems encountered by fire control agencies during the Critical Fire Period.

The meeting was held at the Owyhee Hotel, Boise. Mr. R.L. Guernsey, State Forester, Idaho, opened the meeting by welcoming the delegates. Following a short business session, a panel headed by Mr. Reid Jackson, Fire Staff Officer, Boise National Forest, led discussion on aspects of the critical fire period. Mr. Jackson, in his remarks, suggested that the critical fire period can be identified on the basis of the following points:

1. The fires have great vigour.
2. Fires can start from many sources.
3. The fires are explosive.
4. Early initial attack is often of little value.
5. Fires are usually numerous.
6. Fires are usually brought under control only after a change in the weather.

Following the introductory remarks the moderator called on the panel to lead discussions on the following topics:

1. Identification of the Critical Fire Period.

Mr. C.W. Syverson presented a paper in which he defined the Critical Fire Period from a fire weather forecasters viewpoint. He stated that a critical fire period is likely to develop in the presence of any one of the following weather conditions:

a) A thermal trough and aloft, which gives rise to hot and dry conditions.

b) Cold front type that accompanies thermal trough. This condition can be forecast for short periods.

c) Developing upper trough. This is a pressure trough existing in the upper air. These troughs are usually much more pronounced aloft than near the earth's surface. The condition is common in the summer, characterized by changing winds and unstable clouds. It can be recognized in its development stages or after. Only very short-term forecasts are possible.

Mr. Syverson stressed that the presence of these conditions does not always result in a critical fire period. Much depends on other factors, such as the degree of risk and the type and condition of the fuels. Similarly, what is a critical period in one region may only be a moderate or high danger period in another region. On the other hand, the presence of any one of the above weather conditions means that abnormal conditions are present and a critical fire period is likely to develop if other conditions are also favourable.

2. Fire Prevention.

Discussion leader Art Roberts listed three main causes of forest fires in his district as:

a) lightning,

b) users of the forest, and

c) drunks and kids.

Existing fire prevention methods were discussed briefly, with particular mention made of the usefulness of forest closure and burning permits. Before forest closure can be used to the fullest advantage, there is a need to define the critical fire period from the fire prevention viewpoint. Forest closure should be imposed on the public only when the fire hazard is truly critical.

Research in prevention has been limited. For example, how much advertising is enough? What type of advertising is most effective? To whom should the publicity be directed? What are the relative merits of personal versus group contacts? How can prevention effort be gauged?

Mr. Roberts stressed that in his opinion fire prevention posters should be kept in good condition, and other publicity media should be up to date. For example, a poster left out during the winter loses much of its advertising value by the following spring due to wear and tear.

3. Fire Hazard Reduction.

Mr. M. Kopping outlined the methods of hazard reduction in the Intermountain area and expressed the hope that greater utilization can be made of slash. The discussion indicated the need for research concerned with:

a) special machine for slash reduction,

b) cost studies on logging machinery,

c) retardants to last throughout fire season,

d) decomposing agents,

e) how to control men during the critical fire period,

f) guidelines to evaluate slash hazard,

g) guidelines for prescribed burning, and

h) effect of fire intensity on soil structure.

4. Fire Detection.

The disoussion leader listed the three main phases through which fire detection has progressed as 1) settlers, 2) fixed detection, and 3) air-ground systems. The main problems in this field include 1) detection after dark, 2) poor visibility and 3) sleeper fires. Another question still unsolved is where, when, and how to spend the detection dollar?

5. Evaluating Fire Behaviour.

Mr. J. Birch led the discussion on this important topic. He stressed that fires do not always behave similarly under apparently similar conditions. Fuels, weather, and topographic features influence fire behaviour. Unpredictable fire behaviour, or "misbehaviour", is a term often used to describe fire behaviour, mainly because of the lack of understanding and knowledge about this topic. Fires that behave unpredictably are caused by certain factors or combinations of factors that we can not observe or measure. The number of unpredictable fires will decrease as we increase our knowledge of the various factors that influence and affect fire behaviour.

In this context there is a need for a fire behaviour guidebook, including a definition of normal fire behaviour. Other studies mentioned included those dealing with the effect of topography and type conversion. The latter study would be of particular use in areas of light fuels, such as grass.

6. Initial Attack on Fires.

Initial attack and its effectiveness depends on the amount of planning that is done ahead of the fire season. Planning could be assisted by increased research at the applied level, particularly in communications.

7. Reinforcement Action on Fires.

Discussion on this topic was led by Mr. L.T. Twitchell of the Bureau of Land Management. The more important problems needing attention of research are:

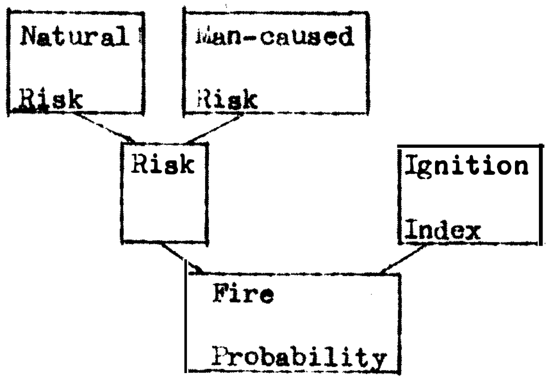
a) logistics of mobilization and dispatch of men and equipment,
b) relative merits of men versus equipment in fire fighting,
c) development of chemicals for ground application,
d) determination of effectiveness of airdrops as related to topography, fire size, fuels, etc.,
e) development of equipment for building of fire lines in flash fuels where speed is of utmost importance, and
f) development of rapidly moving ground tankers.

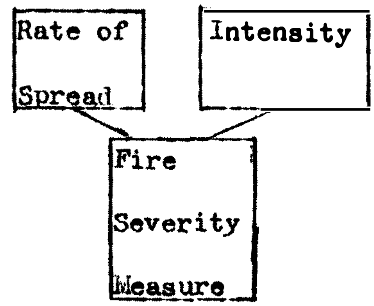
8. Suppression of Large Fires.

The panel discussion revealed that errors in organization and equipment show up during critical periods. A rate of spread classification, some form of lighting for night fire-fighting, and better firing equipment were some of the problems discussed and submitted for research. The discussion leader suggested that it is often advantageous to fight fires during the night when rate of spread and fire intensity are lower than during the day.

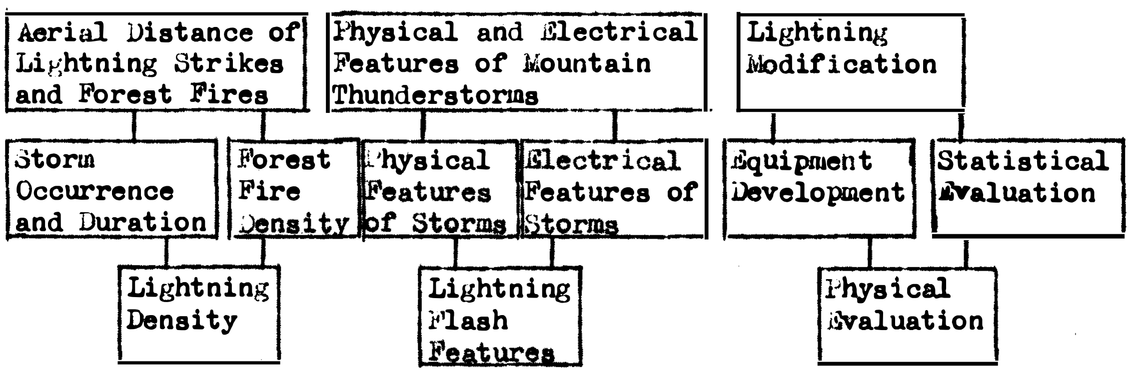
The Wednesday morning session was devoted to research during the Critical Fire Period. Moderator Mr. J. Barrows, heading a panel consisting of Messrs. Anderson, Hardy, Fuquay and Brackebusch, led off the discussion by thanking the delegates for the free interchange of ideas. He noted that before research can tackle a problem to greatest benefit for all concerned, the problem must be defined and identified. Mr. Barrows defined the Critical Fire Period as any period in which a normally adequate protection organization finds it difficult to cope with the fire situation. This critical period is due to increased risk, fire fuels, and fire weather. The definition and measurement of these items remains as the main stumbling block in dealing with periods of critical fire danger.

Following the introductory remarks, Mr. A. Brackenbusch reviewed the new National Fire Danger Rating System. He explained that work on this project is being carried out throughtout the country, and it is expected that the new system will be operational in 1964. The national system will eliminate a number of methods used at the present time in various parts of the country. A general graphical representation of the new system is as follows:





The next speaker on the panel was Mr. Fuquay, who discussed Project Skyfire. A graphical illustration of this project is included below:



This project is being carried out at the Northern Forest Fire Laboratory to attack key problems of lightning storms and lightning fires that are of critical importance to fire control agencies throughout the West. Answers to two critical problems are sought: 1) what characteristics of lightning storms influence lightning fire occurrence and behaviour? and 2) can weather modification reduce lightning fire danger? Studies in progress include lightning occurrence and storm characteristics, electrical properties, and weather modification experiments. Research in weather modification to date indicates a reduction of 38 per cent in cloud-to-ground lightning strikes. At least two more years of cloud seeding work will be necessary before reliable conclusions can be drawn regarding the success of this study. For a more detailed report on Project Skyfire refer to article entitled "Mountain thunderstorms and forest fires", Weatherwise 15(4):149-153, 1962.

Mention was also made of the fire detection research program at the Laboratory. Existing methods of detection depend on the skill of the observer and prevailing weather conditions. Therefore, detection at night and during periods of poor visibility is not always effective. In 1961 a program was initiated to develop a system capable of detecting forest fires both day and night under a wide variety of fuel and weather conditions. One phase of this study is the application of infra-red techniques to the detection and mapping of fires. This method would be particularly useful in locating small fires and mapping of large fires.

To detect a fire with infra-red devices it is necessary to have a direct look at the fuels burning. This direct observation post can be best obtained from an aircraft. Flight tests to determine the feasibility of detecting a target in any particular timber stand, at any given distance of any given size necessitates a knowledge of the probability of having a clear opening as a function of timber type, stand density, and angle of view. To determine these relationships, field tests have been carried out and are continuing. Data collected to date indicate that detection probability is a function of basal area per acre and angle of view, but seems independent of species. Infra-red scanners are capable of penetrating smoke and haze, but not rain.

For those interested in the principles of infra-red detection and its possibilities in forest fire detection refer to publication by Mr. S.N. Hirsch entitled "Possible applications of electronic devices to forest fire detection", U.S. Forest Service Intermountain Forest & Range Expt. Sta. Res. Note 91, 8 pp., 1962.

The next speaker on the panel, Mr. H.E. Anderson, outlined the research program in fire physics. Model fires are being studied under controlled atmospherio conditions and a variety of fuels to learn how individual forest fire phenomena are influenced by certain variables that govern ignition, fire buildup and spread. To date tests have been carried out in a range from two to fifteen per oent moisture oontent of fuels. In this range, rate of spread is a linear funotion of moisture content. Below two per cent moisture content the rate of spread is not a linear function of moisture oontent. Other problems under investigation are:

a) Is fire spread due to conduction, convection, radiation, or a combination of these?

b) How does wind affect fire behaviour?

c) How to measure fuels and the energy emission from a fire?

d) How does fuel compactness affect rate of spread?

e) What is the relationship of rate of spread in sun versus shade?

It was stressed that fire is inanimate, void of life and spirit. Therefore, it does not have the ability to think and reason and to make decisions. Fire behaviour is governed by a combination of fuels, weather and topography, and the interaction of these variables.

Lack of knowledge regarding the combustion process further complicates the prediction of fire behaviour. Until it is possible to identify and write the basic fire behaviour equations there will always be cases of unpredictable fire behaviour, or fire "misbehaviour."

The last speaker on the panel, Mr. C.E. Hardy, discussed briefly fire retardant chemicals, what research is doing, and what is needed in the future. It was pointed out that retardants are a relatively new tool and there is a constant demand to determine the use for each new chemical appearing on the market and its application under a variety of conditions. Fire retardant testing is carried out mainly at Berkeley, California. Two main areas of research remain unsolved:

a) chemistry of combustion, and

b) chemistry of fire extinguishment.

Before a chemical can be used operationally on the fire line, a great amount of information is required. We must know the chemicals available, how much they cost, how they are mixed, handled and stored, and for how long the material adheres to the surface of the fuels.

Therefore, before a new chemical is introduced to the fire line it must be subjected to laboratory, field, and operational tests, and examined from many different angles. The following reports are listed as sources of more detailed information on fire retardants, their testing and evaluation, and their applicability under fire fighting conditions:

Dibble, D.L., Richards, S.S. and Steck, L.V. Testing and Evaluating Chemical Fire Retardants in the Laboratory , U.S. Forest Serv., Pacific Southwest Forest & Range Expt. Sta. Misc. Paper No. 59, August, 1961.

Davis, J.B., Dibble, D.L. and McBride, R.S. Viscous Water and Algin Gel as Fire Control Materials, U.S. Forest Serv., Pacific Southwest Forest and Range Expt. Sta. Technical Paper 71, 1962.

A summary sheet entitled "Firefighting Chemicals" is included for general information.

The next session was entitled "Fire Weather Programs for the Critical Fire Period". The panel consisted of moderator Mr. W.R. Krumm, Western Coordinator, Fire Weather Service, and fire weather forecasters Messrs. Nelson, Syverson, and Mallory. Mr. Krumm opened the discussion by outlining the work of the fire weather forecasters, pointing out that they are operational men. Their primary concern is fire weather, not fire fuels or fire behaviour. At the present time top priority is given to improving and modernizing the fire weather program. This consists of obtaining additional mobile units, preferrably two in each of the major forest districts. These units would be mobile and transferrable between and within districts, depending on the fire situation. Another major objective of the Fire Weather Service is to increase the number of weather radar installations. Only one of these radar units has been built - on Point 6 Mountain near Missoula, Montana. The Point 6 Mountain installation cost approximately one-half million dollars. It was stressed that the radar units must be designed for the job to be done, and must be located on mountain peaks for best results. Although no definite plans for the erection of a radar system to cover the entire United States has been made, it was estimated that complete coverage of the West can be achieved with 12 of the sets. It was also pointed out that subsequent sets would probably cost in the vicinity of 300 thousand dollars to build.

FIREFIGHTING CHEMICALS
Specific Information 1/

Chemical name	Sodium Alginate	Sodium Alginate + calcium chloride.	Ammonium sulphate-attapulgite clay	Bentonite	Sodium Calcium borate
Common or trade name	Keltex F F	Algin Gel	Fire-trol	Bentonite	Firebrake
Where Purchased	Kelco Co. 8225 Aero Drive San Diego 11, Calif.	Kelco Co. 8225 Aero Drive San Diego 11, Calif. (Calcium chloride at any bulk cement plant)	Ariz. Agrichemical Corp. 734 E. S.P. Drive Phoenix, Arizona	FSS	FSS
Cost (FOB plant)	$1.00/lb 4-7¢/gal (6¢ av)	See Keltex FF	5¢/lb 12-15¢/gal	$28.50/ton: 1.5¢/lb 1¼¢/gal	$94/ton 3.29¢/lb 14-22¢/gal (16¢ av)
Viscosity Range (Centipoise)	80-100 (200 cps for 1½" hose)	800-2000	3000 cps after setting	3000	2400
Type	Viscous	Gel	Slurry	Slurry	Slurry
Mixing Ratio	.4-.5% KFF 7 lb/100 gal water	.8-1.0% KFF 7 lb/100 gal water CaCl₂ 1:300-400 for grass; 1:400-800 for brush.	280 lb/100 gal.	80 lb/100 gal	400 lb/100 gal
Total weight per mixed gal	8.4 lb.	8.4 lb.	9.5 lb.	8.8 lb.	10.1 lb.
Corrosiveness	No	No	To copper, brass and mild steel without an inhibitor. Okay with aluminum.	No	A little on some aluminum alloys
Spoilage	Yes	Yes	No	No	No
Galvanic action	Reacts rather strongly. Worst of the viscous waters.	Not great-not much molecular migration	No	No	No
Where best used	Ground	Air. Ground use also if pump can handle viscous material.	Air	Air	Air
Advantages	1. Less rekindling 2. Wraps around & clings to vegetation. 3. Less runoff & waste. 4. Cheap 5. Less wt/gal (8.4 lb/gal) 6. Mixes easily. 7. Not abrasive, erosive, or toxic. 8. Compatible with salts. 9. Little wind drift in air drops.	1. See sodium alginate 2. Forms thick layer, clings well. 3. Drops nicely.	1. Clay is compatible with ammonium salts.	1. Holds lots of water for short time. 2. Stable gel. 3. Cheap, available 4. Non-corrosive. 5. Non-toxic.	1. Good even when dry. 2. Holds to fuel. 3. Retards rekindling. 4. Thixotropic 5. Mixes easily.
Disadvantages	1. May spoil. 2. Can plug & gum equipment. 3. Corrosive to galvanized metal. 4. Sets up solid if contaminated with borate.	1. May spoil. 2. Poor penetration. 3. Effective only 2-3 hours. 4. CaCl₂ must be metered in. 5. Corrosive to galvanized metal. 6. Requires further evaluation. 7. Can plug & gum equipment. 8. Sets up solid if contaminated with borate.	1. Lots of chemical means logistic problem for portable mixers. 2. Requires high-shear mixing procedures. 3. Somewhat abrasive and erosive. 4. Corrosive without inhibitor. 5. Requires further evaluation.	1. Poor mixing results in lumps. 2. Critical to local water conditions. 3. Viscosity increases for several hours. 4. Good for fire use only 1-3 hours. 5. Not compatible with salts. 6. Abrasive & erosive. 7. Slippery.	1. High initial & trans. costs. 2. Lots of material per gallon. 3. Toxic to plants. 4. Slightly corrosive. 5. Abrasive & erosive. 6. Subject to shear damage. 7. Poor water-holding characteristics. 8. Overmixing destroys viscosity.
Ingredients	Sodium alginate	Sodium alginate; Calcium chloride (CaCl₂, technical, flake, 77% variety)	Ammonium sulphate; Attapulgite clay (formulated)	High sodium, swelling type bentonite clay; 90 bbl yield; FS spec. #5100-30a, 2/11/60.	Sodium calcium borate

Chemical name	Sodium carboxymethyl-cellulose	Diammonium Phosphate	Sodium alginate & diammonium phosphate	Ammonium polypectate & DAP (Pectin DAP)	Sodium Carboxymethylcellulose & DAP (CMC-DAP)
Common or trade name	CMC-7HP	DAP	Algin-DAP	Phos-Check 100	Phos-Check 201
Where Purchased	Hercules Powder Co. Virginia Cellulose Div., 120 Montgomery, San Francisco, California	Monsanto Chemical Co., 2710 LaFayette Santa Clara, Calif. or Shell Chemical Co., Shell Bldg. San Francisco 6, California	Algin; Kelco Co. DAP: Monsanto or Shell	Monsanto Chem. Co. 2710 LaFayette Santa Clara, Calif.	Monsanto Chem. Co. 2710 LaFayette Santa Clara, Calif.
Cost (FOB plant)	53¢/lb 2.6¢/gal	7-8¢/lb 10-12¢/gal	15-17½/lb 21-22¢/gal	11¢/lb 17¢/gal	14.5¢/lb 16¢/gal
Viscosity Range (Centipoise)	80-100	-	800-2000	800-2000	800-2000
Type	Viscous	Solution	Viscous or gel	Viscous or gel	Viscous or gel
Mixing Ratio	.5% 4 lb/100 gal	125 lb/100 gal	KFF DAP Brush .75% 15% 6 lb 125 lb/100 gal Grass .6% 12% 4 lb 100 lb/100 gal	6.3 lb pectate/100 gal. .7 lb versene/100 gal 130 lb DAP/100 gal (total 1.6 lb/gal)	10 lb CMC/100 gal 60 lb DAP/100 gal
Total weight per mixed gal	-	9.0 lb.	8.9 lb.	9.0 lb.	8.8 lb.
Corrosiveness	No	Aluminum, copper, & copper alloys, cast iron without inhibitors.	Same as DAP	Same as DAP	Same as DAP
Spoilage	Yes, but not bad. Add 100 ppm formaldehyde. Iodine may also prevent spoilage.	No	Yes; Add formaldehyde.	Yes; Add formaldehyde.	Yes; Add formaldehyde, 100 ppm.
Galvanic action	Yes	No	Some, not as much as algin water.	Some, not as much as algin water.	Some, not as much as algin water.
Where best used	Air or ground	Air or ground	Air or ground	Air or ground	Air or ground
Advantages	1. Rekindling reduced, similar to algin. 2. Sticks to fuel. 3. Less cost. 4. Less wt/gal. 5. Mixes readily. 6. Less abrasion or erosion. 7. Forms cellophane-like film. 8. Does not contaminate readily (with borate eg).	1. Effective though chemical rather than heat absorbing action. Effective even when dry.	1. Initially holds large quantities of water on fuel. 2. Dries to fire retardant coating; thus is effective for long periods. 3. Proven highly effective. 4. Easily mixed.	1. Initially holds large quantities of water on fuel. 2. Dries to fire retardant coating; thus is effective for long periods. 3. Proven highly effective. 4. Easily mixed.	1. Initially holds large quantities of water on fuel. 2. Dries to fire retardant coating; thus is effective for long periods. 3. Proven highly effective. 4. Easily mixed.
Disadvantages	1. Spoils to some extent. 2. Corrosive to galvanized metal. 3. Poor penetration; poor mop-up. 4. Cannot be gelled. 5. Slippery. 6. DAP reduces its viscosity.	1. Unsatisfactory for west U.S.-not enough material per unit area of fuel. 2. Falls off when water evaporates. 3. Corrosive without inhibitors.	1. Moderately costly. 2. Corrosive without inhibitors. 3. May spoil.	1. Moderately costly. 2. Corrosive without inhibitors. 3. May spoil.	1. Moderately costly. 2. Corrosive without inhibitors. 3. May spoil.
Ingredients	Sodium CMC	21-53-0 commercial grade fertilizer	Keltex FF (sodium alginate); DAP	Ammonium Pectate; DAP	Sodium Carboxymethylcellulose; DAP; also inhibitor, preservative, coloring when packaged.

1/ There may be minor discrepancies in this table. Check against NFPA's new publication "Chemicals for Forest Firefighting", to be released soon.

CHK 4/1/63 INTFARES

The last session of the meeting consisted of a presentation by Mr. H. Harris of the Missoula Equipment Development Centre. He pointed out that the research program is projected ahead for about six years.

Considerable work is being done in the field of cross-country transportation. Devices for individual transportation, such as large-tired tote-gotes up to large units carrying several men, are receiving some attention. Work is also being carried out on a wide variety of other equipment, including a paper sleeping bag that is thicker and offers better protection, but is still disposable.

Mr. Harris then showed a series of slides of other equipment being worked on, including:

a) improved fire escape shelters --- fire treated paper covered with aluminium foil,

b) flame resistant shirt, which will be issued in large quantities during the coming fire season,

c) turn simulator for smoke-jumper training,

d) fall simulator for smoke-jumper training,

e) improved slotted parachute,

f) sail parachute,

g) mobile lookout--- cost about $5,800, including small cupola, kitchen, bathroom etc.,

h) light trenching device similar to the Bosworth,

i) overland scooter with 6-inch tires,

j) the "Duracat", a pump and hose unit mounted on a small crawler,

k) hot air balloon to lift 400 pounds, and

l) a balloon barge, which would carry water and have hose extending from it.

In concluding the business session of the meeting, Mr. Barrows pointed out that if anyone wished future publications on forest fire research they should write to the Director, Intermountain Forest and Range Experiment Station, Ogden, Utah, and ask to be put on their mailing list.

It was decided that the next meeting of the Intermountain Forest Fire Research Council will be held in November 1963, probably in Salt Lake City, Utah.

3. Visit to the Lubrecht Forest and the Northern Forest Fire Laboratory, Missoula, Montana.

This side trip was made to familiarize myself with the work carried out by Messrs. Beaufait and Steele, and to tour the Northern Forest Fire Laboratory. Dr. Beaufait is engaged in an extensive prescribed burning research program in cooperation with the resources of Montana State University, its experimental forest, faculty and graduate students. It is proposed to combine basic research with procedural studies to increase the knowledge of fire at the management level. The ultimate goal of this research program will be to provide forest managers with guidelines on how, when, and where to burn under different fuel, weather and topographic conditions. At the same time studies concerned with what fire does to edaphic and biological components of forest sites will be carried out.

One full day was spent on the Lubreoht Forest, about 40 miles east of Missoula, inspecting and sampling prescribed burning sites. The study area has been clearcut and the slash scattered. It is situated on a 30 per cent easterly slope. Burning plots, each covering 2 to 5 acres, have been established by bulldozing fire lines around them.

I was particularly interested in the fuel sampling methods used by Dr. Beaufait. Five samples are taken at random on each plot. Each sample is one by two meters in size. The sample is marked by stakes and string, and hand tools and a power saw are used to separate the sample from the fuel bed. All sample fuels are then transferred to a canvas sheet and taken to a headquarters station for separation into size-classes and weighing. All components of the sample are oven-dried to facilitate calculation of slash weight.

This sampling procedure is part of an investigation to study the variation in the intensity and effects of prescribed burning during successive seasons on the Lubrecht Forest. Its objectives are to compare the intensity and biological effects of replicated prescribed fires during successive seasons after harvest cutting and understory laydown in the ponderosa pine-western larch type. Mr. Steele, Associate Professor, Montana State University, is a cooperator in this study.

A particularly interesting development in this study is the testing of a standardized, organic calorimeter to obtain quantitative comparisons between a wide range of prescribed fire conditions. This calorimeter is a 7-inch cube of laminated material glued together. They will be distributed on the burning sites, encased in plastic containers to maintain a predetermined moisture content. Immediately before burning the plastic container will be removed. Following the fire the blocks will be weighed to determine the loss through fire. It is expected that this will provide a quantitative indication of fire intensity, facilitating comparisons between fires under a wide range of conditions.

Another interesting device is being developed and will be tested this year. It is a firing device that produces light beams in concentrations and intensities heretofore unobtainable. This system is known as LASER (light amplification by stimulated emission of radiation). A narrow band of intense heat projected from a portable LASER unit might permit remote firing from ground-based or aerial platforms. The development of this device would be suitable for prescribed burning experiments and backfiring operations.

Many other questions must be answered before prescribed burning can be carried out with confidence and success. When can various amounts and kinds of logging slash be burned to obtain the desired results and at the same time economically control the fire? What level of fuel moisture is needed at a particular time of year in a particular fuel type to obtain the desired results? How can the key factors, such as fuel quantity, arrangement and distribution be best measured and evaluated? What is the best time to burn? How can chemicals be used to accelerate or retard a fire? What is the best sequence of firing operations? How to measure fire intensity? How to compare burns? Why is one burn successful and another one a failure? What are the thermal effects of fire on plants reproductive organs, photosynthetic organs, meristematic tissues and root systems?

This comprehensive program in which basic and applied studies complement each other will necessitate close cooperation between various phases of research. Dr. Beaufait has set priorities within the problem area and the program will be carried out as time permits.

The time spent discussing prescribed burning in general and sampling techniques in particular was most useful and enlightening.

Dr. Beaufait's philosophy and attitude toward the progress of the use of fire as a useful tool is appreciated and alone worth the time spent with him. He expressed the view that despite 50 years of prescribed burning in the West there is almost no objective basis for evaluating the relative merits andthe advantages and disadvantages of fire. No quantitative measure of slash fire intensity under a variety of fuel, weather and topographic conditions is available. Foresters and others involved in fire protection activities are still burning on empirical basis, with no objective instructions or guide lines available.

It is felt that too much repètition is done in forest fire research. Many forest administrators feel that unless the work was done within their own state or region it is of no value to them. Too much stress is placed on boundary lines that have little or no effect on research results and operational application. At best, pilot trials might be necessary to evaluate the applicability of research to a particular area. Much research done at the present time is repetition and little is achieved in the way of new approaches and methods.

Mr. Steele of Montana State University is in charge of the university students at the Lubrecht Forest. This tract of over 20,000 acres was granted to the university by forest industry to provide a field laboratory for forest research. Mr. Steele was most cooperative in describing the facilities of the Faculty of Forestry for graduate students, stressing that cooperation is maintained with the Northern Forest Fire Laboratory and other agencies. Arrangements can be made for graduate students to use the facilities of the laboratory.

On Friday morning, Dr. Beaufait conducted me on a very brief tour through the Northern Forest Fire Laboratory. I met a number of research workers as well as observing many of the facilities and equipment. The whole building is most impressive, and together with the Smokejumper Training Depot, the United States Weather Service, and the Montana State University forms a major center for forestry and related activities.

In review, the entire trip was most beneficial and successful. A number of contacts with forest fire research workers was made. Discussions with them gave me a better understanding of their problems, their work, and their attitudes. Particularly interesting was the field trip to the Lubrecht Forest with Messrs. Beaufait and Steele to discuss work they are doing in prescribed burning. A good understanding was gained about facilities for graduate work at Montana State University.

A. D. Kiil